The Conversion to Sustainable Agriculture

Principles, Processes, and Practices

Edited by
Stephen R. Gliessman
Martha Rosemeyer

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Preface

This book project began many years ago when the second editor, while still a graduate student, was asked by the first editor to carry out a literature search on the conversion process from conventional to alternative agroecosystems. During the course of this research, funded at that time by the Noyce Foundation, Martha Rosemeyer encountered Stuart Hill's three-level classification system for conversion. Using agroecology as a methodological tool for both researching and promoting the conversion process, and with growing awareness that any change in agriculture also implies social transformations, we eventually added a fourth level to Hill's taxonomy. We described the four levels of conversion in *Agroecology: The Ecology of Sustainable Food Systems* (CRC Press, 1997), but it remained to explore more deeply what conversion meant and to learn how it was actually proceeding around the world. With continuing support from the Ruth and Alfred Heller Chair in Agroecology at University of California–Santa Cruz (UCSC), we conceived of this project and pushed the book forward.

Eric Engles carried out his editing magic on all parts of the book, and ultimately was the person who really extracted the work from all of us. Master indexing was done by Michael Brackney. John Sulzycki, at CRC/Taylor & Francis, with all of his commitment to agroecology, created the space for this project in the first place. And finally, we sincerely appreciate and acknowledge the hard work of all the chapter authors in promoting the conversion process around the world, and thank them for their patience in bringing the book to completion.

Contributors

Antonio M. Alonso
Centro de Investigación y Formación de Agricultura Ecológica y Desarrollo Rural
Santa Fe (Granada), Spain

E. Ann Clark
Plant Agriculture
University of Guelph
Guelph, Ontario, Canada

David Dumaresq
The Fenner School of Environment and Society
The Australian National University
Canberra, ACT, Australia

Saan Ecker
The Fenner School of Environment and Society
The Australian National University
Canberra, ACT, Australia

Fernando R. Funes-Monzote
Estación Experimental "Indio Hatuey"
Universidad de Matanzas
Central España Republicana, Perico, Matanzas, Cuba

Stephen R. Gliessman
Department of Environmental Studies
University of California, Santa Cruz
Santa Cruz, California

Alba González Jácome
Universidad Iberoamericana AC
Santa Fe, Mexico City, Mexico

David Granatstein
Center for Sustaining Agriculture and Natural Resources
Washington State University
Wenatchee, Washington

Gloria I. Guzmán
Centro de Investigación y Formación de Agricultura Ecológica y Desarrollo Rural
Santa Fe (Granada), Spain

Kazumasa Hidaka
Agroecology Rural Community Management
College of Agriculture
Ehime University
Tarumi, Matsuyama, Japan

David Huggins
U.S. Department of Agriculture–Agricultural Research Service (USDA-ARS)
Washington State University
Pullman, Washington

Rachael J. Jamison
Washington State Department of Ecology
Lacey, Washington

Steve Jones
Mount Vernon Northwestern Research and Extension Center
Washington State University
Mount Vernon, Washington

Alireza Koocheki
Faculty of Agriculture
Ferdowsi University of Mashhad
Mashad, Iran

Carol Miles
Washington State University
Mount Vernon Northwestern
Washington Research and Extension
Center
Mount Vernon, Washington

Takuya Mineta
Laboratory of Environmental
Evaluation
Department of Rural Environment
National Institute for Rural Engineering
(NIRE)
Kannondai, Tsukuba, Japan

Joji Muramoto
Program in Community and
Agroecology (PICA)
University of California, Santa Cruz
Santa Cruz, California

James Myers
Oregon State University
Department of Horticulture
Corvallis, Oregon

John H. Perkins
The Evergreen State College
Olympia, Washington

Paul Porter
Agronomy/Plant Genetics
University of Minnesota
St. Paul, Minnesota

María del Rocío Romero Lima
Programa de Agricultura Orgánica
Universidad Autonoma Chapingo
Chapingo, México

Martha E. Rosemeyer
The Evergreen State College
Olympia, Washington

Lori Scott
University of Minnesota
St. Paul, Minnesota

Steve Simmons
University of Minnesota
St. Paul, Minnesota

Jennifer Sumner
Adult Education and Community
Development Program
OISE/University of Toronto
Toronto, Ontario, Canada

Contents

Section I

Basic Principles

1 The Framework for Conversion

Stephen R. Gliessman

CONTENTS

1.1 THE NEED FOR CONVERSION

As we near the end of the first decade of the twenty-first century, we are confronted with an increasing number of signs that our global food system is rapidly approaching, if not already in, a condition of crisis. Issues and problems that go beyond the litany of environmental degradation, pest and disease resistance, loss of genetic diversity, increasing dependence on fossil fuels, and others (Gliessman, 2007) now confront us, creating what is increasingly being called the food crisis. We now face a dramatic rise in food prices, increases in hunger and malnutrition, and even food riots in places in the world where people no longer have access to sufficient food. Making things worse, too many small traditional and family farmers have been forced off their land and out of agriculture due to a wide variety of reasons, including the neoliberalization of trade policy, the loss of support for local food production systems, the entrance of speculative financial capital into food markets, changes in diets and food preferences that accompany greater access to global markets, the agrofuel boom and resulting diversion of food energy to feed the global demand for energy, and the enormous spike in the cost of petroleum in 2008 that caused a rise in the cost for all fossil-fuel-based inputs to agriculture (Rosset, 2006, 2008).

On a global scale, agriculture was very successful in meeting a growing demand for food during the latter half of the twentieth century. Yields per hectare of basic crops such as corn, wheat, and rice increased dramatically, food prices declined, the rate of increase in food production was generally able to keep up with the rate of population growth, and chronic hunger diminished. This boost in food production was due mainly to scientific advances and technological innovations, including the development of new plant varieties, the use of fertilizers and pesticides, and the growth of extensive infrastructures for irrigation. But the elements of the food crisis noted above are signs that this era of ever-rising food production may be coming to

an end. We may be approaching a limit in the amount of food that we can produce relatively inexpensively, given the limited amount of arable land left on the earth and the degraded condition of much that is already being cropped.

At the same time, we face a problem that in the long-term will be even more challenging to the global food system: the techniques, innovations, practices, and policies that have allowed increases in productivity have also undermined the basis for that productivity. They have overdrawn and degraded the natural resources upon which agriculture depends—soil, water resources, and natural genetic diversity. They have also created a dependence on nonrenewable fossil fuels and helped to forge a system that increasingly takes the responsibility for growing food out of the hands of farmers and farmworkers, who are in the best position to be stewards of agricultural land. In short, our system of agricultural production is unsustainable—it cannot continue to produce enough food for the growing global population over the long-term because it deteriorates the conditions that make agriculture possible.

Our global food system also faces threats not entirely of its own making, most notably the emergence of new agricultural diseases (such as mad cow and antibiotic-resistant salmonella), climate change, a growing demand for energy, and an approaching decline in the production of the fossil fuel energy that has subsidized agricultural growth.

Considering all these factors, it is clear that none of the strategies we have relied on in the past—creating higher-yielding varieties, increasing the area of irrigated land, applying more inorganic fertilizers, reducing pest damage with pesticides—can be counted on to come to the rescue. Indeed, it is becoming increasingly evident that these strategies, combined with the commoditization of food and the control of global food production by large transnational agribusiness interests, are a part of the problem, not its solution. The only way to avoid a deepening of the food crisis is to begin converting our unsustainable systems of food production into more sustainable ones. It is the goal of this book to establish a framework for how this conversion can be accomplished, and to provide examples from around the world where the conversion is under way.

1.2 GUIDING PRINCIPLES FOR CONVERSION

Farmers and ranchers have a reputation for being innovators and experimenters, constantly testing new seed, plants, breeds, inputs, and practices. They adopt new farming practices and marketing arrangements when they perceive that some benefit will be gained. The heavy emphasis on high yields and farm profits over the past 40 to 50 years has achieved remarkable results, but with an accompanying array of negative impacts that have restricted farmer-initiated innovation. After responding to this overriding economic focus in agriculture, many farmers are now choosing to make the transition to practices that not only are more environmentally sound in the short-term, but also have the potential for contributing to sustainability for agriculture in the long term (Gliessman, 2001). Several factors are driving the changes in our food systems that are facilitating this transition process. These include factors that range from on-farm issues to conditions well beyond farming communities:

- The uncertain cost of energy.
- The low profit margins of conventional practices.

- The development of new practices that are seen as viable options, especially in organic agriculture.
- Increasing environmental awareness among consumers, producers, and regulators.
- A better understanding of the close link between diet and the recent increases in health issues, such as obesity, diabetes, heart disease, and cancer.
- A growing appreciation for the need to integrate conservation and livelihoods in farming communities.
- New and stronger markets for organically and ecologically grown and processed farm products.

There are many factors that need to be dealt with in the process of converting to sustainable food systems. Many of these factors directly confront the farmer on the farm. As described in many of the chapters of this book, despite the fact that farmers often suffer both yield reduction and loss of profits in the first year or two after initiating conversion, most of those who persist eventually realize both economic and ecological benefits from having made the conversion. Obviously, a farmer's chances of making it through the transition process successfully depend in part on his or her ability to adjust the economics of the farm operation to the new relationships that come from farming with a different set of input and management costs. But as some chapters demonstrate, success in the conversion process is also dependent on factors beyond the farmer's control. These include the development of different marketing systems, pricing structures, policy incentives, and other changes that reach all aspects of the food system, from the grower on one end to the eater on the other.

While the economic goal of conversion is to maintain profitability, the ecological goal is to initiate a complex set of very profound changes. As the types of inputs change, and practices shift to ecologically based management, agroecosystem structure and function change as well. As some authors show in this volume, a range of ecological processes and relationships are altered, beginning with aspects of basic soil structure, organic matter content, and diversity and activity of soil biota. Eventually major changes also occur in the activity and relationships of weed, insect, and disease populations, especially the balance between beneficial and pest organisms. Ultimately, nutrient dynamics and cycling, energy use efficiency, and overall system productivity are impacted. Measuring and monitoring these changes during the conversion period can provide the foundations for developing practical guidelines and indicators of sustainability that will promote the changes that need to occur in the agriculture of the future.

The following principles serve as general guidelines for navigating the overall transformation that food systems undergo during the conversion process (Gliessman, 2007):

- Shift from extractive nutrient management to recycling of nutrients, with increased dependence on natural processes such as biological nitrogen fixation and mycorrhizal relationships.
- Use renewable sources of energy instead of nonrenewable sources.
- Eliminate the use of nonrenewable off-farm inputs that have the potential to harm the environment or the health of farmers, farmworkers, or consumers.

- When materials must be added to the system, use naturally occurring and local materials instead of synthetic, manufactured inputs.
- Manage pests, diseases, and weeds as part of the whole system instead of "controlling" them as individual organisms.
- Reestablish the biological relationships that can occur naturally on farms and ranches instead of reducing and simplifying them.
- Make more appropriate matches between cropping patterns and the productive potential and physical limitations of the agricultural landscape.
- Use a strategy of adapting the biological and genetic potential of agricultural plant and animal species to the ecological conditions of the farm rather than modifying the farm to meet the needs of the crops and animals.
- Value most highly the overall health of the agroecosystem rather than the outcome of a particular crop system or season.
- Emphasize the integrated conservation of soil, water, energy, and biological resources.
- Build food system change on local knowledge and experience.
- Carry out changes that promote justice and equity in all segments of the food system.
- Incorporate the idea of long-term sustainability into overall agroecosystem design and management.

To varying degrees, these principles are reflected in the conversion efforts described in the chapters of this book. The integration of these principles creates a synergism of interactions and relationships from the farm to the table that eventually leads to the development of the properties of sustainable food systems.

1.3 STEPS IN THE CONVERSION PROCESS

For many farmers and ranchers, rapid conversion to sustainable agroecosystem design and practice is neither possible nor practical. As a result, many conversion efforts proceed in slower steps toward the ultimate goal of sustainability, or are simply focused on developing food production systems that are somewhat more environmentally sound or slightly more economically viable or just. For the observed range of conversion efforts seen in this book, four distinct levels of conversion can be discerned. These levels—originally proposed by Hill as three steps (1985, 1998), and expanded to four levels in Gliessman (2007)—help us describe the steps that are actually taken in converting from modern conventional or industrial agroecosystems. They can serve as a map outlining a stepwise, evolutionary conversion process. They are also helpful for categorizing agricultural research as it relates to conversion.

- *Level 1: Increase the efficiency and effectiveness of conventional practices in order to reduce the use and consumption of costly, scarce, or environmentally damaging inputs.* The goal of this approach is to use inputs more efficiently so that fewer inputs will be needed and the negative impacts of their use will be reduced as well. This approach has been the primary emphasis of much of the agricultural research of the past four to five decades,

through which numerous agricultural technologies and practices have been developed. Examples include optimal crop spacing and density, genomics, improved machinery, pest monitoring for improved pesticide application, improved timing of operations, and precision farming for optimal fertilizer and water placement. Although these kinds of efforts may reduce the negative impacts of conventional agriculture, they do not help break its dependence on external human inputs. While this may be a reason for arguing that they do not represent conversion at all, it must be recognized that in the real world of agriculture, level 1 efforts often represent a crucial foundation for initiating efforts at the other levels.

- *Level 2: Substitute conventional inputs and practices with alternative practices.* The goal at this level of conversion is to replace resource-intensive and environment-degrading products and practices with those that are more environmentally benign. The recent expansion in organic farming and ecological agriculture research has emphasized such an approach. Examples of alternative practices include the use of nitrogen-fixing cover crops and rotations to replace synthetic nitrogen fertilizers, the use of biological control agents rather than pesticides, and the shift to reduced or minimal tillage. At this level, the basic agroecosystem structure is not greatly altered; hence, many of the same problems that occur in conventional systems also occur in those with input substitution.
- *Level 3: Redesign the agroecosystem so that it functions on the basis of a new set of ecological processes and relationships.* At this level, overall system design eliminates or at least mitigates the root causes of many of the problems that still exist at levels 1 and 2. In other words, rather than finding sounder ways of solving problems, the problems are prevented from arising in the first place. Whole-system conversion studies allow for an understanding of yield-limiting factors in the context of agroecosystem structure and function. Problems are recognized, and thereby prevented, by internal site- and time-specific design and management approaches, instead of by the application of external inputs. An example is the diversification of farm structure and management through the use of rotations, multiple cropping, and agroforestry.
- *Level 4: Reestablish a more direct connection between those who grow the food and those who consume it, with a goal of reestablishing a culture of sustainability that takes into account the interactions between all components of the food system.* Conversion occurs within a social, cultural, and economic context, and that context must support conversion to more sustainable systems. At a local level, this means consumers value locally grown food and with their food purchasing, support the farmers who are striving to move through conversion level 1 to levels 2 and 3. In a sense, this means the development of a kind of "food citizenship," where everyone forms part of the system and both is able to influence change and be influenced by it. The more we move to this level of integration and action for change in food systems in communities around the world, the closer we move toward building a new culture and economy of sustainability (Hill, 1998; Gliessman, 2007).

In terms of research, agronomists and other agricultural researchers have done a good job of transitioning from level 1 to level 2. Research on the transition to level 3 has been very limited until recently, and work on level 4 is only just getting started. The chapters in this book describe work that is ongoing at several of these levels. The transition from level 1 to level 2 appears most commonly in the chapters of this book as the goal of reaching standards such as organic certification. As shown in Figure 1.1, we have seen considerable growth in the organic food industry in just the past decade, and this indicates that many farmers have reached level 2. The data presented here are from the sale of organic food in the United States, but are indicative of what is happening in other parts of the world as well.

But we must be sure that the movement toward sustainability does not stop at level 2. While the so-called mainstreaming of organic food availability signals a welcome shift in consumer consciousness, it also indicates that the most powerful elements of the conventional, industrialized food system are working to co-opt and contain change. We need to think beyond organic to all levels of the food system, with the idea of transcending product-focused thinking and maintaining a focus on achieving fully sustainable food systems.

In those chapters where agroecology provides the basis for researching level 3, we can see where the redesign and restructuring process is well under way. It is in those few examples in which all members of the food system value the principles of sustainability and relationship where we will we begin to find answers to larger, more abstract questions about the conversion process, such as what sustainability is

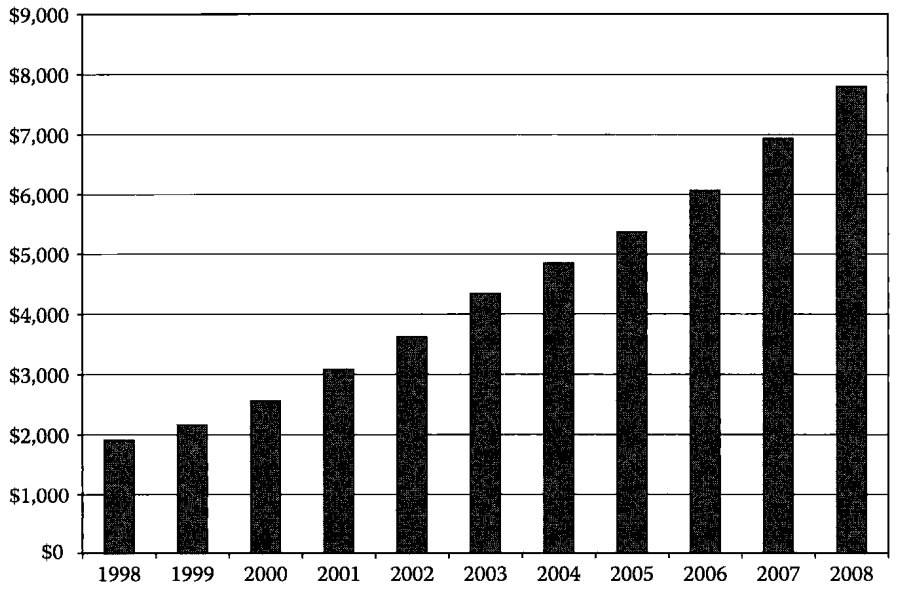

FIGURE 1.1 Sales of organic fruits and vegetables in the United States during the past decade. Sales are in the millions of U.S. dollars. (*Nutrition Business Journal* [http://nutritionbusinessjournal.com/natural-organic/news]; *Santa Cruz Sentinel*, March 18, 2009, pp. A1–A2.)

and how we will know we have achieved it. Ultimately, thinking about sustainability at level 4 can begin to guide the conversion process at all levels, promoting a more rapid transition to full food system sustainability for all parts, peoples, and scales of the global food system.

1.4 THE CHAPTERS IN THIS BOOK

The chapters that follow are highly diverse, each with a unique perspective shaped by the author's location, research, and central concerns. Some authors concentrate on explaining the challenges, while others look more closely at signs of progress and opportunities for change. Some choose a comprehensive overview approach, while others make use of more narrowly focused case studies and examples.

The second chapter provides a review of how researchers have attempted to apply the conversion framework, design experiments, and studies to evaluate conversion; carry out ecological, economic, and social analysis of results; and develop indicators that can tell us if particular conversion efforts are moving us toward sustainability. It is clear that we know how to study the pieces of agroecosystems separately, but we are still limited in our ability to work with the complexities of entire systems simultaneously. This is one of the reasons it is very easy to get stuck at level 2 in the conversion process.

The history of the conversion process as we have known it so far is essentially the history of the organic agriculture movement. This is the topic of Chapter 3. In this chapter, Jamison and Perkins trace the roots of the movement back to the early twentieth century and chronicle its development in the United States. They describe how, in its current phase of burgeoning popularity, the organic movement is in danger of getting stuck at level 2. Organic agriculture is increasingly being captured by market forces as production is concentrated in the hands of larger and vertically integrated growing, processing, shipping, and marketing operations. Knowing the history of the organic movement and the challenges it faces today provides the necessary context for understanding the conversion process as it is described in the chapters that follow.

Despite the fact that organic certification and expanding organic markets have motivated many farmers to convert to alternative production practices, it has also not been the only reason. As described by Porter, Scott, and Simmons in Chapter 4, there are many different constraints facing farmers in such places as the northwest Midwest of the United States. Farming in a difficult ecological transition zone with harsh winters and short growing seasons limits cropping options, and a combination of economic and social limitations limits choice and market access. But despite these limitations, farmers have been making the transition to more sustainable practices. The farmers themselves refer to an evolutionary or even "transformational" process they go through as they make the decision to change their farming systems, sharing in a set of revealing interviews how so much of the conversion process is determined by personal values, family needs, and even the degree of community support. Economics play an important role, but just deciding to farm differently, believing in the choice, and going through the learning process to make it happen shows how level 4 thinking is integral to driving the