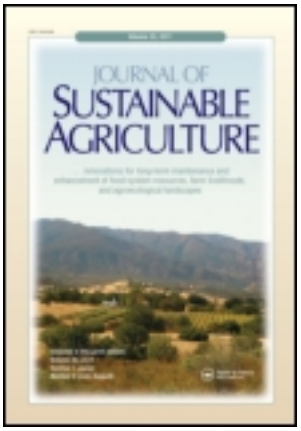

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Agroecology: Growing the Roots of Resistance

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Agroecology today has a strong focus on bringing sustainability to food, feed, and fiber production. But there is also a larger focus on the social, economic, and political "drivers" that move food systems beyond the conditions that have created un-sustainability in modern industrial agriculture. With its ecosystem foundation, the science of agroecology has become a powerful tool for food system change when coupled with an understanding of how change occurs in society. In this article, I trace the roots of agroecology to its emergence as Agroecología *in Mexico in the 1970s as a form of resistance to the Green Revolution. Agroecology has become much more than a science for developing better, safer, and more environmentally sound food production technologies. Agroecology is more than a way to practice agriculture, such as organic or ecological production. Agroecology is also a social movement with a strong ecological grounding that fosters justice, relationship, access, resilience, resistance, and sustainability. Agroecology seeks to join together the ecological and social cultures that helped human society create agriculture in the first place.*

KEYWORDS agroecology, resistance, social change, Mexico

This article is dedicated to Dr. Roberto Garcia Espinosa, plant pathologist and agroecologist, who was one of my main partners in the agroecological resistance that developed at CSAT in the latter half of the 1970s. He passed away shortly after completing his monumental work on agroecology and root diseases in agricultural crops, in large part developed in the intercultural environment of farmers' fields in the tropical lowlands of Tabasco and the classrooms and laboratories of CSAT (Garcia Espinosa 2010).

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INTRODUCTION

One of the most complete definitions of agroecology today is the *ecology of the food system* (Francis et al. 2003, Gliessman 2007). It has the explicit goal of the transformation of food systems toward sustainability where there is a balance between ecological soundness, economic viability, and social justice (Gliessman 2007). But to achieve this transformation, change is needed in all parts of the food system, from the seed and the soil, to the table (Gliessman and Rosemeyer 2010). The two most important parts of the food system—those who grow the food and those that eat it—must be reconnected in a social movement that honors the deep relationship between culture and the environment that created agriculture in the first place. Our current globalized and industrialized food system is showing that it is not sustainable in any of the three aspects of sustainability (economic, social, or environmental). With a deep understanding of what a holistic, ecological view of the food system can be, the change needed to restore sustainability to food systems can occur.

CONCEPTUAL BACKGROUND: EXPLORING THE ROOTS

From the earliest appearance of the term *agroecology*, there has always been an emphasis on the relationship (or lack thereof) of the two fields of ecology and agronomy (see Gliessman 2007, for a brief review of the history of agroecology). But from the beginning of its use, agroecology was divided between the agronomy of crop production and yields, and the ecology of crop distribution and plant or animal adaptation to the environment. The term most commonly used in these earlier times was crop ecology, with a very strong emphasis on developing technologies that allowed for adjusting or modifying the farm environment to meet the needs of the crop organism so that the highest yield could be obtained. Obviously, the array of machinery, fertilizers, pesticides, and other technological innovations that began to become available, especially after World War I were the inputs used to modify the crop environment.

Interestingly, though, one of the first uses of the term agroecology was a response to the indiscriminant use of these inputs. Writing in the publication of the International Institute of Agriculture in Rome (a precursor to Food and Agriculture Organization of the United Nations [FAO]) in 1930, Basil Bensin, a Russian agronomist, called attention to the need for international cooperation in agroecological investigation, and termed the science behind this investigation agroecology (Bensin 1930). He observed that farmers were too often convinced by the organized advertising campaigns of the large companies who manufactured tractors, fertilizers, and seeds without really knowing if these inputs were appropriate for local conditions and

farmer needs. Advertisements, for example, claimed that a single tractor was "universal" and suitable for all kinds of soils, climates, and types of farming. By producing large quantities of a universal machine, the companies could compete more effectively on the market. But too often, Bensin observed, farmers experienced disappointment after having bought a farm machine advertised as universal. The same was true for seeds sold by the well-known seed and plant breeding companies of this time. Attracted by advertisements that claimed these new seeds could succeed anywhere, farmers would order seeds produced in a place and under conditions very different from their farms, and too often also required the machinery and fertilizers used to alter conditions to meet the needs of the new seeds. Local knowledge and experience was not included in the development of this new array of inputs. Farmers were being considered primarily as purchasers of production products, and being taken advantage of in the process.

On one hand, agroecology was seen by Bensin (1930) as a way to generate information through what he called "agroecological research" that would help farmers make better choices on what to purchase. Interestingly, though, he also stated the need "to regulate the purchase of fertilizers, machines and seeds, so as to reduce the risk to the farmer" (278). This can be interpreted as calling for some form of resistance to the pressure being exerted by the corporations, a need that has only grown greater as the industrial model of agriculture has gained more and more dominance of our food system. But Bensin also saw agroecology as a multidisciplinary science, where all factors that have an influence on the development and success of a crop must be considered. For him agroecological investigation needed to be grounded in botany, plant breeding, meteorology, climatology, soil science, and experimental agronomy—in some respects, grounded in knowledge of the entire ecosystem in which agriculture was occurring. He criticized the experimental agronomy of the time as being too focused on the yields obtained by the use of new inputs and practices, rather than a focus on the reasons and causes for the results obtained. But despite its call for resistance, Bensin's agroecological proposal seems to have been reduced to crop ecology over the next several decades. The primary focus became meeting crop needs through environmental modification and agricultural inputs.

One of the best-known examples of agricultural ecology or crop ecology was the work of Azzi (1956). Building upon the same fields of agricultural meteorology and soil science as Bensin, Azzi proposed the field of agricultural ecology as a way to integrate all of the separate sciences that agronomy uses to understand how each affected the crop of interest. For him, agricultural ecology went beyond exploring the ecological characteristics of each species. It also provided a way to analyze yields differently as a way to discover what controls the complex relationships between plants, environment, and yield. Tischler (1965) further elaborated on the need to understand the ecology of each of the components of the agricultural system, from crop

adaptations, to insect management, and to land husbandry. These pioneers were creating a foundation for thinking of agricultural systems as ecosystems, but it still emphasized the crops and not the people who grew them. The lack of a whole-system view of farming and agriculture, especially without any social component, may have been a main reason for the growth of a strong production emphasis, culminating in the so-called Green Revolution of the 1960s.

It took work by ecologists rather than agronomists to finally formalize an ecosystem view of agriculture. One of the first to do this was Daniel Janzen (1973) in his paper on the concept of tropical agroecosystems. An ecologist who was very committed to protecting and preserving tropical forests, yet also very aware of the livelihood needs of local people in tropical regions, Janzen proposed what he called "sustained-yield tropical agroecosystems" (1212) productive ecosystems, in his view, should be grounded in local ecological knowledge, locally adapted, limited by local environments and culture, and designed to meet local needs first rather than respond to the demands of export markets for single commodity crops. By going against the thrust of the Green Revolution's focus on the market, Janzen was echoing the call of Bensin (1930) more than four decades earlier for the need for agroecology, but with a special view towards the needs of people in the tropics. A bit later, a review by Orie Loucks (1977) pointed out how the strengthening of our understanding of ecosystem structure and function that occurred through the 1960's, and which to a certain extent culminated with the classic work on ecosystem development by Odum (1969), brought us to a point where it was clear that agricultural systems possessed similar characteristics to natural ecosystems. They differed, though, in the primary characteristic of continual removal of nutrients through harvest or loss through "leaks" in the ecosystem. This was due to loss of interconnectedness and complexity in energy flow and nutrient cycles that characterize modern agriculture. Loucks (1977) stressed the need for an agroecosystem approach for not only improving yield performance, but also determining the long-term stability of such yield improvements and their impacts on ecosystems in the broader landscape in which the agroecosystems were located.

Loucks (1977) had participated in the preparation of a report sponsored by the newly formed International Association for Ecology (INTECOL; 1975) on the development of an international program for analysis of agroecosystems. This report was commissioned by an ad-hoc working group on agroecosystems that convened at the first International Congress of INTECOL in The Hague, The Netherlands, September 1974. This also coincided with the publication of the first issue of the journal *Agro-Ecosystems*, which was designed as forum to publish research that integrated the many fields of agriculture described by the early crop ecologists. The founding editor of the journal introduced the first issue with a call for research on the ecological interactions that occur in all human-managed ecosystems, from

agriculture to forestry to fisheries (Harper 1974). He emphasized the need for an ecosystem approach that recognized "that each part is a component of a whole and that at some point the whole itself must itself be a subject of study" (1). The journal set in motion a broader, multidisciplinary view of agroecosystems intended to promote the understanding of the function and management of whole ecosystems, from the most extensive to the most intensive, and from the most natural to the most intensively altered by humans. The goal was to increase and maintain production in ways that were efficient, environmentally sound, and agronomically validated. Notably, the social science side of multidisciplinarity was not included, nor did the term agroecology appear.

In 1979, two books appeared that began to discuss the social component within the concept of the agroecosystem. The first was *Agriculture Ecology: An Analysis of World Food Production Systems* (Cox and Atkins 1979). Using a distinctly evolutionary approach, this book first locates food production systems in an ecological and historical context, with agriculture the result of a long process of co-evolution between culture and environment. It is no coincidence that the cover drawing is a pre-Hispanic rendition of the remarkably productive system of raised beds and canals present in the Valley of Mexico when Cortez began his conquest. Considerable emphasis was placed on the value of local and traditional farming systems with a long history of experience, change, and adaptation, especially in developing countries where the highly mechanized and input-intensive production practices of the Green Revolution had not yet penetrated. By using an ecological lens through which agroecosystem dynamics could be investigated, present-day agriculture was examined for its strengths and weaknesses, with ecologically based alternatives proposed as needed. For example, the ecological impacts of cultivation, grazing, irrigation, and fertilization on the soil ecosystem were reviewed, with alternatives proposed that would help maintain a healthy, production soil ecosystem. The negative impacts of the use of pesticides was also reviewed, along with positive alternatives such as biological control, crop rotations and diversification, sanitation, and new advances in chemical attractants, deterrents, and growth regulators. In all components of the agroecosystem, the book tried to look beyond the drive for yield increases at all costs, and instead presented a framework for increasing production without destroying agricultural lands or damaging global ecology. But perhaps most importantly, the book emphasized the need to be aware of the cultural and economic contexts within which any change in agriculture occurs. By drawing attention to the weaknesses of single-crop economies, especially in the developing world, and to what were then recent sociopolitical "setbacks" resulting from the Green Revolution, the book makes a strong call for an agricultural ecology that will "reveal the ecological fitness of past and present agricultural systems as a basis for developing an ecologically sound approach to agriculture in the future" (Cox and Atkins 1979, 684; see also chaps. 25, 26).

The other relevant book was first produced as a text for students at the Tropical Agronomic Center for Research and Teaching in Turrialba, Costa Rica (Hart 1979). Titled *Agroecosistemas: Conceptos Básicos*, the book was designed to give students of tropical agriculture an alternative to the technological focus imported to the tropics from mostly temperate parts of the world. Agronomy students were given a full training in the ecological concepts and principles that today form the foundation of agroecology. It provided in-depth ecological content for understanding structure, function, relationships, and dynamics of agroecosystems, from the individual plant or animal, from the farm to the region, and eventually, to the global food system. All components of the agroecosystem were viewed as subsystems, such as the soil, crops, weeds, pests, and diseases. By understanding the relationships between subsystems, a design for integrating them into a whole could be visualized. Perhaps the most important element of the book was that it began at the local level, with local farmers who had been living under a particular set of ecological, economic, and social conditions that had guided the development of their agroecosystems over time. Hart recognized this richness of knowledge and experience, and in fact, refers to these farmers as his "professors" for convincing him that there was much more to the agroecosystem than the yield of an individual crop plant or animal. These small farmers, who were (and still are) the main food producers that feed people in the tropics and the rest of the developing world, were being forgotten by the Green Revolution.

Both of these books became important components of the teaching and research programs in agroecology that are described below.

THE ROOTS OF RESISTANCE IN MEXICO

By the late 1960s the Green Revolution had achieved a strong foothold in Mexico. The International Wheat and Maize Improvement Center (CIMMYT) was established in 1966 in the same rural town outside of Mexico City where the National Autonomous Agricultural University was located. The new "improved" high-yielding varieties of corn and wheat began to be introduced from CIMMYT to the school, to agronomists, to the extension system, through seed outlets, and ultimately to farmers. But the impacts of these new varieties of corn and wheat were more than just the introduction of new seeds. A food system that was thousands of years old was suddenly being displaced by what is known today as a high external input, fossil fuel based, export oriented, monoculture cropping system. What was being displaced were diverse, low-external input, locally adapted farming systems such as the traditional intercrop of corn, beans, and squash. Despite their ability to deliver the promised dramatic increases in yields, these new Green Revolution crops began having drastic negative

impacts on rural and traditional farming systems. Mexico began to move from self-sufficiency in corn to being a net importer by the end of 1970. Food prices began to climb. Farms and their families began to abandon the rural areas they had lived in for generations. Agrobiodiversity began to drop. The reasons for these changes are many and complex, but at the beginning of the Green Revolution there was also a resistance movement taking root that was grounded in valuing the rich co-evolutionary history and cultural memory of the local, indigenous, traditional farming systems of Mexico (Hernández Xolocotzi 1985, 1987; Gonzalez Jácome 2011).

The development of three programs occurred almost simultaneously in Mexico between 1974 and 1980. Together they formed both a resistance as well as an alternative to the Green Revolution. One of the most important actions was the work of agronomist and ethnobotanist, Efraím Hernández Xolocotzi. In the 1950s and 1960s, he used his training in ethnobotany to lead extensive field collections of the immense agrobiodiversity present in the fields of local Mexican farmers. But when he saw how this genetic richness was being used to create hybrid varieties that focused purely on raising yields and ignored the millennial co-evolutionary processes that had led to the development of the systems in which these varieties had evolved, he started another movement. His struggle to call attention to the strengths of traditional Mexican agriculture and keep it from being displaced culminated in a national seminar in 1976 titled "Analysis of the Agroecosystems of Mexico" with its proceedings published in 1977 (Hernández Xolocotzi 1977). A key aspect of this thinking is shown in Figure 1, where his conceptualization of an agroecosystem took the form of three axes that needed to be balanced in their impacts for sustainability to occur. He argued that the Green Revolution ignored the ecological axis and emphasized introducing new inputs, practices, and technologies aimed at increasing yields in order to respond to market pressures and the dominant development thinking of the time. The socioeconomic axis was reduced to a purely economic one. And in the process, an entire culture of agriculture was being lost (Hernandez Xolocotzi 1985, 1987).

A second focus that was developing at this time in Mexico was called *agrobiología*. Its primary proponent was the ecologist and botanist, Arturo Gomez-Pompa. He established the National Institute for Research on Biotic Resources (INIREB), which was headquartered in Xalapa, Veracruz. INIREB played an important role in drawing attention to the problem of deforestation in the tropics, especially in Mexico, and developed a range of alternatives grounded in biological and ecological knowledge linked with traditional experience of local agricultural systems. In part, this effort was a form of resistance to the large-scale removal of tropical forests in order to install large internationally funded development projects using Green Revolution technology. His work with the reconstruction of different

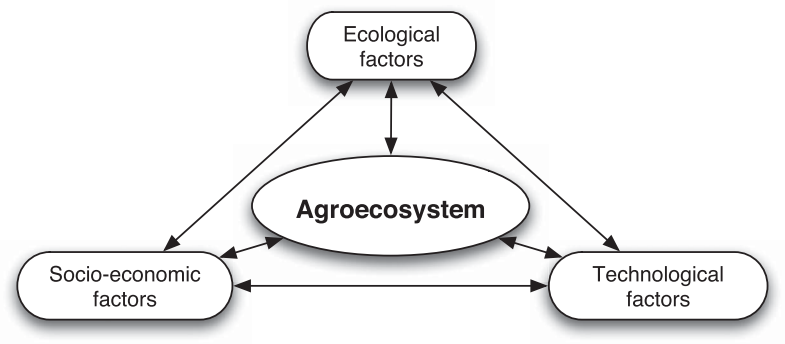

FIGURE 1 The factors influencing the co-evolution of an agroecosystem. (Adapted from Gliessman 2007).

versions of wetland agriculture based on the model of raised fields or *Chinampas* is a good example (Gomez-Pompa 1985). He termed his work as agrobiology.

The third focus began in 1974 with the establishment of a small college of tropical agriculture near Cárdenas, Tabasco, in southeastern Mexico (Colegio Superior de Agricultura Tropical; CSAT). It was conveniently located in the middle of an immense International Development Bank funded project known as the Chontalpa Development Plan (*El Plan Chontalpa*), the first phase of which was a 90,000 hectare clearing of tropical forest, draining of wetlands, moving of local communities to small housing villages located within the Project, and establishment of large scale monoculture crops such as corn, beans, sugar cane, and improved pasture, using Green Revolution technology. The region was to become the new granary of Mexico (Barkin 1978), with a primary focus on export crops, and CSAT was going to train the agronomists and test the technologies on its experimental fields to solve any problems that might arise. Due to several far-sighted founding faculty in the Department of Ecology and the Department of Plant Pathology, as well as connections with Hernández Xolocotzi at the national school of agriculture, ecology courses formed part of the curriculum at CSAT. But it soon became evident that ecology, as a science separate from agriculture, was not of interest to the students. In order to interest the students, most of whom were from the tropical regions of Mexico, ways of applying ecological concepts and principles to local agroecosystems had to occur. Soon, ecology courses began to morph into *agroecología*. International summer courses in agroecology were offered in 1978–1980, a master's degree program in agroecology was begun in 1978, and research projects with the agroecosystem as the organizing concept and agroecology as the research process began as early as 1977 (Department of Ecology, CSAT, unpublished annual reports from 1978, 1979).

When an agroecological approach was focused on the Green Revolution monocultures such as the corn, beans, rice, and sugar cane that were being

grown on the experimental fields of CSAT and the farmers' fields in the *Plan Chontalpa*, it quickly became obvious that they were not sustainable. The lack of sustainability was not just in the ecological realm, but also in the social, economic, and cultural realms. As detailed in Barkin (1978), the social injustices and inequalities that the development project was bringing about were many. Farmers no longer grew the food they ate, planting decisions were made by the bank that funded the project, the farmers found it easier to contract salaried labor from outside the project area than do it themselves, and generations of local agroecological knowledge were being lost. It was at this time that the same ecologists who were now teaching *agroecologia* realized that there was another agriculture on the margins of the project, and, in some cases, being practiced on unoccupied parcels within the project—traditional Maya agriculture.

A key event in the development of agroecology in Mexico was the organization of a regional seminar held at CSAT in March of 1978, with proceedings published that same year (Gliessman 1978), with the title "Agroecosystems with an Emphasis on the Study of Traditional Agricultural Technology (TAT)." The seminar brought together Hernández Xolocotzi and his research group, the growing group of agroecologists at CSAT, persons or groups carrying out studies of TAT from around Mexico, as well as a large number of students and farmers. The agroecosystem focus was defined and applied to the richness of traditional farming systems all around Mexico, not just the lowland Maya region, agroecology was presented as a way for these agroecosystem to be studied, preserved, improved, and expanded, and a strong call made for all studies to include the full participation of farmers and their communities in order to reach the large number of rural cultures being rapidly marginalized by the Green Revolution.

For several years intensive participatory surveys and research projects began to be carried out that demonstrated the strong combination of agroecological and cultural knowledge these systems contained, from the traditional intercrop of corn, beans, and squash (Amador 1980), home gardens (Martínez Tirado 1980, Allison 1983), swampland agriculture (Orozco 1980), and others. More specific agroecological studies delved into the structure and function of TAT (Garcia Espinosa 1978; Chacón and Gliessman 1982; Gliessman 1982), and development projects based on TAT were designed and implemented in rural communities (Gliessman 1980; Gliessman et al. 1981). Traditional agricultural knowledge was seen not only as a foundation for ecological sustainability, but also as a source of alternatives and opportunities for rural communities. Agroecology was also seen as a way to pull modern agriculture back from its un-sustainable track. As stated in one of the presentations at the TAT seminar: "Ecologists motivated by an agroecological approach are not blindly opposed to modern agriculture, but rather opposed to the blind practices associated with it" (Krishnamurthy et al. 1978, 115).

Despite the fact that Hernandez Xolocotzi died in 1991, INIREB was abandoned in the mid-1980s, and CSAT was closed by the government in

1985, the seeds planted during this time continue to grow a movement. The Third International Congress of the Latin American Scientific Society of Agroecology, held in Oaxtepec, Mexico, in August of 2011, was attended by over 700 participants of which the majority were from Mexico. Agroecology, agroecosystems, and food systems were words that appeared on name tags of participants from universities, non-profits, national and international government programs, farmer organizations, extension personnel, and most numerous, of students preparing to become the needed change agents. A part of the closing declaration signed by participants in the congress is a good way to consider just how deep the roots of resistance, and the pathways for growing change, have come:

> Agroecology must integrate science, technology and practice, and movements for social change. We can't let the artificial separation of these three areas be an excuse some may use to justify doing only the research or technology parts. Agroecology focuses on the entire food system, from the seed to the table. The ideal agroecologist is one who does science, farms, and is committed to making sure social justice guides his or her action for change. We must help the people who grow the food and the people who eat the food re-connect in a relationship that benefits both. We must re-establish the food security, food sovereignty, and opportunity in rural communities throughout Latin America that has been severely damaged by the globalized food system. We must respect the different systems of knowledge that have co-evolved for millennia under local ecologies and cultures. By doing this, we can avoid the eminent food crisis and establish a sustainable foundation for the food systems of the future. (Gliessman, 2012)

FUTURE GROWTH

Reflecting on the growth of the agroecology movement since it put down its roots of resistance in the tropical lowlands of southeastern Mexico, one can see how the foundations for this special issue were formed. The agroecological approach to sustainable agriculture and food systems has been clearly enunciated for quite some time (Gliessman 1984). Today, it is active in multiple ways, from university degree programs, in farmer-to-farmer movements, and with consumer organizations. But like most movements, change is slow, and the roots of industrial agriculture are deep as well. Looking back at Hernández Xolocotzi's diagram of the agroecosystem, it is obvious that the social and ecological components of the food system must receive greater emphasis and support, or the strong link between market forces and the technology of production will continue to dominate. As agroecologist Carlos Guadarrama-Zugasti (2007) cautions, we must constantly maintain the interdisciplinary focus of agroecology so that its foundations of resistance are

not captured or corrupted. The roots of resistance described in this special issue have penetrated deeply. Agroecologists at all levels of the food system, working in all three parts of agroecology—integrating science, practice, and participatory action for change—now have the responsibility to see that they flourish.

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