**Volume 5: Agricultural Production and Research Methods**

**[**Submission deadline: February 1, 2021]

Brief intro by Chris Barrett and David Just

**Agricultural Production:**

1. **The Economics of Agricultural Innovation**

 **Julian Alston and Phil Pardey**

Throughout history and in every part of the world, innovation in agriculture has played crucial roles in economic development by increasing farm productivity, enhancing the incomes of poor farmers and making food ever-more abundant and cheaper for consumers, while reducing the demands placed on natural resource stocks. In both rich and poor countries alike, agricultural innovation continues to contribute rich rewards in these ways, but it is widely underappreciated. Governments and markets consistently fail to do enough of the right kinds of R&D—at least if we are to believe the evidence on rates of return to research—and technological choices on farms are becoming ever-more constrained. To begin, this chapter reviews the broad landscape of the economics of innovation and technical change in agriculture, paying attention to issues of attribution, the nature and length of the lags between research spending and its impacts on productivity, and various dimensions of innovation outcomes, including rates of return to agricultural research and the distribution of benefits. This sets the stage for a more focused discussion of technological regulation and its implications for agricultural innovation. In the current era, technological regulation is assuming increasing importance on farms and in the food chain, especially in higher-income countries. Whether through government policy or the actions of influential market intermediaries, ever-tighter restrictions are being imposed on the technologies that may be used on farms and throughout the food chain. These public and private policies are often driven by ill-informed public perceptions and many of the resulting restrictions are demonstrably economically ill-advised. These trends are both constraining the potential for innovation on farms as well as beyond the farm gate and inducing demand for new, more acceptable technologies. This chapter will give detailed attention to the implications of the woke farm and food policy movement and the related technological regulations for agricultural innovation.

1. **Climate, Food and Agriculture**

**Ariel Ortiz-Bobea**

Agriculture is arguably the most climate-sensitive sector of the economy. Growing concerns about anthropogenic climate change have increased research interest in assessing its potential impact on the sector and in identifying policies and adaptation strategies to help farmers cope with a changing climate and extreme weather. This chapter reviews recent advancements in the analysis of climate change impacts on agriculture with an emphasis on econometric and statistical approaches applied to observational data in developed and developing countries. The chapter provides an overview of recent research efforts addressing key conceptual and empirical challenges in this literature.

1. **The Changing Nature of Agricultural Labor Markets**

**Zachariah Rutledge, Diane Charlton and J. Edward Taylor**

Agricultural employment is critical to the lives of hundreds of millions of workers across the globe as well as to the farms that employ them and the communities in which they live. However, as the agricultural transformation unfolds, workers move off the farm to jobs in an expanding food services sector and to urban areas, with far-reaching ramifications for agricultural labor markets. This chapter examines the changing role of agricultural employment in developing and developed economies. It draws from two decades of research using a wide diversity of analytical approaches to document how agricultural labor markets evolve and what this means for workers, farmers, and rural economies. We highlight new empirical findings as well as emerging themes and policy implications.

1. **Risk Management in Agricultural Production**

**Jesse Tack and Jisang Yu**

Risk management in the context of agricultural production is a first order problem as margins are tight and producers’ long-run sustainability often depends on their ability to reduce the adverse effects of interannual profit fluctuations. The purpose of this chapter is to highlight several aspects of the academic literature for which there have been key innovations within the last ten years, and the topics are likely to remain relevant going forward. The cornerstone of research in this area is a theoretical understanding of decision-makers’ objectives, sources of risk that they face, and the dynamics of asset management. Thus, the first section of this chapter will focus on decision theoretic modelling innovations with particular emphasis on generalizations of expected utility frameworks and the ability to disentangle risk preferences from production parameters. The remaining sections of the chapter will all focus on important empirical topics with the literature. Section 2 will focus on farm-level risk management strategies with emphasis on the evolution of irrigation, genetically modified crops, intensity of chemical applications, and seeding rates. Price and weather risk will be discussed in section 3, as well as the influential role that agricultural policy can play in supporting producers’ management of these risks. This discussion will also touch on projections of climate change on farm-level production variability and the implications for support programs targeting downside risk such as crop insurance.

1. **The Economics of Animal Health and Livestock Disease**

 **David A. Hennessy and Thomas L. Marsh**

Livestock health and disease constrain production and trade, contributing directly to the health outcomes, livelihoods, and food security of almost a billion people worldwide. They also indirectly affect the diet, nutrition and health security of all people. Strong public interest in the matter arises from a myriad of external effects, including contagion and information failures. So as to ensure that the allocation of resources to this sector is efficient and sustainable, it is therefore critical that economic theory and empirical evidence guide individual and social investments, programs, and interventions for animal health and livestock diseases. We discuss recent methodological advances and empirical findings in the economics of animal health and livestock disease, including benefit and cost metrics, and designing and implementing prevention and management programs. We close with a discussion of implications for policy and future directions for economic research in this area.

1. **Behavioral and Experimental Economics to Inform Agri-Environmental Programs and Policies**

**Leah Palm-Foster and Kent Messer**

 Agricultural and environmental economists are increasingly using behavioral and experimental economics tools to answer important questions about the design of agri-environmental policies and programs. These approaches offer promising insights into the decision making of producers and consumers that can advance economic understanding of human behavior and inform evidence-based policy. Yet these approaches come with challenges that can make the implementation of these studies difficult and/or limit the applicability of the research results. These opportunities and challenges have motivated researchers to think carefully about methodological advancements in these areas. This chapter is written as a practical guide for new and seasoned researchers on best practices for using the tools of behavioral and experimental economics. We begin the chapter with a brief overview of how behavioral economics approaches and economic experiments have contributed to the growing agri-environmental literature over the couple decades. We then describe the different types of economic experiments used to answer policy-relevant questions, and we carefully consider the advantages and limitations of each method in various contexts. We highlight contemporary issues that researchers are discussing to advance this research area, including the selection of subject pools, participant recruitment, and questions related to internal and external validity. Finally, we outline best practices to ensure that experiments are well-designed, including pre-registration and the use of pre-analysis plans that include a well-developed power analysis.

**Methods:**

1. **Agricultural data collection to minimize measurement error and maximize coverage**

**Gero Carletto, Alberto Zezza and Andrew Dillon**

 As the world is confronted with new challenges driven by rapid demographic, environmental and economic changes, once again the agricultural sector takes centerstage. Climate change, raising inequalities and demographic growth, particularly in the most vulnerable countries with fast-growing population of disaffected youth, are likely to affect disproportionately agriculture and rural areas, which is where the fast majority of the extreme poor live. Facing these new research and policy challenges requires new data and innovative data collection methods which both statistical systems and agricultural economics scholars must address in a systemic and rigorous manner.

 In the past decade, we have seen a burgeoning literature and the emergence of new data collection standards and best practices fueled by an increased awareness that rigorous approaches to data quality are equally important as rigorous empirical methods to inform policy relevant research. New data demands and emerging policy questions are driving much of the innovation of the last decade, with fast technological innovation providing an opportunity to collect more and better data at lower costs. New data sources such as satellite imagery, sensors and computer assisted personal interviewing (CAPI), particularly when used in combination with traditional data sources, provide unparalleled prospects for collecting and analyzing data in a more granular, timely and cost-effective manner.

 The chapter will first lay out some of the key policy issues in agricultural economics, both old and new, and identify the data requirements to address them as well as some of the major data gaps hindering research. Measurement errors in agricultural data, and their implications for key constructs and policy research, will be reviewed, with a focus on documenting the occurrence of flawed inferences associated with it. The chapter will also speak to the challenges and opportunities offered by technological innovation and data integration to meet old and new data demands and address key empirical questions, focusing on the scalable data innovations of greatest potential impact on empirical methods and research, with a focus on low- and middle-income countries. The chapter will conclude with a section offering a way forward, with insights on emerging issues and possible ways to tackle the data ensuing challenges from a technical and institutional perspective.

1. **Gender in Agriculture and Food Systems**

**Agnes Quisumbing and Cheryl Doss**

 This chapter aims to survey the broad literature on gender and intrahousehold relationships in rural households and examine how gender relations play out across a range of topics: from production to consumption to well-being outcomes, including health and nutrition, and throughout the processes of rural and structural transformation. The evidence reviewed will draw on three methodological approaches: observational studies, experimental games (or lab-in-the-field experiments), and impact evaluations (including, but not limited to RCTs).

 The chapter will be divided into five substantive sections. The first section, on understanding rural household behavior, revisits models of household behavior and tests of the unitary vs. the collective model of the household. Although the unitary model has been rejected empirically, the focus on bargaining within households has often led us to ignore the cooperation that occurs within households. Many resources are owned and managed jointly by household members and many decisions are made jointly, although not all parties necessarily have equal voice in these decisions. This section will review the theoretical models and empirical evidence on household behavior, with the aim of exploring both sole and joint decision making within agricultural households.

 The second section will discuss both progress and challenges involved in studying gender in agriculture. It will cover developments in the design and collection of sex-disaggregated data in household surveys, as well as the measurement of concepts such as women’s empowerment in agriculture.

 The third section will review the evidence on how gender affects decisions and outcomes regarding production, processing, marketing, and consumption, eventually tracing its way to well-being outcomes such as health and nutrition. It will begin with an overview of gender inequalities in resources and access to services (land, labor, information/extension, modern inputs, financial services) and examine their implications on the adoption of agricultural technologies and agricultural productivity. It will then examine gender differences in processing and marketing, and how gender-specific barriers to participating in higher-value activities in agriculture can be overcome with appropriate interventions. Finally, it will examine consumption and well-being outcomes related to health and nutrition, with particular emphasis on nutrition-sensitive agricultural programs and interrelationships between agriculture and health.

 The fourth section will examine gender relations in the context of transforming economies, focusing on processes of structural transformation and the so-called feminization of agriculture.

 The final section will explore areas for future research, identified as we find gaps in the literature or promising avenues for future work.

1. **Big Data, Machine Learning Methods for Agricultural and Applied Economists**

**Kathy Baylis and Thomas Heckelei**

With the substantial growth in novel data sources and computational power, machine learning holds great potential for economic analysis. However, like any new approach, the strengths and weaknesses of these tools need to be considered when deciding where and how they can be successfully applied. In this chapter, we first introduce key ML methods, from penalized regressions, to tree-based methods to neural networks, drawing connections between these approaches and common econometric practice. We then explore the potential afforded by ML to fill gaps in our current methodological toolbox. We discuss cases like inflexible functional forms, unstructured data sources, large numbers of explanatory variables in both prediction and causal analysis.  We also highlight the challenges of complex simulation models including calibration, validation and computational demands and identify places where machine learning can help. We also walk through several approaches used in computer science and statistics to make ‘black box’ ML tools more interpretable.  We highlight these issues drawing from existing examples in agricultural and applied economics and identify a wide set of other possible applications in this space. Finally, we highlight some of the limitations of current ML tools. We argue that economists can play a vital role in overcoming these limitations and adapting ML methods for the use in economics by combining them with our domain knowledge of economic mechanisms, and our approach to causal identification.

1. **Social Networks Analysis In Agricultural Economics**

**Mushfiq Mobarak and Zack Barnett-Howell**

 Social networks are fundamental to the organization and efficacy of agricultural economies. The social and kinship ties between households in villages and urban-periphery regions define the fundamental structure on which information is disseminated and aggregated. These networks stretch over long distances, as members move from rural to urban areas, and low- to high-income countries. These networks provide the context in which individuals and households form beliefs and make decisions over agricultural technologies, labor market opportunities, and migration destinations.

 Understanding the network-level architecture and individual-level connections in social networks offers insight into economic behavior. The decision over when and where to migrate depends on who a person knows and whether those people have chosen to migrate; subsequent economic outcomes after they migrate are also a function of their social network at the destination as much as the origin. The pace of agricultural technology adoption, including inputs such as hybrid seeds or fertilizer, depends on which farmers first adopt: their location within the social graph, and how others connect to them. Learning over how to best use these agricultural inputs also comprises a network problem, where farmers learn differentially from different people in their network.

 Research on networks opens up new policy tools. Understanding the dynamics of a social network offers the potential of choosing better "seeds" to disseminate information on job opportunities or micro-enterprises. Appropriate targeting of central, influential individuals within a network can allow faster, more widespread adoption of new technologies. Understanding how people learn from others in their network and share information and resources can allow a more equitable diffusion of opportunities. In this way, harnessing viral network effects to create cascades, ”rapid shifts in mass behavior”, can be crucial to the process of growth and development.

 The theoretical and applied tools for understanding networks, however, remain a work in progress. There is no canonical model of network behavior, or complete theory for how networks disseminate and process information. In many economic problems, the relevant social network is difficult to identify as there exists a multiplicity of types of connections between any sufficiently large group of people. Understanding which network, or combination of networks, is responsible for transmitting and aggregating information on the specific economic behavior requires considerable domain knowledge. The data requirements for capturing networks are onerous, typically requiring full census surveys of the population of interest. The stability of networks is also an open question, as they may evolve over time and in response to interventions in unpredictable ways.

**Volume 6: Food Consumption and Value Chains**

**[**Submission deadline: November 1, 2021]

Brief intro by Chris Barrett and David Just

**Value chains:**

1. **The Economics of Food Loss and Waste**

**Tim Richards, Steve Hamilton and Brian Roe**

The amount of food lost, or wasted, at all points in the food supply chain is substantial. In this chapter, we develop an economic framework to explain why food is wasted at each point in the supply chain, and consider a range of policies that may be successful in mitigating the amount of food lost. Throughout this chapter, we emphasize the core insight that the observation that food is wasted does not necessarily imply a market failure. Rather, policies that leverage the power of economic incentives may be successful in exploiting an opportunity to reduce the amount of loss generated by an otherwise-well-functioning food system.

1. **Empowering Communities Using an Integrated Design of Food Networks**

 **Kathleen Liang**

Topics in food systems have gained a lot of attention among researchers and practitioners in recent years. The literature has discussed factors, drivers, scenarios, and consequences of various initiatives, programs, and policies supporting or hindering the architectures of food systems linking to regional or local food movements. In general, a food system represents a coordinated process from production to supply chain and consumption through relevant decisions on resources, abilities, and adoption. Food networks, however, incorporate components in food systems and additional interactions among stakeholders from social, economic, environmental, and political perspectives. Traditional network theories examine the relationships and interactions of actors within a defined domain, such as an organization, a community, or an institution. Food networks do not necessarily have a defined boundary for individuals, organizations, and institutions to collaborate. Given the flow of the food environment, research topics on food networks are relatively new to scholars. There has been limited information to interpret, conceptualize, and synthesize the composition, framework, function, and implications of food networks. More importantly, it is not clear if the formation of food networks promotes a stronger bond between agricultural and non-agricultural sectors at regional and local levels. This chapter will explain, demonstrate, and recommend different approaches to establish and sustain meaningful, effective, and equitable food networks to respond to community challenges such as food insecurity.

1. **Concentration in Food and Agricultural Markets**

**John M. Crespi and James M.MacDonald**

It is well known that agricultural production has moved to greater and greater concentration in the last 50 years with very large operations accounting for most agricultural production, by value. Likewise, along the marketing chain, fewer but larger food manufacturers buy farm commodities and sell into increasingly concentrated retail markets. Seed and farm input industries have seen similar trends. However, concentration in agricultural markets is not entirely a story about firms getting larger. While there are a growing number of very large farms, for example, there are still very many small farms in the United States, about as many today as there were 40 years ago. Likewise, some, but not all, food manufacturers have extremely large firms existing alongside a profitable competitive fringe (brewing, for example).

Food and farm policy, trade, state laws concerning ownership, transfers and land valuations, economies of scale and scope, distribution, vertical linkages and forms of coordination that differ throughout the agribusiness industries impact how market structures and firm dominance evolve. An analysis of concentration and its idiosyncrasies in food and agriculture is necessary to provide the background to so much of the research in agricultural markets.

In Volume 1, Part B of this Handbook series, Lavoie and Sexton examined market power that might arise in the presence of concentration, focusing on the food processing and distribution stages of the marketing chain. However, that chapter paid particular attention to economic measures of market power. In this chapter we propose examining more closely the concentration itself and the contexts in which it exists along the agricultural marketing chain.

We will begin the chapter by discussing concentration in an historical context. We first present statistical summaries to set the framework for a discussion of the market structure evolution of food and agricultural industries during the 20th and 21st century (especially since World War II). We will next present a framework for the economic theory surrounding concentration discussing historical research paradigms and how those have evolved. Finally, we will examine the main economic research into the concentration issues including discussion of specific industries that have been fodder for much of that research.

1. **Trade in Agricultural and Food Products**

**Christophe Gouel and Carl Gaigné**

This chapter reviews how the literature on trade in agricultural and food products has developed over the last twenty years. Its evolution has been heavily influenced by recent developments in the international trade literature. First, related to trade theories that connect closely with observables: new Ricardian models and firm-level analysis. Second, related to a shift toward applied work involving estimated gravity models and counterfactual simulations. Another key source of evolution relates to the emergence of new policy questions, such as biofuels, climate change, quality standards, and nutrition transition, for which even though trade may not be at the center of the issues it mediates most of the effects. This chapter reviews how the articulation between recent theoretical developments and applications have contributed to make agricultural trade a very active research field.

1. **Producers, Consumers, and Value Chains in Developing Countries**

**Marc Bellemare, Jeffrey Bloem, and Sunghun Lim**

 We offer an overview of the literature on agricultural value chains in developing countries. Starting from farmers’ decision of whether to participate in value chains, we study the process whereby agricultural commodities make their way from the farm gate to the final consumer, documenting the procurement relationship that arises and the organization of markets at every step of the way. To do so, we develop a general theoretical framework that accounts for the behavior of actors and the effects of various market failures along the value chain. We further discuss the implications of international policy for agricultural value chains. Discussing the empirical literature on agricultural value chains in developing countries in light of our theoretical model, we take stock of the evidence, critically assess the research so far, and offer a number of directions for future research.

**Consumer behaviors and outcomes:**

1. **The triple nutritional burden**

**Will Masters, Amelia Finaret and Steve Block**

 This chapter will have three parts. The first section, on Nutrition transition and health outcomes, updates Fogel, Popkin etc. on drivers of attained height, stunting and wasting in childhood, obesity later in life and other health outcomes associated with changes in dietary intake, sanitation and physical activity. The second section, on Dietary transition and food choice, describes global patterns in food consumption, focusing on the degree to which revealed preferences and effective demand contribute to future health. The third section, on Food systems and agricultural transformation, traces the shift in composition of diets from direct consumption of plant and animal-sourced products to processed foods and prepared meals, and the rising role for food manufacturing and food services; family farms remain the primary source of crop and animal-sourced ingredients, but non-farm activity plays an increasing role and is subject to a variety of characteristic market and governance failures with major opportunities for agricultural economists to improve policy.

1. **Psychophysiological Measures and Consumer Food Choice**

**Marco Palma**

Why should agricultural economists care about the neural activation pathway of decision-making? First, neuroeconomics is much more than brain imaging. Neuroeconomics is a relatively new discipline that merges concepts from economics, psychology and neuroscience. Let me try to answer the question by providing an illustrative example. Overconsumption of sugar has been largely blamed for the prevalent obesity pandemic in many countries around the world. The current food environment provides an overabundance of starchy food products. However, this was not always the case. Many centuries ago, the survival of hunter-gatherers depended on their ability to find starchy sources of food to store calories and use them during periods of food scarcity. It is not surprising to learn that the brain pathway of sugar consumption shows similar patterns as highly addictive substances, such as cocaine. After all, the brain rewarded this primal need of individuals in order to ensure the preservation of the human species. However, the pace of the increase in efficiency and productivity of the agricultural sector is exponentially faster than the rate of change in the evolution of the brain structure. Recent evidence suggests that obese individuals experience food anticipation and their brains show signs of food addiction. This behavior is not prevalent among normal weight individuals. Most of the policies adopted to address obesity concerns tend to be generic. The implied assumption is that the interventions should work homogenously for all individuals. This example highlights how understanding the biology of the brain can provide useful insights to design customized programs that target different individuals. Neuroscience is crucial for understanding the biological urges that may be working against the desired outcomes of obesity intervention programs. Economics provides a foundation to design incentive-based interventions to understand behavior under different choice architectures. Psychology provides useful insights about the underlying motivations behind the observed economic outcomes. Neuroeconomics opens a set of tools for collecting automatic involuntary response data useful for understanding, predicting and eventually changing the behavior of economic agents.

This chapter provides an overview of the current state of the art of the neuroeconomics field with particular emphasis and applications to the agricultural economics profession. I start the discussion presenting recent neuroeconomic advances in the prediction power of choice models that align the field with the neoclassical economic paradigm for prediction. Next, I highlight the value of using neurophysiological data to enrich the underlying motivations of the choice process preference formation, crucial for the design of interventions. Third, I elaborate on the value of the field for discerning compliance and effort exertion to separate aggregate treatment effects into differential distributional effects that can help in the design of customized programs for different types of individuals. Next, I provide an overview of a wide range of available neurophysiological tools. I highlight some basic and inexpensive instruments that can be incorporated using existing resources for most researchers, such as response times that can be surprisingly informative about the strength of preferences. Other tools included in this overview are: eye tracking and pupil dilation, facial expressions to study emotions and affective processes, galvanic skin response, respiration and heart rates, electroencephalography (EEG), functional magnetic resonance imaging (fMRI), and brain stimulation to modulate behavior. I close by discussing opportunities for the neuroeconomics agenda to address relevant questions in the food and agriculture domain. Finally, I raise potential ethical concerns about the use of the neuroeconomics paradigm to induce changes that can harm the individual and result in suboptimal and costly behavior.

1. **The Economics of Health and Nutrition Related Food Policies: The Effects on the Public Health and Malnutrition**

Vincenzina Caputo and David R. Just

While hunger is still a problem affecting millions, obesity has also become a global epidemic resulting in a dramatic rise of policies designed to influence consumer diets over the last two decades. Early policies focused on the provision of health information but have grown to include a wide range of tools such as taxes, subsidies, bans on specific foods as well as place-based policies. Food health policies have been the subject of significant political pressure coming from different political belief systems as well as consumer groups and industry groups. In this chapter we will briefly review the history of food related health and nutrition policies and provide a review of the recent literature examining their effectiveness. Given the substantial role played by the underlying conflicts in shaping the debate, we will give significant attention to discussing the tension prevalent between the different stakeholders involved in the implementation.

Aside from debates focused on the actual implementation of policies, another key issue in the economics literature as well as the public health and public policy literatures is evaluating the impact food nutrition policies have. Notably, compared to the economics literature, the public health and public policy literatures take a decidedly different approach in determining effectiveness and answering questions of economic welfare. Interestingly, this has resulted in a relatively outsized influence on policy debates by those two groups. We will review related literature and discuss the specifics of how their approach differs to the one common in the economics literature. In addition to discussing differences in approach, we will also review the general results regarding effectiveness found in both literatures with respect to prominent policies.

One key issue often raised within the framework of welfare economics is the question of whether such policies address an externality. By standard welfare approaches, if the individual faces the total costs of their actions, there is little rationale for government intervention. Behavioral approaches have offered both an alternative rationale for intervention, and fodder for alternative policies. If individuals make systematic mistakes in their consumption decisions, or do not fully have control of their decisions, then intervention may be justified without any specific externality. This raises several philosophical issues that have been debated within the economics literature. Libertarian paternalistic approaches have proposed several potential policies that could contribute to nutrition policy goals with minimal impact on available choices. We will review such debates as well as evidence regarding the effectiveness of behavioral policies general.

Relatedly, we will review the general methods used by economists to study the impacts of food nutrition policies as well as their strengths and weaknesses in creating an evidence base for policy makers. In addition, we will discuss the potential advantages and disadvantages inherent to different data sources used by economists such as secondary data analysis (including natural experiments), laboratory and field experiments. We will discuss the potential advantages and disadvantages of each, as well as how limitations in these methods may be unduly shaping the research evidence base. Finally, we will discuss the direction of this field and the future challenges that must be addressed.