

OXFORD

The Fight Against Hunger & Malnutrition

The Role of Food, Agriculture, and Targeted Policies

Edited by **David E. Sahn**



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Preface

Per Pinstруп-Andersen, to whom we dedicate this book, has been a tireless and effective advocate for the poor and hungry throughout his luminous career as a scholar, teacher, policy advisor, and advocate. For more than 50 years, Dr. Pinstруп-Andersen has inspired and motivated his students in his role as a revered professor, provided leadership in building and strengthening institutions dedicated to food and nutrition policy, and influenced policymakers throughout the world through his understanding and compelling articulation of knowledge and ideas that advance the cause of fighting malnutrition and ameliorating poverty through enlightened policy. Dr. Pinstруп-Andersen's passion and the efficacy of his efforts to promote technological, scientific, and policy advances has only been equaled by his humanity and the strength of his enduring friendships and relationships among the myriad people who have come to know Dr. Pinstруп-Andersen during his long and illustrious career.

Recounting Dr. Pinstруп-Andersen's professional accomplishments is far beyond the scope of this preface. Nonetheless, his roles as Babcock Professor of Food and Nutrition Policy at Cornell University and Director General of the International Food Policy Research Institute exemplify his accomplishments, and are the culmination of numerous important positions that he has held, including at the Centro Internacional de Agricultura Tropical in Cali, Colombia, as the chairman of the Science Council of the Consultative Group on International Agricultural Research, as a professor at the Royal Veterinary and Agricultural University and the University of Copenhagen in Denmark, and as past president of the American Agricultural Economics Association. He was recognized as the 2001 recipient of the World Food Prize and the Charles A. Black Award, as well as the 2002 Agricultural Economics Association Distinguished Policy Contribution Award.

This book, which is a product of a Festschrift that I organized in honor of Dr. Pinstруп-Andersen, is intended to carry forward his research and commitment to the poor and malnourished throughout the world, for whom he has been such a powerful voice. It has been my privilege to have worked on this volume with so many colleagues, all of whom are not only exceptional scholars, but share in common a close personal connection to Per. While I

have worked with Per for more than 30 years, going back to my days in graduate school when he was an inspirational mentor, some contributors to this volume have known him far longer, and others include his recent PhD students. My goal as convener of the *Festschrift* and editor of this book thus aspires to several principles that have been key to Per Pinstrup-Andersen's illustrious career. These include the importance of sound technological advances and scientific research, the dissemination of knowledge, the exchange of information, policy dialogue, and emphasis on policy implementation. Dr. Pinstrup-Andersen's work is not yet finished, and we look forward to his continued leadership and scientific contributions for years to come.

Finally, both the *Festschrift* and this book were made possible by the efforts of several people that deserve special acknowledgment. First and foremost is Birgit Andersen, a truly amazing friend and inspirational figure. Those who have been privileged to know Birgit Andersen fully appreciate that she has been Per's indispensable partner for all his accomplishments. We all salute Birgit Andersen along with Per Pinstrup-Andersen in this book.

Patrick Stover, the Director of the Division of Nutritional Sciences at Cornell University, made the *Festschrift* and this volume possible with his generous encouragement and financial support. I also want to thank Mary-Catherine French for her extraordinary efforts in organizing and providing administrative support in planning and carrying out the *Festschrift*. And as those who contributed to this book can testify, it has been my privilege to once again work with Patricia Mason, whose editorial support and communication and organizational skills contributed to the timeliness and excellence of this book. All three of these wonderful people also have close ties with Dr. Pinstrup-Andersen, which has helped make this book project so thoroughly rewarding and fun.

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List of Abbreviations

ADRA	Adventist Development and Relief Agency
AEI	Agroecological intensification
AGRA	Alliance for a Green Revolution in Africa
ASF	Animal-source foods
AU	African Union
BMGF	Bill & Melinda Gates Foundation
BMI	Body mass index
BRAC	Bangladesh Rural Advancement Committee
CARE	Cooperative for Assistance and Relief Everywhere
CAADP	Comprehensive Africa Agriculture Development Programme
CCS	Carbon capture and storage
CCT	Conditional cash transfer program
CDC	Centers for Disease Control and Prevention, US
CGIAR	Consultative Group on International Agricultural Research
CFS	Committee on World Food Security (UN)
CI	Confidence interval
CIMMYT	CGIAR's International Maize and Wheat Improvement Center
CNI	Child Nutrition Initiative
CONSEA	National Council on Food and Nutritional Security, Brazil
CSO	Civil society organization
CSPI	Center for Science in the Public Interest
DALYs	Disability-adjusted life years
DES	Dietary energy supply
DFID	Department for International Development, UK
DHS	Demographic and Health Surveys
DRC	Democratic Republic of the Congo
DSB	Dispute Settlement Body
EAR	Estimated Average Requirement (of dietary intake)

List of Abbreviations

EE	Eastern Europe
ESSP	Ethiopia Strategy Support Program
FAO	Food and Agriculture Organization of the United Nations
FEWS NET	Famine Early Warning Systems Network
FMC	Food market chains
FSNM	Food Security and Nutrition Monitoring
FSU	Former Soviet Union
G8	Group of 8—Governments of Canada, France, Germany, Italy, Japan, Russia, United Kingdom, and United States, with representation also from European Union
G20	Group of 20—Governments of Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, Korea, Turkey, United Kingdom, United States, European Union
GATT	General Agreement on Tariffs and Trade
GDP	Gross domestic product
GHG	Greenhouse gas
GIEWS	Global Information and Early Warning System on Food and Agriculture
GIS	Geographic Information Systems
GIVAS	Global Impact and Vulnerability Alert System
GM	Genetically modified
GMFS	Global Monitoring for Food Security
GMO	Genetically modified organism
GNI	Global national income
GNP	Gross national product
GR	Green Revolution
GVP	Gross value of production
HANCI	Hunger and Nutrition Commitment Index
IBRD	International Bank for Reconstruction and Development (World Bank)
ICN	International Conference on Nutrition
IDD	Iodine deficiency disorder
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGC	International Growth Centre
IGO	Intergovernmental organization
IMF	International Monetary Fund
INCRA	National Institute for Colonization and Agrarian Reform

INGO	International non-governmental organization
IPCC	Intergovernmental Panel on Climate Change
IPG	International public good
IPM	Integrated pest management
IRRI	International Rice Research Institute
LNS	Lipid-based nutrient supplements
MCLCP	Mesa de Concertación para la Lucha Contra la Pobreza
MDGs	Millennium Development Goals
MFP	Multi-factor productivity
MICS	Multiple Indicator Cluster Surveys
MST	Movement of Rural Landless Workers (Movimento dos Trabalhadores Rurais Sem Terra)
NASS	National Agricultural Statistics Service, US
NEPAD	The New Partnership for Africa's Development (African Union)
NEWS	National Early Warning Systems
NCHS	National Center for Health Statistics, US
NGO	Non-governmental organization
NPK	Nitrogen-phosphorus-potassium (fertilizer rating)
NRM	Natural Resource Management
ODI	Overseas Development Institute
OECD	Organisation for Economic Co-operation and Development
OSP	Orange-Fleshed Sweet Potatoes
PAHO	Pan American Health Organization
PAN	Pesticide Action Network
PI	Probability interval
PNSAN	National Food and Nutritional Security Plan of Brazil
PPP	Public-private partnerships
PROGRESA	Programa de Educación, Salud, y Alimentación (Oportunidades)
PRSP	Poverty Reduction Strategy Program
RCP	Representative Concentration Pathway
RCT	Randomized controlled trial
RDA	Recommended Dietary Allowance
SADC	South African Development Community
SCN	Standing Committee on Nutrition (United Nations System)
SDGs	Sustainable Development Goals
SEC	US Securities and Exchange Commission

List of Abbreviations

SES	Social and economic status
SINESAN	Guatemala's National System of Food and Nutrition Security
SOFA	State of Food and Agriculture
SOWC	State of the World's Children
SSA	Sub-Saharan Africa
SSB	Sugar-sweetened beverage
SSP	Strategy Support Program
TFP	Total factor productivity
TFR	Total fertility rates
UCT	Unconditional cash transfer
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNICEF	United Nations Children's Fund
UPOV	International Union for the Protection of New Varieties of Plants
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USDHHS	United States Department of Health and Human Services
VARHS	Vietnam Access to Resources Household Survey
VHLSS	Vietnam Household Living Standards Survey
WFP	UN World Food Programme
WHO	World Health Organization
WTO	World Trade Organization
ZM	Zero Malnutrition Program

Notes on Contributors

Harold Alderman has a Master's degree in nutrition (Cornell) and a PhD in economics (Harvard)—where Per Pinstrup-Andersen served as an outside member on his thesis committee. He has gravitated to research on the economics of nutrition and food policy. He spent 10 years at the International Food Policy Research Institute (IFPRI) prior to joining the World Bank in 1991. He rejoined IFPRI in 2012. While at the World Bank, he divided his time between the Development Research Group and the Africa region, where he advised on social protection policy. His current research has focused on the linkages between nutrition and early child development and the means by which nutrition and social protection programs contribute to long-term economic growth.

Julian M. Alston is a Professor in the Department of Agricultural and Resource Economics of the University of California at Davis, where he teaches graduate and undergraduate classes in microeconomic theory and the analysis of agricultural markets and policies. At UC-Davis, Alston is a member of the Giannini Foundation of Agricultural Economics and serves as the Director of the Robert Mondavi Institute Center for Wine Economics and as Associate Director for Science and Technology Policy at the University of California Agricultural Issues Center. He is a Fellow of the American Agricultural Economics Association, a Distinguished Fellow and Past President of the Australian Agricultural and Resource Economics Society, a Distinguished Scholar of the Western Agricultural Economics Association, and a Fellow of the American Association of Wine Economists.

Suresh Chandra Babu is a Senior Research Fellow and a Program Leader for the Capacity Strengthening Program at the International Food Policy Research Institute in Washington, DC. He has published more than 65 peer-reviewed journal papers and 13 books and monographs. Over the years, he has trained more than 2,000 people in food policy research and analysis. He has held visiting honorary professorships at American University, Washington, DC; Indira Gandhi National Open University, India; University of Kwazulu-Natal, South Africa; and Zhejiang University, China. He currently serves on several academic journals, including *Food Security*, *Agricultural Economics Research Review*, *African Journal of Agricultural and Resource Economics*, *Journal of Sustainable Development*, *Food and Nutrition Bulletin*, and *African Journal of Food, Nutritional and Development*. Dr. Babu received his PhD and MS in Economics from Iowa State University. He completed his MSc and BSc in Agriculture at the Agricultural Universities in Tamil Nadu, India.

Christopher B. Barrett is the David J. Nolan Director, Stephen B. and Janice G. Ashley Professor of Applied Economics and Management and International Professor of Agriculture in the Charles H. Dyson School of Applied Economics and Management, as well as Professor in the Department of Economics and Fellow of the David R. Atkinson Center for a Sustainable Future (ACSF), all at Cornell University, where he also serves as the Director of the Cornell Institute for International Food, Agriculture and Development's initiative on Stimulating Agricultural and Rural Transformation, and served as the founding Associate Director for Economic Development programs for the ACSF. He holds degrees from Princeton, Oxford, and the University of Wisconsin-Madison. He has held visiting professorships at Monash University and the University of Melbourne and directed summer seminar programs at Calvin College. Professor Barrett has published or has in press 14 books and more than 260 journal articles or book chapters. He has served on a variety of boards; has won several university, national, and international awards for teaching, research, and public outreach; and is an elected Fellow of both the Agricultural and Applied Economics Association and the African Association of Agricultural Economists.

Leah E. M. Bevis is a fifth year PhD candidate in the Dyson School of Applied Economics and Management, and a Fellow of the Food Systems and Poverty Reduction IGERT program at Cornell University. She obtained her undergraduate degree from Middlebury College in Vermont, where she majored in geography and minored in economics. She has been living and working in East Africa for about 10 years now, including a year spent in eastern Uganda running village-level health programs for a nonprofit organization called Uganda Village Project. Leah is interested in the problem of persistent poverty at the household level in Africa and the ways in which food systems and human capital accumulation affect persistent poverty. She is also particularly focused on childhood micronutrient malnutrition. Her dissertation research focuses on soil-to-human micronutrient transmission and soil degradation-based poverty traps in Uganda.

Shenggen Fan (樊胜根) has been Director General of the International Food Policy Research Institute (IFPRI) since 2009. Dr. Fan joined IFPRI in 1995 as a research fellow, conducting extensive research on pro-poor development strategies in Africa, Asia, and the Middle East. He led IFPRI's program on public investment before becoming the Director of the Institute's Development Strategy and Governance Division in 2005. He now serves as the Vice-Chairman of the World Economic Forum's Global Agenda Council on Food and Nutrition Security, after serving as Chair of the Council from 2012 to 2014. In 2014, Dr. Fan received the Hunger Hero Award from the World Food Programme in recognition of his commitment to and leadership in fighting hunger worldwide. Dr. Fan received a PhD in applied economics from the University of Minnesota and Bachelor's and Master's degrees from Nanjing Agricultural University in China.

Edward A. Frongillo is Professor and Chair of the Department of Health Promotion, Education, and Behavior at the University of South Carolina. He has a PhD in biometry and an MS in human nutrition and child development from Cornell University. He studies how to solve undernutrition and overnutrition in populations globally, especially children and families living in poverty, using qualitative and quantitative

methods. His research interests are growth, development, and feeding of infants and young children; family stress and parenting; household and child food insecurity; policy advancement and programs for improving nutrition and development; and design and analysis of longitudinal studies. He has designed, with others, large longitudinal studies, including the World Health Organization's *Multicentre Growth Reference Study* and the *Maternal and Infant Nutrition Interventions in Matlab* study in Bangladesh.

Sinafikeh Gemessa, an Ethiopian national, joined IFPRI in July 2012, as a Senior Research Assistant in the Director General's Office. Sinafikeh received a BS in Statistics and a MS in Economics from Addis Ababa University and a Masters in International Development from Harvard University. He first joined IFPRI, in late 2008, as a research officer in the Ethiopia Strategy Support Program, before he left for his graduate study at Harvard. He has experience working in agricultural development and food security and nutrition issues. In fall 2014, he enrolled in the PhD program in Applied Economics at the University of Minnesota.

Jean-Pierre Habicht, MD (Zurich), PhD (MIT), MPH (Harvard) is a Cornell Professor Emeritus. In retirement, he continues to work as Graduate Professor of Epidemiology in the Division of Nutritional Sciences at Cornell University. In 1969, he went to Guatemala to the Institute of Nutrition of Central America as a WHO medical officer in charge of primary healthcare and epidemiological studies, and then he worked for the US National Center for Health Statistics on nutritional surveillance. He came to Cornell University in 1977 to develop a program of research and training in nutritional epidemiology. This research aimed at elucidating nutritional determinants and their impacts on the health, performance, and survival of mothers and their children. His first experience in bringing epidemiologically derived knowledge to bear programmatically was in developing a Timely Warning and Intervention System to prevent famines in Indonesia. These recurring famines occurred in spite of an excellent food supply system that effectively prevented food scarcity. At this time, Per Pinstrup-Andersen became director of the Cornell Nutrition Surveillance Program, which he transformed into the Cornell Food and Nutrition Policy Program (CFNPP). Jean-Pierre continued working with him as he developed nutrition surveillance systems for policy development in Indonesia and in the People's Republic of China. These experiences led Jean-Pierre to appreciate the importance of translating and utilizing knowledge about the determinants of malnutrition to design nutrition delivery interventions. Per Pinstrup-Andersen's work was a trailblazer for the development of effective policies for the delivery of nutrition. Understanding these delivery systems has become a major focus of Jean-Pierre's present work.

Peter B. R. Hazell trained as an agriculturalist in England before completing his MS and PhD degrees in Agricultural Economics at Cornell University and a postdoctoral assignment at the University of Newcastle upon Tyne, England. From 1972 to 2005, he held various research positions at the World Bank and the International Food Policy Research Institute, including serving as Director of the Environment and Production Technology division (1992–2003) and the Development Strategy and Governance division (2003–05) at IFPRI. After returning to the UK in 2005, he became a Visiting Professor at Imperial College London and a Professorial Research Associate at the

Notes on Contributors

School of Oriental and African Studies, University of London. Peter's extensive and widely cited publications include works on mathematical programming; risk management; insurance; the impact of technological change on growth and poverty; the rural non-farm economy; sustainable development strategies for marginal lands; the role of agriculture in economic development; and the future of small farms. Peter is an elected Fellow of the Agricultural and Applied Economics Association and of the African Association of Agricultural Economists. He currently lives in Santa Barbara, California, from where he undertakes consulting assignments for IFPRI, the World Bank, and the Bill & Melinda Gates Foundation.

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Tina Andersen Huey received her PhD from the University of Pennsylvania's Annenberg School for Communication in Philadelphia, PA. Her dissertation concerned the legitimization of knowledge in discourse about genetically modified (GM) food. Her research interests focus on the meaning people ascribe to food and in popular food movements (e.g., Slow Food, organics, anti-GMO). Dr. Huey is Per Pinstrup-Andersen's daughter.

Andrew D. Jones is a public health nutritionist, interested in understanding the influence of agriculture and food systems on the food security of households and the nutritional status of women, young children, and adolescents in low-income settings. He is especially interested in understanding the pathways through which macro socio-environmental trends, including climate change, urbanization, and globalization, interact with food systems to impact nutrition outcomes. His research includes a strong focus on the evaluation of programs and policies that aim to improve maternal and child nutrition, especially through agriculture and food systems-based approaches. Andrew currently holds the position of Assistant Professor in the School of Public Health at the University of Michigan. Prior to this appointment, Andrew worked as a Research Associate in the Division of Nutritional Sciences at Cornell University. He has also worked as a consultant for several institutions, including the World Bank, the International Food Policy Research Institute, and UNICEF. He received his PhD in International Nutrition from Cornell University and holds BA degrees from the Pennsylvania State University in Geography and Film Production.

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Malden C. Nesheim is Professor of Nutrition Emeritus and Provost Emeritus. He joined the Cornell faculty in 1959. In 1974, he was named Director of the Division of Nutritional Sciences, a post that he held until the summer of 1987. Prior to becoming Provost of Cornell University in September 1989, he held the position of Vice President for Planning and Budgeting. He has received the Conrad A. Elvehjem Award for Public Service from the American Institute of Nutrition. He was elected a Fellow of the American Academy of Arts and Sciences in 1995 and a Fellow of the American Society of Nutritional Sciences in 1997. He earned a BS in Agricultural Science and an MS in Animal Nutrition from the University of Illinois, followed by a PhD in Nutrition from Cornell. His research interests have been aspects of nutritional biochemistry and the relationship of parasitic infections to nutritional status, along with other aspects of human nutrition. His most recent book, with Marion Nestle, *Why Calories Count—From Science to Politics*, was published by the University of California Press in 2012.

Marion Nestle is the Paulette Goddard Professor in the Department of Nutrition, Food Studies, and Public Health at New York University, which she chaired from 1988 to 2003. She is also Professor of Sociology at NYU and Visiting Professor of Nutritional Sciences at Cornell. She earned a PhD in Molecular Biology and an MPH in Public Health Nutrition from the University of California, Berkeley. Previous faculty positions were at Brandeis University and the University of California San Francisco School of Medicine. From 1986 to 1988, she was senior nutrition policy advisor in the Department of Health and Human Services and editor of *The Surgeon General's Report on Nutrition and Health*. Her research examines scientific and socioeconomic influences on food choice, emphasizing the role of food marketing. She is the author or co-author of five prize-winning books: *Food Politics: How the Food Industry Influences Nutrition and Health*; *Safe Food: The Politics of Food Safety*; *What to Eat*; and, with Malden Nesheim, *Why Calories Count*; and *Eat, Drink, Vote: An Illustrated Guide to Food Politics*. She also has written two books about pet food, *Pet Food Politics: The Chihuahua in the Coal Mine* and *Feed Your Pet Right* (also with Malden Nesheim). Her most recent book is *Soda Politics: Taking on Big Soda (and Winning)*. She blogs at www.foodpolitics.com.

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Philip G. Pardey is a Professor in the Department of Applied Economics, University of Minnesota, where he also directs the University's International Science and Technology Practice and Policy (InSTePP) center. Prior to joining the university in 2002, he was a Senior Research Fellow at the International Food Policy Research Institute, Washington, DC, and previously a senior research officer at the International

Service for National Agricultural Research in The Hague, Netherlands. His research deals with the finance and conduct of R&D globally and its economic consequences, the bio-economics of agricultural production and productivity worldwide, and the economic and policy (especially intellectual property) aspects of genetic resources and the biosciences. He is a Fellow of the American Agricultural Economic Association, a Distinguished Fellow and Past President of the Australian Agricultural and Resource Economics Society, and was awarded the Siehl Prize for excellence in agriculture.

Prabhu Pingali is a Professor in the Charles H. Dyson School of Applied Economics and Management and the Founding Director of the Tata–Cornell Agriculture and Nutrition Initiative (TCi). Prior to joining Cornell in June 2013, he was the Deputy Director, Agriculture Development Division of the Bill & Melinda Gates Foundation, based in Seattle, Washington, from 2008 to May 2013. Pingali was elected to the US National Academy of Sciences as a Foreign Fellow in May 2007, a Fellow of the American Agricultural Economics Association (AAEA) in 2006, and a Fellow of the International Association of Agricultural Economists (IAAE) in 2009. He served as the President of IAAE from 2003 to 2006, and was named the 2010 Outstanding Alumnus of North Carolina State University. He has received several international awards for his work, including the Research Discovery Award from the AAEA. Pingali has over three decades of experience working with some of the leading international agricultural development organizations as a research economist, development practitioner, and senior manager. He was the Director of the Agricultural and Development Economics Division of the Food and Agriculture Organization of the United Nations from 2002 to 2007, and the Director of the Economics Program at the Center for International Maize and Wheat Improvement Center (CIMMYT), Mexico, from 1996 to 2002. Prior to joining CIMMYT, he worked at the International Rice Research Institute at Los Banos, Philippines, from 1987 to 1996, as an Agricultural Economist, and at the World Bank's Agriculture and Rural Development Department from 1982 to 1987, as an Economist. Professor Pingali has written 10 books and over 100 referred journal articles and book chapters on food policy, technological change, productivity growth, environmental externalities, and resource management in the developing world.

Mitch Renkow has been a Professor of Agricultural and Resource Economics at North Carolina State University since 1991. Prior to that time, he worked at the International Crops Research Institute for the Semi-Arid-Tropics (ICRISAT) and at CIMMYT. His research focuses on technology adoption, determinants of market participation, and the aggregate and distributional impacts of agricultural research. His work on the impact of agricultural research includes a study of the impacts of CGIAR research since 2000 (as part of the 2010 External Review of the CGIAR); assessments of policy-oriented research on less-favored areas and on pro-poor public investment; work for the Standing Panel on Impact Assessment (SPIA) on the environmental impacts of CGIAR research; and most recently, an assessment of IFPRI's cumulative research in Ethiopia since 1995.

Katie Ricketts is a Research Associate with Cornell University and Cornell Cooperative Extension. She was previously the Program/Research Manager for the Tata–Cornell Agriculture and Nutrition Initiative, where she offered strategic guidance and

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Marie T. Ruel has been Director of IFPRI's Poverty, Health and Nutrition Division since 2004. From 1996 until her current appointment, she served as Senior Research Fellow and Research Fellow in that division. Dr. Ruel has worked for more than 30 years on policies and programs to alleviate poverty, food insecurity, and malnutrition in developing countries. She has published extensively on topics such as maternal and child nutrition; agriculture and food-based strategies to improve diet quality and micronutrient nutrition; and urban livelihoods, food security, and nutrition, with a focus on program evaluation and delivery science. Her current research focuses on the evaluation and strengthening of a wide range of integrated, multisectoral development programs in the areas of agriculture, social protection, and health; and at building the evidence on their role in reducing maternal and child malnutrition globally. Prior to IFPRI, she was head of the Nutrition and Health Division at the Institute of Nutrition of Central America and Panama/Pan American Health Organization (INCAP/PAHO) in Guatemala. Dr. Ruel received her PhD in International Nutrition from Cornell University and her Masters in Health Sciences from Laval University in Canada.

David E. Sahn is an International Professor of Economics in the Division of Nutritional Sciences and the Department of Economics at Cornell University. He is also an IZA Research Fellow at the Institute for the Study of Labor (IZA) in Bonn, Germany. From 2011 to 2013, he was a Professor, holding the Chaire d'Excellence at Centre d'Etudes et de Recherches sur le Développement International (CERDI), l'Université d'Auvergne, France. He has a PhD from the Massachusetts Institute of Technology and a Masters of Public Health from the University of Michigan. His main academic interest is in identifying the solutions to poverty, malnutrition, and disease in developing countries, as well as the determinants of human capital and the role of education and skills in labor market and other social outcomes. In addition to teaching and mentoring of graduate students, he devotes considerable efforts to training and capacity building of research institutions in Africa and working with government officials and international organizations to integrate research findings into policy. Before coming to Cornell in 1988, Professor Sahn was an Economist at the World Bank, and prior to that, a Research Fellow at the International Food Policy Research Institute. He has

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Roger Slade holds undergraduate and graduate degrees from the London School of Economics and the College of St Gregory and St Martin at Wye (University of London). He has nearly 50 years' experience in development as an economist, researcher, evaluator, and manager, including periods of residence in southern and western Africa and Southeast Asia. He is a former trustee and Director of Africa Now, past Director and Treasurer of the International Development Evaluation Association, and a long-time advisor to Farm Africa. From 1975 to 1999, he held progressively senior appointments in the World Bank. His published work spans technology adoption, agricultural research and extension, regional growth, dairy development, and monitoring and evaluation. Since retiring from the World Bank, he has worked as a consultant economist, most recently leading a global study of FAO's role in fostering investment in agriculture and studies for IFAD and IFPRI.

Finn Tarp holds the Chair in Development Economics at the Department of Economics at the University of Copenhagen. He founded the Development Economics Research Group (DERG) in 1996, and in 2009 was appointed Director of the United Nations University World Institute for Development Economics Research (UNU-WIDER), Helsinki, Finland. In this capacity, Professor Tarp leads and manages an internationally recognized multidisciplinary and policy-relevant development economics research program; and UNU-WIDER is widely recognized as a top international development think tank that has contributed effectively to development thinking and practice for 30 years. Finn Tarp has a total of more than 35 years of experience in academic and applied development economics, including 20 years of work experience in some 35 countries across Africa and the developing world, including longer-term assignments in Swaziland, Mozambique, Zimbabwe, and Vietnam. Finn Tarp is a leading international expert on issues of development strategy and foreign aid, and he is a member of a large number of international committees and advisory bodies. They include academic journals, the European Union Development Network (EUDN), and the African Economic Research Consortium (AERC). Special honors include the Vietnamese Government Merit "Medal for the Cause of Science and Technology" and the Vietnamese Government "Medal of Honour for Contributions to the Cause of Planning and Investment." Professor Tarp was appointed member of the Council of Eminent Persons (CEP), advising the Chief Economist of the World Bank in early 2013.

Erik Thorbecke is the H. E. Babcock Professor of Economics Emeritus and Graduate School and International Professor at Cornell University and one of the creators of the Foster-Greer-Thorbecke (FGT) metric for measuring poverty. Professor Thorbecke is also former Director of the Program on Comparative Economic Development at Cornell, and he is a longstanding member of the Advisory Board for the Cornell Institute for African Development. His past positions include Chairman of the Department of Economics at Cornell, a professorship at Iowa State University, and associate assistant administrator for program policy at the Agency for International Development. In 1981, Professor Thorbecke was awarded an honorary doctorate degree by the University of Ghent. He has made contributions in the areas of economic and agricultural development, the measurement and analysis of poverty and malnutrition, the Social Accounting Matrix and general equilibrium modeling, and international economic policy. The Foster-Greer-Thorbecke poverty measure (*Econometrica*, 1984) that he developed (with James Foster and Joel Greer) has been adopted as the standard poverty measure by the World Bank and many UN agencies and is widely used by researchers doing empirical work on poverty. A variant of the FGT was adopted by the Mexican government and used to allocate federal government funds to educational, health, and nutrition programs benefiting the poor. Since the early 1990s, he has been closely associated with the African Economic Research Consortium, a “public, not-for-profit organization devoted to the advancement of economic policy research and training.” He serves as the Chairman of the Thematic Research Group on Poverty, Income Distribution and Food Security. Over the past several years (2005–10), Professor Thorbecke has been co-directing (with Machiko Nissanke) a large-scale research project on “The Impact of Globalization on the World’s Poor” under the auspices of the United Nations University’s World Institute for Development Economics Research. He is the author or co-author of more than 25 books and over 150 articles.

Barbara Boyle Torrey has been a Visiting Fellow at the Population Reference Bureau. She was previously Executive Director of the Division of Behavioral and Social Sciences at the National Research Council. She was also Chief of the Center for International Research at the Census Bureau and an economist at the Office of Management and Budget. She edited *Population and Land Use Change* for the National Academy Press, as well as two other books and has published a number of articles on international population and income trends. She did her undergraduate and graduate work at Stanford University’s Food Research Institute. She is a member of the National Research Council’s Committee on Population.

E. Fuller Torrey, MD, is the former Executive Director of the Stanley Medical Research Institute in Chevy Chase, Maryland (he has recently stepped down and is now Associate Director), and Professor of Psychiatry at the Uniformed Services University of the Health Sciences. He received an AB from Princeton University, an MD from McGill University, and a Master’s in Anthropology and training in Psychiatry at Stanford University. He spent two years as a Peace Corps physician in Ethiopia and has returned there several times. He has published more than 200 professional papers and 20 books, including *Beasts of the Earth: Animals, Humans, and Disease* with Robert

Yolken. *The Roots of Treason*, his biography of Ezra Pound, was nominated as one of the five best biographies of 1983 by the National Book Critics Circle. He is married to Barbara Boyle Torrey, an economist.

Joachim von Braun is an economist with a Doctoral degree in Agricultural Economics from University of Göttingen, Germany. He joined the Center for Development Research (*Zentrum für Entwicklungsforschung*) of the University of Bonn (ZEF) as Professor and Director of the Department for Economic and Technological Change in December 2009. He was also Director of ZEF during its foundation phase, 1997–2002. Professor von Braun was Director General of the International Food Policy Research Institute in Washington, DC, from 2002 to 2009. His research addresses international and development economics topics, including markets and trade, poverty, health and nutrition, agriculture, and science and technology. Professor von Braun was President of the International Association of Agricultural Economists (IAAE). He is a member of the Academy of Science of North-Rhine Westphalia, the German Academy of Science and Engineering (acatech), and the Pontifical Academy of Sciences of the Vatican, as well as Fellow of the American Association for the Advancement of Sciences; he is Vice-President of the NGO “Welthungerhilfe” and Chair of the Bioeconomy Council of the German Federal Government. Among awards received by von Braun are an honorary Doctoral degree from University of Hohenheim, the Bertebos Prize of the Swedish Academy of Agricultural Sciences for his research on food security, and the Justus von Liebig Prize for his research on international nutrition.

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2013–18 strategy, helped organize two 2020 conferences (“Leveraging Agriculture for Improving Nutrition and Health” in New Delhi and “Building Resilience for Food and Nutrition Security” in Addis Ababa), and has supported the publication of numerous books and papers on food and nutrition security. Prior to joining IFPRI in 2008, she co-founded an international development organization operating in Africa, Asia, and the Caribbean.

Introduction

David E. Sahn

Over nearly 50 years, Per Pinstrup-Andersen, who we honor with this book, has tirelessly promoted and conducted research with an overriding goal of combatting the global scourge of hunger and malnutrition. He has focused on the objectives of increasing food supplies to keep pace with a growing population; promoting a sustainable food system that contributes to the availability and accessibility of a low-priced, diverse, and safe supply of foods to consumers; and exploring consumer behavior and intervention programs that are designed to ensure household-level access to an adequate and healthy diet. In this volume, we bring together a truly exceptional group of scholars to formulate and begin to address the major challenges, controversies, and opportunities in combatting hunger and malnutrition in the years ahead. Contributors include distinguished professors and pre-eminent researchers in the fields of economics, nutrition, and agriculture and food systems, and directors and leaders of some of the most important international think tanks and institutes concerned with sustainable initiatives designed to alleviate hunger and malnutrition, with years of experience in Africa, Asia, and Latin America.

Specifically, the first part of this book explores the future of nutrition programs and policies. The second part examines the challenges of agricultural and supply side policies to sustainably feed the world's growing population. The third part concerns globalization and political economy. The chapters cover a wide range of controversies and policy considerations in these three domains.

One immutable fact that underlies this book is that there have been amazing advances in science and policy during the past 50 years that have contributed to preventing global food shortages and that have forestalled the threat of rising global hunger—despite the fact that the world's population

soared in the latter half of the 20th century. Indeed, today, the number of undernourished people is smaller than it has been in decades, even though the population is nearly five times larger than it was in 1900. Furthermore, the share of malnourished individuals is lower than at any point since reliable statistics became available. There are numerous explanations for this tentative success. These begin with the simple fact that economic growth has accelerated in countries and regions, particularly in Southeast Asia, but increasingly in other regions of the world such as in Africa, putting more money into the pockets of a larger number of households. A decline in poverty, however, is only part of the story. Additionally, the decline in global hunger is in large measure attributable to the dynamism of the agricultural sector where food production and markets have kept pace with growing demand, thus contributing to a plentiful supply of food at moderate prices that are within reach of an increasing share of the world's population. Technological change in agriculture has enabled the world's farmers to raise food output to levels that were unforeseen a half-century ago. The Green Revolution, of course, is now recognized as one of the great scientific advances of the latter part of the 20th century; and opportunities from biotechnology hold the promise of being equally transformative, despite the very active discourse that surrounds the role of genetically modified crops. It is in this context, however, that new controversies emerge, such as the sustainability of the global food system that has witnessed dramatic changes in concert with scientific and technology advances: whether it be concerns over climate change, the environmental and health impact of genetically modified foods, or even the marginalization of small farmers.

While supply side advances have been at the nexus of the successes of efforts to prevent and reduce malnutrition, the evolution of global and regional markets and advances in the efficiency of the food system, in general, have been integral to progress in combatting undernourishment. The importance of food markets and value chain in providing a plentiful and safe food supply is not only increasingly better understood, but in practice has evolved in ways that are almost the equal of the agricultural sector in these efforts.

Advances in the food system have also been complemented with a vastly improved understanding of household behavior that focuses more on patterns of demand and choices of households, and the implications for health and nutrition outcomes. This includes understanding food acquisition behaviors, but also a range of other considerations such as intrahousehold decision-making and food allocation, as well as choices regarding nurturing and care behaviors that directly impact the nutritional intake and well-being of vulnerable groups. This knowledge, in turn, has contributed to the design of effective programs and policies that focus on raising demand for and access to food. Likewise, interventions focused on improving the quality and

utilization of foods and related behaviors, such as breastfeeding promotion, the use of oral rehydration therapy, and public health measures to improve water and sanitation, have been integral to the fight against hunger and malnutrition.

Despite all the scientific advances and the growth of evidence to guide policymakers in their efforts to design policies and programs to alleviate hunger, the fact remains that progress is uneven; certain regions, particularly South Asia and much of Africa, show far more modest success in this endeavor. And even in regions where noteworthy reductions in hunger and malnutrition have been recorded, inequalities have left large shares of the population in many countries still at high risk of hunger and malnutrition. The reasons are many and range from a lack of scientific advances in some areas to a paucity of understanding of the true causes of malnutrition in its multiple and complex dimensions. The challenge extends beyond science and knowledge itself, however, and includes the paramount issue of commitment, particularly political will and prioritizing the alleviation of hunger in government policy, something that remains elusive.

Thus, although there is a need to better understand the nature of the progress in the fight against hunger and malnutrition to date, there is even more urgency to look ahead at the evolving landscape and challenges in addressing the persistence of suffering, which afflicts a large share of the world's population. It is that imperative that motivates this book, and the role of research and policy to mitigate hunger and malnutrition is the thread that runs through the chapters in this volume.

More specifically, this book focuses on the future, and particularly, the opportunities to help the poor and malnourished. We do so ever cognizant that we live in a new era of globalization, where change in technology, markets, and social programs are not done in isolation, but rather in a context where problems and suffering may be local, as are many solutions, but both the challenges and the responses inevitably have an increasingly global dimension. This requires a better appreciation of not only the opportunities and choices of farmers and traders, but also the labor market and income-earning prospects of those residing in growing urban settlements. It requires better understanding of the options for consumers of where to buy food and the quality, diversity, and prices of food in traditional markets and new outlets, such as supermarkets—choices that reflect changes in the value chain or the related rapidly changing consumer tastes and preferences. Overlaying all these issues are concerns, such as sustainability and climate change, which will inevitably condition the behavior of local and global institutions and the opportunities and constraints facing policymakers in their efforts to assist those in need. Quite simply, with the progress and change of the past decades come new challenges and concerns that have broad implications for agriculture,

food, and nutrition. These are, perhaps, nowhere more obvious than with issues such as (1) how to make production systems sustainable, in terms of promoting high output agriculture while preserving natural resources and promoting conservation; (2) how to ensure the economic sustainability of farmers and the role of agriculture as a sector of economic growth and employment; and (3) how to foster a competitive environment in which farmers and traders contribute to an efficient and low-cost food system that meets the needs of urban and rural consumers and takes into account other issues such as energy costs and efficiencies in the food supply chain.

The first section of the book takes a microeconomic focus on some critical debates on the future of nutrition programs and policies. In recent years, there has been an emerging consensus that the first 1,000 days of an individual's life, from conception to 2 years of age, is the most critical period for health, and that malnutrition during this period will have long-term consequences over the entire life course of the individual, and even across generations. Consequently, nutrition policy and intervention programs have increasingly targeted women of childbearing age and children less than 24 months of age. However, like all ideas in good currency, there remain a number of uncertainties in terms of the long-term consequences of early childhood malnutrition. One of the most active debates is the opportunity for "catch-up growth" among young children, or in other words, whether programs and policies that are targeted to stunted or chronically malnourished children, will contribute to their catching up to norms. This is a crucial question: the ability, or lack thereof, to catch-up or recover from early nutritional deficits has formidable implications for the timing of and potential benefits from nutritional interventions. Thus, the first chapter of the book, jointly authored by Jef Leroy, Marie Ruel, Jean-Pierre Habicht, and Edward Frongillo, tackles this issue using an innovative methodological approach. Here the authors report their finding of an absence of catch-up growth between 2 and 5 years of age, adding to the support for the critical need of investing in improving nutrition during the first 1,000 days. Their research reinforces the imperative of preventing rather than reversing stunting, and more generally, supports the current programmatic focus on the first 1,000 days, as well as the health of women of childbearing age.

In light of these findings, the second chapter, authored by Harold Alderman, is particularly salient in examining the role of transfer programs in reducing hunger and malnutrition. Alderman's comprehensive and critical review begins by examining the role of income generally in determining nutrition outcomes, and more specifically, how transfer programs can respond to specific shocks or serve to raise consumption over an extended period. Beyond the consumption objectives of transfer programs, many are intended to influence the price of human capital investments, as well as incentivize a shift in

the family's resource allocation through the imposition of conditions. Thus, Alderman focuses on services that accompany transfer programs and broadly concludes that there is limited evidence that such programs reduce malnutrition. A variety of reasons may explain this disappointing outcome, ranging from design of the intervention, such as the failure to focus on the most vulnerable groups, to issues concerning the evaluation methods employed.

The next two chapters of the book, by Chris Barrett and Leah Bevis, and Malden Nesheim and Marion Nestle, respectively, confront two other emerging challenges: the need to go beyond merely addressing chronic malnutrition and wasting, which has traditionally been the focus of programs such as the types of conditional cash transfers discussed in the previous two chapters. Barrett and Bevis address what is often referred to as "hidden hunger" in the form of micronutrient deficiencies. There is some irony in the fact that micronutrient malnutrition is given far less attention than other forms of malnutrition, such as wasting, despite the fact that iron deficiency anemia, for example, is the most prevalent form of malnutrition, affecting approximately 1.6 billion people. The key question that the authors raise is why are micronutrient deficiencies so much less responsive to income growth than other indicators of malnutrition? They explore the causation of micronutrient malnutrition and the implications for structuring policies and programs in the future to address this enormous problem, using a food systems approach that looks at a range of considerations from production-related issues such as soil deficiencies and the role of biofortification, to the role of markets and the value chain in terms of the availability of diverse, low-cost foods that contain requisite levels of minerals and vitamins.

The chapter by Nesheim and Nestle focuses on the growing epidemic of chronic disease that is linked to dietary excesses, including the intake of refined carbohydrates and sugar that contribute to obesity and related chronic diseases such as diabetes. The magnitude of the obesity epidemic is staggering: more than one in three adults in the United States are overweight or obese, and in parts of Europe, the Middle East, and Latin America, more than 60 percent of adults over the age of 15 are classified as overweight or obese. Nesheim and Nestle examine the changing behavior of consumers, and more specifically, the marketing behavior of corporations—especially, the messages directed toward children encouraging consumption of unhealthy foods and large portions. While the chapter focuses on the role of beverage companies, it is clear that there are general lessons that emerge. These include encouraging more responsible marketing behavior by corporations, while considering the role of public policies such as tax initiatives and public information dissemination—including labeling, media campaigns about healthy eating, and public education—more broadly to promote skills for changing the food environment and personal behavior.

In combination, the first four chapters of the book imply a relatively clear agenda for nutrition policy and programs with the well-defined needs: (1) to focus on the first 1,000 days; (2) to place transfer programs at the center of government strategies to reach nutritionally vulnerable groups; (3) to address hidden hunger in the form of micronutrient deficiencies, too long given far too little attention, as the central part of efforts to reduce malnutrition; and (4) to confront the formidable challenge of how the changing food system and patterns of consumer behavior are contributing to new risks of chronic disease, hardly even discussed just a few years ago outside of developed countries, as governments and the international community continue to focus on problems of undernutrition. Although this agenda for action is compelling and scientifically grounded, translating it into action is another matter altogether, and this is, then, the subject of the next two chapters of this part of the book.

Suresh Chandra Babu looks at the challenges in encouraging and improving evidence-based policymaking, particularly in response to emerging food and nutrition crises. He focuses on the development and implementation of food security and nutrition monitoring systems to identify policy, institutional, organizational, and system capacity challenges. He presents lessons that could be useful to overcome these challenges at the global, regional, and national levels. A wide range of lessons are distilled from the review of how governments respond to food crises, and specifically, the role of information systems that are characteristically weak and poorly integrated into the decision-making apparatus of governments and international organizations, who must lead the response to prevent and mitigate the consequences of events such as price shocks and drought. For example, there is a need to improve the accuracy, geographic-specificity, cost-effectiveness, reliability, and availability of timely information, always recognizing that the more precise the information, the more costly it is likely to be. Information systems need to be designed not just to monitor the emergence of crises, but also to understand the efficacy of the response of programs and policies to protect the nutritionally vulnerable.

Although the emphasis on designing and implementing food and nutrition monitoring systems is well supported in Suresh Babu's chapter, one important question left unanswered is how to define the appropriate indicators of food security and nutritional well-being, from the local to the global level. It is this question that motivates the chapter by Anna Herforth. Herforth attempts to answer the question of who will make decisions based on food security indicators, and what are the major information gaps that, if filled, could inform better action to improve food security? In addressing these questions, it becomes clear that relative to what is now available from traditional data sources, generated by governments and international organizations, new

food security indicators are needed that can more effectively guide actions to improve availability of and access to healthy diets. Suggestions are made for how new food indicators can be mainstreamed in the nutrition and agriculture data sets and parlance, to shift the generalized construction of “food” from one of caloric adequacy to one of complete food security: safe, sufficient, and nutritious food for a healthy and active life.

The second part of the book examines the critical challenges of agricultural and supply sides policies to provide healthy and sufficiently available food to feed the world’s growing population. Specifically, we focus on several major debates that will condition success in this regard over the decades ahead. The first chapter of this part begins with a focus by Prabhu Pingali, Katie Ricketts, and David Sahn on a general framework to understand the pathways between agricultural interventions and nutritional outcomes. Their chapter presents a typology of agricultural systems that capture the different stages of agricultural development and how they impact nutritional outcomes. The typology includes small-scale and subsistence agriculture systems, such as those prevalent in sub-Saharan Africa; intensive cereal crop systems, primarily found in Asia; and commercial/export-oriented systems, typically seen in Latin America. The main thrust of the chapter is a discussion of how agricultural policy and interventions can be oriented to address the types of nutritional problems that tend to be most pronounced in areas with different types of agricultural systems. The chapter goes further, however, to consider more broadly the role of agricultural and rural development efforts, in terms of a range of goals, including employment generation, access to clean water and sanitation, and education. Efforts to influence behavioral change and intra-household allocation are also discussed with respect to their importance in alleviating malnutrition. Thus, the authors conclude that although the past 50 years has been a period of extraordinary food crop productivity growth, there is still a great deal of work needed to orient policy and programs driven by nutritional goals, particularly with a focus on rural women and children.

The next chapter, by Peter Hazell, expands on this framework, but focuses on small farm-led development. Small farm-led development has been the dominant agricultural development paradigm among agricultural economists since its remarkable success in driving Asia’s Green Revolution during the 1960s and 1970s. Despite its proven success, the small farm development paradigm is widely challenged today, and there is considerable debate about its continuing relevance for Asia and Africa. Critics argue that because of rural population growth on a fixed land base, the onslaught of globalization and market liberalization policies, and the emergence of new types of farm technologies, the economic context for small-scale farming has changed, and small may no longer be as beautiful as before. This chapter considers these arguments and their implications for agricultural development and

small farm assistance strategies. Although Hazell concludes that there will be a diminished role for small farms in the future, a range of complementary investments, in terms of markets, financial services, and research and development, are paramount to both ensure the sustainability of small farms and their transition to more commercialized enterprises.

In the next chapter, Julian Alston and Philip Pardey take up the issue of the role of agricultural research and development (R&D) as the cornerstone of efforts to alleviate hunger and malnutrition in the decades ahead. As a point of departure, Alston and Pardey extoll the remarkable historical success of public and private agricultural R&D in increasing output, meeting the dramatic growth in demand, and raising productivity that has improved welfare and health and provided cheap wage goods for a rapidly urbanizing population. They point out, though, that all is not well: productivity growth is declining, with a slowdown in R&D spending especially in developed countries, despite the high rates of return from such investments. The authors show how this is a short-sighted policy in terms of the need to accelerate production to keep pace with global growing demand and increase the abundance of food.

Agricultural science R&D, in terms of increasing commodities for the consumer, does not capture the entirety of the role and considerations that underlie the future investment needs of what Joachim von Braun refers to as the “bioeconomy”—the emerging cross-cutting economic sector that produces, transforms, and uses bio-based materials and products. Professor von Braun, in his contribution to this volume, makes a persuasive argument that R&D in agriculture must be viewed in a larger context of the need of the growing population for not only a future with a secure and safe source of food, but also in terms of a source of energy and industrial raw materials, and these, too, should be considered in the larger context of the need to protect renewable resources, such as water. This puts the bioeconomy at the nexus of the discussion on sustainability, especially as food for human consumption competes with other aspects of the bioeconomy, such as demand for biomass. In taking a holistic view, focusing not only on competing claims on agriculture, but also on synergies between technologies and the creation of new links in and between value chains (e.g., production of biochemicals alongside production of biofuels, use for waste products of other bio-based products in chemical and building material industries), von Braun argues for increased investment, including for biotechnologies.

And it is precisely the role of biotechnology that motivates the next chapter in this part of the book, which deals explicitly with the contentious issue of genetically modified foods. The use of genetically modified organisms (GMOs) in food is portrayed by science-driven development organizations as beneficial, while social movements that share a tangential, if not central, concern with poverty and hunger portray them as undesirable. This has set

up a dramatic confrontation and left consumers and policymakers both confused and uncertain as to the potential and risk associated with GMOs. Tina Andersen Huey, whose research interests focus on the meaning people ascribe to food in popular movements, explores this issue of GMOs from a critical angle: the role of communications research in understanding what kind of information is received by food-related social movements, how the information is shared, and how it is acted upon in a policy context. While she focuses on a case study from Connecticut, which was the first state in the United States that required labels on any product containing GMOs, the findings are put into the broader political context through comparison with other states such as California and food labeling movements in other countries. Although the chapter focuses specifically on the GM food controversy, more broadly speaking, it can be seen as a prism through which to view globalization's discontents—that is, the central problem of how to determine the future of the planet absent institutions answerable to citizens.

In the last chapter in this part of the book, Barbara Torrey and Fuller Torrey review the issue of the race between population growth and food production from the perspective of the broad sweep of history, bringing that discussion to a contemporary focus on present-day Africa. As the authors point out, the race between agricultural productivity and population dates back 11,000 years to a period when increasing Neolithic fertility and mortality rates led inexorably to an increasing world population. It was during the 19th century, however, when populations in industrializing countries continued to grow and their fertility and mortality rates began to slowly fall, that the demographic transition began in earnest. It was only in the 1960s, however, with the beginning of the demographic transition in non-industrial countries, that the race between agriculture and population growth accelerated. Fortunately, the agricultural sciences produced one of the most important scientific success stories in the world, especially in many of the developing countries. That being said, Africa remains the one major continent that is not yet feeding its population. This chapter thus concentrates on describing the varieties of sub-Saharan Africa's demographic transitions and the stall observed in a number of them. This, in turn, has placed greater demands on what is often a faltering agricultural sector. Thus, the clear lesson is that we must consider population policy as a necessary adjunct to the types of research and development efforts that need to be accelerated in Africa and other lagging regions.

The final part of this book deals with issues of globalization and political economy, and specifically, how the changing global context and response of governments and international institutions have and will condition the ability of countries to feed their populations and provide for their nutritional well-being. The chapter that leads off this part is by Shenggen Fan,

Director General of IFPRI since 2009, and Chairman of the World Economic Forum's Global Agenda Council on Food Security and Nutrition, and his co-authors, Tolulope Olofinbiyi and Sinafikeh Gemessa, who provide a compelling case that ending hunger by 2025 is not only of paramount importance in terms of the human and economic costs, but more importantly, that this is a goal that is realistic and within reach. More specifically, they draw upon the success of a wide range of countries from Asia and Latin America to inform the way forward, emphasizing the role of technological, policy, and institutional innovations to date that put us in a better position to spur even greater successes in reducing hunger and undernutrition. The chapter outlines a typology of strategies that have been successful, including agricultural growth-led policies and social protection-led strategies. Recalling the earlier chapters in the book by Babu and Herforth, they also emphasize the role of building institutional capacity to collect and analyze more timely data and information for decision-making, as key to fostering evidence-based policymaking. Similarly, they emphasize the role of experimentation as a means to provide vital information on the proper design, sequencing, and implementation of reforms. Policymakers must foster a culture that values adaptation and change by creating the legal and political space for local experimentation.

In the next chapter, Erik Thorbecke also takes a broad look at the experience and the keys to success, in terms of the broader goal of economic growth and poverty alleviation. His chapter focuses on Africa. His main findings, described here, are that: (1) a quantum jump in GDP growth per capita occurred around 2000; (2) income inequality remained stubbornly very high; and (3) absolute poverty declined significantly since 2000. The more interesting issue is his analysis of the interrelationship among growth, inequality, and poverty. Looking back, he argues that the majority of sub-Saharan African countries between 1960 and 2000 underwent a flawed structural transformation, characterized by a stagnating per capita income and a dramatic fall in the share of agriculture in the labor force. This meant that the migration that occurred was not pulled by rising incomes outside agriculture but pushed by lack of income opportunities within it, resulting in stagnant rural incomes. Again, in keeping with the forward-looking theme of this book, Thorbecke addresses the issue of how structural transformation can be further accelerated. He concludes that the two most important elements of a development strategy are the reduction of inequality and the creation of productive jobs. The evidence presented in this chapter suggests that the recent structural changes in Africa have contributed to more inclusive growth and improvements in the well-being of the poor, and that the two key interventions in this regard are investment in infrastructure and integrated rural development to improve small farmers' productivity.

In the next two chapters, there is also a regional focus: Marygold Walsh-Dilley and Wendy Wolford examine the role of civil society and its interactions with government on food security and nutrition in Latin America; and then, Andy McKay and Finn Tarp consider the case of Vietnam and its response to the world food price shocks in 2008. Both chapters emphasize the critical importance of government policy in the fight against hunger and malnutrition, but draw upon very different experiences and methodological approaches to do so.

Wolford has worked for over 15 years with one of the most important grassroots social movements in Latin American history, the *Movimento dos Trabalhadores Rurais Sem Terra* (the Movement of Rural Landless Workers, or the MST). In the case study here of the contemporary experience in Latin America, Wolford and her co-author Walsh-Dilley highlight the role of civil society and how it can influence the nature and extent of a government's actions in combatting malnutrition. They point to the central role that civil society groups have played in pressuring governments to implement legislation and alleviate hunger and malnutrition—in essence, giving voice to vulnerable groups that are often excluded from the political process.

Finn Tarp and Andy McKay take a different approach in examining the political economy of food and nutrition policy in their case study of how the Vietnamese government responded to the price fluctuations during the period 2006 to 2012. They specifically focus on the impact, on both consumers and producers, of the government's response to the dramatic doubling of rice prices that occurred in 2008. Globally, much attention was accorded the deleterious impact of the 2008 price increase, including predictions by the World Bank that as many as 700,000 deaths would result. The overall conclusion of their chapter is that the Vietnamese government responded effectively by imposing an export ban and reducing its export quota. They did so despite widespread criticism, both at home and internationally, that this would have adverse global and domestic results. In fact, the analysis in the chapter indicates that the poorer households, who are often net producers, were the main beneficiaries, while the losers were the wealthier non-producers. The effectiveness of government intervention in Vietnam contrasts with other countries, including those in the region, which were far less successful in buffering their economy from world price instability. McKay and Tarp thus provide some broader lessons, and interestingly, some that depart from the normal policy wisdom that is prevalent, in terms of how governments should intervene in the food system and agricultural economy.

These chapters in this part of the book all emphasize the importance of the decisions that governments make on the productivity of key sectors such as agriculture, and that affect the nutritional status and general well-being of the population. The role of knowledge and research in the policymaking

process is also underscored. This is done with the understanding that there is an important interaction between those institutions charged with generating evidence and the political considerations of government policymakers. Furthermore, there are other institutions, particularly in civil society, that often demand or seek input into the decision-making process. It is in this context that the contribution by Roger Slade and Mitch Renkow to this book is so important. They discuss how institutions conducting research, in their search for relevance, seek close collaboration with a target audience—typically a government or its agents. A review of the germane literature shows that pay-offs to different forms of collaboration is under-researched, and the inherent risks of close collaboration—especially the explicit or implicit trade-offs between independence in choosing and analyzing research questions on the one hand, and the likelihood of influencing policy adoption and implementation on the other—are largely disregarded. These trade-offs often reflect the extent to which policy research agendas are captured by host governments or special interests. They are also influenced by the openness of the policy environment. To examine this issue more fully, the authors conduct a case study of the policy research of the International Food Policy Research Institute (IFPRI) in Ethiopia in support of the government's development of its national agricultural strategy. They find that this relationship gave IFPRI an important role in the policymaking apparatus; but at the same time, this close relationship had large impacts on the composition and nature of IFPRI's research. Not surprisingly, the analysis in this chapter raises some very important questions about the politics of external institutions working in support of government policy analysis, even if their main role is purportedly providing information to support evidence-based policymaking. And, more generally, Slade and Renkow inform the science of policy research in terms of the conceptual basis for how to design, undertake, and learn from this discipline and ensure its relevance.

Looking at the issue of the role of international institutions in an even broader context is the domain of the chapter by Robert Paarlberg, who argues that researchers should focus on the behavior of national governments and try to better understand why, unlike in the case of Vietnam discussed above, governments act in ways that seem ill-advised or inconsistent with economic and social ideals. This question is particularly salient since, according to Paarlberg, public policy remains the responsibility—and firmly under the control—of national and local government, and thus local political considerations. This is despite the global reach and influence of transnational corporations and inter-governmental and international organizations, including non-governmental organizations. Focusing on the same 2008 food price shocks as discussed in the chapter by McKay and Tarp, for example, Paarlberg concludes that despite a robust rhetorical response by inter-governmental organizations, including convening meetings, creating task forces, and

founding new institutions to address the problem, in the end, all these initiatives had “no measurable impact on anybody’s food production or consumption.” This lack of external authority and influence is also applicable to actors such as the World Bank, and, perhaps most surprisingly, transnational corporations. For example, this chapter debunks the myth that private corporations have disproportionate control over global food and farming incomes, and instead, shows that their influence is far less than commonly understood.

The analysis by Paarlberg about authority and influence is particularly relevant in considering the topic of the final chapter of this part, the particularly contentious issue of climate change. Andrew Jones and Sivan Yosef argue that climate change is the most transformative force that will affect the pattern and possibilities for global development in the future. This is indeed a hefty assertion, but one that the authors support by considering the changes in precipitation patterns, global temperatures, and the frequency and severity of extreme weather events. The important contribution of this chapter is that it identifies the principal linkages between climate change and nutrition. They make the case that increases in temperatures in many regions of the world—especially in developing countries where most of the malnourished live—lead to greater rainfall volatility, extreme seasonal heat, and more frequent and severe droughts that will adversely affect nutrition through three principal intermediate outcomes: (1) the quality and quantity of crop and livestock production; (2) the stability of ecosystems; and (3) the distribution and survival of disease vectors. The chapter explores measures to both mitigate and adapt to climate change, and the potential role to be played by governments, industry, and civil society. In the case of mitigation, the strategies to reduce global greenhouse gas emissions are largely the domain of the developed and transition economies, although the chapter points out that agriculture contributes to climate in an important way, and in turn has great potential to mitigate the negative impacts on nutrition outcomes that are predicted from climate change. Strategies such as reducing fossil fuel use and improving energy efficiency in agriculture, adapting techniques such as reduced- or no-till agriculture, promoting agroforestry, and improved irrigation technologies are all discussed. And in terms of adaptation, the authors suggest that the actions required are largely the same as those needed for sustainable development broadly, although they emphasize specific actions such as agroecological intensification.

In its totality, this book addresses emerging challenges, both scientific and at the level of formulating and implementing policies, to alleviating hunger and malnutrition in the years ahead. Many of the issues and problems faced by researchers and policymakers today remain similar to those of years past. These include the widespread stunting and undernutrition that has proven so intractable; the perennial food policy dilemma of remunerative

prices for farmers and low food prices for consumers; and the distributional consequences of technological change. There are also new challenges, some of which have long existed but received relatively little attention, and others that have emerged in the last decade. The former includes the household and health-related problems that have been accorded far too little attention, such as micronutrient deficiencies, as well as more supply side questions such as how to promote and incentivize diversity in production systems. Likewise, among the newly recognized problems at the household level are issues such as the burgeoning prevalence of overweight and chronic disease, while on the production side, is the issue of sustainability as environmental stress and agricultural systems are increasing at the nexus of the discussion of sustainable food systems. What is unambiguously true, however, is that the search for solutions will take place in a dramatically different global landscape from decades past. Globalization, revolutions in information and the biotechnology sectors, changes in the food value chain, issues of sustainability, and the changing political environment—ranging from the realignment of north–south interests and priorities to forms of governance internationally and domestically—have reshaped the thinking on how to address both traditional and newly emergent nutrition, food, and agricultural challenges. By bringing together three intertwined issues—the role of food and nutrition policies at the microeconomic level, the role of agricultural research and development and food systems approaches, and the global scope and political economy of food and nutrition policy—this volume makes it clear that coordinated efforts at the local level must be complemented by a global agenda for action that enables policymakers and stakeholders to work collaboratively to address the vulnerabilities of the poor. And in that context, it is clear that while old prescriptions for success are still relevant—even if sometimes ignored, such as investing more in agricultural research and development—these efforts must be undertaken in a far more complex global economic environment. Whether it be the challenges of dealing with misgivings and misperceptions about genetically modified organisms, the global reach of multinational corporations that have an enormous role on the value chain, the competition of other sectors such as energy with the food sector, or the new realities of the triple burden of malnutrition that includes “hidden hunger” in terms of micronutrients and the scourge of chronic disease, the way forward is far more complicated, despite the progress of the past. Similarly, with more emphasis on evidence-based policymaking and with the raising of the standard of proof, in terms of causal inference and evaluation of impact, the microeconomic-level interventions, traditionally so widely embraced, have come under increased scrutiny. For example, what can really be expected of cash transfer programs with respect to nutritional improvement, and what should be the target groups of these interventions?

And overlaying all of these interventions are the political and social considerations and constraints that need to be taken into account when trying to translate knowledge and information into practice. These factors, too, are highlighted in numerous chapters in the volume. What emerges is a greater understanding and appreciation of the crucial role of government, international organizations, and a range of civil society stakeholders in incorporating and translating the scientific knowledge highlighted in the volume into action. We see, for example, how the public debate over GMOs is of equal or greater importance than the technology itself in effecting adoption of new seeds and agricultural varieties; or how despite the labors and pronouncements of intergovernmental agencies, their influence is receding relative to the state, even with their increased visibility and purported global constituency with shared transnational goals.

The experience of the contributors in research and policymaking, and shared and often long engagement, in the fight to alleviate hunger—albeit often from very different disciplinary and institutional perspectives—provides a way forward in addressing these multiple policy challenges and dimensions.

Part I

Nutrition Policy and Programs

1

Using Height-for-Age Difference Instead of Height-for-Age Z-Scores for the Meaningful Measurement of Catch-Up Growth in Children under 5 Years of Age

Jef L. Leroy, Marie T. Ruel, Jean-Pierre Habicht, and Edward A. Frongillo

Introduction

Chronic malnutrition in children remains an important global problem, with an estimated 165 million children under 5 years old being stunted (Black et al. 2013). Evidence suggests that the most effective way to reduce stunting globally is to scale up interventions to *prevent* (rather than *treat* or *reverse*) stunting, and that children should be exposed to these interventions during the full first 1,000 days of life (from conception to the child's second birthday) (Black et al. 2008, 2013; Ruel et al. 2008). This period is now universally recognized as the "window of opportunity for preventing undernutrition," and nutrition programs increasingly target women and children during this critical period. This programmatic shift from the earlier focus on children under 5 years of age has been implemented not only because of the recognition that this is the period of most rapid growth failure (Victora et al. 2010), but also because there is some evidence, albeit mostly from one country (Guatemala), that interventions beyond this age have little or no impact on child linear growth (Ruel 2010). Thus, a common view among the nutrition community is that stunting is largely irreversible after 2 years of age, when the window of opportunity for preventing undernutrition has closed.

Despite the general consensus achieved about the importance of the first 1,000 days, the verdict on the potential for catch-up in linear growth during mid- or later childhood or at adolescence remains open. The term *catch-up*

growth was first used to describe the reversal of linear growth retardation in children treated for secondary growth disorders, such as renal disease, Cushing's syndrome, celiac disease, and hypothyroidism (Prader et al. 1963; Boersma and Wit 1997). Catch-up growth has been defined as "rapid linear growth that allowed the child to accelerate toward and, in favorable circumstances, resume his/her pre-illness growth curve" (Boersma and Wit 1997, p. 646). Adoption studies have also shown that malnourished children, adopted into wealthier households during their first few years of life, experience substantial catch-up growth. Little or no catch-up growth has been found, however, in children who remained in the same deprived settings in which growth retardation had occurred in the first place (Martorell et al. 1994).

Notwithstanding these earlier findings, the possibility that linear growth retardation can be reversed, even if only partially, has continued to intrigue researchers. A number of recent studies document catch-up growth after 2 years of age in children exposed to standard of care practices typical of developing country contexts, but in the absence of interventions specifically aimed at improving linear growth (Crookston et al. 2010; Outes and Porter 2013; Prentice et al. 2013). In contrast with earlier studies, which mostly used reductions in the absolute height deficit (Martorell et al. 1994), this new body of research is entirely based on the use of height-for-age Z-scores (HAZ) to define catch-up growth (e.g., improvements in HAZ or the reversal of stunting).

The main objective of this study was to assess whether there is evidence of catch-up growth in children between 2 and 5 years old, when catch-up growth is defined as it was originally—as a *reduction in the deficit in height* (compared with standards) between two points in time. We use absolute height-for-age difference (HAD: child's height compared to standards, expressed in centimeters) and compare with findings using HAZ. The rationale for this comparison is that HAZ, which is constructed from cross-sectional data, is useful to assess children's attained height at a given age, but inappropriate to evaluate changes in height over time. We first show mathematically that using HAD to assess catch-up growth is fundamentally different from defining catch-up growth using HAZ. We then use data from select developing countries and compare changes in linear growth and evidence of catch-up growth in children between 2 and 5 years old when estimated using HAD versus HAZ.

Study Scope and Definition

Most recent studies that documented catch-up growth have looked at changes in HAZ between childhood and either adolescence or adulthood (Adair 1999; Coly et al. 2006; Hirvonen 2013; Prentice et al. 2013). Others have looked at

changes in HAZ between early infancy (first 2 years of age) and mid-childhood (e.g., 5–6 years) (Crookston et al. 2010; Outes and Porter 2013; Prentice et al. 2013). Our analysis focuses on the latter; therefore, our research addresses the question of whether or not catch-up in linear growth is achieved between 2 and 5 years of age.

We define catch-up growth as population-level reductions in mean linear growth deficit with age. For simplicity, throughout this chapter, we use the terms height, HAZ, and HAD, irrespective of the child’s age, despite the fact that supine length, rather than standing height, is usually measured in children less than 2 years old and that the terms “length” and “length-for-age” are normally used for these children.

Theoretical Background

Since infants and young children from diverse ethnic groups grow similarly for the first 5 years of life when their nutrition, health, and care needs are met (Habicht et al. 1974; WHO Multicentre Growth Reference Study Group 2006a), a single international growth standard is used to quantify the growth deficit for the first 5 years of life. The mean growth trajectory of a population of healthy children is expected to be at the median of the growth standards. Growth deficits in height for groups of children are thus expressed as the mean of the individual deficits. These are calculated as the difference between the measured height and the median sex- and age-specific height obtained from the growth standards. This HAD can be used in absolute terms (as proposed here), or be used relative to the sex- and age-specific standard deviation (SD) (i.e., standardized by dividing HAD by the SD from the growth standards to calculate HAZ as is traditionally done; see Equation 1.1). Catch-up growth is defined as a reduction in the absolute deficit as groups of children age.

Mathematical Background

HAZ is calculated as the age- and sex-specific absolute deficit in height (measured height minus age- and sex-specific median obtained from the growth standards) divided by the age- and sex-specific SD:

$$\begin{aligned}
 \text{HAZ} &= \frac{\text{observed height} - \text{median height growth standards}}{\text{SD}} \\
 &= \frac{\text{height - for - age difference}}{\text{SD}} = \frac{\text{HAD}}{\text{SD}}
 \end{aligned}
 \tag{1.1}$$

The SDs for height are not constant over time—they increase substantially from birth to 5 years of age (see Figure 1.1).

Therefore, if HAD is negative but remains constant with age, the Z-score will increase with age (suggesting catch-up growth), for the simple mathematical reason that the denominator (SD) increases, and not because the numerator (the height deficit) has decreased over time. Likewise, HAZ can remain constant with age or even improve, even while HAD decreases with age.

As noted earlier, most of the recent studies that found evidence of catch-up growth based their conclusions on the observation that population mean HAZ increased after 2 years of age. These studies define population-level catch-up growth as an increase in mean HAZ over time (see Equation 1.2).

$$\begin{aligned} HAZ_{t=2} &> HAZ_{t=1} \\ \Leftrightarrow \Delta HAZ &> 0 \end{aligned} \quad (1.2)$$

The interpretation of Equation 1.2 is that, if HAZ is higher at time 2 than at time 1, there is catch-up growth in this population during the time period studied. Note that the definition based on the reversal of stunting (being stunted ($HAZ < -2$ SD) at time 1 and not stunted ($HAZ > -2$ SD) at time 2) used in some studies (e.g., Crookston et al. 2010) is mathematically equivalent. The validity of this definition of catch-up growth is questionable. HAZ is

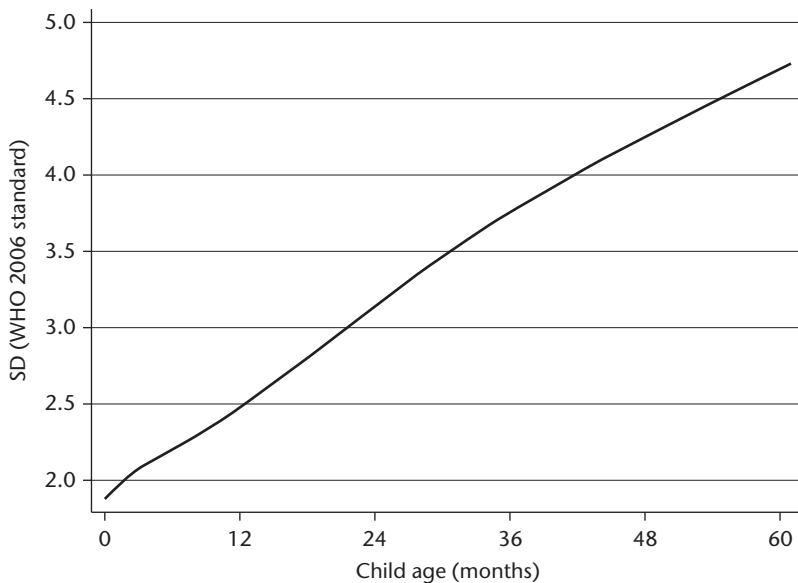


Figure 1.1. Standard deviation of the WHO 2006 growth standard by age

Source: Authors' calculations using WHO child growth standards (http://www.who.int/childgrowth/standards/height_for_age/en/).