Institute on Science for Global Policy (ISGP)

Socioeconomic Contexts of Sustainable Agriculture

Conference organized and convened by the ISGP in partnership with Western Connecticut State University, in Danbury, Connecticut, U.S.
October 14–15, 2016

ISGP Academic Partnership (IAP) with Western Connecticut State University

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United States

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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 content of this book was taken from material presented at a conference organized and convened by the Institute on Science for Global Policy (ISGP) on October 14–15, 2016, in partnership with Western Connecticut State University. This specific ISGP conference, *Socioeconomic Contexts of Sustainable Agriculture,* was part of the ISGP Academic Partnerships (IAP) program, which is based on collaborations with a variety of distinguished academic institutions. IAP conferences reflect a common commitment to significantly improve the communication of credible scientific and technological (S&T) understanding for both the public and private-sector policy communities and for the public *writ large.*

The organization of this IAP conference is based on the recognition that sustainable agriculture has become a focal point on the international stage for numerous critical issues affecting public health spanning the diverse cultural, ethical, and economic characteristics that define all societies. Societal decisions concerning how to appropriately incorporate the often-transformational scientific advances associated with sustainable agriculture into public and private sector policies rely on debates that highlight the practicably credible options developed worldwide. ISGP conferences offer rarely encountered environments in which such critical debates can occur among internationally distinguished scientists representing diverse disciplines, influential policy makers, societal stakeholders, and the public.

Current realities

At the outset of the 21st century, most societies face difficult challenges concerning how to appropriately use, or reject, the dramatic new opportunities offered by modern S&T advances. Since scientific research programs, and commercially viable technologies, are now developed globally, societal challenges 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 potential risks, are critical governmental and private sector responsibilities. The complexity of these responsibilities reflects the multitude of societal demands, most having conflicting goals. Policy decisions must balance critical commercial interests promoting economic prosperity with the cultural sensitivities that often determine if, and how, S&T is successfully integrated into any society.

ISGP Academic Partnerships (IAP)

The IAP programs recognize that communication between those with S&T expertise and those responsible for ensuring safe, secure, and prosperous societies must be effective and timely. Venues that use concise, accurate presentations of viable S&T options to policy makers while encouraging critical review are essential in identifying effective policy decisions that can be publicly supported and therefore, effectively implemented. Such venues need to promote broad public participation in assessing the advantages and potential risks of all S&T options. IAP events provide such opportunities by engaging both college- and university-level students in helping to organize and convene ISGP conferences on topics of societal importance. The ISGP has pioneered a debate/caucus format that promotes the candid exchanges of ideas and criticism among distinguished S&T professionals, policy makers in government and the private sector, societal leaders, and in some cases, the public. This debate/caucus format is the centerpiece for the pedagogical approach underlying IAP programs at each of the partner academic institutions.

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, students are offered opportunities to (i) assist the ISGP staff in interviewing S&T experts worldwide, (ii) help edit the policy position papers used for the debates, (iii) read and analyze the extensive background material available to the ISGP, (iv) participate in the formal debates alongside leading experts in the field, and (v) guide the caucuses at ISGP conferences used to identify Areas of Consensus and Actionable Next Steps.

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 their views through informed debates and caucuses focused on realistic conclusions. Collectively, the IAP experience seeks to demonstrate the

importance of rational thinking in the future formulation and implementation of public and private sector policies.

ISGP format

Extensive interviews by ISGP staff and selected IAP students are used to identify internationally recognized subject-matter experts who are invited to prepare concise (three-page) policy position papers. For the October 14–15, 2016, IAP conference at Western Connecticut State University, three authors were invited to present their views on the current realities, scientifically credible opportunities and associated risks, and policy issues concerning the *Socioeconomic Contexts of Sustainable Agriculture*. Students from the class taught at Western Connecticut State University, by Professor Theodora Pinou, with strong support from Dean Missy Alexander, were involved in these activities. Conference participants came from the communities the University serves, including research and teaching faculty and students, governmental representatives, farmers, members of the private sector and industry leaders, and the public.

The conference agenda was comprised of three 90-minute sessions, each 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. Written questions were also fielded from the public audience that observed all debates. The debates and subsequent caucuses focused on clarifying understanding among nonspecialists and identifying areas of consensus and actionable policy decisions supported by scientifically credible information.

Following the three debates, small, moderated 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.

The material presented in this book includes the three policy position papers together with the not-for-attribution summaries of the debates of each paper. The not-for-attribution summaries prepared by the ISGP staff are based on the collective notes and recordings from each debate and are presented here immediately following each policy position paper. These summaries represent ISGP's best effort 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 or her 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.

The areas of consensus and actionable next steps emerging from this IAP conference are presented immediately following this introduction under the title "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, 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 1

Given the realities of a rapidly increasing human population, changing global climates, and accelerating rates of chronic disease (e.g., diabetes, colon cancer), integrated policies are needed at all levels of government that simultaneously expand effective, sustainable food systems and encourage nutritious dietary patterns. These policies need to ensure an efficient nexus between consumer demand and farming/environmental priorities.

Actionable Next Steps

- Redirect economic development investments to support a regionalized United States food system by establishing new regional infrastructures for food production and distribution (e.g., food hubs, capacity for livestock, processing).
- Revise government regulations, policies, taxes, and incentives to effectively support the transition to sustainable production practices (e.g., integrated crop management), promote a diversity of food-system sizes, and integrate programs designed to achieve agricultural, environmental, and nutritional goals.
- Create a consortium of professional societies, nongovernmental organizations, and educational institutions focused on educating stakeholders in the advantages, and potential risks, of sustainable food production practices.
- Initiate programs to establish accurate definitions and/or effective certification procedures that promote sustainable food systems and nutritious diets and help define practical guidelines for decision-making (including advisory and mandatory standards).

Area of Consensus 2

To enhance the resilience of agricultural systems worldwide, food production must emphasize (i) more diversified cropping, both locally and regionally, (ii) modularity (i.e., increased self-reliance within a region), and (iii) preservation of

natural resources (e.g., soil, water, biodiversity), while prioritizing human, cultural, and societal imperatives.

Actionable Next Steps

- Use existing and develop new education infrastructures to encourage food system stakeholders to apply sustainable practices, including a diversity of crop and livestock production schemes, local knowledge, and the potential use of all of available tools in the modern scientific tool box (e.g., genetic engineering).
- Provide financial incentives for small-scale farmers to increase profitability in accordance with international trade agreements.
- Utilize existing agricultural and food production data (e.g., U.S. census data, biennial census data) to promote the revision of the U.S. Farm Bill that emphasizes priority for sustainable, resilient, and regionally based food systems.
- Encourage international organizations (e.g., United Nations Food and Agriculture Organization) to work collaboratively with other international organizations, national governments, and private sector stakeholders to improve distribution infrastructure (e.g., transportation and storage).

Area of Consensus 3

While profitability remains the dominant measure of the viability of a food production system, sustainable systems require that higher priority be given to the barriers posed by the large, corporate food system, the structure and operation of the global financial system, and the general lack of civic knowledge and commitment to programs supporting the long-term health of soil, water, and air.

Actionable Next Steps

- Encourage governmental agencies and departments (e.g., the U.S. Department of Agriculture) to create national standards for sustainable farming practices for farms of all sizes, including creating federal, state and local regulations that support sustainable practices while recognizing the need for farm profitability.
- Teach and actively model an integrated approach at all levels of public education to food decisions that focuses on sustainable agricultural practices, and locally/culturally appropriate nutritional guidelines.

- Monetize the multiple benefits of local agriculture (e.g., conservation value, community development, reduction in cost of community service), and the difference between the costs of community services and other land uses.

ISGP conference program

Friday October 14

09:30 – 10:15 **Registration**

10:15 – 10:30 ***Welcoming Remarks***

- **Dr. John B. Clark**, President, Western Connecticut State University (WCSU)
- **Dr. Missy Alexander,** Interim Provost and Vice President for Academic Affairs, WCSU
- **Dr. George Atkinson**, Founder and Executive Director of the Institute on Science for Global Policy

Presentations and Debates

10:30 – 12:00 **Dr. Laura Lengnick, Lead Scientist, Cultivating Resilience, LLC**
Cultivating a Sustainable and Resilient Food Future
Moderated by Dr. George Atkinson, Founder and Executive Director, ISGP

12:00 – 12:30 *Break*

12:30 – 14:00 **Dr. Cristina Tirado, Chair, International Union of Nutritional Sciences Task Force on Climate and Nutrition, and Adjunct Associate Professor, University of California, Los Angeles**
Sustainable and Healthy Food Systems: Addressing Climate Change While Promoting Health
Moderated by Dr. Sweta Chakraborty, Associate Director, ISGP

14:00 – 14:15 *Break*

14:15 – 15:45 **Mr. Henry Talmage, Director, Connecticut Farm Bureau Association**
Profitability: the Key to Sustainable Agriculture
Moderated by Ms. Daniela Baeza, ISGP

15:45 – 16:00 **Concluding Remarks and Caucus Information**

The conference resumes on Saturday morning with caucuses, which are moderated discussions to identify Areas of Consensus and Actionable Next Steps that will be published. The caucuses are open to all participants. All participants are encouraged to participate in the caucuses to obtain a cross section of views of those living in the Danbury and WCSU area.

16:00 – 17:00 *Reception*

17:00 – 19:00 "Dinner in a Bite:" feast on the fruits from the WCSU Jane Goodall Permaculture Garden, in a fundraiser to benefit the Permaculture Garden Project sponsored by the Jane Goodall Center for Excellence in Environmental Studies
(Ticket Purchase Required)

Saturday October 15

08:00 – 08:45 **Registration and Caucus Assignments**

Caucuses

09:00 – 12:30 **Focused Group Sessions**

12:30 – 14:00 *Lunch*

14:00 – 16:00 **Plenary Caucus Session**

16:00 – 16:15 **Closing Remarks**
Dr. George Atkinson

16:15 *Adjournment*

Cultivating a Sustainable and Resilient Food Future**

Laura Lengnick, Ph.D.
Lead Scientist, Cultivating Resilience, LLC, Asheville, North Carolina, U.S.

Summary

A growing awareness of the costs of industrial food in the latter half of the 20th century drove a search for solutions that emerged as the sustainable agriculture movement. Over this same time period, global movements regarding food accelerated in an increasingly specialized and concentrated global industrial food system. Current national and international policy clearly favors the continued consolidation and concentration of this system, despite widely accepted evidence that these characteristics create critical sustainability challenges, as well as new evidence that this specialization and consolidation creates barriers to the resilience of the global food system. This maladaptive path is doubly destructive: not only does it finance the continued development of the existing system, it also squanders the resources needed to finance a transition to a more sustainable global food system. Resilience science offers a novel framework and a set of concepts uniquely suited to the challenges of managing food systems under conditions of high uncertainty and dynamic change. Although research exploring food system resilience is only just beginning, initial results suggest that, compared with industrial food systems, sustainable food systems are more resilient while providing a host of other natural resources, social, and financial benefits to the communities they serve. A sustainable and resilient food future is possible through policies designed to transform the global industrial food system into a global network of food systems serving local and regional populations.

Current realities

The United States industrial food system has proven remarkably adaptable over the last 150 years, responding to a diversity of production conditions across North America to supply commodities to national and international markets. This success has been largely achieved through (i) continuous financial, natural, and social subsidies (e.g., direct and indirect payments designed to stabilize production, recover from disaster, and reduce environmental harms); (ii) public support for education, research and development that serves the agricultural industrial complex; (iii) natural resource subsides produced through the degradation of soil, water, and air

quality, biodiversity, ecosystem services; and (iv) social resource subsidies through the degradation of the health and well-being of local communities both at home and abroad.

In the latter half of the 20th century, a growing awareness of the environmental and social harms of an increasingly specialized and concentrated U.S. food system led to a search for solutions that emerged as the sustainable agriculture and food systems movement. This work focused on understanding the sustainability challenges created by the changing structure, function, and purpose of the U.S. food system during a period of intense industrialization and globalization, which began to accelerate in the 1980s. In the early years of the 21st century, awareness of the multiple benefits of local and regional food systems to community well-being increased as physicians, dieticians, public health specialists, and municipal planners explored land use, transportation, and economic development issues, and advocated for increased access to healthy, nutrient-dense foods.

Recent empirical research confirms that sustainable systems are as productive as industrial systems, are less vulnerable to global environmental change, and have a greater capacity to restore the degraded natural and social resources that are crucial to community resilience. Sustainable food systems are now widely accepted as a core component of sustainable development strategies by many regional, national, and international organizations promoting sustainable and resilient development of rural and urban areas.

Despite widespread awareness of the multiple benefits of sustainable food systems and new evidence that the global industrial system is uniquely vulnerable to climate change and other 21st century challenges, national and international agricultural policy clearly favors the continued development of a global industrial food system. This puts global society squarely on a maladaptive path by investing in a food system that cultivates unprecedented vulnerability to global environmental change and threatens the sustainability and resilience of communities throughout the world.

Scientific opportunities and challenges

Resilience involves more than just the ability to "bounce back" from a disturbance, shock, or change. Resilience also means having the capacity to make adjustments that avoid or reduce potential damages and take advantage of the opportunities created by change. Resilience is the capacity of the system *to respond* to disturbances to avoid or limit damage, *to recover swiftly* when disturbances cause damage, and to *undergo transformation* when needed to sustain the system as conditions change.

With roots in complexity and systems science, resilience science offers a novel

framework and a set of concepts uniquely suited to the challenges of managing social-ecological systems under conditions of high uncertainty. Resilience science is grounded in ecological theory and has a long history of development in natural resource management. Resilience science clarifies and extends sustainability concepts to include dynamic change and has identified a number of qualities that promote sustainability in natural and social-ecological systems: diversity, modularity, tightness of feedbacks, and high levels of all types of capital (e.g., natural, human, social, physical, and financial). These qualities enhance the capacity for self-organization, learning, and innovation, essential behaviors of resilient systems. Sustainable food systems and the communities they serve exhibit all of these qualities; industrial food systems do not.

Recently, scientists and practitioners have applied resilience theory to understand and manage so-called "wicked problems," such as climate change, poverty, and food security. A number of new analytical tools are currently under development to support the application of resilience theory to agricultural and food system design, assessment, and management including (i) a set of proposed food system design criteria; (ii) adaptive management; (iii) the application of the adaptive cycle to business and governance; and (iv) sustainability and resilience assessment based on ecological network analysis. These tools appear to be widely applicable, scale-neutral, and equally useful in education, research and development, private business, policy-making, and government program management.

Although the existing knowledge base in sustainable food systems supports resilience theory, the application of resilience science to food system design and management is novel. Until resilience concepts are validated through additional research and development, there are many legitimate concerns about the application of resilience theory in public policy and programs. Strong objections to resilience science are also expected to arise because its theories require the examination of several neoclassical economic assumptions, including the overemphasis on land and labor efficiency, myth of unlimited growth, utility of externalizing the costs of industrial harms, and disregard for the dangers of concentrated wealth and complex global networks.

Policy issues

Local and regional actions, supported by enabling policies at local, regional, national, and international levels, can put the global industrial food system on a path to a resilient food future. The recommendations below build on existing U.S. Department of Agriculture (USDA) programs and integrative initiatives, and international partnerships that engage local and regional governments, educational

and research institutions, businesses, and community-based organizations to address six significant levers of change:

- Redirect USDA credit and crop insurance programs to support farmers and ranchers using ecosystem-based, diversified production and marketing practices, especially small and midsized farms supplying local and regional markets (e.g., Farm Service Agency's [FSA] Direct Operating Loans Program, Risk Management Agency's Whole Farm Revenue Protection Program).
- Expand incentives and rewards for producers that help protect and restore ecosystem services that enhance sustainability and resilience of U.S. food systems (e.g., Natural Resources Conservation Service's Agricultural Conservation Easement, Conservation Stewardship, and Regional Conservation Partnership Programs; FSA's Conservation Loan and Conservation Reserve Programs).
- Redirect economic development investments to promote the re-regionalization of the U.S. food system (e.g., Agricultural Marketing Service's Farmers Market and Local Food Promotion and Specialty Crops Block Grant Programs; National Institute of Food and Agriculture's [NIFA] Community Food Projects Program; Rural Business Cooperative Service's Value Added Producer Grants; Rural Business Development Grants' Local Foods, Local Places Initiative).
- Redirect agricultural education, research, and extension investments to support sustainable food systems (e.g., NIFA's Sustainable Agriculture, Research and Education Program; National Center for Appropriate Technology's National Sustainable Agriculture Information Service; Know Your Farmer, Know Your Food Initiative).
- Expand nutrition assistance and education programs that support sustainable food systems (e.g., Food and Nutrition Service's Farmers' Market Nutrition, Farm to School Grant, School and Community Gardens, and Department of Defense's Fresh Programs; NIFA's Food Insecurity Nutrition Incentive Grants Program; Healthy Food Financing Initiative).
- Redirect U.S. international development investments to support collaborative development of sustainable and resilient regional food systems worldwide (e.g., Global Partnership on Nutrient Management; Feed the Future; North American Pollinator Protection Campaign; Local and Regional Food Aid Procurement; U.S. Agency for International

Development Sustainable Agriculture and Natural Resource Management Innovation Lab).

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*** A policy position paper prepared for presentation at the conference on Socioeconomic Contexts of Sustainable Agriculture Conference, convened by the Institute on Science for Global Policy (ISGP), October 14-15, 2016, at Western Connecticut State University, Danbury, Connecticut, U.S.*

Debate Summary

The following summary is based on the transcriptions of a recording made during the debate of the policy position paper prepared by Dr. Laura Lengnick (see above). Dr. Lengnick initiated the debate with a 5-minute summary of her views and then actively engaged the conference participants, including other authors, throughout the remainder of the 90-minute debate 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. Lengnick. Although this summary has been written without attribution, the conference itself was open to the public and media and as such, did not restrict participants from attributing remarks to specific individuals. The views comprising this summary do not necessarily represent the views of Dr. Lengnick, as evidenced by her policy position paper, or those of the ISGP, which does not lobby on any issue except rational thinking. 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

- Since multiple economic, societal, and environmental challenges confront the U.S. food system (e.g., concentration of large-scale farming at the expense of mid- and small-scale farms, ongoing disaster recovery costs, overproduction of low-nutrition foods that contribute to chronic disease, food insecurity in the midst of abundant production, degradation of natural resources), it is imperative to determine whether current agricultural polices encourage an economically unsustainable system. Policymakers needs to conduct an unbiased, broad-ranging assessment of agricultural policy goals and outcomes, looking beyond archaic default assumptions and approaches to craft policies that support system resilience and sustainability.
- Given that sustainable U.S. agricultural practices are already underway for small-, mid- and large-scale operations, policies must not favor the profitability of industrial agriculture by constraining farmers' actions and subsidizing risk over resilience. Policymakers from the federal to the local level need to (i) eliminate barriers to resilient, sustainable agriculture, (ii) realign priorities for subsidies, and (iii) create new revenue streams (i.e., enabling policies) that support local adaptation and ensure that the burden of the transition does not fall hardest on farmers.
- Although the science of resilience theory, and its application in some fields (e.g., ecology, economics), are well established, its application to agriculture has not been widely studied causing its use by practitioners of sustainable and resilient agriculture to lag. The profound changes underway in agriculture demand that researchers learn the long-term consequences of implementing resilience models with respect to supporting the ongoing changes in sustainable farming.
- The characterization of modern agriculture as a problem to be solved (e.g., suffering from climate change, food insecurity) overlooks its potential as a source of major solutions to global issues (e.g., mitigating climate change, improving food distribution, enhancing nutrition). The World Bank designation of sustainable agriculture as the primary way to feed the world's population has motivated farmers worldwide to demand

polices that support resilient agricultural practices at all levels (i.e., global, national, regional, local).

Current realities

The U.S. food system currently is confronted by serious challenges that threaten its economic, ecological, and social resilience. This can be attributed to U.S. agriculture policies established in the 1950s with an industrial focus that promote a heavy reliance on technology, thereby enabling profitability primarily in the largest agricultural producers, imposing on society the costs of environmental degradation, accelerating climate change, and the spread of chronic diseases. Resiliency challenges affecting U.S. agriculture include (i) geographic concentration of production, (ii) dependence on imports, (iii) specialization of production, (iv) concentration of production, processing, and marketing, (v) degradation of natural, human, and social assets, and (vi) overemphasis on labor/land efficiency, technological solutions, and investment in recovery.

Given evidence that current federal policies do not improve food-system resiliency (e.g., $14 billion in drought insurance payments in 2012), there were questions as to why the system continues to be maintained. U.S. food system policy was described as being caught in a "lock-in trap" in which inefficient or undesirable systems continue to be supported as the default approach. Despite the promise of longer-term gains, this trap keeps the system from naturally changing, primarily due to the considerable resources spent in the system's creation and longevity protection. In the case of industrial agriculture, policies constrain farmers' actions, subsidize risk, promote concentration and consolidation, and ignore the social and ecological harms of industrial agriculture (e.g., overproduction of foods low in nutritional value, simultaneous over-abundance and extreme shortage of food around the globe, air/water contamination). Under the current system, the majority of profits go to the middleman (e.g., food processors, retailers) while the number of small and very large farms is growing and the number of mid-size farms is decreasing. However, even as the effects of industrial food policies become clearer, the lock-in trap prevents rational analysis of policy strategies.

While resilience theory may provide a practical alternative to the current agricultural system, it has not been widely applied to agriculture, despite being well developed in other fields (e.g., ecology, economics). In a resilient agricultural framework, the focus of the food system is shifted from producing profit to producing community assets (e.g., every country produces its own food and has low imports and exports, the community develops a balanced portfolio of community assets). Resilient practices span a continuum that extends from protecting the existing

system, to adapting the existing system, to completely changing (i.e., transforming) the system's structure, form, and function. Application of resilience theory centers on knowing when to intervene as the system naturally changes to ensure the release of assets is most efficient and effective. Challenges to this notion include the potential for total systems collapse during the asset release phase. People, however, are able to preserve and progress without completely destroying existing structures unlike in other theories (e.g., "lazy 8" model of ecological resilience).

Resilience models address the inequitable distribution of food by regenerating social assets (i.e., capital, equity, people, social pathways) that are an integral part of the system itself. This is already happening in the rise of urban gardens that put food production near food-insecure populations, a strategy that increases the availability of nutrients without the need to grow high volumes of food. These projects are not necessarily difficult to implement, but often are not supported by policies that recognize them as community benefits.

The rise of the sustainable agriculture movement shows that it is possible to shift the agricultural system away from a focus on large yields of low-nutrition food without regard to environmental costs (e.g., sustainable farmers, including large-scale farmers, already are effectively dealing with insects, plant disease, and weeds using nonchemical management practices). Given the World Bank report that sustainable agriculture has been designated the only kind of system that can feed the world, resilience theory can provide a helpful framework for sustainable agriculture by providing tools for dealing with dynamic change, and by clarifying the practical dimensions of sustainability.

While food systems that are sustainable and resilient automatically can lead to more diverse and nutritious foods being available (e.g., due to eating seasonally), human nature makes it likely there always will be foods in the system that serve mainly as entertainment and to strengthen familial and community bonds (e.g., red wine, chocolate, coffee).

Scientific opportunities and challenges

Although farmers are pushing for resilience policies in parts of the global food industry, land grant universities (i.e., agricultural research and education) are lagging behind this trend and need to do more to identify, acknowledge, and support sustainable and resilient systems. While technology has been the main tool for addressing challenges in the past, resilience requires assessing solutions from all asset classes (e.g., soil quality, market diversity) in efforts to adopt and use best practices. If American agriculture continues on its present course of focusing on

technological solutions and fending off change, it is predicted that it will fail, but only after consuming billions of dollars.

To evolve from 20th to 21st century thinking, agricultural science needs to shift its focus from (i) seeking optimum to finding variable conditions, (ii) moving from national best practices to local "learn as you go" practices, (iii) relying on imported to adopting place-based resources, (iv) supporting extractive rather than regenerative economies, (v) finding efficient as opposed to redundant systems, and (vi) prioritizing profit versus producing community assets.

Although agriculture is now viewed primarily as a problem through various lenses (e.g., climate change, social issues), the resilience framework can help to reframe agriculture as part of solutions. For example, international negotiations have largely ignored the potential for sustainable agriculture (if practiced globally) to mitigate climate change through sequestration of global carbon emissions, a process that also enhances soil quality. Similarly, food insecurity in less-affluent countries is being addressed in some areas by food systems oriented around major metropolitan areas, in which the outlying areas provide food for the city and the city ensures quality of life for the farmers.

Although sustainable agriculture can improve food security by more widely distributing food production, it has been found that sustainable practices decrease yields in poor countries by about 10% compared with industrial techniques. However, in areas where resources are severely degraded, sustainable practices increase production by up to 50%. Unlike sustainable agriculture, resilience theory does not reject any tool from its toolbox, including genetically modified organisms (GMOs). Although GMOs were developed with the goal of improving sustainability, resilient agriculture neither relies upon GMOs nor rejects their usage in appropriate situations (e.g., breeding long-lived crops such as apple trees). To learn from and build on such developments, the application of resiliency theory in agriculture needs more study.

Policy issues

Given that sustainable and resilient agriculture is already occurring, policymakers need to acknowledge that previous American values directed at feeding the world must give way to a new set of goals that better serve both domestic and global interests. Just as 1950s policy radically changed U.S. agriculture by intentionally promoting a system that was industrial rather than natural, so too can modern policy be used to promote resilient agriculture.

Policymakers must take a holistic view of the agriculture system to determine whether it is meeting its established goals, whether those goals are still relevant,

and how the system can adapt and improve. While it is important to engage local communities in devising solutions that fit their unique characteristics, policies must ensure that the burden of change rests on society *writ large* and not primarily on farmers, whose earnings have decreased by 30% in the last 3 years and whose role in the system is increasingly fragile.

Despite the general impression at the policy level that American agriculture achieves its high levels of production due to large-scale subsidies and widespread use of fertilizers, pesticides, insecticides, and GMOs, a number of elected representatives are scrutinizing subsidies, including those from large farming states. There is a call for shifting subsidies in several ways, including (i) increasing the profit shares of farmers using the industrial food system, (ii) increasing funds for U.S. Department of Agriculture research into diversified farms, and (iii) performing a resilience assessment of policies to determine which are creating the biggest barriers. To help fund the transition, enabling policies that support local change also have been proposed (e.g., a carbon emission fee could be used to generate funds that stimulate local innovation to adapt to climate change).

A significant concern is that as the system becomes more resilient, there will be a large release of assets and people will be left behind. However, the negative effects of resilience can be mitigated by relationships between communities (i.e., small towns, big metropolitan areas) that supply each other with support and new ideas when systems fail. Although the public education system currently largely upholds the industrial agricultural approach, it could prove to be a strong community asset in facilitating changes in the shift of systems towards a more resilient future.

Sustainable and Healthy Food Systems: Addressing Climate Change While Promoting Health**

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Summary

Promoting good nutrition and health and delivering sustainable food systems in a context of growing populations, dietary transition and a changing climate is a central challenge of our time. Sustainable food systems and dietary patterns can contribute to both a reduction of emissions and improved public health and nutritional outcomes. These critical issues need to be considered in the climate mechanisms and negotiations and in the Sustainable Development Goal's (SDGs) agenda.

Current realities

More than half of the world's 7 billion people are affected by malnutrition in all its forms. While millions people suffer from under-nutrition, many high and middle-income countries are facing an epidemic of obesity. Despite the abundance of food supplies, the current food system leaves 795 million people hungry, 2 billion people micronutrient deficient and more than 600 million people obese. Climate change has a negative impact on food and nutrition security and the health of millions of vulnerable people, particularly poor women and children. According to the Intergovernmental Panel of Climate Change (IPCC), it is estimated that an additional 1 billion to 3 billion people will be affected by water scarcity and 200 million to 600 million will suffer from hunger by 2080, particularly in sub-Sahara African countries. Although safeguarding food production is part of the ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC), yet food security and nutrition considerations are weak or absent within the work of the UNFCCC. The global food system will be further challenged over the coming decades with increases in the human population, changes in diet, climate change, and greater demands on energy and water resources. High food output achieved in the past has placed great stress on natural resources. The agriculture sector

specifically is a major source of greenhouse gas (GHG) emissions. Agriculture, forestry, and associated land use and land use change contribute to 20% to 30% of the total anthropogenic GHG emissions. The expansion of livestock and biofuel sectors plays a major role in deforestation and land degradation contributing to climate change. Other GHG emissions stem from fossil fuel use in the field, as well as from across the whole food system continuum, such as food transport, storage, cold chains, processing, and food loss and waste. Globally about one-third of food produced for human consumption per year is lost or wasted. Global diets link environmental sustainability and human health. The production of certain kinds of animal protein, particularly beef, is significantly more greenhouse gas-intensive per unit than poultry production or cultivation of plant-based protein sources (pulses) and, thus contributes more to climate change. Changes in dietary patterns toward more production and consumption of meat and animal products present a set of complex challenges for climate change mitigation, for health, for agriculture, and for achieving food and nutrition security. At the same time, overconsumption of meat and animal products is associated with an increased risk of non-communicable diseases (NCDs) such as heart disease, type 2 diabetes, and certain types of cancer.

Scientific opportunities and challenges

The fundamental challenge today is to sustainably improve nutrition through implementation of coherent policies and better, coordinated actions across all relevant sectors, strengthening and preserving healthy and sustainable food systems. The Rome Declaration on Nutrition, adopted by Member States at the Food and Agriculture Organization (FAO)/World Health Organization (WHO) Second International Conference on Nutrition (ICN2) recognizes the need to address the impacts of climate change and other environmental factors on food security and nutrition, in particular on the quantity, quality, and diversity of food produced, taking appropriate action to tackle negative effects. The ICN2 Framework for Action provides policy options and actions for sustainable food systems promoting healthy diets. These include the integration of nutrition objectives into food and agriculture policies and programming to ensure food security and enable healthy diets and enhance the resilience of the food supply in crisis-prone areas, including areas affected by climate change.

The UN General Assembly has adopted a resolution proclaiming a UN Decade of Action on Nutrition from 2016 to 2025. The resolution aims to trigger intensified action to end hunger and eradicate malnutrition worldwide, and ensure universal access to healthier and more sustainable diets — for all people, whoever they are and wherever they live. The Decade offers a time-bound window for joint action

on human and planetary health through translation and implementation into national policies and integration in climate actions. One of the action pillars of the Decade of Action on Nutrition is therefore built around food systems for healthy and sustainable diets and can bring co-benefits to environment and health. Indeed, there are many co-benefits to the environment, biodiversity, and health of sustainable and healthy food systems and diets, including nutrition-sensitive climate change adaptation and mitigation that need to be explored within the context of the climate agenda and the 2030 Agenda for Sustainable Development. Many of the SDGs relate to food security and nutrition, covering poverty, health, gender equality, education, water and sanitation, responsible production and consumption, and climate change among others. Sustainable Development Goal 2 (SDG2) commits to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture," whereas SDG12 requests to ensure sustainable consumption and production patterns, and SDG13 urges them to take urgent action to combat climate change and its impacts. The delivery of the SDGs 2030 agenda requires a reshaping of the global food system.

Policy issues

Key messages and action points to integrating sustainable food systems and healthy diets in the climate and SDGs agendas include:

Sustainable and healthy dietary patterns contribute to the reduction of climate emissions and improved public health and nutritional outcomes. To foster healthy and sustainable food systems and eating patterns worldwide, it is necessary to reshape food production and consumption towards contraction and convergence. The Second WHO Global Climate Change and Health Conference recommended enhancing sustainable, lower carbon, and health promoting food systems. This can be achieved by enhanced multistakeholder dialogue and integrated policy development that promote diversified, sustainable, and healthy diet, which contribute to climate mitigation, adaptation, and biodiversity conservation. These dialogues and policies also must include the adoption of WHO guidelines on healthy diets and the consideration of sustainability criteria in dietary guidelines. Understanding the social and economic dimensions of sustainable diets and developing effective strategies to encourage them in a developing country context is critical.

Leadership and engagement in nutrition-sensitive climate actions to support sustainable and healthy food systems and diets is needed. Nutrition-sensitive climate adaptation and mitigation actions, nutrition-smart investments in sustainable agriculture, social protection, education, and community-based disaster risk reduction can contribute

to promoting nutrition under a changing climate. In this context, the nutrition community must engage in multisectoral decision-making processes for climate adaptation, mitigation, and sustainable development initiatives that support, among others, sustainable and healthy food systems and diets. This includes contributing to national processes related to climate action, such as the National (Climate) Adaptation Plans, Nationally Determined Contributions (NDC) to the UNFCCC, Nationally Appropriate Mitigation Actions (NAMAs) and the SDGs.

Sustainable and health promoting food systems and diets require coherent public policies from production to consumption across relevant sectors. Since food systems have become increasingly complex and strongly influence people's ability to consume healthy diets, coherent action and innovative food system solutions are needed to ensure access to sustainable, balanced and healthy diets for all. Policy coherence needs to be ensured through institutional and cross-sectoral collaboration and good governance. Agreement on shared principles of sustainability in promoting healthy diets is needed.

Scale up financing investments to ensure support for nutrition and climate action. This includes strengthening evidence, integration into national policy, outreach and community engagement to ensure that the promotion of nutrition and sustainable and healthy food systems and diets are recognized as a priority for climate financing. In this context, the nutrition community needs to build its capacity to provide evidence and engage in policy development on nutrition-sensitive climate change mitigation and adaptation, as well as climate-informed nutrition programming and services. The most vulnerable countries require support in developing strategies and facilitating access to climate change finances to promote nutrition, health, and sustainable food systems. There is a need to improve effectiveness, monitoring, and accountability of investments in protecting nutrition from climate risks, and in developing sustainable food systems that promote health and emphasize low carbon and that are aligned with monitoring progress towards the SDGs and with commitments under the UNFCCC and the World Health Assembly (WHA).

The sustainable development goals provide crucial framework for joint action to nourish the world sustainably by 2030. Governments, business and civil society have major opportunities to collaborate to implement international targets that support a transition to more sustainable food systems, coordinating action across government ministries and the supply chain. Shifts to sustainable diets can contribute to climate stabilization, and can reduce deforestation, water stress, and biodiversity loss, while counteracting non-communicable diseases and improving public health. Reductions in meat consumption, in particular, relieve land pressure enabling the production

of additional food for a growing population, a key enabling condition for food and nutrition security. Coherent policies implemented through collaborative action among the food sector, local authorities and civil society, can help transform food systems, alongside sustainable agricultural practices and food waste reduction, to substantially reduce impacts on climate change, while underwriting better outcomes in nutrition and health.

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** ***A policy position paper prepared for presentation at the conference on Socioeconomic Contexts of Sustainable Agriculture Conference, convened by the Institute on Science for Global Policy (ISGP), October 14-15, 2016, at Western Connecticut State University, Danbury, Connecticut, U.S.***

Debate Summary

The following summary is based on the transcriptions of a recording made during the debate of the policy position paper prepared by Dr. Cristina Tirado-von der Pahlen (see above). Dr. Tirado initiated the debate with a 5-minute summary of her views and then actively engaged the conference participants, including other authors, throughout the remainder of the 90-minute debate 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. Tirado. Although this summary has been written without attribution, the conference itself was open to the public and media and as such, did not restrict participants from attributing remarks to specific individuals. The views comprising this summary do not necessarily represent the views of Dr. Tirado, as evidenced by her policy position paper, or those of the ISGP, which does not lobby on any issue except rational thinking. 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 sustainable nutrition offers an effective means of producing sufficient quantities of healthy foods without degrading the environment, sustainability must be explicitly incorporated into official dietary recommendations (e.g., Brazil), agricultural policies (e.g., supporting subsidies for conservation practices), and international food standards (e.g., Codex Alimentarius regulations).
- Despite dietary guidelines that recommend reducing meat consumption and increasing fish consumption, ecological and behavioral barriers (e.g., collapse of wild fish colonies, fish farm contamination, consumer preference for meat as a status symbol) still require governments to provide incentives to encourage dietary and agricultural change (e.g., fast- food taxes, subsidies for conservation practices, regulations on water usage and carbon footprint in food production), Recognition of consumer backlash stemming from a perception of threatened personal choice demands programs using sociobehavioral expertise establish widespread societal acceptance of such policy changes.
- Although genetically modified organisms can effectively support sustainable nutrition efforts (e.g., by lowering water usage, or causing fish to grow bigger and faster), they may carry risks with potentially large consequences (e.g., the possibility of transgenic fish escaping and threatening biodiversity in the wild despite built-in fail-safe mechanisms). Thus, such advanced technologically innovative programs must not completely replace alternative sustainability methods (e.g., sustainable fish farming) for which governmental support is required.
- Since value judgements play a powerful role in changing behavior (e.g., the millennial generation's preference for vegan/vegetarian diets as compared to previous generations), it is imperative that scientific, medical, governmental, and educational organizations clarify sustainable nutrition values for the public, and design effective educational campaigns that support those values (e.g., school gardens, doctor-patient consultations, corporate marketing campaigns).
- Given the realities of a rapidly growing global population, changing climate, limited natural resources, and uneven geographical distribution

of food and wealth, it is essential that multidisciplinary, multilateral collaboration identify strategies to optimize global populations if sustainability is to be achieved.

Current realities

In the United States greenhouse gas emissions and the amount of land needed to feed its population are twice the world average, and are significant contributors to global climate change and environmental destruction. Further, Americans are accused of individually wasting approximately 209 to 254 pounds of edible food each year, even as 17.2 million U.S. households are food insecure. Although U.S. life expectancy is higher than other countries, the high-sugar, high-fat, low-fiber American diet is implicated in the rise of diet-associated diseases (e.g., colon cancer, diabetes), and contains an average of 32 grams more protein per day than the U.S. Department of Agriculture (USDA) daily requirement.

Despite current U.S. dietary guidelines recommendations to decrease meat intake and increase seafood and vegetable consumption, inherent ecological and sociobehavioral complications make this difficult to enact. For example, although three servings of fish per week are evidenced to provide cardiovascular protection, the collapse of wild fish populations (e.g., cod, salmon), and the ecological contamination caused by large-scale fish farming practices hamper increasing fish consumption. Further, as incomes rise in developing countries, so does meat consumption, which is often viewed as a sign of status and identity. While there are examples that give hope for the future of sustainable nutrition (e.g., China has vowed to cut meat consumption by 50% to cut CO2 emissions; Brazil has included sustainability criteria in their dietary guidelines), U.S. policies currently support the status quo.

Although sociologists point out that diet choices often are dictated by the corporate food industry, explicit personal values also are an essential element in creating sustainable diets. Sustainable values are becoming more prevalent among the younger generation, which is trending toward vegetarianism and veganism as it recognizes the environmental challenges facing the planet.

Yet as concerns mount about feeding a rising global population in the face of changing climates, disagreement surrounds the role to be played by genetically modified organisms (GMOs) in improving nutrition and mitigating climate change. While some argue GMO foods can be utilized to provide lower-cost, more-nutritious, less-environmentally destructive sources of protein (e.g., genetically modified salmon, which grow faster than wild salmon and which contain essential oils not found in other fish, can be grown in tanks on land, minimizing the risk of

escape into the wild, and protecting the environment through sustainable practices), others counter that (i) not enough is known about the impact on human health of releasing GMOs into the environment, (ii) the risk of escape of transgenic animals threatens biodiversity and has already occurred in some places (e.g., transgenic fish have been found in lakes and the Gulf of Mexico), and (iii) it is possible to achieve the same nutritional and ecological benefits either by mimicking natural systems (e.g., circulating systems are being used to sustainably farm fish in Mississippi and Florida) or through biofortication (e.g., rather than salmon, give pregnant women a pill containing essential oils found in algae).

While the issue of population control is beginning to be raised by international bodies such as the Intergovernmental Panel on Climate Change, it remains very controversial and difficult to frame in a way that doesn't provoke public anger.

Scientific opportunities and challenges

Despite the links between sustainable agriculture, nutrition, and climate change mitigation, there remains the overriding challenge of convincing the public *writ large* to change its diet, (i.e., who should do it and how?). Around the world, the main drivers of dietary choices are science-based dietary guidelines (e.g., USDA guidelines), but U.S. guidelines are criticized for being too cautious and conservative in their recommendations, and for not including sustainability goals. Given the certainty of widespread public resistance to being told what to eat, especially in the U.S., scientists are challenged to both identify and implement effective marketing strategies (e.g., utilizing corporate marketing techniques), and to improve the effectiveness of the medical community in educating and encouraging patients to make dietary changes. Due to contradictory recommendations by the medical establishment (e.g., conflicting views on the health effects of eggs, butter, coffee), and the perception of collusion between doctors and the pharmaceutical industry, medical credibility has suffered among consumers and needs to be improved for doctors to be effective change agents.

To sustainably increase fish consumption, natural and non-contaminating systems (e.g., sustainable shrimp farms on the Gulf coast) need to be further studied and scaled.

A glaring scientific challenge is the lack of agreement about the appropriate use of GMOs in improving nutrition and addressing climate change. While a large number of scientists promote GMOs as a tool for bolstering food security and sustainability (e.g., lower water usage), others discourage their use as potentially risky to the environment and unnecessary when natural methods can be just as effective. Additional studies may help to alleviate concerns about the impact of

GMOs on human health (e.g., allergies) and of releasing GMOs into the environment. Regardless, the public must be better educated about what is known about the pros and cons of GMOs.

As natural resources dwindle and the global population grows, there is a need for scientists and policy makers to recognize and openly discuss population as a factor in sustainability.

Since alternative sources of protein will be needed if meat consumption is to be reduced, the nutritional value of entomophagy (insect protein) needs to be further examined. While crickets, termites, and worms play important nutritional roles in some parts of the world, they currently are unlikely to be widely consumed in the Western diet, and using powdered entomophagy as a large-scale nutritional supplement remains challenging without more information about consumer behavior and safety. Synthetic meats are currently in development and could play some role in reducing meat consumption, although they are an impractical solution in less-affluent nations and societies, and particularly those where livelihoods, services and societal balance depends on livestock.

Policy issues

A combination of strategies is needed to expand sustainable agriculture and improve nutrition, and governments need to assume a leadership role through the effective use of incentives and disincentives, and by explicitly recognizing the value of sustainable nutrition within official dietary recommendations. However, given that some foods (i.e., meat) are associated not only with climate change and nutrition, but with identity and status, it is important that governments not overstep their bounds and threaten personal dietary choice, which could heighten issues of inequality and cause a backlash.

As was done to reduce smoking, public policies are needed that influence consumer and corporate behavior toward more sustainable nutrition (e.g., education campaigns, levying taxes on meat and sugar, creating subsidies for healthy foods). Taxing fast food and thereby reducing hamburger consumption could affect the size of livestock operations in the U.S., lowering greenhouse gas emissions. Including environmental and social costs into the price of beef could lower meat consumption, as could federal incentives to retailers and meat producers. Instituting subsidies for conservation (e.g., intensification practices that protect ecosystems) could help change how food is produced in the U.S. Rationing access to high-sugar and high-fat foods could help change eating habits, although gaining public acceptance of such a policy would prove challenging and would require the collaboration of sociobehavioral experts. As a wealthy nation that over-produces and wastes food,

the U.S. needs to consider whether it should abolish its current food production subsidies.

The Codex Alimentarius Commission, an international organization that sets international food standards, is proposing that standards begin to account for a food's carbon dioxide footprint and water index (i.e., the amount of water needed to produce the product). Some individuals go even further in searching for an action step with broad positive consequences for sustainable nutrition, suggesting that governments leverage control over agricultural water based on the crop being grown.

The emerging trend of explicitly incorporating values (e.g., sustainability) in governmental dietary recommendations needs to continue, and — in tandem with policies that encourage behavior change — needs to begin to define those values and how they differ from the status quo. While parents may have a hard time getting their children to eat their vegetables, it has been shown that students place greater value on sustainable and nutritious diets when their schools provide them the opportunity to grow their own food and eat it or sell it, and when they are praised in school for healthy behaviors. Schools also can play a key role in preventing sugar addiction by not exposing children to added sugars at school.

In seeking to improve food security, protect the environment, and ensure proper nutrition, governments and organizations (e.g., Food and Agriculture Organization) must continue the promising and empowering trend of sharing technology and knowledge with less-affluent nations, rather than simply providing more food.

Profitability: The Key to Sustainable Agriculture**

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Summary

There has been significant interest in recent years in sustainable agriculture as an alternative to what many perceive to be an undesirable system of large-scale global agriculture. Locally grown food systems have been touted as desirable alternatives and have been embraced by communities across the United States. Many new and established farmers have committed to provide more local and sustainable farm products. Despite this apparent interest on the part of consumers, policy makers, farmers, and others, there has yet to be significant progress toward shifting food production to more sustainable and local systems. The barrier for success seems to center on a lack of profitably in sustainable and local agriculture as it is currently practiced. If significant progress is to be made, there must be better understanding of the barriers to profitability, including the effects of scale of operations and local and regional costs (e.g., labor, land costs, transportation, energy, taxes). For sustainable and local agriculture to succeed on a large scale, policy and implementation strategies that address these barriers and allow for meaningful improvement of the business environment must be adopted by state and local policy makers.

Current realities

In many ways, the concept of developing alternative sustainable and local food production is no longer a new idea. For decades now there have been ongoing discussions around these topics and today even more consumers, stakeholders, and policy makers are engaged. Most of the focus to date has been around sustainable production techniques and practices. These are complicated issues; and even the definitions of 'sustainable' and 'local' have sparked debate — adding many opinions, but even more ambiguity, regarding consensus on the definitions of these terms.

Some focus has been placed on the apparent increase in consumer demand for sustainable and local farm products. Researchers from the University of Connecticut and others have conducted consumer studies that attempt to understand consumer preferences and behaviors around local and sustainable foods. However, very little effort has been made by advocates and policy makers to really understand consumer

demand and, most importantly, design programs and policies that reflect their preferences. In fact the conversation around consumer demand is often described as "consumers want safe, healthy, sustainably grown local food and they are willing to pay a premium for it." That assertion has become the justification to charge ahead on programs and policy initiatives without much critical analysis.

In addition, there has been precious little attention paid to how the current food system works and how sustainable and local agriculture must be positioned to participate within that system. Instead, sustainable and local foods have been positioned by many as "alternatives" to the global food system, requiring the creation or re-creation of parallel marketing and distribution channels outside of the current system, which will likely carry steep costs that must be borne by industry or through regional or state public investment.

Little emphasis has been placed on understanding the realities of the cost of production of sustainable and local agriculture, especially in the Northeast. Again, it is common to hear simplistic statements like "it's crazy that our food travels 1,500 miles to get to us when we can grow food sustainably right here." There is a need to establish marketing, aggregation, and distribution infrastructure strategies that facilitate getting local and sustainable foods to consumers where they purchase food in significant quantities, primarily grocery stores.

The effects of having (i) a limited growing season, (ii) fragmented, expensive farmland, and (iii) high energy costs are all major factors that must be overcome to achieve success. Although there are an increasing number of farms participating in sustainable and local food production, the aggregate amount of food produced and sold by those farms has been disappointing. The reason seems to be that the economic performances of sustainable and local farms are constraining production growth. Most small farmers trying to engage in sustainable and local food production simply do not have the economic returns from their operations to increase production substantially. The issues listed above must be recognized, studied, and addressed by both the public and private sectors with the goal of improving profitability. Without such actions, the sustainable and local food movement will likely remain at demonstration level and not much more.

Scientific opportunities and challenges

The largest opportunity to advance the sustainable and local food systems is to examine and challenge the assumptions that have been the basis of the sustainable and local food movement for the past few decades. We need to collectively answer the following question: "If this is such a great idea, and if everyone wants sustainable and local food, why hasn't it happened yet?"

The desire to see more sustainable and local food production is an emotional issue to many filled with passion. That passion is perhaps the best reason to be optimistic. However, as we are witnessing in our experience, passion alone will not result in the desired outcomes. There is no question that many consumers are more interested in where their food comes from and how it is produced. Consumer research suggests that if local and sustainable foods can be offered at or very near market prices, food retailers and consumers will respond with substantial demand. That interest can present an opportunity for local farmers to connect with consumers and boost profits beyond what would be realized by simply producing an agricultural commodity.

A full understanding of scale of production must be considered in sustainable and local food systems. In many ways the new global food system is a result of increased scale of production by farms around the world and their ability to drive the per-unit cost of food down and supply large quantities though centralized distribution systems. Although larger-scale operations can sometimes benefit from automation, production labor availability and cost is perhaps the largest single challenge to sustainable and local agriculture. Very little attention has been paid to this factor and without strategies to address production labor, the prospects of success for sustainable and local agriculture are very limited.

Policy issues

Conduct detailed market studies to determine consumer demand for sustainable and local food.

- To allow for the marketplace to assign appropriate value to local and sustainable agriculture, the U.S. Department of Agriculture (USDA) along with lawmakers, farmers, distributors, retailers, and other food system stakeholders must develop consensus definitions for local and sustainable agriculture similar to the process that was developed for *USDA Certified Organic*.
- The USDA and State Departments of Agriculture must fund global, national, and local marketing studies utilizing product placement expertise from professional marketing firms to determine specific market position goals for sustainable and local foods.
- Studies must evaluate the opportunity of low-volume/high-margin specialty products versus high-volume/low-margin commodity products and evaluate where sustainable and local foods best fits in that continuum.

- Specific production/marketing opportunities must be developed based on identified regional and local consumer demand profiles.

Conduct a critical analysis of the limiting factors for growth of sustainable and local food production.

- Land grant universities must lead the effort to research the state-specific limiting infrastructure factors for sustainable and local food production with a full evaluation of existing regional and local food systems. Realistic opportunities for integration of sustainable and local food into existing large-scale food systems need to be evaluated.
- Evaluation of regional and state-specific cost-of-production factors must be included for taxes, land access, energy, transportation, aggregation, distribution, and the general business climate.
- Special consideration must be given to labor-related issues facing local and sustainable agriculture. Cost and availability of seasonal production labor as well as other support labor for aggregation, marketing, transportation, and light processing is critical to the success of local food systems. Local, state and federal officials must be willing to embrace strategies for developing more local agricultural workers or encourage the recruitment and housing of temporary workers to carry out the relatively high labor needs of local and sustainable food production.

Evaluate the impact of scale of operations and how it relates to production of sustainable and local food.

- State Departments of Agriculture and State Departments of Economic Development must initiate studies to determine the type and scale of operations most likely to succeed in appreciably increasing sustainable and local food production.

Focus on profitability.

- Food system advocates, farmers, consumers, and public officials must develop priorities and limited expectations as to what sustainable and local food systems are realistically capable of achieving.
- Agricultural lenders, farm organizations, and land grant universities need to increase efforts to provide industry benchmark data and business plan creation that focus on growth strategies that will prioritize significant sustainable and local food production. These benchmarks need to be

used to identify ways to increase efficiency to lower costs of production for sustainable and local food production through scale and automation.

Target finite public resources to entities that have the best chance of success.

- Federal and state grant programs and support services must be prioritized to focus on the type of operations that will have the best chance to produce significant, long-term business success while producing significant volume of sustainable and local food.

In addition to the science of sustainable farming cultural practices, social sciences need to be increasingly engaged in the socioeconomic issues surrounding sustainable and local agriculture to fully explore the possibilities of a robust and sustainable model of agriculture. Local, state and regional policy makers must evaluate the ancillary benefits of local and sustainable agriculture to the local economy, food security, open space and other environmental benefits as well as rural character and quality of life. Evaluation of investment in local and sustainable agricultural systems must take into account all benefits.

*** A policy position paper prepared for presentation at the conference on Socioeconomic Contexts of Sustainable Agriculture Conference, convened by the Institute on Science for Global Policy (ISGP), October 14-15, 2016, at Western Connecticut State University, Danbury, Connecticut, U.S.*

Debate Summary

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an overview of the areas of agreement and disagreement that emerged from all those participating in the critical debate.

Debate conclusions

- Given the relatively small amount of locally produced food consumed by Connecticut residents, and the inability of most of Connecticut's 6,000 farms to be self-sustaining, it is imperative that residents and state policymakers have a clear set of priorities with respect to the future of sustainable, local agriculture. Considering the realities of the marketplace (i.e., price is the primary factor driving sales), and the ancillary value to the state of maintaining sustainable, local farming, policymakers must decide (i) whether increasing local food production is a priority and if so, (ii) do small farmers need to be subsidized to profitably increase local food production?
- If Connecticut's priority is to increase local food production, significant changes are needed to enable farmers to control their per-unit costs and become commercially competitive with global industrial agriculture. These changes encompass (i) farming practices and technology (e.g., greenhouse growing, automation, other intensification strategies), (ii) public support (e.g., targeted subsidies, certification programs), and (iii) consumer behavior (e.g., education programs aimed at increasing the number of people who will pay a premium for locally and sustainably produced food).
- Beyond improving the profitability of local food producers, policies need to preserve and expand the ancillary benefits that farms provide to the state (e.g., tourism, ecological services, person-to-person education, opportunities for second careers, preserving agricultural lifestyes). High-value specialty crops (e.g., medical marijuana) need to be explored as alternatives to food production.
- Given that subsidies have the potential to sustain local food production despite the lack of profitability (e.g., Connecticut's successful dairy support program), it is imperative that farmers and their advocates effectively define and communicate the value of "sustainable" and "local" to consumers, private industry, and legislators.

Current realities

While Connecticut has a long history of farming and the number of farms in the

state has increased by more than 1,000 over the past decade, farm gate sales (i.e., sales of farm products on or near where they are produced) have decreased during the same time period. Only 2.5% of food eaten in Connecticut is grown there, and more than half of that amount is dairy products and eggs. Of the 6,000 Connecticut farms counted by the United States Department of Agriculture (i.e., farms selling at least $1,000 worth of produce per year) 22 farms account for 46% of all sales in the state. More than half the state's agriculture industry produces inedible products (e.g., ornamental plants, tobacco), a statistic that holds true for agriculture in other areas near large population centers as well (e.g., in Illinois around Chicago). Given these statistics, if every farm in Connecticut went out of business, there would be no shortage of food in the state.

Given that 56% of Connecticut farms gross less than $1,500 in produce a year, the vast majority of farmers — by design or inability to scale production — are not able to depend solely on agriculture for their livelihoods. Scale of production is essential to agricultural profitability, and collectively, small farms' production is negligible compared with large farms. Although consumers may believe that farms with sales of $500,000 a year are doing fine, the reality is that such farmers net only about $40,000 after all costs have been counted, and many farms have turned to agrotourism (e.g., hay rides, pick-your-own) to add additional revenue streams.

While Connecticut poses numerous economic challenges to farming (e.g., high taxes, high land and energy costs, and labor costs that are three times the national average), the primary factor influencing farm profitability is the cost of production per unit sold. Improving upon this factor would allow small-scale farmers to sell more product at a price closer to market prices without necessarily having to produce more product.

Although research indicates consumers highly value local and sustainably grown foods, studies also show that only a small subset of consumers (8%) is actually willing to pay a premium price for them. Farmers markets and Community Supported Agriculture (CSAs) are traditional outlets for local and sustainable foods, but are economically inefficient due to the very small amount of produce sold and high labor costs incurred. While mainstream retail grocers acknowledge and support their customers' keen interest in consuming local/sustainably grown foods, they are not otherwise incentivized to purchase local produce at higher-than-standard market prices.. Given that the industrialized global food system allows for consumers to affordably buy produce on demand despite seasonality, there is not wider support for local food.

Although the high price of land is often cited as a barrier to young farmers, that barrier is a symptom of the larger problem of farm profitability: If it were possible

to make money farming the land, it would be possible to pay for land costs. Despite increasing interest among the younger generation in local and sustainable agriculture, it often is the older generation (i.e., retirees) who are moving into agriculture as a second career because they can afford to do so.

Farmers overwhelmingly cite labor costs, rather than land costs, as a high barrier to profitability. Only one-third of Connecticut farms have a single employee; most farm laborers are permanent residents or guest workers who are paid prevailing wages. Because labor-intensive farming practices reduce efficiency and drive up costs, farmers are increasing their use of technology (e.g., milking machines) where possible. Although intensification (i.e., increasing production without increasing inputs) is cited as an effective avenue for farmers to cut costs, it has a negative impact on farm laborers.

In light of these many economic challenges and the narrow demographic of customers willing to pay more for local/sustainable produce, the value of subsidizing local agriculture continues to welcome debate. Given the convenience and diversity of modern diets, in which consumer demand prevails over seasonality, it is unlikely that even 5% of area residents' diets would consist of local food. Although there are efforts to recreate food hubs for local agriculture, such infrastructure does not address the overriding problem of cost competitiveness for small- and mid-size growers versus large producers. The old system of regional markets cannot compete with the large producers' economies of scale, even accounting for the cost of transporting goods long distances, which is negligible for large producers. Given that only about 1,000 Connecticut farms are full-time farms, with the rest relying on some type of outside income to pay the bills, it can be said that area farm families are providing their own form agricultural subsidy.

Despite residential neighbors who complain about the smell of manure or tractor noise, Connecticut generally is committed to supporting local farming in order to enjoy its many benefits beyond growing food, such as (i) providing a scenic backdrop for the tourist industry, (ii) supporting biodiversity, (iii) providing wildlife habitat, (iv) keeping down municipal taxes due to lack of residential development, and (v) preserving a cherished family lifestyle. However, the fact that some farmers now earn income by managing their farmland for migratory birds or providing hay rides does not improve the outlook for local farms as profitable food producers in the state.

Scientific opportunities and challenges

If the goal in Connecticut is to produce more food locally, that can be accomplished by increasing the output of six or seven farms, not 6,000. The ultimate questions

are (i) whether increasing local food production is a priority?, and if so, (ii) do small farmers need to be subsidized to profitably increase local food production?

To drive down production costs, farmers need to find new models for agriculture (e.g., greenhouses, hydroponics), as has been done in Europe and Canada. The greatest opportunity for local farm profitability comes from the use of intensification practices that cut costs per unit of production. However, models that lower costs through scale, innovation, and specialization may result in farms that don't look the way the general public expects a farm to look (e.g., more food grown in greenhouses at much larger farms producing $20 million in sales a year). Additionally, a significant consequence of intensification is the reduction of jobs for farm workers, and strategies are needed that address this issue to avoid adverse outcomes (e.g., poverty).

Although consumers typically say they prefer products that align with their values (e.g., locally and/or sustainably produced, humanely raised), they balk at paying premium prices for such products, making it difficult for small- and mid-size farmers to compete. Because consumers are more likely to pay a higher price if they know for sure the product fits their values, opportunities exist to expand the development and implementation of certification programs that apply strict definitions to verify a product has been locally and/or sustainably produced.

The widespread disagreement about the meaning of the terms "local" and "sustainable," coupled with general consumer lack of knowledge about where food comes from (e.g., expecting to have pomegranates available all year round), create opportunities to improve consumer knowledge through school programs, farm field trips, and one-on-one conversations about the global food system.

Given the niche popularity of Connecticut tobacco as a cigar wrapper leaf, opportunities exist to develop alternate high-value crops targeted to specialty or high-income consumer bases (e.g., marijuana). Although medical marijuana usage has been approved in Connecticut, development of this crop in the state is not currently underway.

Policy issues

Because it is not currently possible for smaller farmers to profitably increase the amount of local food they produce, determining priorities is the first step toward crafting policies that enable realistic goals. Connecticut residents must decide upon their priorities in supporting sustainable and local agriculture: Is the goal to increase local food production, or to help local and sustainable farmers succeed?

Connecticut demonstrated its willingness to prioritize some sectors of agriculture in its decision to sustain the state dairy industry by adding a fee on land

record filings. The fee, which is split among the dairy industry and several other groups (e.g., open space preservation, historic preservation), goes directly to a dairy support program for Connecticut farmers that makes it possible for the industry to remain profitable in the state. This type of prioritization can and must continue to be applied in agriculture statewide.

Connecticut's farming model currently is focused on selling to those few who will pay a premium price for local and sustainable products, but this is unsustainable. Although massive government subsidies are given to large-scale farming in the U.S., there are few subsidies at any level for fresh fruits and vegetables, and the worldwide expansion of this market has been due to the ability of large-scale farmers to drive down the cost of production and distribution. Because the cost of food is the primary selling factor for consumers, small-scale farmers cannot compete against large-scale producers without government subsidies. In spite of strong arguments in favor of local and regional subsidies to small-scale farmers, the nature of the legislative process makes it unlikely that such an appropriation would be passed without a long and concerted effort by stakeholders.

Given the high value placed on the nutritional, economic, ecological, and lifestyle benefits provided by farming, it is suggested that Connecticut residents might consider regulating farms as public utilities with assigned profit margins (e.g., as has been done with the defense industry, which is a semi-regulated government "utility" operating on a guaranteed profit margin of 13%-15%). Other suggestions for raising income that could subsidize small-scale farming include taxing meat, sugar, and any future medical marijuana crops.

Improved education regarding local and sustainable agriculture is needed from kindergarten through adulthood so that consumers know where and how their food is produced, have opportunities to work on farms, and can make informed decisions that effectively and sustainably support local farmers.

Acknowledgment

Numerous individuals and organizations have made important contributions to the Institute on Science for Global Policy (ISGP) program on climate change. Some of these contributions directly supported the efforts needed to organize the ISGP conference, *Socioeconomic Contexts of Sustainable Agriculture,* convened in partnership with Western Connecticut State University on its campus in Danbury, Connecticut, October 14–15, 2016. Other contributions aided the ISGP in preparing the material presented in this book, which includes the three invited policy position papers and the not-for-attribution summaries of the views presented in the discussions, critical debates, and caucuses that ensued at Western Connecticut State University.

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 sustainable agriculture in their policy position papers. The willingness of these authors to engage all conference participants in the vigorous debates and caucuses that comprise 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 Western Connecticut State University are greatly indebted to all those who participated in the conference.

The efforts made by the faculty, students, and administration of Western Connecticut State University, in collaboration with the ISGP to organize and convene the sixth 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 Western Connecticut State University. The brief biographies of the faculty and students from Western Connecticut State University 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 *Socioeconomic Context of Sustainable Agriculture* received funding from Western Connecticut State University. The ISGP benefited greatly from generous gifts provided by Young Living, MARS Corp., and Edward and Jill Bessey.

Dr. George H. Atkinson
Founder and Executive Director
Institute on Science for Global Policy
October 2016

ISGP books from ISGP conferences (listed below) are freely available to the public and can be downloaded from the ISGP 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: Equitable, Sustainable, and Healthy Food Environments*, convened May 1–4, 2016 in Vancouver, British Columbia, Canada, in partnership with Simon Fraser University.
- *FSSD: Food Security and Diet-linked Public Health Challenges*, 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

- *Socioeconomic Contexts of Sustainable Agriculture,* convened October 14–15, 2016, in Danbury, Connecticut, in partnership with Western Connecticut State University.
- *Water and Fire: Impacts of Climate Change*, convened April 10–11, 2016, in Sacramento, California, in partnership with California State University.
- *Communicating Science for Policy*, convened August 10–11, 2015, in Durham, North Carolina, in partnership with Sigma Xi, The Scientific Research Society.
- *FSSD: 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):

- *Climate Impact on National Security,* convened November 28–December 1, 2016, in Carlisle, Pennsylvania, in partnership with the U.S. Army War College.
- *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 Program (ICCP): The Shore's Future: Living with Storms & Sea Level Rise*, convened November 20–21, 2015, in Toms River, New Jersey, in cooperation with the Toms River Working Group, Barnegat Bay Partnership, Barnegat Bay Foundation, and the Jay and Linda Grunin Foundation.
- *ICCP: Sea Level Rise: What's Our Next Move?*, convened October 2–3, 2015, in St. Petersburg, Florida, in cooperation with the St. Petersburg Working Group.
- *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

Laura Lengnick, Ph.D.

Dr. Lengnick, Owner and Lead Scientist at Cultivating Resilience, LLC (www.cultivatingresilience.com), is an award-winning soil scientist who has explored agricultural sustainability for more than 30 years as a researcher, policy maker, educator, and farmer. Her work in sustainable farming systems was nationally recognized with a U.S. Department of Agriculture (USDA) Secretary's Honor Award. She contributed to the 3rd National Climate Assessment as a lead author of the USDA report Climate Change and U.S. Agriculture: Effects and Adaptation. Dr. Lengnick also led the academic program in sustainable agriculture at Warren Wilson College for more than a decade, where she also served as the Director of Sustainability Education, conducted research in sustainability assessment and holistic management, led energy descent action planning, and developed an adaptive sustainable dining policy for the college. In 2015, she left the college to launch Cultivating Resilience, LLC, a private consulting firm offering ecosystem-based climate risk management services to government, businesses, and communities. She serves as an advisor to the USDA Climate Science Learning Network, North Carolina Agriculture and Forestry Adaptation Work Group (NC-Adapt), and the North American Climate Smart Agriculture Alliance. She holds an adjunct faculty position in Horticulture at North Carolina State University. Her new book, Resilient Agriculture: Cultivating Food Systems for a Changing Climate (New Society Publishers), examines climate change, resilience, and the future of food through the adaptation stories of 25 award-winning sustainable producers across the U.S.

Henry Talmage

Mr. Talmage is the Executive Director of Connecticut Farm Bureau Association (CFBA), The Voice of Connecticut Agriculture. CFBA is a 4,500 member, non-profit organization dedicated to farming and future of Connecticut agriculture by focusing on the economic viability, land use, labor, taxation, and the protection of farmland. He serves as Vice Chairman of the Governor's Council for Agricultural Development and serves on the Farmland Preservation Advisory Board, the Working Lands Alliance steering committee, as well as numerous other agricultural boards, councils, and committees. These include the Health and Natural Resources Advisory Board at the University of Connecticut's College of Agriculture, and the Advisory Council of the College of Agriculture and Life Sciences at Cornell University. Prior to his current

position at CFBA, Mr. Talmage served as the Executive Director of the Connecticut Farmland Trust for five years. He is a graduate of Cornell University with a degree in Agricultural Economics. He is a native of Long Island, New York, and before coming to Connecticut, he was Director of Operations for Talmage Farm, a family owned wholesale greenhouse and nursery business with a retail farm and garden store.

Cristina Tirado-von der Pahlen, D.V.M., Ph.D., M.S.

Dr. Tirado works on climate change, food, health, gender, and sustainable development with the World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO), other UN agencies, NGOs, and universities worldwide. She has served as Pan American Health Organization (PAHO)/WHO Food Adviser for Latin America, WHO Regional Adviser in Europe, Coordinator of the WHO Foodborne Surveillance Program, and Director of the Public Health Institute's Center for Climate Change and Health in California. She is an adviser for several UN organizations and is affiliated with the University of California, Los Angeles (UCLA) Institute of Environment and Sustainability. Her current research focus is on the cobenefits to health of climate change adaptation and mitigation in the agriculture, transport, and energy sectors. She is moderator of the UN Standing Committee of Nutrition Working Group on Climate Change and chair of the International Union of Nutritional Sciences task force for Climate and Nutrition. She has been a health and nutrition advocate at the UN Framework Convention on Climate Change (UNFCC), was key partnerships' driver at Rio+20, and she contributed to the Women Major Group consultations and Food Security and Nutrition for the Sustainable Development Goals (SDGs) and 2030 agenda. She was a contributing author of the health chapter of the IPCC Fourth Assessment Report and has authored numerous research and policy publications and books. Dr. Tirado is a doctor of veterinary medicine, with M.S./Ph.D. degrees in environmental sciences from Cornell University.

List of Conference Debaters

Theodore Andreadis
Director
Connecticut Agricultural Experiment Station

George Atkinson
Executive Director and Founder
Institute on Science for Global Policy

Peter Backlund
Professor, School of Global Environmental Sustainability, Colorado State University

Daniela Baeza
Senior Fellow
Institute on Science for Global Policy

Shirley Bergin
Partner COO/CMO
TEDMED, LLC

Michelle Bissett
Student Panelist
Western Connecticut State University

Waverly Brim
Student Panelist
Western Connecticut State University

Sweta Chakraborty
Associate Director
Institute on Science for Global Policy

Scott Chaskey
Director
Quail Hill Farm

Stavros Christofi
Associate Professor
Western Connecticut State University

Peter Davies
International Professor of Plant Science
Cornell University

Ram Dixit
Student Panelist
Western Connecticut State University

Frederick Downey
Consultant

Karina Escobar
Student Panelist
Western Connecticut State University

Dean Fenton
Director
Spring Creek School

Phoebe Godfrey
Associate Professor in Residence
University of Connecticut

Zachary Goodwin
Student Panelist
Western Connecticut State University

Ruth Gyure
Emeritus Professor
Western Connecticut State University

Jasmine Jacobs
Student Panelist
Western Connecticut State University

Ashley Kenney
Manager
Jane Goodall Permaculture Garden, WCSU

Jean Kreizinger
Emeritus Professor
Western Connecticut State University

Gail Lavielle
143rd Assembly District Representative
Connecticut House of Representatives

Samantha Lipscomb
Student Panelist
Western Connecticut State University

Marx Mbunji
Manager Africa Business Development
CIAT-HarvestPlus

Shannon McFarland
Student Panelist
Western Connecticut State University

Neil McRoberts
Associate Professor
University of California, Davis

Bethany Morrison
Archaeologist
Western Connecticut State University

Theodora Pinou
Professor
Western Connecticut University

David Rothbart
Student Panelist
Western Connecticut State University

Neil Schultes
Plant Geneticist
Connecticut Agricultural Experiment Station

Antonio St. Lorenzo
Founder
Boot Camp Farms

Janice Thies
Associate Professor
Cornell University

Mitch Wagener
Professor of Biology
Western Connecticut State University

John Weaver
Owner
The Foodcrafters, LLC

Biographical information of Western Connecticut State University (WCSU) faculty and student participants

Faculty

Theodora Pinou, Ph.D.

Dr. Pinou is a professor of Biology at WCSU, and a Curatorial Affiliate in Vertebrate Zoology at the Peabody Museum of Natural History at Yale University. She received her Bachelor's, Master's, and Doctorate degrees at New York University in Biology, with a focus in vertebrate evolution and ecology. Her research interests include effective college level instructional practices that diversify and strengthen the nation's STEM pipeline.

Student participants

Karina Escobar

Karina Escobar is a Biology major at WCSU. She will be volunteering with the Peace Corps in Malawi starting June 2017, as a Natural Resource Management Volunteer.

Zachary Goodwin

Zachary Goodwin is a senior at WCSU and a Finance major. He is also currently President of the Finance Club. In his free time he enjoys lifting weights, playing basketball, and bowling.

Shannon McFarland

Shannon McFarland is a junior in the Honors program at WCSU studying Biology with a focus on ecology. She attended an agri-science high school program in Connecticut focusing on horticulture. She has spent several years working on a community based sustainable vegetable farm. She was awarded a National Science Foundation grant to conduct independent research focused on climate change and limnology. She plans to pursue graduate school and a career focused on the environment.

David Rothbart

David Rothbart is a Biology major at WCSU with a strong interest in population genetics and Mathematics. He is involved in several research projects and is aiming

to be published for the first time by the end of the year. After graduation, he plans on pursuing further education in the field of bioinformatics.

Jasmine Jacobs:

Jasmine Jacobs, a Connecticut resident, is studying Biology at WCSU. Her interest in the sciences inspires and feeds her enthusiasm for her artwork and love of the natural world. She looks to the future with the hopes of getting published and being a teacher so she can share her adventures and passion for life.

Samantha Lipscomb

Samantha Lipscomb is a senior Biology major at WCSU with interests in ecology, biodiversity, and the future of agriculture amidst climate change. She is a member of the Entomology Club on campus, and is working on building a synoptic collection of plant species for a local wildlife preserve in Northwestern Connecticut.

Michelle Bissett

Michelle Bissett is a junior at WCSU. She is pursuing a degree in Biology that focuses on ecological sciences. Issues in the environment such as climate change and pollution affect all living organisms including humans, and she hopes to have a career that allows her to make a positive impact in the world.

Waverly Rose Brim

Waverly Rose Brim is a junior at WCSU majoring in Biology with a pre-medical track in the university's Honors program. She has participated in research at Georgetown and Yale Universities and plans on becoming a medical doctor, specializing in surgery. She is a diligent volunteer on and off campus as well as a Clinical Research Associate in St. Vincent Medical Center's Emergency Room.

Ram Dixit

Ram Dixit is an Indian native in his third year studying Bio-chemistry at WCSU. He additionally minors in Computer Science and Math. He is a member of several clubs such as the Astronomy Club, Math Society, Commuter Student Organization, Latin American Student Organization, Gaming Club, Chemistry Club, and Drum Circle. He is working towards an eventual Ph.D. in Bio-chemistry.

Biographical information of ISGP Board of Directors

Dr. George Atkinson, Chairman

Dr. 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. 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. Bingham is President of the George Mason University (GMU) Foundation and GMU's Vice President for Advancement and Alumni Relations. 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. 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. 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. 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. 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. 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. 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. 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, Science and Technology Adviser (STAS) to U.S. Secretaries of State Colin Powell and Condoleezza Rice, and past president of Sigma Xi, The Scientific Research Society. 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.

Daniela Baeza, B.A.

Ms. Baeza, ISGP Senior Fellow, holds bachelor's degrees in Global Affairs/ International Relations and Political Science. With a focus on interdisciplinary cooperation between the scientific community, the private sector, and the public sector for international development, she has worked on various domestic and international research projects assessing development strategies, the latest evaluating the effects of economic development on living standards in Singapore.

Jennifer Boice, M.B.A

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

Sweta Chakraborty, Ph.D.

Dr. Chakraborty, ISGP Associate Director, received her doctorate in Risk Management from King's College London, and has more than 22 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 a former

adjunct assistant professor at Columbia University and a current program associate at Oxford University's Centre for Socio-Legal Studies.

Christina Medvescek, B.A.

Ms. Medvescek, ISGP Program Administrator, holds bachelor's degrees in Journalism and Psychology from Valparaiso University. An internationally published journalist and editor, she is former Vice President of Publications for the Muscular Dystrophy Association, an EEO mediator for the U.S. Postal Service, and a mediator, facilitator and instructor for the Center for Community Dialogue, Tucson, AZ.

Aubrey Paris, B.S.

Ms. Paris received undergraduate degrees in Chemistry and Biology from Ursinus College, Collegeville, Pennsylvania, and is currently pursuing a Ph.D. in Physical Inorganic Chemistry at Princeton University, where she is a National Science Foundation Graduate Research Fellow. She is also the manager and co-host of "The Forum," ISGP's biweekly audio podcast "where science comes to socialize." Ms. Paris has served as a Fellow of the Ursinus College Center for Science and the Common Good since its inception in 2012.

Cleo Warner, B.A.

Ms. Warner, ISGP Senior Fellow and social media manager, is a 2015 Eckerd College graduate with a degree in Literature and Environmental Studies. Her research interests include food systems, science communication, and other various ways in which society and the environment interact. Ms. Warner has worked on numerous environmental community development projects both in Florida and internationally, the latest being the threatened mangrove communities throughout Indonesia.

Andrea Vazquez

Ms. Vazquez, an ISGP Fellow, graduated from Arizona State University with a degree in social work. She is also a College Prep-Assistant at a high school in Tucson, Arizona. Her goal as a social worker is to challenge social injustice and advocate for people who are vulnerable and oppressed, especially youth.