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978-1-107-02670-4 - Successful Agricultural Innovation in Emerging Economies:
New Genetic Technologies for Global Food Production

Edited by David J. Bennett and Richard C. Jennings

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Successful Agricultural Innovation in Emerging Economies

World population is forecast to grow from 7 to 9 billion by 2050, one in six is already hungry and food production must increase by 70–100% if it is to feed this growing population. No single solution will solve this problem but recent developments in the genetic technologies of plant breeding can help to increase agricultural efficiencies and save people from hunger in a sustainable manner, particularly in African nations where the need is greatest. These advances can rapidly incorporate new traits and tailor existing crops to meet new requirements and also greatly reduce the time and costs taken to improve local crop varieties. This book provides a collected, reliable, succinct review which deals expressly with the successful implementation of the new plant genetic sciences in emerging economies in the context of the interrelated key regulatory, social, ethical, political and trade matters.

DAVID J. BENNETT has long-term experience in the relations between the biosciences, industry, government, education, law, the public and the media. He works with the European Commission, government departments, companies, universities, public interest organisations and the media, having worked in universities and companies in the UK, USA, Australia and Europe.

RICHARD C. JENNINGS is an Affiliated Research Scholar at the University of Cambridge. His research interests are in the ethics of science and technology. He pioneered the university's teaching of ethics in science and continues to run graduate ethics workshops. He has developed, with others, a framework for assessing ethical issues in new technologies.

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New Genetic
Technologies for Global
Food Production

EDITED BY

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ALFREDO AGUILAR

Alfredo Aguilar has been at the European Commission, Directorate-General DG Research, since 1986. His job involves preparation, implementation and follow-up of the EC Research Framework Programmes and being at the interface between research and other Community policies. He is the Head of Unit for Biotechnologies, and his main objective is to promote the so-called KBBE (Knowledge-Based Bioeconomy in Europe) through the R&D activities in Biotechnology in FP7. Prior to this, Aguilar was the Head of the INCO (International Cooperation) Programme, Head of Unit for Biotechnology and Applied Genomics, Head of Unit 'The Cell Factory' and Head of Unit of Demonstration Projects in Life Sciences.

Aguilar has a PhD in chemistry (biochemistry). He is Associate Professor of Microbiology at the University Complutense of Madrid and prior to this was at the University of León. He has carried out research at postdoctoral level for several years at the John Innes Centre (Norwich, UK) and at the Institut für Zellbiologie, Eidgenössische Technische Hochschule (Zurich, Switzerland). He also worked as manager at the Chemistry R&D Department, Lever Ibérica (Unilever), Aranjuez, E. He has three Japanese patents, more than 100 publications on science management and science policy in Europe and around 85 scientific publications in international journals, books, patents, etc. on experimental research prior to his incorporation to the European Commission.

KLAUS AMMANN

Professor Klaus Ammann is Professor Emeritus of Biodiversity at the University of Bern, and formerly Director of the Bern Botanical Garden (1996–2006). He gained his PhD in 1972 at the University of Bern, for a

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thesis on vegetation and glacier history, *summa cum laude*. His research interests include biodiversity, vegetation ecology, lichens and mosses, bioindication of air pollution, ethnobotany, plant biotechnology, and biosafety and ecology of transgenic crops. He has been a guest lecturer at Delft, The Netherlands and Istanbul, Turkey, and has researched at Duke University, North Carolina, USA. He is the author of over 350 publications. He was involved in several international research projects focusing on chemotaxonomy of macro-lichens, ecological monitoring and ecological risk assessment of vertical gene flow. He is also involved in two EU projects on gene flow and plant conservation. Professor Ammann is active as editor or co-editor of journals published by Elsevier, Springer and Landes, and sits on numerous scientific committees in Switzerland and the EU.

TINA BARSBY

Dr Tina Barsby was appointed Director and CEO of the National Institute of Agricultural Botany (NIAB), Cambridge in September 2008. She has significant experience in the agricultural crop sector and is internationally recognised for scientific achievements in plant biotechnology. Her earlier work laid the foundation for the application of somatic hybridisation in commercial plant breeding and the development of cytoplasmic male sterility in vegetable breeding. She has led and managed multifaceted, product-driven R&D programmes in North America and UK/mainland Europe.

Tina has a first degree in agricultural botany from the University of Wales at Bangor, and a PhD from the University of Nottingham. She spent a postdoctoral period at Kansas State University, and worked at Allelix Inc., Ontario, Canada for several years before returning to the UK in 1989. She joined Nickerson UK (now part of the LG Group) where she remained until joining NIAB in 2006. Under her leadership NIAB and The Arable Group (TAG) combined operations and merged to form a single entity offering impartial science-based research and information. The company is active at all points along the crop development pipeline, with partnerships in place to ensure first-class research and service provision.

DAVID BAULCOMBE

Professor Sir David Baulcombe is the Regius Professor of Botany and Royal Society Research Professor at the Department of Plant Sciences of the University of Cambridge. He is a molecular biologist and his

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research interest in plants focuses on how genes can be silenced. He has now moved into the field of epigenetics – the science of how nurture can influence nature. This research links to disease resistance in plants and understanding of hybrids. David is a poor field botanist. Extramural activities include membership of the Biotechnology and Biological Sciences Research Council and in 2009 he chaired a Royal Society policy study on the contribution of biological science to food crop productivity.

ROGER BEACHY

Dr Roger Beachy was appointed by President Obama as the first Director of the National Institute of Food and Agriculture (NIFA) in the US Department of Agriculture, serving from October 2009 to May 2011. He served as Chief Scientist of the US Department of Agriculture from January to October 2010. Dr Beachy was founding president of the Donald Danforth Plant Science Center in St Louis, Missouri, 1999–2002, and headed the Division of Plant Biology at The Scripps Research Institute as the Scripps Family Chair in Cell Biology from 1998 to 2001. He was Professor in the Biology Department at Washington University in St Louis, and Director of the Center for Plant Science and Biotechnology from 1978 to 1991. Dr Beachy is a member of the US National Academy of Sciences, and was awarded the Wolf Prize in Agriculture (2001). He is a Fellow of the American Association for the Advancement of Science and the American Academy of Microbiology, Foreign Associate of the National Academy of Science India, the Indian National Science Academy, and The Third World Academy of Sciences, and is a Fellow in the Academy of Science of St Louis. He received the Bank of Delaware's Commonwealth Award for Science and Industry (1991) and the Ruth Allen award 1990 from the American Phytopathological Society (1990), among other awards.

DAVID J. BENNETT

Dr David Bennett is now a Visitor to the Senior Combination Room of St Edmund's College, Cambridge, UK and a Guest at the Department of Biotechnology of the Delft University of Technology in The Netherlands. He has a PhD in biochemical genetics and an MA in science policy studies with long-term experience, activities and interests in the relations between science, industry, government, education, law, the public and the media. He works with the European Commission, government departments, companies, universities, public interest organisations and

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the media in these areas, having worked in universities and companies in the UK, USA, Australia and, most recently, The Netherlands. He was a founder member and secretary of the European Federation of Biotechnology Task Group on Public Perceptions of Biotechnology established in 1991 and one of the first organisations in this field. For the last 20 years or so he has been running many international network-based, multidisciplinary projects, courses, conferences, workshops, etc. funded by the European Commission and other bodies in biotechnology and, of late, nanobiotechnology. He co-edited with Richard Jennings *Successful Science Communication: Telling It Like It Is* published in 2011 by Cambridge University Press.

JACK A. BOBO

Jack Bobo is the Senior Advisor for Biotechnology in the Bureau of Economic and Business Affairs (EB) at the US Department of State. He also serves as the Chief of the Department's Biotechnology and Textile Trade Policy Division. He works on trade policy, food security, climate change and development issues related to agricultural science and technology, including agricultural biotechnology. He is responsible for developing and implementing US trade policy related to new technologies and working with foreign governments to address regulatory barriers to US agricultural exports. Prior to joining the State Department, Jack Bobo practised law at the Washington, DC firm of Crowell & Moring, LLP. His education includes a degree in law and an MSc in environmental science, as well as degrees in chemistry, biology and psychology. Previously, he received a research fellowship in international law at the University of Cambridge, served as an advisor to the President's Information Technology Advisory Committee, and taught science in Mekambo, Gabon in Central Africa as a Peace Corps volunteer.

GRAHAM BROOKES

Graham Brookes is an agricultural economist and consultant with 26 years' experience of examining economic issues relating to the agricultural and food sectors. He is a specialist in analysing the impact of technology, policy changes and regulatory impact. He has undertaken several evaluations of EU regulations including economic impact assessments of pesticide approvals, GMO regulations, novel foods and health claims. He has also, since the late 1990s, undertaken a number of research projects relating to the impact of agricultural biotechnology

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and written widely on this subject in peer-reviewed journals. This work includes annual updates of the global economic and environmental impact of GM crops since 1996, the impact of insect-resistant maize in Spain and herbicide-tolerant soya beans in Romania, the impact of GMO labelling in Europe, the economic impact of GMO zero-tolerance legislation and the cost to the UK economy of failure to embrace agricultural biotechnology.

SAMUEL BURCKHARDT

Samuel Burckhardt graduated at the University of Zurich with an MSc in business information systems. He also holds an MBA from the London Business School where he did various engagements in the social sector. At the time of writing this chapter, he was employed as an external consultant to the Cambridge Malaysian Education and Development Trust, c/o Trinity College, Cambridge, UK. Samuel currently works as a Senior Associate with McKinsey & Co. in Zurich, focusing on various industries on technology as an enabler.

CLAUDIA CANALES HOLZEIS

Dr Claudia Canales Holzeis is an Associate Scientist at the Department of Plant Sciences, University of Oxford. She has 9 years' experience in plant genetics research. She worked for 2 years as a Senior Project Officer for the International Service for the Acquisition of Agri-Biotech Applications (ISAAA), based in the Philippines, on science communication and technology transfer projects. She is a graduate of the University of Reading in environmental biology and holds a PhD in plant genetics from the University of Oxford.

MARK F. CANTLEY

Mark Cantley graduated in mathematics (Cambridge, 1963), economics (London School of Economics, 1965), operational research (London School of Economics, 1965) and accounting and finance (1980s). His initial career was in the operations research department of BISRA (British Iron and Steel Research Association), then he went to the University of Lancaster 1967–77 as lecturer in operations research and project leader. Mark detached to the Management and Technology Department of the International Institute for Applied Systems Analysis (IIASA) in Vienna, 1978–9. In September 1979, he moved to Brussels,

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as a member of the FAST team (Forecasting and Assessment in Science and Technology) in Directorate-General XII (Research and Innovation) of the European Commission, switching interests to biotechnology. There he headed a new unit, CUBE (Concertation Unit for Biotechnology in Europe), 1982–92. Then he went to the Organisation for Economic Co-operation and Development (OECD), 1993–8, heading the biotech unit, and drafting reports. In 1999–2005, Mark was back at DG XII as Adviser to Director, Life Sciences – he was involved in policy discussions, reporting. His activities have included frequent public speaking, reporting, etc. on modern biotech, with extensive travel in Europe, and occasionally further afield. Mark retired in 2005.

EUGENIO J. CAP

Dr Eugenio J. Cap is currently Director of the Institute of Economics and Sociology, with Argentina's National Institute of Agricultural Technology (INTA). He graduated from the University of Buenos Aires, did graduate work both at the University of California, Davis (MSc in vegetable crops) and at the University of Minnesota (PhD in agricultural and applied economics). His research work includes the development of quantitative tools for the analysis of the agricultural sector, with emphasis on technological variables and the impact assessment of agricultural research. He has authored numerous publications on those subjects. He has also worked as a consultant for the Food and Agriculture Organization, The World Bank, the Interamerican Development Bank and the Interamerican Institute for Cooperation in Agriculture, among other national and international organisations.

DANUTA CICHOCKA

Danuta Cichocka graduated in environmental protection at Warsaw University and environmental resources at the University of Salford. She carried out her PhD research on microbial degradation of environmental contaminants and the application of stable isotope techniques for environmental monitoring at the Helmholtz Centre for Environmental Research in Leipzig. She was awarded a PhD in environmental microbiology from the Technical University in Freiberg in 2008, and completed postdoctoral training at the Catholic University in Leuven (KUL). In 2009 she joined the Research and Innovation Directorate-General of the European Commission. As a Research Programme Officer, she worked on both projects and policies in the area of Knowledge-Based Bioeconomy, with a

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major focus on environmental biotechnology. She has represented the EC in both the European Federation of Biotechnology and the EU–US Task Force on Biotechnology Research, and led the preparation of the EC publication *A Decade of EU-Funded GMO Research (2001–2010)*, which led to her interest in the European GMO research and regulatory framework.

GORDON CONWAY

Professor Gordon Conway FRS trained in agricultural ecology, attending the Universities of Bangor, Cambridge, West Indies (Trinidad) and California (Davis). In the 1960s he was a pioneer of sustainable agriculture developing an integrated pest management programme for the State of Sabah in Malaysia. He joined Imperial College in 1970, setting up the Centre for Environmental Technology in 1976. In the 1970s and 1980s he lived and worked extensively in Asia and the Middle East, for the Ford Foundation, the World Bank and USAID. He directed the Sustainable Agriculture Programme at the International Institute for Environment and Development (IIED) and then became representative of the Ford Foundation in New Delhi. Subsequently he became Vice-Chancellor of the University of Sussex and Chair of the Institute of Development Studies (IDS). From 1998–2004 he was President of the Rockefeller Foundation and from 2004 to 2008 Chief Scientific Adviser to the Department for International Development and President of the Royal Geographical Society. He is a KCMG, Deputy Lieutenant of East Sussex, and an Honorary Fellow of the Royal Academy of Engineering. He holds five honorary degrees and fellowships. He is the author of *The Doubly Green Revolution: Food for All in the Twenty-First Century*, and currently Director of the advocacy group, Agriculture for Impact.

ADRIAN DUBOCK

Adrian Dubock has a PhD in vertebrate zoology from Reading University. After 2 years working for the UK Ministry of Agriculture Fisheries and Food he joined ICI, Plant Protection Division in 1977. Following company demergers and mergers in 2001 Adrian moved to Switzerland as head of Syngenta's global function responsible for Mergers, Acquisitions, Ventures and Intellectual Property Licensing. Adrian has lived in four and worked in more than 90 countries with a broad range of business development, strategic and operational responsibilities. As a sideline, for 15 years he also owned and worked a 52-hectare UK grass farm with 320 sheep. He retired from Syngenta after 30 years' service at the end of 2007. Since 2008 he has been a member of the Advisory Board

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of the Freiburg Institute of Advanced Studies, School of Life Sciences and School of Soft Matter Research, Albert-Ludwigs-Universität, Freiburg, Germany, one of the German universities' excellence cluster. In 2000 he negotiated with the inventors of Golden Rice, the first purposefully created biofortified crop, and has worked with them closely and others since in trying to bring their humanitarian not-for-profit vision to fruition. Currently he is Executive Secretary of the Golden Rice Humanitarian Board, and also Golden Rice Project Manager.

JIM M. DUNWELL

Professor Jim M. Dunwell graduated in botany from the University of Oxford, and worked for 16 years at the John Innes Institute (Norwich, UK) where he obtained a PhD in plant physiology. He then spent 10 years at ICI Seeds, later Zeneca Plant Sciences, where he was responsible for an international programme on transgenic crops. He moved to the University of Reading where he is Professor of Plant Biotechnology and has research interests in plant breeding, gene expression and protein evolution. He was a member of the Royal Society Working Group on food-crop production, and at present is a member of the Advisory Committee for Releases to the Environment, the committee that advises the UK government on the field testing of GM plants.

IOANNIS ECONOMIDIS

Dr Ioannis Economidis is a graduate of the Agricultural University of Athens and holds a PhD in biochemical genetics from the University of Texas at Austin. His research was concentrated on protein/nucleic acid interactions related to gene expression. He has worked as a research associate in the USA, in Belgium and in Greece. In 1987, he joined the Research Directorate-General of the European Commission where he developed research sectors in the interface of biotechnology and the environment such as the safety of GMOs, topics of environmental biotechnology and issues on molecular diversity. In 2005, he joined the team which developed the concept of the Knowledge-Based Bioeconomy and developed sectors such as environmental biotechnology, molecular diversity, metagenomics, GMO safety and emerging technologies serving biotechnology such as synthetic biology. He represented his service in the European Federation of Biotechnology, the Working Party on Biotechnology of the OECD and the EU-US Task Force on Biotechnology

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Research. Dr Economidis is a Visiting Professor at the University of Athens and Crete on topics of bioeconomy, biosafety and bioethics. He is also a Member of the Advisory Boards of the Centre for Environmental Risk Assessment of the International Life Sciences Institute Research Foundation, of the International Symposia of Biosafety Research and of the Working Group on Synthetic Biology of the EU–US Task Force on Biotechnology Research.

CLAUDE FISCHLER

Claude Fischler is a “Directeur de recherche” at CNRS, the national research agency of France, and heads IIAC (Institut Interdisciplinaire d’Anthropologie du Contemporain, Interdisciplinary Institute for Contemporary Anthropology), a research unit of the Ecole des Hautes Etudes en Sciences Sociales in Paris. His main area of research has been a comparative, social science perspective on food and nutrition. His main current research is on commensality - eating together - its forms and functions, and its possible impact on public health. He served on the Scientific Committee and the Expert Committee on Human Nutrition of AFSSA, the French Agency for Food Safety and on its board of directors. He has been a member of the steering committee of the French National Program on Nutrition and Health and of the Executive Committee of the European Sociological Association. He serves on the the Strategic Committee on Sustainable Agriculture and Development advising the French Minister of Food and Agriculture and on the Advisory Group on Risk Communication of the European Food Safety Authority.

GEORGE GASKELL

Professor George Gaskell BSc PhD, Professor of Social Psychology, is Pro-Director of the London School of Economics and Political Science. His research focuses on science, technology and society; in particular the issues of risk and trust; how values influence people’s views about technological innovation, and the governance of science and technology. His research competencies include survey methodology and both quantitative analysis and qualitative inquiry. Since 1996 he has coordinated the series of Eurobarometer surveys on *Biotechnology and the Life Sciences* for the EC Directorate-General for Research and Innovation. He was principal investigator of *Life Sciences in European Society*, a European comparative study of biotechnology in the public sphere funded by the European Commission, and is now leading a project on sensitive

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technologies and European public ethics. He is a member of the Expert Group on Risk Communication of the European Food Standard Authority and chairs the International Advisory Group of the Centre for Genomics and Society in the Netherlands. He was Vice-Chair of the European Commission's Science and Society Advisory Committee and was also a member of the Science in Society Committee of the Royal Society.

IAN GRAHAM

Professor Ian Graham holds the Weston Chair of Biochemical Genetics and is the Director of the Centre for Novel Agricultural Products (CNAP) at the University of York. His research interests focus on the metabolic regulation of gene expression in higher plants and metabolic engineering of novel oils and other high-value chemicals. Current projects range from the development of novel oilcrops such as *Jatropha curcas* to the production of new varieties of *Artemisia annua* that deliver higher yields of the antimalarial compound artemisinin. Funding for Ian's research comes from a range of sources including industry, UK government, EU, UK and overseas charities.

JULIAN GRAY

Julian Gray is a double graduate of Imperial College London, with a BSc in cellular and molecular biology and a PhD in proteomics. Julian also holds an MBA from the London Business School and The Wharton School, University of Pennsylvania (Exchange Program). At the time of writing this chapter, he was employed as an external consultant to The Cambridge Malaysian Education and Development Trust, c/o Trinity College, Cambridge, UK. Julian currently works as a consultant at The Boston Consulting Group with a special interest in the social impact, healthcare and public sector practices.

JONATHAN GRESSEL

Professor Jonathan Gressel is a plant scientist devoted to issues of world food security and how it can only be obtained by increasing crop productivity and the introduction of new crops, using all available tools, especially genetic engineering. He has performed extensive research on issues of transgene flow between crops and weeds, as well as developing crops resistant to weeds, especially the parasitic weeds that plague Africa. He has authored or co-authored over 300 scientific publications including eight books. His most recent book is *Genetic Glass Ceilings: Transgenics for*

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Crop Biodiversity. He is presently a Professor Emeritus at the Weizmann Institute of Science in Rehovot, Israel, and recently spent 3 years as chief scientist at TransAlgae Ltd, a company he co-founded.

BRIAN HEAP

Professor Sir Brian Heap CBE FRS is President of the European Academies Science Advisory Council. He was Master of St Edmund's College, Cambridge, Vice-President and Foreign Secretary of the Royal Society, President of the Institute of Biology and President of the International Society for Science and Religion. He has doctorates from Nottingham and Cambridge with publications in physiology, biotechnology, sustainability and science advice for policy. He was Director of Research at the Institute of Animal Physiology and Genetics Research (Cambridge and Edinburgh) and at the Biotechnology and Biological Sciences Research Council (Swindon). He served as UK Representative at the European Science Foundation at Strasbourg and the NATO Science Committee at Brussels. With the Nuffield Council on Bioethics, the Department of Health's Expert Group on Cloning, the Parliamentary Select Committee on Science and Technology and the President's Advisory Group on Biotechnology he has been engaged in public issues of biotechnology, population growth, sustainability and science policy working with the World Health Organization, the UK–China Forum and the European Commission. He was scientific consultant for several international pharmaceutical companies and is Special Scientific Adviser for ZyGEM Co. Ltd, New Zealand. He was knighted in 2001 for services to science internationally.

T. J. V. HIGGINS

T. J. V. Higgins is an Honorary Fellow at CSIRO Plant Industry. He works on protecting food legumes from insect damage, researching the application of gene technology for plant improvement. His current research is focused on international agriculture with particular emphasis on Africa and India and he has a special interest in public awareness of science.

JENS HÖGEL

Jens Högel graduated in 1992 from the Technical University of Berlin as engineer for fermentation technology and expert for quality management systems based on the Hazard Analysis Critical Control Points (HACCP) concept in the food and beverage industry. His professional

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career is marked by more than 10 years of experience in international sales and product management in the food and beverage and pharmaceutical industry. After joining the European Commission in 2002 as Food and Veterinary Inspector, he specialised further in the areas of food safety and genetically modified organisms. In this position he reviewed the governance of food safety systems in EU Member States and countries outside the European Union, in particular in the North and South Americas and Asia. After working in the Directorate-General for Environment as Policy Officer in the area of biotechnology he joined the Directorate-General for Research and Innovation in July 2008, where he is working as Research Programme Officer in the area of Knowledge-Based Bioeconomy. Apart from project management, he remains heavily involved in policy making in relation to genetically modified organisms in the European Union. He is currently also involved in the preparation of Horizon2020 and related issues, and in the preparation and management of the annual work programmes in the area of biotechnologies under the Seventh Framework Programme for Research.

RICHARD C. JENNINGS

Dr Richard C. Jennings is an Affiliated Research Scholar in the Department of History and Philosophy of Science in the University of Cambridge. His research interests are focused on the Responsible Conduct of Research, and the ethical uses of science and technology. He is a member of BCS, the Chartered Institute for IT, has worked with the BCS Ethics Forum defining and refining the BCS Code of Conduct, and with four other members has developed a Framework For Assessing Ethical Issues in New Technologies. He teaches philosophy of science to undergraduate natural science students and philosophy to undergraduate philosophy students. He lectures on ethics in science and runs graduate workshops on ethical conduct and ethical practice in science. He has a long-standing interest in the history of science and the history of philosophy of science. He is a member of Queens' College, Cambridge. He co-edited with David Bennett *Successful Science Communication: Telling It Like It Is* published in 2011 by Cambridge University Press.

DREW L. KERSHEN

Professor Drew L. Kershen is the Earl Sneed Centennial Professor of Law at the University of Oklahoma, College of Law. Professor Kershen has been teaching at the University of Oklahoma since 1971. His academic work has

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been primarily in the areas of agricultural law and water law. His degrees are: BA Notre Dame (1966), JD Texas (1968) and LLM Harvard (1975).

Since 1998, Professor Kershen has focused his teaching, writing and speaking on agricultural biotechnology law and policy issues. He has written extensively on legal liability, intellectual property and regulatory issues in agricultural biotechnology. In addition to many presentations in the USA, he has been a speaker on agricultural biotechnology to conferences in 11 other nations. He is also a member of the Public Research Regulation Initiative, a public service organisation, through which he has participated in international negotiations concerning agricultural biotechnology.

CHRISTOPHER J. LEAVER

Professor Christopher J. Leaver CBE FRS FRSE was Sibthorpe Professor (1990–2007) and Head of the Department of Plant Science (1991–2007) at the University of Oxford. He is now Emeritus Professor of Plant Science and a Fellow of St John's College. His main research interests were the molecular and biochemical basis of plant growth and differentiation. This included an investigation of energy metabolism and the regulation of mitochondrial biogenesis during plant growth and differentiation, coupled with an investigation of the molecular and biochemical basis, and phenotypic consequences, of mitochondrial genetic diversity in plants in general and cytoplasmic male sterility in important crop plants in particular. He also worked on the metabolic and genetic regulation of genes encoding glyoxylate cycle enzymes and factors regulating the biosynthesis of glutathione and its function during oxidative stress. In recent years he has made important contributions to our understanding of senescence and programmed cell death in plants.

Professor Leaver has a strong interest in the public understanding of science and has been actively involved in the debate on genetically modified crops both nationally and internationally. He was elected a member of the European Molecular Biology Organisation in 1982, Fellow of the Royal Society in 1986, Royal Society of Edinburgh 1987, Academiae Europaeae 1989. In 2000, he was awarded the CBE for services to plant sciences, elected a corresponding member of the American Society of Plant Biologists (2003) and Inaugural Fellow of the American Society of Plant Biologists (2007) and has served on the councils of the Agricultural and Food Research Council and the Biotechnology and Biological Sciences Research Council, and was Chair of the UK Biochemical Society, the Council of the European Molecular Biology

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Organisation and a Trustee of the Natural History Museum, London. He has been a member of the Governing Body of the John Innes Centre since 1984 and a Trustee of the John Innes Foundation since 1987. He is a founding Trustee of Sense about Science and visiting Professor at the University of Western Australia and serves on a number of international advisory boards and committees.

LU BAO-RONG

Professor Lu Bao-Rong is the Chair of the Department of Ecology and Evolutionary Biology in Fudan University, Shanghai, PR China. He received a PhD from the Swedish University of Agricultural Sciences in 1993. He was awarded as a Distinguished Young Scholar in 2001 by the Natural Science Foundation of China (NSFC). He is actively involved in research and teaching of botany, evolutionary biology and biodiversity conservation. He has published more 260 articles which have been cited more than 3500 times. Currently, he focuses on research of the molecular evolution and environmental biosafety of GMOs, particularly transgene flow and its ecological impacts. He is the President of the International Society for Biosafety Research (ISBR), and a Member of the Chinese National Biosafety Committee. He sits on the editorial board of a number of national and international journals.

DIRAN MAKINDE

Dr Diran Makinde is Director of the NEPAD Planning and Coordinating Agency, African Biosafety Network of Expertise (ABNE) based in Ouagadougou, Burkina Faso. He is the immediate past Director of the NEPAD West African Biosciences Network in Dakar, Senegal. He earned the degrees of Doctor of Veterinary Medicine in 1976, and a PhD in veterinary physiology from the University of Ibadan in 1986. Prior to his current appointment, he was Professor of Animal Science at the University of Venda, South Africa where he also served a 5-year term as Dean of the School of Agriculture, Rural Development and Forestry (1997–2001). In addition, he taught at the universities of Ibadan (Nigeria), 1977–91 and Zimbabwe, 1989–95. His research interest was in the field of gastrointestinal physiology of monogastrics, which includes such areas as digestibility and intestinal transport. As a result he developed and applied this in risk-assessment studies and became involved in advocacy for agricultural biotechnology and biosafety. He has well over 45 publications in peer-reviewed journals locally and internationally, as well as

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several contributions in the form of books/chapters in books. He is a C-rated scientist as evaluated (1998) by the South Africa National Research Foundation.

CAREL DU MARCHIE SARVAAS

Carel du Marchie Sarvaas is Director for Agricultural Biotechnology at EuropaBio, the European Association for Bioindustries. Carel has worked as a public affairs and communications advisor in Brussels, The Hague and Washington DC over some two decades. He leads a team of six specialists at EuropaBio and coordinates biotechnology outreach programmes across Europe. In agriculture, EuropaBio represents all main producers of biotechnology seeds as well as developers of new breeding techniques.

NATHALIE MOLL

Nathalie Moll is Secretary-General of EuropaBio, the European Association for Bioindustries. Nathalie is an honours graduate in biochemistry and biotechnology from St Andrews University, UK and has spent the past 16 years working for the biotechnology industry at European Union and national level focusing on improving awareness of the importance and benefits of biotechnology for society.

LARRY MURDOCK

Larry Murdock is Professor of Entomology at Purdue University, Indiana. His interests range from basic research in insect physiology, biochemistry and molecular biology to biotechnology and simple technology. He hopes his work benefits food production and availability in developing nations, especially Africa.

MARTIN PORTER

Martin Porter is Managing Director of Edelman | The Centre and was a co-founder of The Centre, Brussels' first think-do tank, before it joined the Edelman network in March 2010. Since April 2012, he has also taken on the role of overseeing Edelman's European Medicines Agency (EMA) Public Affairs practice. He is closely involved and highly active in consulting activities, where he specialises in strategic advice and high-level public engagement support, especially in areas related to the low carbon economy, sustainability and risk-management issues.

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His track record during his 15 years of European Union public affairs activity in Brussels includes advocacy and communications campaign design and support to companies, associations, coalitions, NGOs and governments involved in the above areas to create shared-value outcomes that deliver public goods as well as private enterprise benefits.

With a PhD in political science from the University of Bath and a first-class joint honours degree in modern languages and European studies from the same university, he is also a Visiting Fellow of the School of Public Policy at University College London, a Board Member of its European Institute and a Senior Associate of the Cambridge University Programme for Sustainability Leadership.

WAYNE POWELL

Professor Wayne Powell trained in plant breeding and cytogenetics at the University College Wales, Aberystwyth (H. Rees, FRS) and in quantitative genetics (Birmingham, School of Biometrical Genetics, J.L. Jinks FRS). His earlier work laid the foundations for the use of doubled haploids and cross prediction in plant breeding. He was awarded the Broekhuizen Prize in 1990 for outstanding contribution to European cereal science and obtained his DSc (plant genetic manipulation) in 1993 (University of Birmingham). His personal research interests are at the interface of plant genetics, genome science, plant breeding and conservation of genetic resources with a strong emphasis on the delivery of 'public good' outcomes. He has published over 250 refereed scientific journal papers which have attracted 9300 citations, with an H index of 50, and a further 120 book chapters and conference proceedings, and he has presented numerous invited papers at international meetings and successfully supervised 20 PhD students and numerous visiting workers. His professional career has spanned academia, the public sector and commerce (Dupont). He is currently Professor and Director of the Institute of Biological, Environmental and Rural Sciences (IBERS) at Aberystwyth University. This was formed in 2008 by merging the Institutes of Biological and Rural Sciences of the university with the Institute of Grassland and Environmental Research (IGER) to form one of the largest groups of academics and support staff in the UK focusing on plant and land-based sciences, with more than 350 staff, 1200 undergraduates and a complex range of stakeholders. In his current role he has led and managed a significant organisational and cultural change programme to create a fully integrated institute that

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embraces mission diversity: education, research and enterprise. This has involved attracting more than £80 million of investment to support new faculty appointments, capital infrastructure and national capability to underpin world-class research.

TIM RADFORD

Tim Radford is a freelance journalist. He was born in New Zealand in 1940. He joined the *New Zealand Herald* as a reporter at the age of 16, and moved to the UK in 1961. Apart from a brief spell as a Whitehall information officer, he has spent all his life in weekly, evening or daily newspapers. He worked for the *Guardian* for 32 years, becoming – among other things – letters editor, arts editor, literary editor and science editor. He won the Association of British Science Writers award for Science Writer of the Year four times, and a lifetime achievement award in 2005. He has served on the UK committee for the UN International Decade for Natural Disaster Reduction; on the council of Copus, the Royal Society's committee for the public understanding of science; and on the external relations committee of the Geological Society of London. He is an Honorary Fellow of the British Science Association and a Fellow of the Royal Geographical Society. He has lectured on, or taken part in debates about, science and the media in many cities in Europe, the USA, China and Russia. He has also written for *Nature*, *The Lancet*, *New Scientist*, the *London Review of Books*, *Geographical* and many other journals. He has written two books – *The Crisis of Life on Earth* (1990) and *The Address Book: Our Place in the Scheme of Things* (2011) – and edited two books of science writing for the *Guardian*.

CHAVALI KAMESWARA RAO

Professor Chavali Kameswara Rao, born 1937, received his BSc (Hons), MSc and PhD in botany from the Andhra University, Waltair and his DSc (*hon. Cos.*) from the Open International University for Complementary Medicines, Colombo. His university teaching and research career spanned from 1965 to 2003. He was Professor and Chairman, Department of Botany and Department of Sericulture, Bangalore University, Bangalore, India. On a Commonwealth Academic Staff Fellowship and a Royal Society and Nuffield Foundation Bursary, he worked at the Natural History Museum, London, the Royal Botanic Gardens, Kew, and Royal Botanic Gardens, Edinburgh on computer applications in plant systematics. He was awarded a Certificate of Merit by the Lama

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Gangchen Peace Foundation (affiliated to the UN), Beijing, for services rendered to alternative and complementary systems of medicine. He is an author of four books on flora and medicinal plants and co-author of three international reports on biosecurity and modern biotechnology. He served on several international committees and special working groups of the US National Academies of Science, US National Institutes of Health, World Health Organization, etc., and several national policy committees of the Department of Biotechnology, Ministry of Environment and Forests, and Department of Science and Technology, Government of India. He is a Member of the European Federation of Biotechnology, and European Association of Pharma Biotechnology, Delft, the Netherlands and is on the Expert Panel on Agricultural Biotechnology, Council for Biotechnology Information, Washington DC. For the past 12 years he has been the Executive Secretary, Foundation for Biotechnology Awareness and Education (FBAE), Bangalore (www.fbae.org). For over a decade he has been regularly writing critical articles on various issues of biosecurity and agricultural biotechnology in developing countries, posted at www.plantbiotechnology.org.in, www.fbae.org and AgBioView. Some of these articles have been translated into other languages such as German, French, Belorussian, etc. He was an invited speaker at international conferences/workshops/seminars on biotechnology and biosecurity, held at Washington DC, Bethesda, Cornell University, Princeton University, Brussels, Basel (Syngenta Foundation, Basel University), Geneva, Brighton, Berlin, Budapest, Vienna, Cuernavaca (Mexico), Beijing, Tripoli, Bangkok, Des Moines (US) Cambridge (UK), and Den Hague, besides at numerous places in India.

PAMELA RONALD

Pamela Ronald is Professor of the Department of Plant Pathology and the Genome Center at the University of California, Davis. Ronald's laboratory has engineered rice for resistance to disease and tolerance to flooding which seriously threaten rice crops in Asia and Africa. In 1996, she established the Genetic Resources Recognition Fund, a mechanism to recognise intellectual property contributions from less developed countries. She and her colleagues were recipients of the US Department of Agriculture 2008 National Research Initiative Discovery Award for their work on rice submergence tolerance. Ronald was awarded a Guggenheim Fellowship, the Fulbright–Tocqueville Distinguished Chair and the National Association of Science Writers Science in Society Journalism Award. She is an elected Fellow of the American

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Association for the Advancement of Science. Ronald has written opinion pieces for the *Boston Globe*, *The Economist* and the *New York Times* and is a blogger for *National Geographic's* ScienceBlogs. She is co-author with her husband, Raoul Adamchak, an organic farmer, of *Tomorrow's Table: Organic Farming, Genetics and the Future of Food*. Bill Gates calls the book 'a fantastic piece of work'. In 2011, Ronald was selected as one of the 100 most creative people in business by *Fast Company Magazine*.

PIET SCHENKELAARS

Piet Schenkelaars finished his studies in molecular sciences and philosophy of science in 1984 at the Agricultural University Wageningen in The Netherlands. Thereafter he worked for many years for civil society organisations in The Netherlands. From 1990 to 1993 he worked as coordinator of the Clearinghouse on Biotechnology at Friends of the Earth Europe in Brussels. Subsequently, he was employed by an environmental consultancy and a consultancy in societal communication both located in The Netherlands. In 1998 he founded Schenkelaars Biotechnology Consultancy. Since then he has conducted many studies on regulatory and sustainability aspects of biotechnology. He has also coordinated European Union research projects, organised conferences and moderated stakeholder dialogues.

IDAH SITHOLE-NIANG

Idah Sithole-Niang is an Associate Professor in the Department of Biochemistry, University of Zimbabwe. She has worked on cowpea crop improvement for two decades, and maintains a keen interest in agricultural biotechnology and biosafety issues in sub-Saharan Africa.

SALLY STARES

Dr Sally Stares is a Research Fellow in the Methodology Institute at the London School of Economics and Political Science. Her research is based around the methodological theme of social measurement, with a focus on the measurement of social psychological concepts in cross-national social surveys, and an emphasis on the use of latent variable models to address common challenges encountered in this field of work, such as capturing complex constructs, taking account of 'don't know' responses and exploring the comparability of measures between

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groups – particularly between countries. She works on public perceptions of various aspects of science and technology, as well as on public opinion and social attitudes and values more broadly, particularly as they relate to aspects of civil society. She works on a European Commission project 'Sensitive technologies and European public ethics', and on an ESRC-funded project 'Latent variable models for categorical data: tools of analysis for cross-national surveys'.

EDUARDO J. TRIGO

Dr Eduardo J. Trigo has a PhD in agricultural economics from the University of Wisconsin. He is Director of Grupo CEO (www.grupoceo.com.ar), a consulting and research group specialising in agricultural development policy and management issues in Buenos Aires, Argentina. He also sits on the Academic Council of the Alberto Soriano Graduate School of the Faculty of Agriculture of the University of Buenos Aires and is Scientific Adviser for International Relations at the Ministry of Science, Technology and Innovation of Argentina. In the past he has served as a member of the Global Authors Team within the Global Conference on Agricultural Research for Development (GCARD 2010), Director of Science and Technology at the Interamerican Institute for Cooperation on Agriculture (IICA) and Director of Research at the International Service for National Agricultural Research (ISNAR). He has extensive academic and consulting experience in the areas of science and technology policy, organisation and management with emphasis on agricultural research and biotechnology applications to the agricultural and food sectors. He has worked with a number of national governments in Latin America and other parts of the world and different international organisations, and published extensively.

PIERO VENTURI

Dr Piero Venturi has a degree in agricultural science and a PhD in agricultural engineering from the University of Bologna, Italy. He worked for several years as a researcher at the Polytechnic University of Madrid, at Wageningen Agricultural University and at the University of Bologna, dealing with energy crops production and non-food-chains modelling. He was lecturer in agricultural mechanisation and energy integrated systems at the University of Bologna, and worked on the development of non-food-chains for several uses. Presently he works at the Directorate-General for Research and Innovation of the European

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Commission, as Policy Officer dealing with biotechnologies and international cooperation.

KATY WILSON

Katy Wilson has a background in biological sciences and an MSc in environmental technology from Imperial College, London. She has worked in research in New York and at Harnas Wildlife Foundation in Namibia. Since 2010 she has worked for Agriculture for Impact, a Bill and Melinda Gates Foundation-funded initiative, in a research and editorial role and has contributed to Gordon Conway's book *One Billion Hungry: Can We Feed the World?*