Envisioning the Future Development of Farming in the USA: Agroecology Between Extinction and Multifunctionality?

Frederick H. Buttel
William H. Sewell Professor of Rural Sociology
and Professor of Environmental Studies
University of Wisconsin-Madison

The Context of Agroecology in the New Millennium

Agroecology has been a significant area of natural science research for approximately 25 years. To be sure, the notion of agroecology (or crop ecology) has been around at least since Klages' (1928) paper in the *Journal of the American Society of Agronomy*, and each of us can identify antecedents of crop ecology research or agroecological thought (such as our own F. K. King's *Farmers of Forty Centuries*, 1911) that go back a good many more years than this. Even so, there is general agreement that the intellectual and socioeconomic environment of agroecology has changed dramatically over the past few decades. Thus, while there is now an impressive volume of literature in the general field of agroecology (a good share of which is cited in Francis et al., 2003, and elsewhere in this volume), we are not much closer to closure on the meaning and role of agroecology than we were when the works of scholars such as Jantzen, Gliessman, Vandermeer, and Altieri first began to make the term a widespread and accepted one in agricultural research, agricultural science, and land-grant university circles in the late 1970s and early 1980s.

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Agroecology has remained an elusive and controversial notion and interdiscipline for three interrelated reasons. First, agroecology is by any definition a kind of interdiscipline that involves reshaping scientific and social boundaries in ways that represent major intellectual challenges to agricultural scientists and agricultural research institutions. At a minimum, agroecology is an interdisciplinary field that draws on ecology and on the crop and livestock sciences. And it is the case that essentially all of the contributors to this volume see agroecology as an interdiscipline that includes the social and humanistic sciences as well as the ecological and agricultural sciences. Each of these three disciplinary groupings has a somewhat uncomfortable fit with each of the others. The hypotheses that appeal to ecologists, for example, tend not to mesh parsimoniously with the types of hypotheses that have prevailed in the agricultural production sciences or in the social and humanistic disciplines. Nonetheless, in such a highly interdisciplinary field it is not surprising that there are differences of view about what are the dominant sources of methods and hypotheses and which are the less important disciplines.

Second, agroecology is associated, even if only implicitly, with criticism of or critical reflection on "conventional" research, technology, production practices, and policy priorities. There are, to be sure, a good many who work within the agroecology frame of reference who prefer to distance themselves from critiques of prevailing practices. Many agroecologists, for example, are uncomfortable with the use of agroecology to disparage genetically modified (GM) crops, large-scale industrial farming, or even monoculture. But the fact remains that agroecology has the connotation of being critical of nonecological approaches. Third, the implicit or explicit rooting of agroecology in critical reflection on prevailing practices means that agroecology and agroecologists make overtures toward social analysis and the social sciences. These overtures to social analysis range from the minor and cosmetic to the fundamental. Thus, while many agroecologists see themselves as scientists working though an agenda for research that derives mainly from the experimental ecology or agricultural production sciences, there are other agroecologists who

believe this field of inquiry ought to be as much policy- or politically driven as it is natural-science-driven.

I am somewhat agnostic about these debates within the agroecology community. Some of my agnosticism comes from my experience as a social scientist in a college of agriculture setting over the past 28 years (and over 30 years if I include my period of graduate training). Anyone who has been a social scientist in a college of agriculture setting for such a lengthy period comes to value two things. First, given the fact that there has long been a tendency for rural sociology's research agenda to be induced strongly by the agents of mainstream agriculture, I believe that there is something to be said for scientific autonomy. I am thus sympathetic with a community of agroecologists setting forth their research agenda. Second, however, I do have considerable sympathy with the notion that the social sciences have a considerable amount to contribute to fields such as agroecology (or, for that matter, to fields such as plant breeding, molecular biology, and so on) and that social scientists are increasingly able to play an agenda-setting role in interdisciplinary research. But my sympathy with social science analysis does not lead me to the view that every agroecologist must become an amateur or professional social science analyst. Third, having been a rural social science professional for about three decades has enabled me to experience a breathtaking amount of social change. American agriculture and land-grant colleges of agriculture do not look very much like what even the most intelligent and perceptive of analysts were suggesting when I first began my graduate training. As much as I value thinking about the big picture and the long term, I believe that doing so is very difficult and involves a large error term. I thus tend to be agnostic about claims that there is only one way to do things in the future. For this reason I am happier that there are debates and a diversity of perspectives among agroecologists than I would be if there was closure on a single "correct" agroecological view.

In this paper I will aim to do three major things that relate to these introductory observations. First, my view is that, at a minimum, social science can be useful to agroecology by helping to understand the socioeconomic context of the rise, significance, and possible roles of this interdiscipline. Thus, I will provide an overview of the institutional context of agroecology, mainly from the vantage point of the structural transformation of the land-grant college system and of the agricultural sciences. Second, my earlier comments have stressed that there is a good deal to be said for diversity in agroecology. Accordingly, I will set forth a typology of approaches to agroecology that is based on the roles that the ecological, agricultural, and social and humanistic sciences play in each of the five approaches. Finally, I believe another contribution of social science can be to stimulate creativity in our field by asking pointed questions about the future of agriculture and the role that agroecology can play. In each major section that follows I will stress the indeterminacy of the future of agriculture by comparing and contrasting two different visions of the future of American agriculture.

Agricultural Research and Productivism: The Rise and Fall of the "Golden Age"

A number of the authors in this volume, especially Allen, Bawden, Bland, Giampietro, Röling, and Waltner-Toews, have written persuasively about the fact that the changing social character of agriculture and the environmental stresses caused by mainstream agriculture suggest the need for agricultural researchers to embrace an agroecological perspective. I am inclined to agree, and in fact the bulk of this paper will be devoted to setting forth some of the important dimensions of the contemporary context of agricultural research and production practices. I would only add that it is useful for to consider some of the historical patterns that have brought us to this time of debate over the future of agricultural research as well as agroecology research and education.

I would argue that the *ancien régime* referred to by several presenters at this symposium is not a single historical model of the land-grant university or public agricultural research institution, but rather two quite different models, one of which is on its way to being eclipsed and the other of which is in ascendancy. I refer the first such model, which lasted from roughly the late 1930s through early 1970s in the U.S. context, as the "Golden Age of Agricultural Research." The essence of the golden age of agricultural re-

search was that it combined: (1) the growing confidence in the efficacy of science and research that derived from the hybrid corn success story and from the subsequent track record of rising output and productivity in agriculture, (2) a strong consensus on "productivism" (increased productivity and/or output) as the principal goal of public agricultural research, (3) the forging of a "productionist coalition" of land-grant and U.S. officials and of agribusiness, farm organization, and commodity group leaders in support of the productivist agenda, and (4) growing public funding, which in large part based on the power of the productivist coalition and public support of the productivist agenda. The key research practices of the golden age were (1) the emphasis on applied, locally adapted research aimed mainly at farmers in a particular state or region, (2) the predominance of public-domain technology and the norm of widespread sharing of research results and materials among scientists, and (3) publicly dominated technology transfer, mainly through extension (see Buttel, 2001). In addition, the golden-age structure of agricultural research led to the consolidation of the college of agriculture discipline structure, and contributed to both discipline proliferation (e.g., crop husbandry departments splitting into agronomy, crop science, horticulture, and soil science departments) as well as to an increased emphasis on disciplinary research (Busch and Lacy, 1983).

The golden age model, however, began its slow, but steady decline, beginning in the early 1970s, due to a number of factors and forces: (1) growing recognition of environmental and health problems associated with agricultural chemicals and monoculture, (2) emerging criticism of the green revolution, which was widely seen as the Third World version of the Western productivist model; (3) the growing role of private agricultural R&D and the decreased centrality of public research, (4) stagnation of public agricultural research funding, and (5) dissatisfaction with the efficacy of Cooperative Extension (CE) as a technology transfer agency (including not only criticism by large commercial farmers that CE does not meet their needs as well as private industry, but also complaints by smaller farmers that CE has become a taxpayer-supported promotional system for agribusiness' new technologies). But perhaps the most prescient critique of agricultural science and the public agricultural research system of the time was the so-called Pound Report (National Academy of Sciences, 1972), which assailed public agricultural research for being routine, too commodity oriented, and for its having neglected "basic science." The Pound Report did not create much of a stir when it was originally published. But by the early 1980s the Pound Report was being widely cited because of the excitement that was being generated at the time by the rise of molecular biology and "biotechnology." The Cohen-Boyer discovery of recombinant DNA in 1972 and its elaboration over the next decade created the scientific basis for validating the Pound Report's case that basic or fundamental research was the way forward for agricultural science. In addition, a number of changes in patent and related proprietary protection law (passage of the Plant Variety Protection Act of 1970, the *Diamond v. Chakrabary* Supreme Court decision in 1980, and the *ex parte Hibbard* and *ex parte Allen* decisions by the Patent and Trademark Office) all had the effect of encouraging the widespread patenting of genes, plant parts, and crop varieties developed through transgenic and other molecular methods. As a result, there was a rapid establishment of start-up biotechnolology companies, most of which were incorporated within huge chemical-seed-biotechnology multinational corporations by the early 1990s.

In 1982, the Rockefeller Foundation (1982) report *Science for Agriculture* stressed that biotechnology was the key area of fundamental biology around which modern agricultural research should be built. *Science for Agriculture* thus made arguments very similar to those of its predecessor, the Pound Report. But *Science for Agriculture* also reflected very clearly the fact that the new era of agricultural research was a private sector-driven era, and thus the role of public research needed to be shifted to stressing provision of basic, but proprietary knowledge to private sector firms. Very shortly thereafter the research staffs and agendas of public research institutions became very rapidly "molecularized." The public funding for doing so came largely from the National Institutes of Health, the National Science Foundation, the Department of Energy, and other agencies lacking a "mission orientation" to agriculture or the food system. The private funding of research in the age of molecular biology of agriculture came

partly from the seed-chemical multinationals, and partly from the start-up companies (such as Calgene, Advanced Genetic Sciences, Agricetus, Mycogen, and Agrigenetics) that spearheaded the initial commercialization of agricultural biotechnology.

The molecularization (or "geneticization") and privatization of agricultural research were the two most fundamental cornerstones of the "new model." It is important to stress, in fact, that without the emergent intellectual property milieu of the 1980s, in which seemingly everything that might be valuable as a product or research technique was becoming patented, it is by no means clear that the golden age model would have been transcended as rapidly as it proved to be. This new intellectual property milieu not only involved strong incentives for agricultural-molecular biology innovations to be patented by individuals and firms. The Bayh-Dole Act of 1980, however, was as or more fundamental to the privatization of agricultural research as was *Diamond*. Bayh-Dole permitted universities to patent technologies developed with federal funding. As a result of Bayh-Dole, universities became increasingly active agents in privatizing the research programs of their scientists because of the lure of extracting patent royalties to supplement declining public appropriations for higher education. Privatization was also extended to the technology transfer system as private entities—agribusiness firms, crop consultants, pesticide applicator firms, agricultural input dealers, and so on—increasingly displaced Cooperative Extension as the source of technical information to farmers. The content and focus of research became increasingly generic—that is, increasingly focused on technologies applicable to a wide range of agricultural zones—and were decreasingly focused on the locally adapted knowledge of the golden age model. The prototypical types of technology developed under the new model, either in land-grant universities or private agribusiness firms, were those of GM crops and other biotechnology products, and precision farming and other information technologies.

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While molecularization and privatization are the two most important internal characteristics of the new model of agricultural research, its other fundamental dimension—globalization—pertains to the social environment of public research. Globalization's effects on agricultural research have been mostly indirect, but still profound. Globalization has been reflected in the concentration of agro-industry and private agricultural research firms on a global scale, in the rise of vertically integrated cross-border "value chains," and in the fact that the World Trade Organization and the North American Free Trade Agreement increasingly spelled out many of the conditions (recognition of patents, policies for regulating new agricultural technology products, reduction of export subsidies and of the scope of permissible protection of domestic agriculture) that pertain to agriculture and agricultural research (McMichael, 1994). Agricultural biotechnology, in fact, is a highly globalized technology. The technology is mainly propelled through the activities of a handful of seed-chemical multinationals (Heffernan et al., 1999). The basic components of the knowledge base are "protected" through internationally recognized patents (largely by way of the TRIPS provisions of the WTO agreement). The goods produced from agricultural biotechnology—soybeans, cotton, maize, and canola—are commodities that are extensively traded on world markets. Globalization, in sum, not only dramatically hastened the eclipse of the golden age model but also helped to rapidly usher in the new model.

The new model of public agricultural research was superseded, but many of its remnants yet remain. Colleges of agriculture still consist largely of the disciplinary departments that arose during the golden age of public research. While both the golden age model and the new model tended toward reductionism, the narrow disciplinarity decried by many agroecology advocates is actually of more a remnant of the golden age model than a particular feature of the new model. There remains widespread adherence to the goal of increased agricultural productivity, even though the social structure that led to consensus on this goal has been substantially transformed.

Agroecology is both a *critique* of productivism, molecularization, and privatization as well as a set of

responses to their shortcomings. On one hand, agroecology is part of a larger pattern of critique of agriculture and agricultural research—a pattern I refer to as "environmentalization."

Environmentalization refers to the bringing to bear of environmental considerations in agricultural research or agricultural policy. Environmentalization includes things such as the environmental movement's scrutiny of agriculture, pressure to upgrade nonpoint regulations of agriculture, and encouragement of organic farming, ethical consumption, sustainable agriculture, local food systems (farmers markets, community-supported agriculture; Harrison et al., 1999; Kloppenburg et al., 1996). The growing attention to agroecology is also a manifestation of environmentalization.

I noted earlier that agroecology is not only a critique of productivism and molecularization in agricultural research, but it is also represents a set of responses to productivism and molecularization. It is crucial to stress here that agroecology is not a single (or simplistic) response. This is partly because there are many different visions of what agroecology is or ought to be, and also partly because agroecologists are not always in agreement about what will be the essential character of agriculture in the medium to long term. In the next two sections of the paper I will explore some of the consequences of the changing context of agriculture and agricultural research. First, I will identify the major varieties of agreocology that have been developed in response to the competing visions for this interdiscipline. Second, I will discuss some of the rival or alternative visions of agriculture's future (and, in particular, views of agriculture's most important problems) and what their implications might be for agroecology.

Varieties of Agroecology

Modern agroecology is a nearly a quarter century old. For most of the modern history of agroecology there have been two major varieties of this approach that have vied for dominance. One is *ecosystems agroecology*, which is an approach to agroecology that is primarily driven by the ecosystems biology of Eugene Odum (1969). Ecosystems agroecology has been anchored in the comparative analysis of "natural" and agroecosystems, and its research agenda and hypotheses have traditionally been built around the notion that agroecosystem redesign built around diversity will best enable agriculture to mimic the resilience and stability of natural agroecosystems. Steve Gliessman (1998) is particularly closely associated with this perspective on agroecology. Ecosystems agroecology tends not to involve an active role for social science, with one exception. Ecosystems agroecology is essentially based on the notion that agriculture wrongly or inappropriately came to be based on large-scale monoculture. Social science can be useful to ecosystems agroecology in understanding the social processes that have led to large-scale monoculture and in coming to grips with the social structure and economics of designing ecologically based production systems.

The second most important variety of agroecology is what I call *agronomic agroecology*. Agronomic agroecology can be defined as the agronomic analysis of sustainable agriculture. That is, the methods and hypotheses derive largely from agronomy (broadly understood, to include the traditional agricultural production sciences), and the goal of research in this framework is to develop knowledge and practices that help to make agriculture more sustainable. Some agronomic agroecologists work on organic farming techniques, while others, particularly weed ecologists and cropping systems specialists, focus on more mainstream agriculture. Chuck Francis, Richard Harwood, Richardo Salvador, and Matt Liebman are major exemplars of this approach. The role of social science in agronomic agroecology is by and large similar to that in ecosystems agroecology. That is to say, social science is not directly involved in the analysis; at the same time, social science can be a useful adjunct by developing understandings of the processes by which agriculture has become unsustainable and of the possible adoption processes of more sustainable systems.[1]

The third most longstanding form of agroecology can be referred to as *ecological political economy*. The principal focus is on a political-economic critique of modern agriculture. Ecological shortcomings of agriculture are a major—but not exclusive—component of this critique. Ecological political-economists argue that the distortions of current market systems, buttressed by the self-interested behavior of agricul-

tural input firms, cause farmers to make decisions that lead to enormous socioeconomic and ecological costs. Ecological political economists argue that radical changes in the political economy of agriculture and the moral economy of research are needed to reduce these unacceptable social costs. Exemplars of this approach are Miguel Altieri, John Vandermeer, Richard Lewontin, and Richard Levins, and Richard Levens. Ecological political economy is largely politically (and, thus, largely social-science-) driven even though the bulk of its adherents were originally trained as ecologists or agricultural scientists. The social science that is employed is largely radical political economy. Ecological political economists' ecological commitments tend to be quite variable, ranging from ecosystems biology (in the case of Altieri, 1987) to population ecology (in the cases of Vandermeer, 2003, and Levins and Lewontin, 1985).

Integrated assessment analysts tend to be highly suspicious of the notion that any one discipline—ecology, agronomy, or economics—is intrinsically the lead discipline in agroecology.

A more recent variety of agroecology is what I call *agro-population ecology*. In one sense, agro-population ecology is very similar to ecosystems agroecology in that its main hypotheses and methods derive from the discipline of ecology. But the essential difference between agro-population ecology and ecosystems ecology lies in the ecological perspective within which each is anchored. In contemporary ecology the most influential approach is population ecology, which has progressively displaced the ecosystems biology of Odum over the past three decades or so. The application of population ecology to agroecology involves the primacy not only of analyzing agroecosystems from the perspective of the population dynamics of their constituent species and their relationships to climate and biogeochemistry, but also there is a major emphasis placed on the role of genetics. David Andow (this volume) and Alison Power (2000) are major exemplars of this approach. The role of social science in agro-population ecology is perhaps more modest than in any other contemporary variety of agroecology. The main methods and hypotheses involve little role for social science. Social science, however, may be useful in understanding the evolution of agroecosystems and the constraints to redesign of these systems.

The most recent variety of agroecology, what I call the *integrated assessment of multifunctional agricultural landscapes*, is arguably the most well represented view at this symposium. Integrated assessment of multifunctional agricultural landscapes is most well developed and most coherent as an approach (in the sense of integrating ecological, agronomic, marketing, and social perspectives) in Europe. Our European colleagues participating in this conference, along with researchers from the Systèmes Agraires et Développement department of the Institut National de la Recherche Agronomique (INRA) in France, are among the key exemplars of this variety of agroecology. The key notion behind this approach is that it denies the primacy of the farm and the agricultural enterprise as the basic unit of production and the unit of analysis. Instead, integrated assessment is based on the notion of multifunctional landscape, a conception that sees agriculture and the food system as joint occupants of landscapes and as an institutional complex that is related to other social institutions in geographic space. Integrated assessment approaches are the most interdisciplinary of the agroecology traditions considered here. Some of its exemplars are trained in ecology, others in agricultural science, and still others in social science. Integrated assessment analysts tend to be highly suspicious of the notion that any one discipline—ecology, agronomy, or economics—is intrinsically the lead discipline in agroecology.

Slow, But Steady Extinction? The Profitability Squeeze and the Blank Hypothesis

Agroecologists are mostly agreed that modern agriculture has a number of shortcomings that must be addressed through research. However, as just noted, there are a number of rival images about the essential nature of agriculture's problems and shortcomings. Just what is it about modern agriculture that leads one to believe that a wholesale "paradigm shift" is needed among agricultural researchers and research institutions?

One way to think about the *ancien régime* of the world of agricultural policy and agricultural research is that business-as-usual continues despite the fact that American agriculture is in the midst of a long-term profitability squeeze. This long-term profitability squeeze not only has no end in sight, but its existence testifies to the fact that there is a crisis occurring in American agriculture that is systematically ignored by policy-makers, most researchers, and by most leaders in agriculture. ERS Historical farm balance sheet data (provided in private communication by Roger Strickland, Economic Research Service, U.S. Department of Agriculture, May 2002) show that net value added in U.S. agriculture (expressed in constant 1996 dollars) has declined steadily since the end of World War II, from a peak of $131.4 billion in 1946 to $76.6 billion in 2002. Net farm income declined in tandem, from a peak of $102.2 billion in 1948 to $36.7 billion in 2002, and the net income situation would have been far more serious over the past few years if it were not for the $20 billion or so spent annually on subsidies. While farm assets data are unavailable prior to 1960, the U.S. farm balance sheet shows that total farm assets *increased* from $785.7 billion in 1960 to $1,108.5 billion in 2002. Thus, while there has been an enormous increase in investment and assets in the sector, net value added and net income have declined appreciably. While the reasons for the profitability squeeze are beyond the scope of this paper, it should be stressed that the profitability squeeze does not have a single cause, such as inappropriate technology, too much or too little international trade, lack of state intervention, and so on. Instead, it reflects a systemic problem of the disintegration of agriculture, as many of the authors in this volume note.

Most agricultural scientists—even most social scientists—have scarcely made note of this systemic disintegration of American agriculture. Most of us, as it were, seem to be disinclined to admit that there is a "crazy aunt" in the midst of our dysfunctional family. One of the few who has done so is Steven C. Blank, an agricultural economist and (and former Assistant Vice Provost) at the University of California-Davis. One enlightening—though, I believe, highly flawed—way to think about the systemic disintegration of American agriculture is from the perspective of the provocative "Blank hypothesis." In Blank's hotly debated book, *The End of Agriculture in the American Portfolio* (Blank, 1998), and in a series of related articles (e.g., Blank, 1999), he makes the seemingly outrageous argument that in roughly two generations America agriculture will essentially disappear. Note that Blank's hypothesis is not that American agriculture will merely go through a "great transformation" (as Lobao and Meyer, 2001, have depicted for the twentieth century) that will result in many fewer, larger, nonfamily farms cultivating about the same amount of land. Blank has in mind a far more radical disappearance of agriculture: the end not only of a way of life and of a household livelihood strategy, but essentially the end of agriculture as a rural land use.

Blank argues that there are four major forces that will increasingly propel the disappearance of American agriculture. First, U.S. agriculture is already essentially uncompetitive with several powerhouse agrofood exporting nations (e.g, Brazil, Argentina, Australia, Canada, New Zealand), and shortly will be uncompetitive with other major world regions (e.g., Ukraine, Russia, Mexico, Uruguay, Paraguay, and much of Eastern Europe) as they modernize and become low-cost agricultural producers. The lack of competitiveness of U.S. agriculture is revealed in the progressively worsening profitability squeeze in American farming—one that would have been truly devastating in its impacts if it were not for lavish federal subsidies (mostly "emergency" payments) that began in the late 1990s (Ray, 2000) and that will continue under the 2002 Farm Bill. Second, global agribusiness, including firms with U.S. headquarters, are increasingly seeking out the least-cost suppliers of commodities on a global basis through multiple sourcing of agricultural inputs, strategic alliances, cross-border inter-subsidiary movements of products, direct foreign investment, and other means of getting access to the cheapest sources of inputs into their processing and distribution industries.

Third, Blank argues that U.S. farmers are becoming decreasingly competitive on the domestic rural land market. Non-farm owners and users of land (homeowners, real estate developers and speculators, governments, municipalities, vacationers and the tourist industries, and so on) are increasingly outbidding farmers for rural land. Higher farmland values are contributing to high production costs and the

profitability squeeze. Fourth, consumers and non-farm people will continue to be well fed at cheap prices. In addition, they will value the rural land at their disposal for parks, vacationing, second homes, trout streams, water, subdivisions, tourist sites, and shopping centers more than they will value having farms in the hinterland. Consumers and citizens will thus be largely comfortable with the end of agriculture and the (mostly irreversible) conversion of rural land into nonfarm uses. Urban America, in Blank's view, is tired of subsidizing farmers. And now that there are well under 1 million full-time farmers still in business, farmers will not have nearly enough clout to win any political battles against the over 260 million people who like cheap food that can be provided by the global market and who value non-farm uses of rural land.

When Blank's book was originally published in the late 1990s, it did not generate much attention, and a good many people who read *The End of Agriculture in the American Portfolio* felt that it was an extreme perspective that ignored the persistence of noncorporate (or "family") production forms in the agrofood system, especially in farm-level production (for a particularly insightful review of the Blank book by a well known agricultural economist, see Harl, n.d.). Blank's ideas have been attacked even more vigorously by some members of the public (see, for example the letters to the *UC-Davis Magazine* in spring 2000 in response to his article in a previous issue of the *Magazine*) who were outraged that a land-grant scientist would be saying in public that American farmers are on their way to being thoroughly outcompeted. Thus, if the book has attracted a swarm of criticism, why has it become more widely read after every year passes since its publication date?

Blank deserves credit for putting his finger on the late twentieth century and early twenty-first century as being the confluence of several critical trends in agriculture: declining food agricultural commodity prices and the profit squeeze on American producers despite unprecedented federal subsidies, the shifting locus of control over the food system as multinational food firms increasingly make decisions on a global basis to ensure access to cheap commodity inputs, rising local (U.S.) costs of production due to competition on the rural land market, and technological changes that are facilitating very large production units and/or reduced labor demands. Thus, while Blank's book generated little disciplinary acclaim or policy attention when it was published—e.g., the flagship journal of the American Agricultural Economics Association did not find that his book merited a review—the events and policy struggles of the past four or so years have given his ideas a certain cache.

There are, however, several reasons why the Blank scenario is unlikely to come to pass. First, Blank arguably overestimates the degree to which nonfarm uses and users will compete with agriculture in much of the American agricultural landscape, such as the heart of the Corn Belt and most of the Great Plains. (Who wants to build a vacation home, shopping center, or theme park in the middle of Illinois? Second, every indication suggests that most world nations continue to have a preference for spending substantial money on various types of agricultural subsidies rather than gambling on the annihilation of their farmers and agricultural sectors and risking the political costs that would result. Third, Blank's model assumes a progressive implementation of trade liberalization and global neoliberalism that seems unlikely given the long historical tendency for the world political economy to oscillate between protectionism and "free trade." As of this writing, in fact, there is such discord over the Doha Round agricultural agreement that supporters of agricultural trade liberalization—and trade liberalization in general—are getting increasingly nervous that the Doha Round will fall apart for the lack of an agreement on agriculture (*The Economist*, 2003).

Interestingly, the Blank hypothesis, to the degree it comes to pass, is both supportive of and inimical to agroecology. The Blank hypothesis is, in effect, an kind of an establishment pronouncement that what we are now doing in agricultural colleges—particularly, designing more finely tuned systems for progressively more large-scale monocultural production of the same basic grains, oilseeds, fibers, and livestock products—is essentially tantamount to rearranging the deck chairs on the Titanic. The Blank hypothesis is thus a wake up call to the persons who champion the new model of public agricultural research while pretending that the golden age model—productivism, service to

"family farming" constituents through research and extension—is still operative. Further, Blank's image of the future of the rural landscape has more in common with the multifunctionality view to be discussed later than it does with the standard twentieth century/ golden age view of rural space being largely devoted to agricultural commodity production. Finally, the Blank hypothesis, which is essentially that mainstream commercial agriculture cannot survive past 2050 or so, may be compatible with the view that organic and other types of "niche agriculture" may ultimately provide be more competitive than 5,000-acre cash grain farms.

At the same time, the Blank hypothesis, taken to its logical extreme, is that there will shortly be no place for publicly provided subsidies, including public research subsidies, to agriculture. A sober and unsentimental analyst such as Blank is likely to think that there will be few roles for land-grant colleges of agriculture that can survive even a casual cost-benefit test. Even in the starkness and outrageousness of his analysis, however, Blank highlights the fact that current policy conjuncture will cast the die of the future course of development of American—even world—agriculture for decades to come. Thus, the future role—and even the future—of agroecology cannot be understood apart from the political choices that will be made about agriculture.

Toward Multifunctionality?

Multifunctionality consists of two interrelated notions: The first is that, in addition to production of food and fiber (and other marketable goods), agriculture has a number of *other, mostly non-commodity, outputs*. Agriculture's non-commodity outputs include environmental protection, flood control, ecosystem services, maintenance of landscape or habitat, rural development, maintenance of agricultural heritage or culture, and so on. Non-commodity outputs, because they do not have a market price, tend to be underproduced. Most of the non-commodity outputs of agriculture are also unrecognized. As was noted earlier, one particular group of agroecologists goes so far as to argue that agricultural researchers and professionals need to reconceptualize agriculture in terms of its being a set of goods and services produced within, and other activities that occur in the context of, *multifunctional agricultural landscapes*.

A second meaning of multifunctionality is that of a *type of agricultural policy*, one that involves investments in and payments for the non-commodity functions of agriculture to ensure that they are provided as optimal levels. Given that the first conception of multifunctionality is given admirable treatment by Giampietro in this volume, in my discussion I will refer primarily to the notion of multifunctionality as a type of agricultural policy (see OECD, 2001).

For several decades now there has been a growing role played by groups that advocate that the U.S. Farm Bill include provisions that contribute to environmental quality. For example, the 2002 Farm Bill debate, particularly in the Senate, focused not only on how much to invest in conservation programs. In addition, there was a significant degree of discussion about whether and how there should be a prominent role for what might be called "green payments" to farmers. Prior to the late 1990s, however, there was not much talk of "green payments" as such; most of the conservation content of Farm Bills affected whether and how land is farmed.

The notion of green payments—also often referred to as agri-environmental payments—has emerged for several reasons. First, the notion of green payments implies that if we are going to pay or compensate farmers, we should ask for something in return. Thus, in return for subsidies, Congress and the public ought to expect farmers to do something—essentially to protect the environment, conserve natural resources, provide "ecosystem services," and so on—in return. This appeals to many groups who feel that farm programs ought to have "strings" or accountability. The green payments notion owes its existence as a terminology in part to the new policy discourses that have emerged from the Uruguay Round Agreement on Agriculture (URAA) and subsequent global policy debate. Green payments have been advocated for their ability to combine conservation and provision of ecosystem services along with farm income support, and for their ability to deliver more benefits more efficiently and to more people.

What would or should green payments pay for? Among the possible "green things" that we can pay farmers to do would be the following. Some "green"

goods and services are already being provided by farmers, and require no changes in their current management practices; thus, farmers in certain locations enhance the environment simply by being farmers (e.g., maintaining open space for tourism). Other "green goods" require a change in cropping patterns or management practices; conservation policy can create other environmental goods by encouraging farmers to change their management practices (e.g., farmers could improve water quality if they lowered soil erosion rates through adoption of conservation tillage).

With so many arguments in favor of a conservation payments program, why not immediately adopt one? There are two apparent reasons. The first is that a green payments program would be difficult to design and administer. For example, a number of political and pragmatic implementation issues would need to be addressed. What is the "value" of various environmental goods? What emphasis should be placed on conservation versus income support? Should farmers who have previously adopted environmentally friendly practices be given green payments? Should green payments programs be based on performance or practices? How should agencies monitor and verify that conservation contracts are being complied with? What agencies will have primary enforcement responsibility? Will the practices and environmental goods targeted differ regionally? How should bidding for contracts will be carried out? Should there be payment limitations for green payments?

In addition to these admittedly formidable implementation issues, there are broader political issues at stake. One is that around the world today a comprehensive program of "green" agricultural payments is known as "multifunctionality," and multifunctionality is recognized one component of the European Union bargaining position in the World Trade Organization negotiations. Unfortunately, we live in era in which the U.S. government sees Europe as insignificant and troublesome, and tends instinctively to see European ideas and proposals as being irrelevant.

The basic policy goal of European and other supporters of multifunctionality is to expand the definition of "green box" policies in the World Trade Organization agriculture agreement to include those that attain multifunctional objectives. European national government advocates of multifunctionality suggest that multifunctionality payments are far preferable to trade barriers, and say they are willing to trade off trade barriers for multifunctionality. Multifunctionality is now endorsed—in both senses—by Europe plus Japan and South Korea, which could be influential in the ongoing Doha Round if they act in concert. But multifunctionality is rejected by the U.S., Canada, Australia, and other agricultural exporting powers because these countries prioritize international market expansion over environmental quality and protection of domestic producers. Developing countries tend to be suspicious of multifunctionality because it seems as if it is nothing more than a sophisticated justification for rich countries to continue to subsidize their farmers. Thus, the second reason why multifunctionality as a specific type of policy will encounter formidable obstacles is that this policy is seen as another example of European protectionism.

It seems unlikely at this point that the Doha Round of the WTO negotiations will result in agreement on a multifunctionality agenda (such as permitting EU countries to implement multifunctionality payments if they agree to reduce export subsidies). Nonetheless, Article 20 of the URAA (the current agriculture agreement of the WTO), which permits so-called "non-trade concerns" to be included in the next WTO round, represents a "foot in the door" that is now being approached aggressively by several European countries, particularly the Norwegians (http://odin.dep.no/ld/mf/).

Even if the Doha Round makes no provision for national multifunctionality policies toward agriculture, the fact remains that the stylized type of farm program envisioned at the outset of the URAA (essentially no domestic production subsidies or export subsidies) has proven to be politically infeasible *as a package* for most countries, especially those that are not major agro-exporting powers. For the foreseeable future, Farm Bills that do not have farm income maintenance as a major objective are not realistic; when income in the sector is low, payments of some sort must compensate for the difference. The objective—*or at least the stated objective*—of keeping people on the land is also a political necessity. The provisions of the 2002 U.S. Farm Bill may be WTO-

compliant in a narrow technical sense, but they clearly violate the spirit of the URAA; they essentially patch up what has been a longstanding secular decline in profitability and net value added in American agriculture, and they also make the U.S. look laughably hypocritical when it exhorts other countries to liberalize their agricultures. Multifunctionality provides a defensible framework for rationalizing what are likely to be continuing subsidies of farmers and farm sectors.

Multifunctionality-oriented farm policies would clearly be a huge boon to agroecology. Agroecological research would be necessary to help understand the nature and value of the ecological services provided by agriculture, and would be essential in understanding the ecological costs of agriculture and how these could be minimized through multifunctionality programs. Multifunctionality would also make possible a far more interdisciplinary agroecology than we have seen thus far.

Conclusion

I find it difficult to conceive of a future for American agriculture and agricultural research that does not include a prominent role for agroecology, understood broadly to include the five categories of agroecology discussed earlier (and doubtless additional categories of agroecology scholarship that will develop in the future). This said, it remains to be seen whether agroecology will blossom as a result of an eventual "paradigm shift," or whether the policy environment of agriculture will change in ways that make it possible to use that which agroecology has to offer. If forced to make a guess, I would expect agriculture in this new millennium to veer between extinction and multifunctionality. That is, we will limp along for some time by pretending that the long-term profitability squeeze will "turn around" if we just give it more time, and in the process net value added and net income will decline, and subsidy programs will increase. At the same time, the dysfunctionality of American agriculture, and much of world agricultures, in conventional balance sheet terms will make occasional flirtations with multifunctionality policies more and more likely. Agroecology will need to be able to respond to both of these scenarios.

Agroecologists as well as agricultural scientists also face a growing imperative to come to grips with the two master processes that are affecting agricultural research in our epoch: molecularization and privatization.[2] I would like to conclude with some remarks about each of these overarching processes. I will also make a concluding observation about what I believe is the most significant ethical dilemma of agroecology.

There is no doubt that agricultural research as a whole has undergone so much molecularization and geneticization that there is, as it were, no going back. How should agroecologists, or supporters of sustainable agriculture, approach molecularization? My view is that agroecology can benefit a great deal from the geneticization of agricultural biology. Molecular biology has brought about new tools that are of broad potential applicability to the agricultural and biological sciences. It is also the case that one of the weaknesses of agroecology has been its neglect of one of the key lessons from studies of traditional agroecosystems: that cultivars matter a great deal, and the viability of alternative production systems depends on selection among genotypes and phenotypes to identify those that are optimally adapted to the agroecosystem and production practices (Buttel, 2000). The rise of genomics, particularly comparative functional genomics and bioinformatics, portends an era in which agroecologists can be actively involved in cultivar development, can select cultivar materials that are highly adapted for particular environments, and do not have to depend on the varieties developed for Pioneer and Monsanto for use in chemical-intensive, monocultural production systems.

But how should agroecologists approach the matters of GM crops and "genetic engineering"? My own view is that agroecology has little to gain by defining itself *primarily* in opposition to GM crops and genetic engineering. I prefer to see the current generation of GM crops (essentially Bt and herbicide-resistant crops) as being a relatively obsolete or "spent" technology, based on the fortuitous availability of a single transgenes whose role in cultivars is almost certain to be undermined by herbicide and insect resistance and other problems. Further, I would be surprised if there will be any additional "blockbuster"

single-gene input traits in the future. Most important agricultural traits are polygenic and quantitative, and GM-style transgenic technology cannot readily deal with traits such as these. I believe we should neither laud nor condemn genetic engineering as a whole (see Buttel, 2000, for an earlier statement of this argument).

Over the long haul, the following conclusions about genetic engineering seem warranted. Genetic engineering will—actually, already has—become an increasingly standard technique, since transgenic and other molecular biology techniques make it so much easier and quicker to take advantage of the increasingly detailed genetic knowledge that is being developed. It will not do for agroecologists to base their science and approach on denying themselves and others the use of these and related technologies (RFLP, embryo culture, clonal propagation, QTL identification, marker-assisted selection). In other words, it is not hypocritical to be agnostic or negative about the current generation of GM crops and be supportive of genomics and molecular biology. The knowledge that is accumulating in comparative functional genomics and bioinformatics suggests that a genetic engineering approach that seriously examines gene-ecosystem interactions and confines itself to use of transgenes from the same species or very closely related species is biologically defensible and socially acceptable (see Strauss, 2003).

Agroecologists ought to position themselves on these issues based on both scientific data and on responsiveness to the public's views on the topic.

As for privatization, I believe that agroecologists, public agricultural researchers, and most farmers have little to gain and much to lose from the privatization of agricultural biological innovations. Most of the gains that have been made in agriculture during the twentieth century were made possible because of the fact that agricultural knowledge and materials were largely public domain information. Agroecologists need to recognize that while molecularization and privatization have occurred in tandem, there is good reason to see the former as basically positive and the latter as basically negative, and that the two are separate and separable. I hope that there will be a day that agricultural knowledge will be restored to its previous status as public domain knowledge.

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The careful reader will note that one of the major differences between my chapter and those of most of the authors in this collection is that I have had little to say thus far about responsiveness to the public. My reason for deemphasizing this issue until now is that I view this as a complex and ethically charged one that does not have a convenient resolution. I am comfortable in the abstract with accepting the notion that there is considerable room for more active engagement of agroecologists, and agricultural scientists as a whole, with the public. And as suggested in the preceding paragraph, I am comfortable with the view that agroecologists are not likely to see agricultural input multinationals as being a key part of the public to whom they should feel accountable or with whom they should aim to engage. This said, what do we mean by "the public"? Agroecologists and agricultural scientists as a whole face several difficult choices in making good on their intention of engaging with and being responsive to the public. First, should agroecologists make any definitive judgments about *which types of farmers should be their major clienteles*? Should agroecologists mainly serve those farmers with an already significant commitment to sustainable agriculture, environmental protection, and de-industrialization of the food system? Or should agroecologists aim to serve and be responsive to both these farmers and as well as more mainstream agriculturalists who operate large commercial farms, rely primarily on hired labor, sell undifferentiated agricultural commodities, and would just as soon have their products be marketed globally rather than being sold locally. Should agroecologists be actively critical of certain groups of growers? Second, *should agroecologists see their principal*

clienteles as being farmers? If it is true that farmers are becoming a minute portion of the public in percentage terms while other stakeholders with an interest in food and agriculture are ten or more fold the number of farmers, should agroecology see the former or the latter as their "natural" audience?

It is possible, of course, for agroecologists to continue to duck these two questions and to be content with various members of the academic community making individual choices about clientele priorities as they see fit. Ultimately, however, I imagine that choices will have to be made. Thirty or fifty years hence will agroecologists legitimate their research and their roles mainly through service to agricultural producers, through service to particular groups of growers, or through service to the far more numerous non-farming stakeholders? This issue, of course, does not pertain only to agroecologists. Agricultural scientists and research institutions as a whole will need to make judgments on the matter of what are their major clienteles.

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Endnotes

[1] It is worthwhile noting, following Palladino's important study of the history of integrated pest management (IPM), that in the earliest days of IPM during the late 1960s, what I call the ecosystems agroecology perspective was predominant. The ecosystems agroecology of IPM was largely eclipsed, however, within about a decade as IPM researchers increasingly found that hypotheses from ecosystem biology did not prove very useful in the development of farming practices. By 1985 IPM was dominated by agronomic agroecology, if not by quite conventional agronomy and entomology.

[2] We will also need to address the implications of globalization, though analysis of this extraordinarily complex phenomenon and process is beyond the scope of this paper.