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Challenges Facing a Second Green Revolution: Expanding the Reach of Organic Agriculture

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> "The word 'revolution' has been greatly abused, but no other term adequately describes the effects of the new seeds on the poor countries where they are being used. The technological breakthrough achieved by agricultural scientists foreshadows widespread changes in the economic, social, and political orders of the poor countries."
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> -- Lester Brown (2), describing the "Green Revolution" in developing countries, in his book *Seeds of Change: The Green Revolution and Development in the 1970s*

> "The future for organic farming is uncertain. Much depends on the availability and price of fertilizer (especially nitrogen) and farm labor, produce-price relationships, the domestic and world demand for food, concern for soil and water conservation, concern for health and the environment, and U.S. policies toward the development and promotion of organic farming practices. Due to one or more of the above factors, it may be economical for some farmers to produce certain crops and livestock organically rather than conventionally."
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> -- From the USDA's classic *Report and Recommendations on Organic Farming* (44)

Introduction

It is timely now to review the status of organic agriculture, especially for those of us old enough to have observed or participated in the 1960s/1970s "Green Revolution" in many developing countries. As Lester Brown explained in *Seeds of Change: The Green Revolution and Development in the 1970s* (2), US government policy emphasis shifted in 1965 from direct food aid for developing countries to more active assistance to these countries in developing their own food production capacities. At the time, Brown was a senior US Department of Agriculture (USDA) official dealing with international agriculture policies. Also at about the same time, governments of several major developing countries such as India and the Philippines began to place much more emphasis on aggressive, coordinated programs to boost food production. The result was dramatic increases in cereal production between the late 1960s and the mid-1970s in many parts of the developing world, especially in regions with abundant rainfall or irrigation water. The increases

were the result of rapid farmer adoption of "packages" of inputs consisting of high-yielding seed varieties [especially wheat (*Triticum aestivum*) and rice (*Oryza sativa L.*)], inorganic fertilizer, and, in many areas, irrigation from groundwater. The dramatic changes in farming practices and in cereal output per hectare soon became known as the "Green Revolution." I witnessed the unfolding of this agricultural revolution on the Gangetic Plain of north India while conducting research there in 1967/1968 for my doctoral dissertation (10,13).

The groundwork for this Green Revolution in developing country agricultures had been laid much earlier, of course. The basic technologies and practices had been evolving for some time in Europe and North America — to some extent since about the 1930s, and especially following World War II. I have described elsewhere the specialization and intensification "evolution" in United Kingdom (UK) and US agricultures (11). More specific groundwork for the Green Revolution of developing countries, however, can be traced to plant breeding work supported by the Rockefeller and Ford Foundations in Mexico and the Philippines. This work was critical to development of short-stemmed wheat and rice varieties that were adapted to climates of developing countries and that could utilize high applications of water and nitrogen fertilizer without lodging.

The year 1980 also is of historic significance for this review of the status of organic agriculture. In that year, only 10 years after the publication of Brown's *Seeds of Change* book, the USDA released its *Report and Recommendations on Organic Farming* (44). Although USDA scientists had shown interest in organic agriculture in earlier eras—most notably F. H. King (27), in writing about agriculture in east Asia—the 1980 report signaled recognition that there might still be some role for organic farming systems in the intensification, high-yield era that had evolved since World War II. Like the Green Revolution described above, the intellectual and political groundwork that made the USDA study team's work and report possible had been laid by numerous individuals and organizations. In the US, the work of J. I. and Robert Rodale and the publication of Rachel Carson's *Silent Spring* (3) were of special significance. Prior to that, the contributions of England's Sir Albert Howard, author of *An Agricultural Testament* (25), and Lady Eve Balfour, founder of Britain's Soil Association, were of enormous importance (32). Later, the formation of California Certified Organic Farmers (CCOF) in 1973 (29) helped give visibility and credibility to the emerging US organic farming movement.

The release of the 1980 USDA report may have been politically bold at the time, but the report itself was written — and appropriately so — with careful scientific qualifications. The report helped open the door for renewed scientific investigation of organic agriculture in the USDA/Land Grant University complex. Although organic research today still makes up only a small fraction of publicly funded agricultural research in the US, organic agriculture research has much greater visibility and perceived credibility than it did 25 years ago. Unlike in Western Europe, however, US public policies, for the most part, do not actively encourage expansion of organic farming. There are no national goals or strategies in the US to encourage growth in organic farming and food consumption.

To set the stage for this examination of the status of organic agriculture, I will outline some challenges this country would face if policy makers were to decide to follow Europe's path in attempting to launch a second "Green Revolution" based on organic agriculture. As we have seen, the "green" terminology previously symbolized high-yield cropping based on synthetic chemical inputs. Ironically, "green" terminology also has been used for some time now in both Europe and the US to characterize more environment-friendly agriculture based on organic and other ecologically-

based farming systems. Therefore, it seems appropriate to identify lessons that might be drawn from the first "Green Revolution."

The term "organic agriculture" is used in this article in ways consistent with the current definition of the USDA's National Organic Program. In condensed form, that definition reads as follows:

> "Organic crops are raised without using most conventional pesticides, petroleum-based fertilizers, or sewage-based fertilizers. Animals raised on an organic operation must be fed organic feed and given access to the outdoors. They are given no antibiotics or growth hormones." (45)

Essentially, this means that organic crops are grown without synthetic chemical inputs and organic livestock are raised and maintained on organic feed. This definition does not limit organic production to farms and ranches of any particular size or method of business organization. Although many supporters of organic agriculture feel that it is, potentially, one form of ecologically "sustainable" agriculture, most people do not restrict their definition of "sustainable" agriculture to organic agriculture. In other words, other forms of agriculture also may be ecologically sustainable. Moreover, even if a particular system of agriculture satisfies the above definition of organic agriculture, that system may not be ecologically sustainable in all respects and under all conditions.

Framework for Developing Green Revolution Strategies

Let us go back again to the mid-1960s when, as indicated above, US government policy began to place much greater emphasis on food production within developing countries. In 1966, a non-profit agency called the Agricultural Development Council released a little booklet by Arthur Mosher (33) entitled *Getting Agriculture Moving: Essentials for Development and Modernization*. Mosher discussed five "essentials" for "agricultural development" in his booklet: (i) markets for farm products; (ii) constantly changing technology; (iii) local availability of supplies and equipment; (iv) production incentives for farmers; and (v) transportation. In addition, he listed five potential "accelerators" of agricultural development: (i) education for development; (ii) production credit; (iii) group action by farmers; (iv) improving and expanding agricultural land; and (v) national planning for agricultural development.

Interestingly, Leslie Duram's list of "influences" on organic farming in her recent book has many similarities to Mosher's lists. Duram (21) lists the following four broad categories of influences on decisions of organic farmers: (i) economic (markets, organic food prices, etc.); (ii) ecology (balance, soil health, etc.); (iii) society (American culture, policies/information); and (iv) personal (independence, innovation, tradition).

The similarities between these lists, separated in time by nearly 40 years, should not be surprising. Agricultural adoption and diffusion theories received a great deal of attention during the years leading up to the first Green Revolution, and social scientists have continued to adapt, refine, and apply the theories and concepts from that period to new situations. In my own recent work with Jules Pretty on agri-environmental policies (14,16), we have utilized a conceptual framework that focuses on the following three important goals of farmers (Endnote 1): (i) to have adequate net income (profits); (ii) to keep risk within manageable proportions; and (iii) to achieve good stewardship of natural resources.

The framework is focused on how agri-environmental policies, including policies for organic agriculture, influence farmers' incentives to

move from "conventional" to more ecologically sustainable farming systems by effects on their abilities to achieve these goals. The following "contextual factors" can either enhance or inhibit the effectiveness of policies in moving farmers to more ecologically sustainable farming systems: (i) prices and access to markets; (ii) technologies; (iii) the structure of agriculture; and (iv) social and human capital.

To some extent, social capital accounts for influences of neighbors on farmers' decisions. Where organic and similar "sustainable" farming societies and networks are strong, farmers receive positive feedback for decisions to farm organically (14); this helps to offset any remaining negative peer pressure from conventional neighbors. Fifteen or 20 years ago, negative peer pressure from neighbors may have been more of an inhibiting factor for adoption of organic and other "alternative" or "sustainable" farming systems than it is today (1). At present, negative peer pressure from neighbors is probably greater in some regions of the US than others. Durum notes the more positive atmosphere in California, compared to some other parts of the country (21). Some studies also have noted family traditions as an inhibiting factor (20,38). Social capital that supports organic agriculture can influence family values over time, however.

Drawing on these various conceptual frameworks — from those of the first Green Revolution period, represented by that of Mosher, to ones of more recent vintage, including Durum's and Dobbs and Pretty's — I will focus on challenges facing a second Green Revolution based on organic agriculture by considering three sets of influences:

1. technology, prices, and markets;
2. the structure of agriculture;
3. public policies.

Research, education, and planning leading to the first Green Revolution gave a great deal of attention to #1 and #3. The "institutionalists" also paid attention to #2, but the structure of agriculture received even more attention as the Green Revolution matured. While pre-Green Revolution attention of institutionalists was on the necessary structural conditions for agricultural development, post-Green Revolution attention turned to issues of equity, especially with regard to impacts on the poorest members of society, including landless laborers. Drawing on the first Green Revolution experience, I will consider the "structure of agriculture" from both *cause* and *effect* standpoints. Post-Green Revolution analysis also focused much greater attention on "appropriate technology," which I address briefly in the following section of this paper.

Influences of Technology, Prices, and Markets on Farm Profits and Risk

Technologies, consumer demand, and markets together strongly influence the profitability and risks for farmers in changing from more conventional farming systems to organic systems. Therefore, central to any strategy for expanding organic agriculture is the challenge of developing appropriate technology and marketing institutions.

Klonsky and Greene (28) recently described the trends in US organic food consumption. They present a picture of rapidly expanding consumption — annual rates of growth averaging 20% since 1997 — based, to a substantial extent, on consumers' health and food safety concerns. Organic food sales reached $10.4 billion in 2003, about 2% of total US food sales. They suggest that the US organic food market could realize continued expansion by:

> "1) increasing the number of retail outlets with respect to type and number, 2) increasing the number of organic products available in each outlet type, 3) entry of mainstream food manufacturers into organic, 4) branding of organic, and 5) increased export." (28)

Streff and Dobbs (42) have documented relatively high price premiums for organic grains and soybeans (*Glycine* max) during some periods between 1995 and 2003. Also, the USDA's Economic Research Service (9) has reported substantial price premiums for some organic vegetables in recent years. However, there remain many challenges in expanding processing and retail outlets for organic farm products and strengthening the marketing linkages from farmers all the way to consumers (7,17). Research cited by Dimitri and Oberholtzer (8) indicates that price is the leading barrier to greater organic purchases by consumers. Organic price premiums at the retail level are due to many factors in addition to sometimes higher production costs at the farm level, including higher transaction costs associated with dispersed and relatively small production levels (8). Closely related to these transactions costs are the costs of identity preservation throughout the food chain.

Reviews of US comparative profitability studies indicate that price premiums at the farm level are necessary for some organic systems to be competitive with their conventional counterparts. This is especially true for crops like processed tomatoes (*Lycopersicon esculentum*) and cotton (*Gossypium hirsutom*). However, some organic systems have been shown to be competitive even without price premiums at least some of the time. This is the case for organic systems featuring corn (*Zea mays*) and soybeans in some Midwest areas (28,47). Recently reported research in Iowa indicated that an organic corn/soybeans/oats (*Avena sativa*)/alfalfa (*Medicago sativa*) rotation could be more profitable than a conventional corn/soybean rotation even without price premiums, but the organic system was less profitable when a charge for purchasing compost was included in the organic budgets (6). In a similar study in Minnesota, the 4-year organic rotation consisting of corn, soybeans, oats, and alfalfa had higher average net returns over the period 1990 through 1999 than conventional corn/soybean rotations when organic price premiums were included. When organic price premiums were excluded, the organic system still had higher average net returns, but the differences were not statistically significant (31). Recently reported comparisons of organic and conventional small grain/oilseed crop systems in Alberta, Canada found the organic systems to be less profitable, on average, than the most profitable conventional system (continuous wheat) when organic premiums were not included. When the "most likely" organic price premiums were included, however, one of the organic systems had net returns that were similar, on average, to the most profitable conventional system (41).

Given the fact that organic price premiums do exist for many crop and animal products, why does organic agriculture remain such a small proportion of US agriculture? Although certified organic cropland in the US increased by 53% between 1997 and 2001, it was still only 0.36% of total US cropland. Certified organic pasture and rangeland was only 0.23% of the total in 2001, in spite of more than doubling since 1997 (22). Some clues to answering the question about why there is not more organic production in the US may be found in the most recent (2002) organic farmer survey by the Organic Farming Research Foundation (OFRF) (46). Farmers responding to that survey ranked the following (in order) as their top eight *production, marketing, or regulatory problems*:

1. weather-related production costs;
2. organic certification costs;
3. obtaining organic price premiums;
4. high input costs;
5. lack of organic marketing networks;
6. high labor costs;
7. weed-related production losses;
8. production losses due to pests or diseases.

Four of these eight problems (#1, #3, #7, and #8) involve some aspect of *risk*. Organic farming systems are not inherently more risky in all respects than conventional systems. In fact, organic systems tend to be more drought tolerant, and organic farms have a larger mix of crops (and often of livestock) than do conventional farms. Both of these features tend to make the economics of organic farms less risky than conventional farms. To gain greater insight on risks associated with organic farming, Hansen, et al. (24) solicited organic farmers' views in a series of focus groups during 2001 and 2002. Among the risks identified in this study that are of special concern to organic farmers are: (i) risks of contamination of organic crops by genetically modified organisms (GMOs); (ii) shortages of particular inputs such as certified organic seeds and biological pesticides; (iii) access to capital, because banks are sometimes unfamiliar with organic production systems; (iv) instability of organic price premiums; and (v) some crops in organic rotations do not benefit from USDA commodity program price and income protection. The study was used in part to identify ways that Federal risk management programs (e.g., crop insurance) might better serve organic farmers.

Organic certification costs (#2 on the above list) reflect a portion of the farmer's costs of identity preservation (mentioned earlier in the context of transactions costs). Farmers often have handling and storage costs associated with identity preservation, also, especially when only a portion of a farm is organic. This can contribute to some farmers' reluctance to convert to organic, or part-organic, production.

The OFRF 2002 organic farmer survey also included a place for respondents to give open-ended responses to a question about *marketing conditions* that have the greatest negative impact on organic farming economic sustainability and profitability. The most common responses were these:

1. competition with large-scale producers;
2. competition with organic imports;
3. low prices;
4. buyer consolidation in organic market place;
5. finding buyers and markets;
6. market overproduction [in soybeans, especially; also apples (*Malus* spp.) and raisins (*Vitis vinifera*)].

These responses suggest that, though organic markets have been rapidly expanding at the retail level, expansions in supply and demand do not always move smoothly together, thereby sometimes resulting in price declines at the farm level. Also, farmers are concerned about the changing structure of the organic industry (40), which I address in the next section of this paper.

Continued expansions in demand and reductions in transactions costs throughout the marketing chain can help enable price signals to be effective in encouraging continued growth in organic production at the farm level. What is the role, then, of *technology* in facilitating further growth in organic

production? After all, it was new technology packages that triggered the first Green Revolution. It is highly unlikely that we will see technology breakthroughs for organic systems that could have the dramatic effect that the high-yielding grain varieties had in the first Green Revolution. Some lessons about technology can be drawn from that previous Green Revolution experience, however.

One lesson is that there were long, sustained plant breeding efforts that led to the varietal breakthroughs. A second lesson is that agricultural development professionals took a systems approach in attempting to encourage adoption of the new varieties. In India, for example, there was an integrated agricultural development strategy that targeted districts with high production potential. The integrated approach attempted to see that all the key ingredients — seeds, fertilizer, irrigation water, and information — were in place to encourage rapid and high rates of adoption. When all the key ingredients were in place, the result was, indeed, rapid adoption of the Green Revolution technology packages.

The first Green Revolution experience does not imply that plant breeding should necessarily lead the way for a second Green Revolution based on organic agriculture. However, the previous experience does suggest that research and education on organic technologies should continue to have a heavy *systems orientation* and should focus on *technology packages*. In fact, organic agriculture research and education have been known for their systems approaches. I am concerned, however, that as organic research programs mature and garner their own sources of funding, there is a very real danger that the research will look more and more like that of conventional agriculture. Although projects may continue to have systems and multidiscipline appearances, the appearances may simply mask the same old kinds of highly specialized research on small technological refinements. While there is an important place for disciplinary and reductionist research in organic agriculture, we need to be wary of researching-to-death particular technologies. It seems as if research on conventional agriculture has produced an endless stream of fertilizer response and pesticide application studies. Ten or 20 years from now, will organic research consist mainly of a similar stream of biological pest control studies on virtually every crop, under every conceivable growing condition?

A key concept that arose in the 1970s out of some of the unintended consequences of the first Green Revolution was that of "appropriate technology" (Endnote 2). Some of the of the post-Green Revolution concerns about the "successful" technologies was that they were not always appropriate for poor farmers in marginal, dryland (rainfed) areas and that they generally led to great losses in biodiversity. While almost everyone agrees that economically successful organic systems are specific to agro-climatic regions and resource conditions, there is a tendency among some organic researchers to feel that the main challenge in each region is to adapt the "conventional" crops and livestock of that region to organic farming methods. Instead, we should back up and ask whether the crops and livestock that have evolved over time due to specialization and the use of chemical inputs really are appropriate to that region. Maybe there is no "natural" comparative advantage for some crops or livestock species in a particular region. An "appropriate technology" approach would focus on technologies and systems for crops and livestock that are ecologically "appropriate" for the climate and resources of each region.

The Structure of Agriculture

As noted in the "framework" section of this paper, the structure of agriculture is an important consideration from both *cause* and *effect* standpoints in strategies for expanding the reach of organic agriculture. At least in Great Plains and Midwest agriculture, the evolving structure of agriculture appears to inhibit expansion of ecologically diverse farming systems, including organic systems [e.g., see Dumke and Dobbs (19)]. Organic and other ecologically diverse farming systems require a great deal of management attention to both production and marketing. They also generally require more labor in the production process than do conventional systems. Historically, moderate-sized, full-time farms that also had several family members available to assist with farming operations were best able to supply the requisite management and labor for diverse operations. As we all know, US farm structure for several decades now has been evolving into an increasingly bi-modal structure — with very large farms on one end and smaller, part-time farms on the other. Both of these farm types lend themselves best to specialization in just a few crop or livestock operations. With smaller families and usually either wife or husband (or both) working off the farm, this structure lends itself best to capital-intensive, rather than labor-intensive, farming systems.

Dumke and Dobbs (19) have examined and explained the numerous forces that have contributed to the growing farm size, increased specialization, and reduced ecological diversity of US agriculture over the last half century. Among those forces have been agricultural price and income support policies, discussed briefly in the next section of this article. The agricultural structure that has evolved presents somewhat of a "chicken-or-egg" situation with respect to organic agriculture. The current structure makes it difficult for widespread adoption of organic and other ecologically diverse farming systems to take place. But, unless and until organic and other forms of ecological agriculture displace significant portions of the currently dominant chemical-intensive agriculture, the US's agricultural structure is unlikely to change substantially.

Given the current structure of agriculture, it is sometimes difficult to be optimistic about the prospects for a major expansion in US land area covered by organic farming systems. One might envision some major expansion in organic *farm numbers*, based on small-hectareage operations near major urban markets that produce fruits, vegetables, and specialized livestock or other value-added products. From the standpoint of producing organic food for urban consumers, this kind of expansion would be regarded as a very positive thing by most organic agriculture proponents. However, from the standpoint of impact on the environment and ecology of US agriculture, the effect might be very limited because it could leave the vast majority of US agricultural hectareage in chemical-intensive conventional farming.

This brings us to the question of whether large-scale — what some might refer to as "industrial organic" — farms can fulfill the goals of organic agriculture. Recall that the definition of organic agriculture used by the USDA, presented in the opening section of this article, makes no reference to farm size. Nevertheless, large-scale organic farms would not fulfill the "Jeffersonian" or "agrarian" small family farm goals that have characterized much of the early organic movement in Midwest and Great Plains agriculture. We need to bear in mind, however, that this "Jeffersonian" ideal has not traditionally been central to all of US agriculture. California, for example, "*never had an agrarian tradition*," according to Guthman (23; the italics appear in the original). Guthman argues that in the far West, "the central struggle has always been between industrial producers and wage labor" (23),

not between large growers and small growers. Hence, adopting the Midwest's large farm/small farm agrarian rhetoric in California implies, in Guthman's view, that organic agriculture could or should save a type of family farming tradition that actually never existed to any substantial extent in much of California agriculture.

Guthman's observations also are relevant to areas other than California, however. If organic agriculture is going to have social goals, the goals should go beyond some idealized vision of a family farm. Concern about agricultural laborers should take on much greater importance. Many agricultural laborers (beyond those who are part of the farm family) also are involved in organic agriculture in the Midwest, even where organic agriculture still comes close to the "Jeffersonian" ideal. They are involved not only in production — especially in hand weeding in the case of grain/oilseed crop farms — but also in processing. Seldom if ever do organic and sustainable agriculture forums in the Midwest feature sessions on the sources of labor or wages and working conditions of these field laborers and laborers needed to slaughter organic chickens, hogs, or cattle. The organic farming movement is on very weak footing when it asks for consumer and public support on "social" grounds when almost the only social focus is that of the farm operator family (Endnote 3).

Aside from social goals, then, can "industrial organic" satisfy the environmental and ecological goals inherent in the organic agriculture movement? If we take the Federal rules for organic certification as necessary conditions for satisfying environmental and ecological goals, then the answer might be yes — for those large-scale operations that can achieve certification. But, as we can all observe, these rules continue to be challenged and debated. There is great pressure to have rules that industrial organic can live with, particularly for animal agriculture. Depending on where lines are drawn in many of these rule disputes, large-scale organic farming operations may or may not be able to achieve and maintain certification.

The first Green Revolution had one overriding goal — to satisfy extremely pressing food needs of large and rapidly growing populations in developing countries. Other social goals and environmental goals were not central to the strategies of most countries leading up to that revolution, but such goals have taken on much greater importance in the revolution's aftermath, as unintended consequences have become more apparent. The original, and still primary, driving goals of the organic movement are environmental or ecological. In addition, food safety and nutrition goals are now taking on greater importance. However, the place and nature of social goals related to the "structure of agriculture" constitute an outstanding issue in the US organic agriculture movement.

Public Policies

I noted earlier in this article that public policies played an important role in the first Green Revolution. After the first waves of success in agricultural areas that were especially well-suited to the Green Revolution technology packages, economic policy took on even greater importance as governments of developing countries and donor agencies such as the US Agency for International Development tried to increase agricultural production in other areas. In a sense — though we are yet to see a comparable Green Revolution in the US based on organic agriculture—the situation today with respect to adoption of organic farming systems is somewhat like the mid-1970s regarding adoption of the first Green Revolution technology packages. By the mid-1970s, many farmers in areas of the developing world where the Green Revolution packages were profitable and not too risky had adopted them. It was then clear that much greater attention to a range of policy factors

was needed in order to increase food production in other areas. Today, roughly 25 years after release of the USDA's *Report and Recommendations on Organic Farming*, it is abundantly clear that much greater attention to public policies is needed if there is to be a major expansion of organic hectareage in the US. There has already been more than a decade of such policy attention to organic agriculture in Western Europe (5).

Several decades of agricultural price and income support policies in the European Union (EU) and the US that "coupled" support, either directly or indirectly, to crop and livestock production had the effect of favoring chemical-intensive systems over organic and other ecologically-based systems (15,34). US agricultural policy took important steps toward "decoupling" supports from current production in the 1996 Federal farm bill, and then, in effect, took some backward steps in the 2002 farm bill. Like the US, the EU began the decoupling process in the 1990s. However, unlike in the US, the latest major agricultural policy changes in the EU's Common Agricultural Policy (CAP)—approved in 2003 and now in the process of being implemented in EU member states—appear to constitute a significant step toward even greater decoupling (16). These latest CAP reforms should help greatly to further "leveling of the playing field" for organic agriculture in Europe.

EU member states also have many agri-environmental policies, some of which aggressively support organic agriculture (5). There is growing documentation of the negative environmental externalities of "conventional agriculture" in Europe and the US (e.g., 36,37,43). That research and an emerging body of literature indicating that organic agriculture performs better in at least some environmental and energy use respects than conventional agriculture (5,26,35) provide bases for pubic policies that go beyond simply leveling the playing field for organic agriculture. There is not as much evidence in support of the argument that organic farming also provides a significant boost for rural economic development. However, to the extent organic farming is tied to local food systems, local value-added products, and a positive image of rural areas, it may play at least some positive role in rural development (4,5,21). If that additional dimension of organic agriculture's "multifunctionality" is present, there is further rationale for public policies actively supporting organic agriculture.

In some ways, the challenges in developing and sustaining public policies to support organic agriculture may be even greater than they were for supporting the first Green Revolution. In that previous Green Revolution, new technology packages clearly and dramatically increased profits for many farmers. Those highly profitable technologies could be sold in the market, so there was clear potential for private sector industries to emerge and develop to market the technology package ingredients — namely, seeds, fertilizers, irrigation equipment, and chemical pesticides. A new Green Revolution based on organic farming systems, in contrast, would have more emphasis on natural and human capital than physical capital. There is less potential for the private market to profitably promote and provide the ingredients for natural and human capital. The benefits of organic agriculture, for the most part, are expressed in ways other than yield increases, which constituted the central feature of the first Green Revolution. Organic agriculture's multifunctionality implies that many segments of society in addition to farmers receive benefits, and many of those benefits are not easily captured in market mechanisms.

At present, there is only very limited policy support for organic agriculture in the US. There is very modest but growing support for organic agriculture research, and there is a program that provides some cost-share funds for organic certification. The Federal crop insurance program has been revised to somewhat better accommodate organic farmers. The Environmental Quality Incentives Program (EQIP) has been used in some States as an organic transition assistance program somewhat like transition

assistance programs in the EU. However, all of these programs are extremely modest in comparison to agri-environmental programs focused on organic agriculture in Europe.

There was some hope that the Conservation Security Program (CSP), newly created in the 2002 US Federal farm bill, might serve in part as an organic incentive payment program like ones in Europe (30). At South Dakota State University, we recently analyzed potential for the CSP to induce adoption of more ecologically diverse crop rotations, including organic crop rotation systems, in the US's Western Corn Belt (18). At the time our analysis was conducted, implementation rules for the CSP had not been finalized and no CSP signup had yet been approved for South Dakota, where our case study region was located. Therefore, it was necessary to make a number of assumptions about qualifying practices and payment rates. We assumed that organic crop rotations would qualify for payments in Tier 3, the highest of the CSP's three payment tiers. Later, when the first CSP signups took place in South Dakota in 2005, eligible practices and payment rates were examined. Payment rates actually allowed for establishment of ecologically diverse crop rotations were substantially lower than those assumed in our representative farm analysis for southeastern South Dakota.

Briefly stated, our results suggest that both organic and non-organic systems that are ecologically diverse may be more profitable than conventional corn-soybean systems in the region of southeastern South Dakota that we studied—with or without Federal commodity payments, CSP payments, or price premiums for the organic system. If that is actually the case, are CSP or other agri-environmental program payments really needed to encourage adoption of organic systems? The results would seem to imply "no," if the decision is simply whether to continue with a conventional corn/soybean system or to go organic. If the choice is between ecologically diverse systems that are not organic and ones that are organic, the answer might be "yes," if farmers are not confident of the level and continuity of organic price premiums. However, neither organic nor non-organic ecologically diverse systems are very common in the study region. This suggests that some of the risk and other factors discussed earlier in this paper are holding back the adoption of organic and other ecologically diverse farming systems. If that is the case, CSP or other incentive payments may be critical to any major expansion of organic hectareage, at least for so long as Federal farm program commodity-type payments continue to be so important to the net returns and associated land values of conventional agriculture.

Summary

I have tried to raise some issues and challenges facing organic agriculture in the US. The articles to follow identify and elaborate technology, market, research, policy, and other components of a possible second Green Revolution, this one based on organic farming methods. As researchers and policy makers develop strategies addressed to those components, it is important to keep in mind some experiences and possible lessons of the previous Green Revolution based on chemical-intensive farming methods. Though many proponents of organic agriculture are quite critical of some aspects of that previous Green Revolution, there are lessons about strategies that we can draw from that experience as we lay groundwork for the next agricultural revolution.

Endnotes

1. Farmers have other goals, also, of course, but these three are considered especially important from a policy standpoint. Among the other goals that could have been included are ones to maintain flexibility and not be tied down by bureaucracy (12). Back to text.
2. This is closely related to the term "intermediate technology" that Schumacher used in his famous *Small is Beautiful* book (39). Schumacher also used the term "appropriate technology," but he used the term "intermediate technology" in the title of one chapter devoted to the subject, and he used that term in most of his discussion. Back to text.
3. I am not including food nutrition and safety goals and environmental goals under the "social" heading here. Those are important organic agriculture goals, but I am simply not placing them under the "social" heading. Back to text.

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