Agroecology

Agroecology is one of several fields that emerged as a response to the environmental and social impacts of industrialized agriculture (also termed *conventional agriculture*). Industrial agriculture's focus on maximizing yields and profits has resulted in negative impacts on social and ecological systems around the world. Many of the practices associated with industrial agriculture (e.g., soil tillage; excessive use of water, pesticides, and fertilizers) have led to increasing degradation of the long-term productivity and health of agricultural land. The term *agroecology* began appearing more frequently in the sustainable agriculture literature in the 1970s through contributions of academics based mostly in the United States and Latin America. Some of the most influential among these people were Stephen Gliessman, from the University of California, Santa Cruz; Miguel Altieri from the University of California, Berkeley; John Vandermeer, from the University of Michigan; and Charles Francis, from the University of Nebraska. However, in what is widely recognized as the first textbook in the field, Gliessman traces the first forms of agroecology to the German geographer K. Klages, who published an article on crop ecology in 1928. This was followed by the first actual use of the term *agroecology* by the Czechoslovakian agronomist Basil Bensin in 1930, as part of a proposal to the then International Institute of Agriculture in Rome for an agroecologically based research agenda for agriculture. However, it was not until the past 25 years that agroecology has become a vibrant field of research and practice, with increasing importance in policy, academic, and field applications.

Early definitions of agroecology focused on the application of ecological concepts and principles to the design and management of sustainable agroecosystems. This initial conception of agroecology remains the most widely known, but a recent key publication by a group of renowned agroecologists has redefined and expanded the term as an interdisciplinary field that explicitly addresses social, economic, and ecological factors associated with food systems. This new definition by Francis and colleagues (2003) defines agroecology as "the integrative study of the ecology of the entire food system, encompassing ecological, economic and social dimensions" (p. 100). In Francis and colleagues' article and in subsequent contributions on the theoretical basis of the field, agroecologists have strongly shifted the focus from a farm-based approach to addressing the entirety of the food system, including production, processing, transportation, financial intermediation, marketing, and consumption.

Ecological Basis

Agroecology argues for a whole-systems approach to analyze agroecosystems and their surrounding environments, which examines components and their arrangements (structure), as well as their interactions and their impact on ecological processes (function). The ecological characteristics of the agroecosystem are linked to its plant, animal, and management components (Figure 1).

Natural Ecosystem and Traditional Agricultural Models

Agroecologists have usually relied on two main sources of inspiration to guide the design and management of agroecosystems and agricultural landscapes. The first one seeks to understand ecological processes in natural ecosystems, as they have proven to be resilient over time. The theory is that most of the ecological processes found in natural ecosystems can be replicated in agricultural fields, albeit in modified forms. An understanding of natural ecological processes is used to provide insight on how best to replicate these in an agricultural setting, with the goal of minimizing external synthetic inputs (e.g., fertilizers and pesticides) and maintaining important agroecosystem conditions, such as soil fertility.

The second source of inspiration for agroecological models is traditional agriculture, which is sometimes synonymously termed *local* or *indigenous*. Again, the idea is that agricultural systems that have persisted through time can provide lessons to design more sustainable modern agroecosystems. Many of the farming systems used as models by agroecologists come from the tropical regions, where agriculture has been practiced for thousands of years and where traditional systems have not yet been displaced by industrial systems.

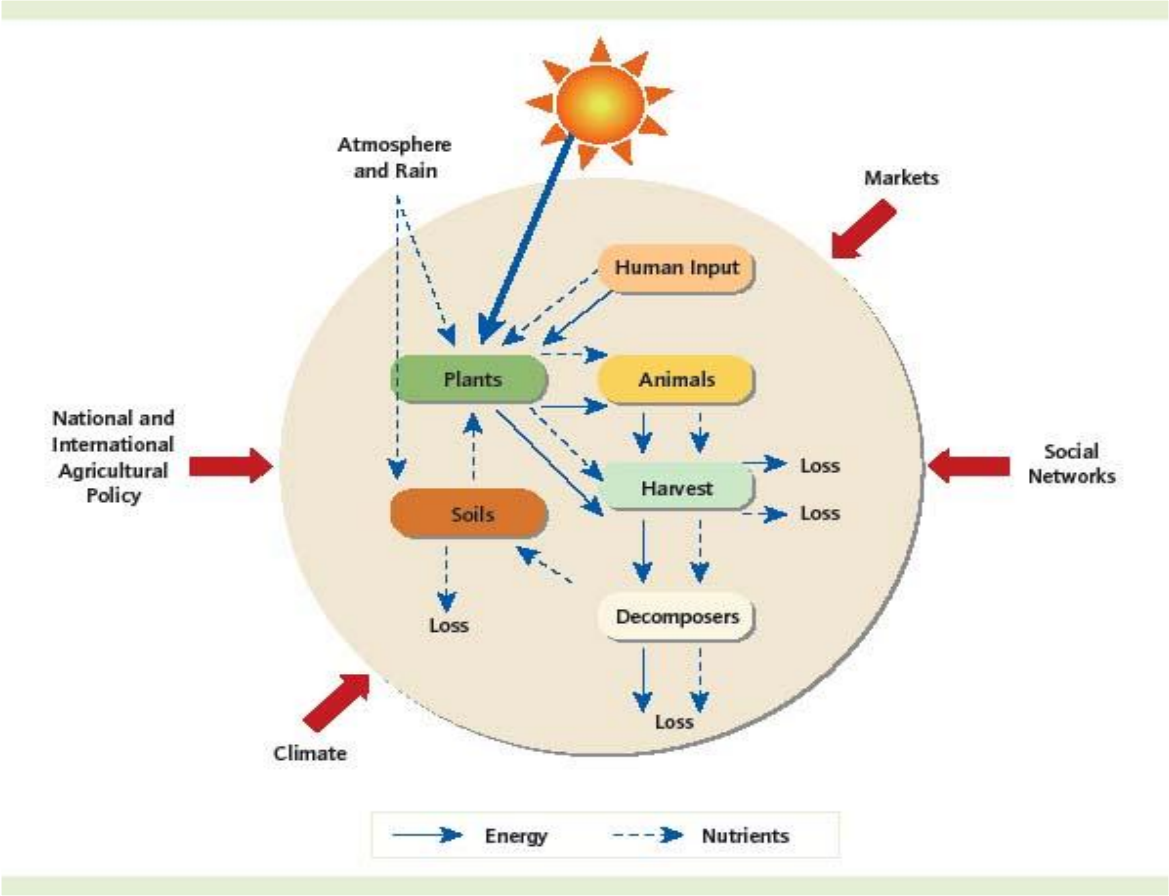

Figure 1 Schematic diagram of an agroecosystem and some of the external factors that affect it. *Source: Adapted from Gliessman, S. (2007). Agroecology: The ecology of food systems (2nd ed.). Boca Raton, FL: Taylor & Francis.*

An example of traditional agriculture, with valuable lessons for sustainability, is agroforestry, a practice of integrating and managing trees and agricultural crops in the same land area.Many agroforestry systems illustrate important agroecological principles, such as replicating the structure and some of the ecological processes of local natural ecosystems (tropical forests). They have also survived for long periods of time through processes of cultural and ecological adaptation. Specific examples of tropical agroforestry with desirable agroecological characteristics include shade coffee and cacao plantations, mixtures of trees and annual crops, and agroforestry home gardens (see photo). A focus on supporting and maintaining key ecological processes on the farm is at the core of agroecological management. Gliessman has identified the following four broad ecological processes to be managed and monitored.

Energy Flow. In natural ecosystems, the primary source of energy is the sun, and this light energy gets captured and stored in plant biomass. In agroecosystems, additional energy is derived from human inputs, and plant biomass is removed from the system with each harvest.

An example of an agroforestry home garden in Cupilco, Tabasco, Mexico. Researchers at the University of California, Santa Cruz, and the Colegio de Postgraduados in Tabasco have documented that this home garden has maintained a very similar structure and crop composition for at least several decades. Some of the components of the home garden include fruit and timber trees, cacao, vanilla, medicinal and cooking herbs, and bananas.
Source: Author.

Nutrient Cycling. Nutrients are the chemical compounds organisms use to maintain their basic life functions; they include different forms of nitrogen, phosphorus, potassium, carbon, and many others. In natural ecosystems, nutrients get recycled in a relatively closed loop, while in agroecosystems there are more losses through leaching and harvest.

Population-Regulating Mechanisms. A population is a group of organisms of the same species. In ecological communities, these populations interact with each other in different ways, such as predation (one organism feeding on the whole or part of the other), competition (two species competing for the same limited resources), or facilitation (interactions that do not harm or can benefit each other). In natural ecosystems, population interactions usually result in a self-regulating control of populations that prevents a particular species from excluding others. In contrast, the simplification of the ecological community in agroecosystems results in loss of self-regulation. This usually translates into large population outbreaks, which can turn into pests and require human interference to control them.

Resilience/Stability. Natural ecosystems usually attain a state of relative stability, maintaining their structure and function over long periods of time. Although disturbances continue to occur, the natural ecosystem is able to respond quickly and return to the state it was in prior to the disturbance (resilience). The simplification of agroecosystems, in terms of structure and function, has resulted in loss of resilience and stability. The high levels of disturbance that agroecosystems are subjected to and the complete removal of biomass through harvesting require that humans invest labor and inputs to maintain a certain level of stability.

The four ecological processes broadly outlined above can be used to compare natural ecosystems and agroecosystems. Agroecology has used these types of comparisons to try to design agricultural systems that “mimic” natural ecosystems as much as possible, in order to increase the efficiency and resilience of agroecosystems.

Social, Economic, and Cultural Basis

In agroecology, the agricultural and ecological characteristics of farming communities are seen as part of a broader social and ecological landscape in which farmers and other rural actors interact and negotiate to pursue their particular goals. The livelihoods of farming families and communities are central to agroecological research and practice. Livelihood refers broadly to the multiple resources and capacities that people use to make a living. Understanding the social and ecological processes in local or traditional agriculture has been of particular importance to agroecological research. For example, agroecological work on agroforestry home gardens (see photo) in Mexico and Central America has shown that the ecological structure of these agroecosystems, in terms of plant arrangements and horizontal allocation of space, was mainly influenced by each family's livelihood strategies.

A notable contribution to the socioeconomic and cultural basis of agroecology has been provided by a group led by the rural sociologist Eduardo Sevilla-Guzmán at the University of Cordoba, Spain. The group's publications (most of them in Spanish) have critically examined agroecology as an option to support small-scale and peasant agriculture in the context of accelerating globalization. Through an analysis of the epistemological roots and characteristics of

agroecology, these researchers have concluded that the field is an ideal foundation for "participatory and endogenous" rural development, with a focus on small-scale agriculture. These characteristics include (a) agroecology's value, use, and integration of different forms of knowledge, including scientific, indigenous, local, and experiential; (b) the ecological, not economic, basis of agroecological management; and (c) agroecology's concern for the social and cultural factors that interact with and affect agriculture.

Participatory Approaches and Direct Applications

Agroecology's concern for small-scale agriculture has led to interaction with and support for farmer organizations and social movements. Examples of this can be found in Spain (ecological olive grove cooperatives), Latin America (the Agroecological Movement of Latin America and the Caribbean [MAELA]), Brazil (the Landless Rural Workers' Movement [MST]), and Central America and Mexico (the Campesino a Campesino Movement [MCAC]).

Direct support for farmers has also taken the form of participatory approaches in agroecological research and implementation that seek to directly benefit farming communities. Most of these initiatives have used long-term participatory action research, a process that combines research with direct action to directly benefit participating stakeholders (i.e., farmers, researchers, and rural communities). Examples of this work can be found among the shade coffee communities of Mesoamerica, olive growers in Spain, and strawberry farmers in California.

An increased focus on the food system has resulted in many agroecologists supporting alternative food network initiatives, such as Fair Trade, direct marketing, and eco-friendly farming. This has been done through participatory research on the role that alternative food networks (e.g., certifications, direct marketing) might play in increasing the sustainability of food systems. A recent example of this work addressed shade coffee production in Mexico and Central America and included an examination of "sustainable coffee" and the certifications associated with it (i.e., Fair Trade, organic, and eco-friendly). Other direct applications of agroecology exploring alternative food networks have been accomplished through researcher-NGO partnerships, such as the Community Agroecology Network (CAN, www.communityagroecology.net), which works on marketing innovations for small-scale coffee farmers in Mexico and Central America.

Agroecology and Sustainability

Although there is an ongoing debate on the meaning of sustainability and how to measure it, most would agree that it relates to maintaining or enhancing social and ecological conditions indefinitely. In agriculture, this refers to a way of farming that will not degrade the land in a way that hinders agricultural production in the future. It also includes factors related to social equity and economic viability for future generations. Agricultural sustainability has been one of the core issues addressed by agroecology. A large portion of current agroecological research is devoted to analyzing and developing agricultural management that is more sustainable. This is a daunting task and rife with debate and controversy. However, agroecology's integration of ecology,

agriculture, and social and economic concerns renders it one of the most promising fields to help us better understand and resolve the challenge of sustainable food systems.

Critiques, Challenges, and Future Trends

Since the publications and interest in agroecology first appeared in the 1970s, the field has been challenged from supporters of industrialized agriculture and narrow disciplinary scientists. Some of the criticism against agroecology has been directed at its potential for major reduction in agricultural production and farmer profit, which would result from its widespread adoption. In addition, as an emergent, interdisciplinary field, agroecology has been questioned by the disciplines that it sought to integrate, mostly from purists in the fields of agronomy and ecology. Many of these critiques have dissipated because of the general consensus that industrialized agriculture has had negative social and ecological impacts; the need to keep sustainability in mind; evidence that organic agriculture, as a form of agroecological management, can produce comparable yields to industrialized agriculture; and a wider acceptance of interdisciplinary approaches as part of scientific inquiry. Nonetheless, there is still a strong financial and ideological sector that continues to support industrialized agriculture and that will continue to defy agroecology.

One of the greatest tasks faced by agroecologists is to be able to develop a fully integrated interdisciplinary approach. Agroecology has strong ecological roots, and early work in the 1970s and 1980s focused on analyzing and improving agronomic and ecological management. In-depth analyses of social, economic, and cultural aspects were incorporated later. One of agroecology's current challenges is to develop a flexible and adaptive interdisciplinary framework that fully integrates the ecological, social, economic, and cultural dimensions.

—V. Ernesto Méndez

Further Readings

Altieri, M , (1995). *Agroecology: The science of sustainable agriculture.* Boulder, CO: Westview Press.
Bacon, C. , ed. , Méndez, V. , ed. , Gliessman, S. , ed. , Goodman, D. , ed. , & Fox, J. (Eds.), (2008). *Confronting the coffee crisis: Fair trade, sustainable livelihoods and ecosystems in Mexico and Central America.* Cambridge: MIT Press.
Clements, D. , ed. , & Shrestha, A. (Eds.), (2004). *New dimensions in agroecology for developing a biological approach to crop production.* Binghamton, NY: Food Products Press.
Francis, C. , Lieblein, G. , Gliessman, S. , Breland, T. , Creamer, N. , Harwood, R. , and et al *Agroecology: The ecology of food systems. Journal of Sustainable Agriculture* vol. 22 no. (3) pp. 99–118. (2003).
Gliessman, S , (2007). *Agroecology: The ecology of sustainable food systems (2nd ed.).* Boca Raton, FL: CRC Press.
Uphoff, N. (Ed.), (2002). *Agroecological innovations: Increasing food production with participatory development.* London: Earthscan.

Entry Citation:

Méndez, V. Ernesto. "Agroecology." *Encyclopedia of Geography*. 2010. SAGE Publications. 1 Oct. 2010. <http://www.sage-ereference.com/geography/Article_n25.html>.