

foragri

FONDO PARITETICO NAZIONALE
INTERPROFESSIONALE
PER LA FORMAZIONE CONTINUA
IN AGRICOLTURA

**FINANCING INNOVATION FOR AGRICULTURE, FOOD, AND THE
BIOECONOMY: BUSINESS AS USUAL?**

Sunday, June 26 2016

Oscar Niemeyer Auditorium
Via della Repubblica
Ravello (Amalfi Coast, Italy)

WORKSHOP PROCEEDINGS



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Foreword

An important workshop on “Financing Innovation for Agriculture, Food, and the Bioeconomy: Business As Usual?” was held on June 26, 2016 in Ravello, on the beautiful Amalfi coast. By all measures it was a great success.

Foragri, the organization that I serve as Presidente, was honored to take the opportunity to serve as the primary sponsor for the workshop, the subject of which is central to our mission—to promote innovation that will serve the interests of agriculture in Italy, and in particular the people who work in the industry.

This workshop was the brainchild of Julian Alston, Davide Gaeta and Sara Savastano. They conceived the idea, organized the program, managed the workshop on the day, participated in the program, and produced this proceedings document.

On behalf of the other participants, Foragri, and others who have benefited, I thank them for their many hours of hard work to make the workshop so successful.

Stefano Bianchi
Presidente, Foragri

Welcome

Thank you for giving me the opportunity to participate in such an illustrious and prestigious forum. First and foremost, I bring you the greetings and thanks of the President of Foragri, Stefano Bianchi, who for serious reasons cannot be here today.

The organization that I direct, Foragri, attaches particular importance to the work of today. As Professor Davide Gaeta will show in his presentation, Foragri finances training activities for employees of companies in the food and agriculture sector, under procedures established by a special Italian law and using resources that come from the companies themselves.

It is just five years Foragri began operating. After some initial settling times, we have now acquired the necessary skills, knowledge, and information to be in a position to refine and better target their activities towards the needs of industry. To this end, Foragri has begun to establish relations and links with the world of research in order to understand what innovations companies will introduce in the near future.

In this context we also want to understand the evolving scenarios that will be facing the agriculture and agri-food sector, the trends of the international markets, the competitive environment and the changes in demand and consumers. Agricultural enterprises and Italian food are becoming more and more internationalized and are developing marketing relationships with different areas of the world, particularly in some sectors and products.

Foragri want to understand, to know, to accommodate businesses in these innovation and development processes, and to support them in their adaptation and growth processes, with an understanding that human capital, and the professionalism and skills of human resources are crucial to success in the evolving international marketplace.

Also, we want learn about the experiences of other countries and other systems, and how this can help to improve our expertise, to grasp ideas and suggestions, which adapted to our reality can improve our effectiveness in dealing with the business world.

It is for these reasons that we think that today's meeting presents an extraordinary opportunity for discussion and proposals, knowledge and hope, full of ideas and stimuli.

Roberto Bianchi
General Manager, Foragri

Preface

The global landscape of funding for food and agricultural R&D has changed. The middle-income countries (in particular China, Brazil, and to some extent India) have grown in importance relative to the high-income countries of the OECD. Some high-income countries have been reducing their total investment in agricultural science in spite of strong evidence of a high social return to the investment. At the same time, and in spite of a slowdown in farm productivity growth, the composition of that spending has drifted away from farm productivity growth to other issues. These shifts have implications for the global sustainability of agriculture, food, and the broader bioeconomy given their predictable consequences for the global food supply and demand balance; the price of food; hunger and poverty; pressure on natural resource stocks; and vulnerability of the bioeconomy to biotic and abiotic stresses.

Ample evidence exists showing first, that the returns to investments in agricultural research have yielded handsome dividends for society, and second, that in spite of that fact and despite the significant government involvement in science and technology policy around the world, we continue to underinvest significantly in R&D for agriculture, food, and the bioeconomy. The world will benefit significantly if we can find a way to increase funding support for R&D for agriculture, food, and the bioeconomy. General revenue funding from government is an important source of funding, and an increase in funding from that source is well justified. Making greater use of other sources that involve public-private partnerships might be even more efficient in terms of the potential for both augmenting funding from government and the private sector and directing those funds to high-value investments.

This workshop was undertaken to explore new models for public-private partnerships to support innovation for agriculture, food, and the broader bioeconomy, in view of the shifting global balance of research investments, slowing agricultural productivity growth in many countries, and emerging evidence that the approaches of the past will not be sufficient. The concept was to engage perspectives of participants from academia, government, and industry, from around the world to develop ideas for practical possibilities for governments to implement new policies in time to take useful effect before the middle of the 21st century, by which time the world may have more than nine billion mouths to feed.

To undertake and organize such a workshop is costly in terms of both time and money for the participants and the hosts. Many people helped to defray those costs. As the organizers, we are very grateful for the primary sponsorship provided by Foragri, additional sponsorship provided by the Giannini Foundation of Agricultural Economics, and in-kind and substantial financial support provided by the ICABR and its secretariat. We gratefully acknowledge a group of volunteers from the University of Rome Tor Vergata – CEIS for their hard work as room monitors and registration assistants. Finally we thank Robin Goldstein who recorded the discussion at the meetings and drafted the summary of the proceedings.

Julian Alston, Davide Gaeta, Sara Savastano
Workshop Organizing Committee

Workshop Program

Welcome and Introduction

Julian Alston, UC Davis; **Roberto Bianchi**, Foragri; **Kostas Stamoulis**, FAO

Session 1: Global Perspectives

Chair: **Kostas Stamoulis**, FAO

Public and Private Investments in Agricultural and Food R&D: The New Global Landscape

Philip Pardey, University of Minnesota

The Evolving Institutional Structure of Public and Private Agricultural Research

Keith Fuglie, USDA Economic Research Service

Structuring Private-Public Partnerships for Success: Empowering University Partners

Gordon Rausser, University of California, Berkeley

Discussant: **Carl Pray**, Rutgers University

Session 2: Producer-Public Partnerships—Principles and Practice, Policies and Politics

Chair: **Robert Goodman**, Rutgers University

Public-Private-Producer Partnerships: Theory and Practice

Richard Gray, University of Saskatchewan

The Economics and Politics of Alternative Funding Models: Benefits and Beneficiaries

Julian Alston, University of California, Davis

Levy-Funded Research in Australia: An Evolving Structure

Rick Roush, Pennsylvania State University

Discussant: **David Zilberman**, University of California, Berkeley

Session 3: Producer-Public Partnerships in Practice: Selected Examples

Chair **Pasquale L. Scandizzo**, University of Rome Tor Vergata

Public-Private-Producer Partnerships for Farms and Farm Labor in Italy

Davide Gaeta, University of Verona

The Role of Public-Private Partnerships and Investment in Supporting Innovation in the Bioeconomy

Carolina Navarrete Frias, CIAT

Producers' Objectives in Variety Development Partnerships – Recent Examples from Canada

Harvey Brooks, Saskatchewan Wheat Development Commission

Financing Innovation for Agriculture, Food, and the Bioeconomy: The Role of Value Chains

Jo Swinnen, KU Leuven

Session 4: Moderated Panel Discussion

Moderator: **Robert Paarlberg**, Wesseley College

- *A View from Mars* – **Howard Yana-Shapiro**, Mars Inc.
- *A View from Monsanto* – **Eric Sachs**, Monsanto
- *Macarese Experience* – **Andrea Benetton**, Macarese Spa
- *Aboca Experience* – **Valentino Mercati**, Aboca

Closing Remarks

Davide Gaeta, University of Verona, **Sara Savastano**, University of Rome Tor Vergata

Workshop Proceedings

The tiny village of Ravello, clinging to the cliffs of Italy's Amalfi Coast, was the dramatic setting for this summer's twentieth annual conference of the International Consortium on Applied Bioeconomy Research (ICABR). The ICABR is an interdisciplinary group of scientists that has gathered each year for the past two decades to discuss a broad variety of scientific perspectives on the global food and agriculture industries, and this year's conference was attended by more scholars than any other in the organization's 20-year history.

Leading off the program in Ravello was a June 26 pre-conference workshop, entitled "Financing Innovation for Agriculture, Food, and the Bioeconomy: Business as Usual?" This full-day workshop was organized by Julian Alston, from UC Davis, Davide Gaeta of the University of Verona, and Sara Savastano of the World Bank and University of Rome Tor Vergata, who was also the lead coordinator of the entire Ravello conference, with financial support from the Fondo paritetico interprofessionale nazionale per la formazione continua in Agricoltura (ForAgri) and the Giannini Foundation of Agricultural Economics.

The workshop program featured 16 of the world's leading agricultural economists, policymakers, research scientists and industry leaders. What resulted was a frank, open, and intellectually challenging discussion of the changing global landscape of public and private investment in food and agricultural research and development.

Session I. Global Perspectives

After a brief welcome address by **Roberto Bianchi**, Consiglio di Amministrazione at ForAgri, Dr. **Kostas Stamoulis** of the FAO made some introductory remarks to open the day's proceedings.

The first session featured presentations from three leading thinkers on the interplay between public and private agricultural research around the world. The first of these was from **Philip Pardey**, who is currently Professor of Science and Technology Policy in the Department of Applied Economics at the University of Minnesota, Director of Global Research Strategy for the University's College of Food, Agricultural, and Natural Resource Sciences.

Pardey dove straight into substance with a compact and fact-filled opening address entitled "Public and Private Investments in Agricultural and Food R&D: The New Global Landscape." Pardey's talk, delivered in precise Australian English and accompanied by a series of highly informative charts, told the surprising story of what he described as "a growing bifurcation of the world's scientific haves and have-nots" that has been unfolding over the past three decades.

The data, which were compiled by Pardey's International Science and Technology Practice and Policy Center (InSTePP), measured long-run changes in spending on food and agricultural research and development in a variety of countries around the world. The key measure of R&D spending used by Pardey and his colleagues is called "GERD" (gross expenditures on research and development). His team's analyses of the longitudinal InSTePP data focused on the relative changes in "agGERD" (agricultural GERD) between low-income, middle-income, and high-income countries around the world between 1980 and 2011.

In the highest-income countries, such as the economic powerhouses of North America and Western Europe, Pardey found that the cumulative real spending on agricultural R&D has been falling, resulting in an even more dramatic drop in the share of total global spending on agricultural R&D contributed by the richest countries—from 68.9% to 54.8% over that three-decade span. Pardey also observed, however, that the balance of agricultural R&D investment had not shifted to the lowest-income countries (e.g. sub-Saharan Africa), whose cumulative global share also fallen (from 2.0% to 1.8%). It was thus the middle-income countries, especially China, that have increasingly become the global growth leaders in agricultural R&D investment.

As a result, Pardey concluded that the middle-income bloc has become, and will likely continue to become, relatively more productive and important on the global agricultural stage as investments by middle-income countries yield medium- and long-term returns from more efficient production systems, lower prices, higher quality, and better competitive positioning in global agricultural trade. The increasing commitment to investment in agricultural research by middle-income countries, he suggested, may be one of the major drivers of their recent success in growing agricultural GDP and overall GDP.

Keith Fuglie, who has served as branch chief and economist at the USDA Economic Research Service, followed Pardey with a presentation entitled "The Evolving Institutional Structure of Public and Private Agricultural Research." Fuglie began with the observation that in recent years, the private sector has been funding an increasing percentage of all agricultural R&D undertaken in America. But what about the USDA and other agencies in the public sector?

Since 2000, Fuglie observed, public R&D has increased in the areas of crop seeds, biotechnology, and farm machinery, whereas public R&D in the areas of agricultural chemicals, fertilizers, animal health, nutrition, and genetics has stagnated. Are public and private research programs complements to each other, Fuglie asked, or are they substitutes for each other? Fuglie noted that while research dedicated to growing the underlying base of human scientific knowledge (think Niels Bohr) has declined in recent years, research on "applied" agricultural R&D programs (think Thomas Edison), many of which are funded by private industry, has meanwhile grown.

In 1980, the landmark U.S. Supreme Court decision *Diamond v. Chakrabarty* ruled that biotechnology inventions are patentable, thus opening the doors for private industry to collect patent royalties on crops grown from seeds genetically designed by private research scientists to increase fruit and vegetable yields and quality. Fuglie argued that this new patentability standard has increased incentives for private-sector innovation and been partially responsible for the continuing push toward innovation in genetic technologies, even in the shadow of decreasing public funding for general-purpose scientific research—a phenomenon that is by no means limited to the agricultural sector.

In today's world, Fuglie observed, the vast majority of R&D that is dedicated to improving food processing technology, not to mention the larger body of production-oriented agricultural R&D in general, is funded by private companies. With that fact in mind, Fuglie suggested that public-private research partnerships (PPRPs) are now playing an increasingly important role in agricultural science research, and he argued that such mutually beneficial public-private arrangements must continue to grow in order for current-day scientists to have the financial support and economic incentives necessary to contribute their expertise to tackling the most important technological challenges of our time, including climate change, water availability, and food safety.

Gordon Rausser, the Robert Gordon Sproul Distinguished Professor in the Department of Agriculture and Resource Economics at the University of California, Berkeley—previously Dean of the College of Natural Resource at Berkeley and prior to that Chief Economist at the US Agency for International Development (USAID)—, closed out the opening “Global Perspectives” session with a presentation inspired in part by material from his upcoming book, *Structuring Public-Private Research Partnerships for Success: Empowering University Partners*, which will be released by Edward Elgar in September 2016.

Rausser, who is famous for being a Socratic provocateur at conferences, stayed true to form in his opening appearance in Ravello by drawing the audience into a challenging discussion of the role played by universities in PPRPs. He began by joining the two previous presenters in acknowledging the relatively uncontroversial fact that the public sector is playing a declining role in funding scientific R&D—a topic that would come up again and again throughout the day's discussions—but went on to apply this insight to the case of universities, whose research influence has grown in recent years vs. that of scientifically oriented government agencies.

Rausser began with the observation that incentives for universities to innovate have increased in recent years, beginning with the Bayh-Dole Act of 1980, which endowed universities with legal claims on intellectual property rights to biotechnology innovations. This legislation, in conjunction with the U.S. Supreme Court decision in *Diamond v. Chakrabarty* (also discussed by Fuglie), created new incentives for universities to make investments in patentable biotechnology because of the

unprecedented upsides that were now available to the lucky institutional winners of expensive, risky battles in ground-level biotech innovation.

Such incentives, continued Rausser, also led to the widespread emergence of so-called “technology transfer offices” at universities, and even to a related industry association: the AUTM (Association of University Transfer Managers). Rausser argued that the simultaneous proliferation of public-private research and development partnerships (PPRPs) gave these university divisions even more potential to contribute to their organizations’ bottom lines. He praised this development, citing Louis Pasteur’s quote that “there is no such thing as special category called ‘applied science’ – there is science and its applications, which are related to one another as the fruit is related to the tree that has borne it.”

In the best-case scenario, in an environment of diminishing generalized public funding for agricultural R&D, Rausser suggested that PPRPs were beneficial to all parties: private industry gains access to new innovations, research, and intellectual capital from academia, while at the same time universities gain access to financial capital from the private sector and proprietary research tools whose development is subsidized by for-profit interests.

On the flip side, Rausser noted that concerns may still be raised about academic freedom. In a research world increasingly dominated by PPRPs, he noted, scientists whose longstanding culture is merely to expand the limits of human knowledge may be constrained by the need to direct their efforts toward research with the real potential to improve industrial efficiency. Although universities should be wary of ceding too much control to private industry and should set up systems to recognize and resolve conflicts of interest, PPRPs at their best—Rausser concluded—can bring about pure and easily measurable improvements to human well-being.

The opening session was closed out by **Carl Pray**, Distinguished Professor in the Department of Agricultural, Food and Resource Economics at Rutgers University, and President of the ICABR, who led a spirited question-and-answer debate with the audience members. In response to a query on the increasing concentration of research funds into large organizations, Fuglie noted that there has indeed been tremendous concentration of R&D expenditure market share into the three or four largest companies in each sector, presenting a potential challenge to consumer welfare. Rausser, however, responded that good startup companies are increasingly finding liquidity in acquisition opportunities, thus aligning their incentives with those of larger companies even in an environment of increasing consolidation.

Whereas an academic scientist may once have been judged only by the merits of his or her publication record, Rausser argued, his or her standing within the scientific community may now also be influenced by the question: “what company did this person start?” While this change may represent a shift in the expectations of academic research scientists in the public and university worlds, consumers may enjoy a countervailing

benefit from the fact that the scientific capital of their society is increasingly diverted toward innovations in products that the consumers themselves believe to be worth paying for, and vote with their wallets to encourage.

Session II. Producer-Public Partnerships: Principles and Practice, Policies and Politics.

The second session of the pre-conference, chaired by Professor **Robert Goodman**, Dean of the College of Agriculture and Natural Resources at Rutgers University, was led off by Professor **Richard Gray** from the University of Saskatchewan who also has long time first-hand experience in running a family grain farm.

Gray's presentation began with a discussion of the so-called "commons" dilemma in economic philosophy. The issue is that the marginal cost of using knowledge, once it's created, is virtually zero. Given this fact, what system of incentives is optimal? In a natural "commons" environment—i.e. one in which knowledge can be shared freely—the right to use a knowledge resource takes precedence over the right to exclude such a use, whereas in an "anti-commons" environment, it is the converse: the right to exclude takes precedence.

From a welfare perspective, Gray pointed out, the "commons" is *prima facie* preferable to the "anti-commons": any restriction on the use of knowledge will move utilization away from a social optimum. On the other hand, private firms don't have incentives to distribute their knowledge innovations freely, and the free use of privately produced knowledge may inhibit incentives for producing such innovations.

Bringing the debate to bear on modern real-world markets, Gray divided knowledge goods into two categories—"excludable" (e.g. patents usable only by patent owners) and "non-excludable" (e.g. public goods accessible to all)—and described the pros and cons of each category: while there are greater economic incentives for individuals or companies to produce excludable goods (e.g. the upside of collecting monopoly rents), there is also a downside to excludability, namely the potential for redundancy and the duplication of intellectual innovation and resulting misallocation of society's intellectual resources.

As for the present state of things, "the bad news," said Gray—echoing the sentiments of the presenters in the first session—"is that governments are less interested in funding agricultural research." Producer-led industry organizations, Gray agreed, are playing the increasingly important role of gathering social capital to assemble the most effective possible agricultural innovation systems.

Gray concluded by describing an example of a public-private partnership that resolves this conflict by sharing costs and benefits between universities and private enterprises: the Soybean Croppportunity Network, an initiative led by SaskPulse, which is a collaboration between the University of Saskatchewan and for-profit soybean firms in Canada.

Professor **Rick Roush**, Dean of Penn State’s College of Agricultural Sciences, picked up where Gray left off with an empirically driven description of the evolving structure of levy-funded research in Australia—another example of the sort of public-private collaboration that may help resolve the welfare dilemmas inherent to the economic commons problem.

The idea of engaging “farmers” as research consumers and thought leaders, especially cotton, has driven the levy-funded research investment approach in Australia. “Instead of just standing on the sidelines and complaining that the egg-heads in the university are doing irrelevant research,” said Roush, “they get to participate in guiding the research direction.”

In the United States, on the other hand, Roush argued that public funding is much harder to attain, even funding for research that is urgent to consumer interests, such as solutions to the tomato psyllid crisis in California. US levy funds have frequently been diverted to marketing activities rather than research activities. Roush cited research by Julian Alston and Dan Sumner finding that in 2002, only \$18 million of the \$170 million in levy-funded “check-offs” in California was spent on research, whereas more than \$125 million was spent on industry promotion.

In New Zealand and South Africa, Roush acknowledged, the trend has been simply toward the complete privatization of agricultural research—an outcome that may be sub-optimal from a social welfare standpoint. On the other hand, Roush offered an optimistic outlook on Australian levy-funded research, which went from AUS\$27M to AUS\$404M between 1985 and 2011, with grain research registering the biggest gains in resulting R&D expenditures. In Australia, Cooperative Research Centres (CRCs)—which link universities, governments, and industry with Commonwealth matching funds—play an important role, Roush concluded, in sustaining agricultural research that serves the public good.

Julian Alston, who is a Distinguished Professor in the Department of Agricultural and Resource Economics at UC Davis and Director of the Robert Mondavi Institute Center for Wine Economics, wound up the second session with an investigative piece entitled “Economics and Politics of Alternative Funding Models: Benefits and Beneficiaries.” His presentation began with a concrete example the real-world consequences of the issues being discussed: while few outside the academic world are familiar with Norman Borlaug, the man who revolutionized crop technology, Borlaug may well have “saved more lives than any person who ever lived,” according to Alston, by enabling farmers to produce at an unprecedented scale and save hundreds of millions—perhaps a billion—of the world’s poorest people from starvation. Not bad for a science geek.

In spite of the comprehensive evidence for high aggregate returns to agricultural research investment, Alston observed that public funding is declining. He suggested that the agricultural R&D industry suffers from a “failure to communicate” to policymakers and to the public about these returns—a problem that connects in part to

a lack of overall clarity on defining the constituency that benefits from such research. Who are the principal beneficiaries of agricultural R&D? Scientists? Bureaucrats? The economists who do their bidding? Whatever the answers, Alston suggested that this communication problem may be contributing to the current situation of underfunded agricultural research across the board.

We have compiled a “mountain of evidence,” argued Alston, indicating widespread underinvestment in agricultural R&D—but evaluating the returns to R&D can be a tricky business. Alston pointed out that many past studies on the topic have yielded downright implausible estimates of the returns to agricultural R&D investment, thus undermining the credibility of the whole literature.

In a 2000 meta-study, for instance, Alston and his colleagues found a mean estimated real IRR of 81.3%—a number that would imply, implausibly, that a \$2 billion investment over 20 years would yield \$2.9 quadrillion in economic gains, thus “exceeding the GDP of the solar system.” Are there more credible metrics for measuring such gains? Alston suggested that perhaps focusing on more relatable, less money-driven success stories—like the millions of lives saved by Bourlaug—might be more useful ways of communicating with the public than facially dubious IRR measurements.

In terms of policy, Alston argued that in some cases levy funding distributes costs fairly and efficiently across producers, consumers, and other market participants in proportion to their benefits from the research. On the other hand, in many cases the conditions for this perfect matching may not hold, thus blurring the picture. Alston raised the problem of “diseconomies of diversity” in using collective action approaches to provide R&D, which compounds the problems caused by unclear payoffs. Producers may differ in their respective propensities for innovation, their respective abilities to benefit from technologies developed through levy-funded research, and the actual and perceived benefits to each of them from adoption.

Producers who do not adopt may even be harmed by levy-funded innovation—not only because they don’t benefit from the technologies for which they have contributed to funding, but also because prices may be driven down by others’ adoption. Finally, some innovations may benefit the future producers who don’t pay for them rather than the current producers who pay for them. How should society deal with these complex incentive problems?

In conclusion, Alston reviewed several possible strategies of improving on the current state of affairs. Optimizing the ways that firms directly or indirectly vote on levy systems, for instance, may not resolve such issues completely, but it may help. Matching grants from government may encourage producers to provide agricultural R&D collectively, based on levies. He noted that producers could be much worse off under strictly private funding arrangements or mixed approaches, such as the Australian public-private wheat-breeding system that uses end-point royalties.

To conclude the day's second session, **David Zilberman**, Professor and Robinson Chair in the Department of Agricultural and Resource Economics at the University of California at Berkeley, moderated a lively debate over issues of differing incentives for startup companies, large companies, academic institutions, and individual researchers to invest in agricultural technology research, and the vagaries of such investments. To illustrate the challenges sometimes faced in public-private partnerships, Zilberman told the story of a failed \$500 million investment by a multinational oil company in biofuel research at UC Berkeley. The research, while academically productive, ultimately yielded few gains for the oil company, which turned out not to have the institutional resources to implement the technology. The funding was withdrawn early, and neither party's expectations were met.

In closing, Zilberman pointed to a need for academics to stay in touch with the real world and understand the real capacities of industry and its ability to understand and absorb technical scientific knowledge: "Numbers give us some sexual pleasure," he quipped, "but we also need to learn to communicate in plain English."

Session III. Producer-Public Partnerships in Practice: Selected Examples

The first session after lunch was "Producer-Public Partnerships in Practice: Selected Examples," chaired by **Pasquale L. Scandizzo**, professor at the University of Rome Tor Vergata, and fellow of the Fondazione Tor Vergata Economia.

The session began with a presentation by **Davide Gaeta** of the University of Verona, who also happens to be a well-known wine producer in Italy's Veneto region, who talked on the topic of "Public-Private-Producer Partnerships for Farms and Farm Labor in Italy."

Gaeta's work documented the two-decades-long story of the Italian government's introduction of new laws on national compulsory training programs and their effects. He focused on the FORAGRI program, which aimed to address the need for better trained workers in Italy. FORAGRI, Gaeta explained, was an example of a public-private partnership between the government, farms, and farm laborers whose goal was to benefit all of the above parties—and to invest in human capital—at a relatively minor tax cost.

ForAgri was part of a larger government initiative under which 0.3% of total employee payroll costs were appropriated to 18 different "interprofessional" funds, each with a different industry focus. FORAGRI was the fund dedicated to training agricultural workers, and Gaeta devoted his presentation to describing its mechanics and growth. In 2009, its first year, the value of FORAGRI's vocational training investments was €495,000. By 2015, it had expanded to €4.5 million, distributed across 550 projects, 6,000 firms, and 37,000 employees in industries across the agricultural spectrum, most prominently produce, livestock, wine, and flowers.

Although the program is still relatively small, its growth has been steady and recognition and participation have increased. The biggest problem has been coordination between the various parties: Gaeta joked that coordination “is not a word in the Italian dictionary.” Bureaucracy and the imbalance of company sizes and maturity levels have been other challenges for the program.

Carolina Navarrete-Frías continued the session with a detailed discussion of her role at the International Center for Tropical Agriculture (CIAT), based in Cali, Colombia. Navarrete-Frías is also a PhD student at the University of Southampton, where her dissertation research focuses on institutional arrangements and natural resource governance in the Amazon.

She began in poetic fashion, first by expounding on the vast agricultural production potential for Latin America—with its vast, underutilized areas suitable for agriculture, plenty of available water and other resources, and highly diverse agro-economies—and then by explaining how the goals of her own research and her work with CIAT were aligned with the larger aim of helping turn Latin America into “the food basket for the world.”

Navarrete-Frías’ first story was that of the Latin American rice industry and FLAR the Latin American Fund for Irrigated Rice (FLAR). This is a voluntary consortium of more than 30 public and private sector organizations in 17 countries, dedicated to developing new technology for sustainable rice production. Members shape FLAR’s research agenda and provide funds for the development of technologies that satisfy shared demands—each member contributes to the organization according to size of rice industry and production and in return receives germplasm access.

Next, Navarrete-Frías moved on to cassava. Here, the public-private partnership aimed to broaden the use of cassava starch in applications currently dominated by maize starch. The potential in this space, Navarrete-Frías explained, lies in a newly discovered gene for “waxy cassava” that has potential to generate high value to the Latin American cassava industry by enabling producers to sell specialty waxy-cassava products into specialty markets at higher-than-normal margins.

In setting the scene for these examples, Navarrete-Frías also described the workings of CIAT, which operates in countries all over the developing world, with an annual budget of \$180 million and more than 1,400 staff members. The operations of the group are highly diverse: in Cali, Colombia, for instance, where the organization has a science park, CIAT has been involved with the United States and USAID efforts to negotiate peace between armed militia groups in the region, which has recently culminated in the successful signing of a ceasefire.

Navarrete-Frías concluded by describing CIAT’s current and potential future role in the “transformation of rural Colombia in the post-conflict era,” which center around launching new production and distribution channels for 14 “elite genomes” of cocoa,

which, like waxy cassava, have the potential to reach a global specialty market and increase revenue for farmers in the region.

Next up was **Harvey Brooks**, the General Manager of the Saskatchewan Wheat Development Commission in Saskatoon, Canada. Brooks, the former Co-operative Chair in Agricultural Marketing and Business at the University of Alberta, Head of Corporate Policy for the Canadian Wheat Board, and former Deputy Minister with the Government of Saskatchewan, told the story of the unprecedented challenges faced by the wheat industry in recent years. The planted area of wheat in Brooks' region has fallen from 14 million to 10 million acres since 1991, in part due to competition from the exploding canola industry, and the goal of Brooks and his team was to help wheat compete with canola by increasing its profitability, which meant finding a way to increase yields dramatically and thus bringing down costs.

The embodiment of disease and pest resistance in germplasm was paramount to achieving this goal. Until recently, however, due in large part to the peculiarities of the institutional structures and economic incentives that had been in place—and perhaps also to economic collective action problems—the private sector had not yet stepped in to create the genetic technology necessary to bring about these desperately needed improvements. Conventional breeding, said Brooks, was yielding “singles rather than triples or home runs”—i.e. not the kinds of “large discrete gains from disruptive technology” that were needed to turn the industry around.

The solution submitted by Brooks was a series of large-scale public-private partnerships that were able to transform the local industry's future, including a 5-year, CAN\$20 million core wheat breeding agreement with Agriculture and Agri-Food Canada (AAFC); deals with the University of Alberta, University of Manitoba, and University of Saskatchewan; a CAN\$8.8 million Canadian Triticum Applied Genomics (CTAG2) project to map the wheat genome and develop genomic breeding tools; and CAN\$3.9 million in research funding over four years from the Saskatchewan, Alberta, and Manitoba wheat commissions to fund key early-stage research.

Brooks' Saskatchewan Wheat Development Commission was also able to partner with seed distributor Secan in a \$3.5 million, 10-year deal to help develop better technology for durum (for the pasta market), and a public-private producer partnership of similar scale between Alberta Wheat and Canterra.

The inimitable agricultural economist **Jo Swinnen**, Professor of Economics and Director of the LICOS Centre for Institutions and Economic Performance at KU Leuven, former Lead Economist at the World Bank and Economic Advisor at the European Commission, and co-editor of the newly released book *The Economics of Chocolate* (which he presented to the Ravello conference later in the week), closed out the day's third session with a riveting 54-slide presentation on value chain finance (VCF).

Swinnen's intense, fast-moving talk began by taking the audience through the complex mechanics of value chain finance, which addresses a fundamental problem that plagues farmers all over the developing world: the lack of access to credit and capital. The problem takes different forms in different markets, but its effects are widespread, and the systems that have recently sprung up to remedy those effects have surprising similarities across continents.

In many post-communist economies, credit that was granted to producers by governments—and was thus taken for granted by firms' managers for generations—has often suddenly disappeared or changed form, sometimes quickly and without warning. In countries that were never under communism, other forms of liberalization have similarly thrown longstanding systems of credit and subsidy into chaos. The results of these changes have posed serious economic threats to agricultural producers around the world.

Swinnen's presentation offered a whirlwind tour of the VCF system, in which a private third-party agricultural marketing company emerges and offers credit, loan guarantees, or other forms of financing to primary smallholders while hedging their risks by simultaneously contracting with distributors or other upstream companies. Swinnen told a variety of stories detailing the diverse ways in which such VCF companies have come to the rescue, from the Kazakh cotton industry to the Romanian dairy industry to family farms in Lithuania to the Brazilian agri-food supply chain, where 69% of the \$35 billion in total credit is supply-chain credit.

VCF systems and the private organizations that participate in them, explained Swinnen, vary widely; various combinations of retail, processing, farms, banks, and technology companies collaborate with banks or special-purpose vehicles and distribute the gains among partners according to their various levels of investment and risk. Swinnen noted that in low-value staple food crops (e.g. African economies), where state-controlled governance systems are still prevalent and food self-sufficiency is still a political issue, private VCF is still largely absent, in part due to major problems with contract enforcement and in part because there is still limited value in these low-margin supply chains. The biggest potential in markets such as sub-Saharan Africa, however, seems to lie in non-traditional high-value export foods, whose consumer markets have grown tremendously since the 1990s, and where there are much better prospects for VCF-

In some underprivileged communities, Corporate Social Responsibility (CSR) programs and NGOs have also stepped in to play VCF-type roles and help smallholders get credit or other forms of financing to cover their cash-flow and investment needs. The model is developing, spreading, and turning over quickly—perhaps even more quickly than Swinnen's 54 slides—and it will be interesting to follow its development in the coming years.

Session IV. Moderated panel discussion

The final session of the whirlwind pre-conference day was a diverse panel discussion moderated by **Robert Paarlberg**, adjunct Professor of Public Policy at the Harvard Kennedy School and author of *Starved for Science: How Biotechnology is Being Kept Out of Africa*, published by Harvard University Press. This panel was unique amongst the day's various proceedings in that it was composed of industry practitioners rather than academics.

The first of these was **Howard-Yana Shapiro**, Global Director of Plant Science and External Research for Mars Incorporated, the chocolate-and-candy multinational, one of the world's foremost food scientists. His talk, which was amusingly entitled "A View from Mars," jumped straight into a description of one of his company's most noble projects: the African Orphan Crops Consortium (AOCC).

Every hour, said Shapiro, 300 children in the world die from chronic hunger or malnutrition. In the rural sectors of developing countries, Shapiro claimed that thirty-nine percent of children suffered from some form of neurological or physical "stunting." The AOCC has undertaken the ambitious project of sequencing, assembling, and annotating the full genomes of cacao and more than 100 other key crops in sub-Saharan Africa. To accomplish this, Shapiro and his colleagues put together the African Plant Breeding Academy, staffed by African PhDs in molecular biology; by 2015, the group had already sequenced 16 of these reference genomes. All of this is being funded by the Mars Corporation.

Rather than being sold or held in proprietary databases, the data from this project, Shapiro explained, are being made publicly available, hosted at the University of Arizona's Cyverse system, and kept in the public domain for any and all to use however they like. "With respect to African orphan crops," responded Shapiro, "the idea of patenting...is impractical. The only way we thought we could do it," he continued, "was to make everything public so that everyone could use it—to speed up research by not limiting it to our people or proprietary [technologies]."

Andrea Benetton, President of Cirio Agricola, is a member of the Board of Directors of Maccarese SpA, which runs innovative farms in Italy's Campania and Lazio regions, as well as Agriventure, part of the Intesa/Sanpaolo banking group that funds agricultural-sector projects across Italy. Benetton began his remarks by comparing the state of the Italian vs. US agricultural industries and noting that many mature technologies that have been used in the US for many years are still not seen in Italy due to lack of investment.

Benetton has led recent efforts within his company to catch up in this regard, beginning with a precision-farming project, undertaken in collaboration with the University of Perugia, that has mapped the geography of his company's terrain and used that information to realize environmental savings such as using less water and achieving

better yields, and minimizing the risk of contamination. In 2005, he installed dairy digesters to convert the methane gas emitted by cows into useful energy.

Maccarese has also led efforts to reduce the suffering of dairy cows in hot times of years by employing cutting-edge bathing machinery. Although his company is large, Benneton said that he still considers himself a farmer, the manager of a family business without the resources of a Monsanto-level enterprise, and thus that improvements in technology have more generally come from humble collaborations with universities and consultations with experts rather than in-house development. He added that in Italy, widespread corruption means that things don't work well in government, and these kinds of exchanges aren't always easy.

The session's next representative from Italian industry was **Valentino Mercati** of Aboca, the pharmaceutical company, which he founded in 1978 after leaving the automobile sector. Since its founding, the company has focused on deriving molecular compounds from plants using organic farming technology to improve those plants to derive the most effective pharmaceuticals.

Mercati argued that while any living "natural" system, including human beings, can support artificial products within it—and, indeed, that by some definitions, all pharmaceutical and medical industries are totally artificial—the GMO debate has been mis-framed as one of "natural" vs. "artificial," and his primary concern was in preventing the contamination of organic or non-GMO crops by GMO crops.

Vertical integration, Mercati explained, is the key to his company's future—whether for the purpose of better controlling his own distribution system, or creating a profitable franchise network of proprietary pharmacies. All of these plans, Mercati concluded, have elements of the artificial and of the natural; while we should not become victims of "fear-of-the-artificial" tactics that have taken over much of the public discourse, we should also be careful not to rush into adopting GMO technologies whose long-term effects on crop health and human health are still unknown.

On the other side of this debate was **Eric Sachs**, a geneticist from Monsanto who has devoted his career to demystifying GM crop technology for policymakers, opinion leaders, and the general public. Sachs offered a broad overview of his company's newest technology initiatives. Monsanto, which sells its products in 160 countries, runs 400 facilities, employs 22,000 people, and booked \$15 billion in 2015 revenues, is in the process of launching a whole new range of technology platforms, including crop protection, plant breeding, plant biotech, and R&D pipeline platforms, and digital agriculture solutions.

Sachs focused on Monsanto Growth Ventures (MGV), a new venture-capital project based in California's Bay Area that manages 11 agricultural technology funds with a total value of \$338 million. Investment in the agricultural technology sector went from \$400 million in 2010 to \$4.6 billion in 2015, and MGV's acquisition strategy is to acquire

promising companies and absorb them into Monsanto. The latest priority areas named by Sachs included water and soil management, nucleic acid delivery tech, IT solutions, phenotyping, robotics and automation, remote sensing and measurements, crop protection and chemistry discovery, new breeding technology, insect control, and disease control.

The final session concluded with a spirited discussion among these four industry practitioners and an active group of audience members, which focused on whether the distinction between “artificial” and “natural” was artificial or natural.

Throughout the proceedings, a single theme pervaded the discussions: how scientists at the top of their fields may join forces with passionate industry practitioners to mitigate the natural weaknesses of the human condition and environment, encourage public scientific awareness, and help human beings eat better, work less, and live longer, happier lives.

Speakers, Discussants, and Organizers

Julian Alston

University of California, Davis

Julian Alston is a distinguished professor in the Department of Agricultural and Resource Economics at the University of California, Davis, where he studies the causes and consequences of government policy affecting agriculture and food, including science and technology policy and the economics of agricultural innovation, as well as food and nutrition policy, and the global challenges of poverty, malnutrition, and obesity. At UC Davis, Julian also serves as director of the Robert Mondavi Institute Center for Wine Economics, and is engaged in a variety of projects on the economics of wine and beer.

<http://are.ucdavis.edu/en/people/faculty/julian-alston/>

Andrea Benetton

Maccarese

Andrea Benetton is the President of Cirio Agricola and sits on the Board of Directors of Maccarese the innovative farms extending in the Campania and Lazio Regions of Italy. Cirio Agricola stocks 1,750 head of dairy cows that produce 38,000 liters of milk per day on 550 hectares and Maccarese stocks 3,300 head that produce 32,000 liters of milk per day on 3,200 hectares. In size they rank first in Italy .

Roberto Bianchi

Foragri

Roberto Bianchi is General Manager of Foragri, the Italian Fund for continuing education in the agricultural and agri-food sector. Within FORAGRI, he manages all the training programs to support the needs of the Italian industries. This involves supporting internationalization and developing marketing relationships, and fostering businesses, innovation and development processes in the agri-food sector. After competing a thesis in Philosophy, he spent the past 30 years managing vocational training projects and programs in various training institutions and Italian national organizations.

Harvey Brooks**Saskatchewan Wheat Development Commission**

Harvey Brooks is the General Manager of the Saskatchewan Wheat Development Commission. Raised on a mixed farming operation in Saskatchewan, Brooks has extensive experience in Western Canada's agriculture industry, having served as Director of Policy and Economic Research for the Saskatchewan Wheat Pool, Co-operative Chair in Agricultural Marketing and Business at the University of Alberta, and Head of Corporate Policy for the Canadian Wheat Board. A former deputy minister with the Government of Saskatchewan, Harvey served four different departments during his tenure: Agriculture and Food, Government Relations, Highways and Transportation, and Rural Revitalization. Most recently, he served as deputy minister for the Yukon Territory in the departments of Economic Development and Community Services. He received a BSA and M.Sc ('83) in Agricultural Economics at the University of Saskatchewan and a Ph.D. in Economics at Iowa State University ('90).

Paola Corsinovi**Hochschule Geisenheim University**

Paola Corsinovi is Visiting Professor at the Hochschule Geisenheim University (Germany) affiliated with the center of Economics of Geisenheim University. She teaches at the International Wine Business Programme. She has been Research fellow at University of Verona (2015) at the Department of Business Administration. Corsinovi earned a Phd in Wine Economics and Rural Development at the university of Florence. During her studies, she has been PhD Visiting at LICOS, Centre for Institutions and Economic Performance (Leuven) and Visiting Research at University of California, Davis, Department of Agricultural and Resource Economics. Her research focuses on the European Agricultural Policy with particular to the wine sector and the effects of decision-making and lobby groups. She has been President of Young Agriculture Association (as Tuscany's representative).

Davide Gaeta**University of Verona**

Davide Gaeta is Associate Professor in the Department of Business Administration at the University of Verona, Italy, where he teaches economics of wine firms and wine policy. His fields of research are studies of wine markets and agro-food, the Community and national policies related to the typical products, and the dynamics of consumption of food and beverages. He has managed many private and public institutions, policy organizations and EU lobbies in the wine sector. He also serves on the boards of several wine companies and as advisor at the interprofessional fund For.Agri. He is co-owner of Vini Eleva, which produces, among other wines, Amarone della Valpolicella "Piovesole" and Valpolicella Classico "Fralibri" www.vinieleva.it

Robin Goldstein**University of California, Davis**

Robin Goldstein is an American author and food and wine critic. He is known for his books and articles questioning conventional wisdom in the food and wine industries, particularly a widely publicized exposé of Wine Spectator magazine, and for his writing on the Freakonomics blog. He is author of several books, including “The Wine Trials” (the world's bestselling guide to cheap wine), “The Beer Trials, and an upcoming book tentatively entitled A Defense of Fast Food. Goldstein was also one of the subjects of “Think Like a Freak”, the 2014 book by “Freakonomics” authors Steven Levitt and Stephen Dubner. He lives in Oakland, California.

Robert Goodman**Rutgers University**

Robert “Bob” M. Goodman is a prominent plant biologist and virologist, and has served as the executive dean of agriculture and natural resources at Rutgers, The State University of New Jersey since June 2005. He is the executive dean of Rutgers School of Environmental and Biological Sciences and the executive director of Rutgers New Jersey Agricultural Experiment Station.

Richard Gray**University of Saskatchewan**

Professor Bioresource Policy, Business and Economics - University of Saskatchewan - Canada. Richard Gray joined the University of Saskatchewan in 1990 after completing his PhD in Agricultural & Resource Economics from UC Berkeley. Over time his policy research has increasingly focused on various aspects of agricultural research and innovation systems. From 2003 to 2013 he led the Canadian Agricultural Innovation Research Network. Richard is a Fellow of the Canadian Agricultural Economics Society. He regularly provides advice to farm organisations and government regarding innovation policy. His active engagement in the family grain farm continues to provide first hand experience with agriculture.

Valentino Mercati**Aboca**

Valentino Mercati is President and founder of Aboca S.p.A. – Sansepolcro (AR) Italy. The company operates with 1,000 hectares, cultivating 70 species of medicinal herbs, it produces 2,300 tons of fresh dried product every year, holds 16 international patents and exports to 13 countries with 4 branch offices worldwide. It employs more than 700 employees. Aboca develops and produces medicinal plants for dietary nutrition and cosmetics.

Carolina Navarrete Frias
CIAT

Carolina graduated with honors from the International Relations Program from the Universidad del Rosario in Bogotá in 2004. She also holds an MA in Latin American Studies from the University of Texas at Austin. She is currently a PhD student in the Sociology and Social Policy Program in the University of Southampton, England. Her doctoral research focuses on institutional arrangements and natural resource governance in the Amazon. She joined CIAT in July 2011 and is now the Technical Focal point for Latin America and the Caribbean in the Communications and Alliances Office

Robert Paarlberg
Harvard Kennedy School

Robert Paarlberg is Adjunct Professor of Public Policy at the Harvard Kennedy School. From 1976 until 2015 he was Professor of Political Science at Wellesley College. He received his B.A. from Carleton College and earned a PhD in International Relations from Harvard University. He is the author of six university press books, including *Food Politics: What Everyone Needs to Know* (Oxford 2013) and *The United States of Excess: Gluttony, and the Dark Side of American Exceptionalism* (Oxford 2015). Paarlberg has been a member of the Board of Agriculture and Natural Resources at the National Research Council of the National Academies, and was a member of the Board of Directors of Winrock International. He currently serves as Chair of the Independent Steering Committee of the Agriculture for Nutrition and Health Research Program at the CGIAR.

Philip Pardey
University of Minnesota

Philip Pardey is Professor of Science and Technology Policy in the Department of Applied Economics at the University of Minnesota. He is also the Director of Global Research Strategy for the College of Food Agricultural and Natural Resource Sciences and the Minnesota Agricultural Experiment Station and directs the University's International Science and Technology Practice and Policy (InSTePP) center. Previously he was a senior research fellow at the International Food Policy Research Institute, Washington D.C., and prior to 1994 at the International Service for National Agricultural Research in The Hague, Netherlands. His research deals with productivity measurement and assessment, the finance and conduct of R&D globally, methods for assessing the economic impacts of research, and the economic and policy (especially intellectual property) aspects of genetic resources and the biosciences. Philip is a Fellow of the American Association for the Advancement of Science and the American Agricultural Economics Association, a Distinguished Fellow and Past President of the Australian Agricultural and Resource Economics Society, a Distinguished Life Member of the International Association of Agricultural Economists, and a winner of the Siehl Prize for Excellence in Agriculture.

Carl Pray
Rutgers University

Carl Pray is President of ICABR, and chair of the Department of Agricultural, Food and Resource Economics at Rutgers School of Environmental and Biological Sciences. He is also an adjunct professor and advisor of the Ph.D. Program and a member of the Board of Academic Advisors of the Center for Chinese Agricultural Policy, Chinese Academy of Science. The focus of his current research is agricultural science and technology policy in China, India, South Africa, and other developing countries. In the recent past he has studied how public policies could induce private companies to conduct research that would reduce hunger and poverty in developing countries, and the political economy of public sector research in developing countries.

Gordon Rausser
University of California, Berkeley

Dr. Gordon Rausser is an internationally recognized economist who has combined active careers in academia, business, and public policy. He has received 22 major awards for original research and distinguished service. Since 1986, Dr. Rausser has been the Robert Gordon Sproul Distinguished Professor at University of California, Berkeley. Dr. Rausser has been elected a Fellow of the American Association for the Advancement of Science, the American Statistical Association, and the Agricultural and Applied Economics Association. He has held faculty positions in Economics and Statistics at the University of Chicago, Harvard University, Iowa State University, Hebrew University, and UC Davis. Over the course of his career, Dr. Rausser has published over 300 journal articles, book chapters, and books. His newest book, Structuring Public-Private Research Partnerships for Success: Empowering University Partners, presents a framework for structuring public-private research partnerships that protect both these institutions' academic freedom and the private firm's corporate interests.

Rick Roush
Pennsylvania State University

Rick Roush is Dean of Pennsylvania State University's College of Agricultural Sciences. Trained as an entomologist, Rick's career spans research, teaching, and administrative appointments in both the USA and Australia, with a focus on slowing pests and weeds from evolving resistance to insecticides, herbicides, and GM crops. Rick was Dean of the Melbourne School of Land and Environment (2006-2014), Director of the University of California Integrated Pest Management and Sustainable Agriculture Programs (2003-2006), and Director of the Cooperative Research Centre on Australian Weed Management (1998-2003). These positions provided ample and stressful opportunities to contemplate funding of agricultural research and extension.

Eric Sachs**Monsanto**

Dr. Sachs received his PhD in Genetics at Texas A&M University, and MS and BS degrees in Botany from the University of California, Davis. Over his 39 year career at Monsanto Company he has made key contributions to the development, authorization and commercial application of genetically engineered crops. Today, he focuses his attention on the role of agricultural innovation for helping to provide needed nutrition to a growing world while also creating more sustainable landscapes that value crop productivity and biodiversity equally. Dr. Sachs is not a stranger to controversy. He regularly communicates about ways to address regulatory and policy barriers to innovation and encourages a skeptical public to more clearly see the benefits of current and future agricultural advancements in genetics, breeding, chemistry and data science.

Sara Savastano**World Bank and University of Rome Tor Vergata**

Sara Savastano is Senior Economist at DECSI. She joined the Enabling the Business of Agriculture project in January 2016, and works as topic leader for land. She is assistant professor in economics at the University of Rome Tor Vergata currently on leave. After working, from 2001 to 2005 at the Development Research Group of the World Bank, she served as an Economist at the Public Investment Evaluation Unit of the Italian Ministry of Economy and Finance until 2008. She is secretary general of ICABR, the International Consortium on Applied Bioeconomy Research. Her research focuses on land policies and institutions, rural development, agriculture efficiency and productivity, technology adoption. She has been consultant to FAO, World Bank, IFPRI, UNIDO; Italian Ministry of Economy and Ministry of Labor. She holds a PhD in Economics from the University of Rome Tor Vergata.

Pasquale Scandizzo**University of Rome, Tor Vergata**

Pasquale Lucio Scandizzo, who holds a Ph.D. from the University of California, Berkeley, is Professor of Political Economy and Senior Fellow of the Economic Foundation and the Center of Economic International Studies (CEIS) at the University of Rome "Tor Vergata". He is President of the Italian Association of Development Economists. He was Senior Economist and Resident Representative with the World Bank, and held several senior positions in government institutions in Italy. He has widely published on topics of development economics and is presently advising the World Bank and other international institutions on the evaluation of policies of sustainable development.

Kostas G. Stamoulis**FAO**

Kostas G. Stamoulis is currently the Assistant Director-General a.i. of the Economic and Social Development Department at the FAO of the United Nations. He served as Director, Strategic Programme Leader, Food Security and Nutrition in FAO. He led through 2015 the design and provided strategic guidance of FAO's Strategic Programme on Food Security and Nutrition. Between 2008 and 2015 he was the Director of the Agricultural Development Economics Division of FAO. From 2007 to 2015 he has been the Secretary of the Committee on World Food Security (CFS) and played a key role in the reform of the committee. Before joining FAO in 1989, he was Assistant Professor of Agricultural Economics at the University of Illinois in Urbana Champaign. He holds a Master's Degree in Agricultural Economics from the University of Georgia (USA) and a Ph.D. in Agricultural and Resource Economics from the University of California at Berkeley.

Jo Swinnen**KU Leuven**

Johan Swinnen is Professor of Economics and Director of the LICOS-Centre for Institutions and Economic Performance at the KU Leuven; Senior Research Fellow at the Centre for European Policy Studies (CEPS); and a Visiting Scholar at the Centre for Food Security and the Environment (FSE) at Stanford University. He was previously Lead Economist at the World Bank and Economic Advisor at the European Commission, and is a regular consultant for OECD, FAO, EBRD, and coordinator of international research networks. He was President of the International Association of Agricultural Economists (2012-2015); is a Fellow of the European and the American Associations of Agricultural Economists. He holds a Ph.D from Cornell University and a Honorary Doctorate from the Slovak Agricultural University. He is President of The Beeronomics Society (The global association studying the economics of beer and the business of brewing).

Howard-Yana Shapiro**Mars Inc.**

Howard-Yana Shapiro is Global Director of Plant Science and External Research, Mars Incorporated. Within Mars, Incorporated, Howard is responsible for the plant science of their primary agricultural products, investigation of potential new plant based solutions for use in their brands, review and oversight of our existing and future plant based research, co-chair of the Plant Science Pod of the Mars Sustainability Advisory Council, member of the Technical Committee, and leader of the sustainability/production models for agroecological, agroforestry and agroecconomics of multifunctional cacao systems globally.

David Zilberman
University of California, Berkeley

David Zilberman is a Professor and holds the Robinson Chair in the Department of Agricultural and Resource Economics at the University of California at Berkeley. Dr. Zilberman's areas of expertise include agricultural and environmental policy, marketing, risk management, the economics of innovation, natural resources, water, biotechnology, and biofuels. He is a Fellow of the AAEA and AERE. He has published 250 refereed articles in Science, AER, Econometrica, AJAE, and JEEM, among others, and has edited 13 books. He has served as a consultant to the EPA, USDA, the World Bank, FAO, and OECD. He received his B.A. in Economics and Statistics at Tel Aviv University, Israel, and his Ph.D. at the University of California at Berkeley in 1979.