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Small Farms and Sustainable Development: Is Small *More* Sustainable?

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ABSTRACT

A new, post-industrial, paradigm for agriculture is emerging under the concept of sustainable agriculture. The sustainability paradigm has emerged to solve problems created by the industrial model, primarily environmental pollution and resource base degradation. The role of farm size in this transformation to a more sustainable agriculture is the issue addressed. Using a descriptive approach, and relying on a survey of the literature including emerging paradigms and observations, we conclude that, from a sustainability perspective, the smallest effective size will be the most competitive size for farms, as for other knowledge-based enterprises of the future.

Key Words: agriculture, farm size, paradigms, sustainability.

All farms have some impact on the environment and the local community of which they are a part. The type of impact (positive or negative) and the intensity are likely to be different for different types of farms. Whether or not small farms possess characteristics that, individually or as a group, make them more likely to contribute to sustainability objectives is something we set out to address.

This paper session seems to be a logical follow-up to a session at last year's SAEA meetings devoted to examining the consequences of agricultural industrialization on sustainable development (papers published in the July 1995 issue of the *Journal of Agricultural and Applied Economics*). One conclusion from that session is that the trend toward agricultural industrialization is gaining momentum. Another conclusion is that agricultural industrialization and the quest for a sustainable agriculture are consequences of similar global forces. It seems to be implied that the two can coexist. However, a discussion by Weatherspoon argues otherwise, and unwittingly lays the groundwork for this session by raising the question: "Agriculture is well on its way to becoming industrialized, but is it doing so at the expense of our environment?" (p. 41).

Our analysis, by necessity, is descriptive and qualitative. Our analysis is also positive rather than normative. We treat large farms as synonymous with "industrial farms," but do not regard good management as necessarily inclusive of good stewardship. We rely on the literature, which we attempt to link together with the available evidence and with our own observations. We also explore emerging paradigms and contrast them with the industrial paradigm of agriculture. While there is a large body of literature on sustainable development and on small farms, little attempt has been made to tie the two together.

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The Problem

The historical increase in farm size, mechanization, and accompanying reliance on off-farm inputs, specialization, and globalization is often associated with what is perceived to be a trend toward the declining sustainability of agriculture. This "industrialization" of agriculture has progressed to the point where it is important to attempt to isolate the role, if any, that farm size plays in sustainable agricultural development.

Ikerd, among others, attributes environmental concerns from agriculture mainly to the industrial paradigm of agricultural production, manifested in large-scale, commercial units. Industrial methods rely heavily on machinery and commercial fertilizers and pesticides which, on the one hand, have accounted for most of the productivity increases in agriculture (as conventionally measured). On the other hand, they are an important source of environmental and (some would argue) rural development problems.

As long as the natural resource base is viewed as costless in the market place, the short-term benefits from using industrial methods are likely to continue to exceed the short-run costs, thereby encouraging their continued adoption. Over time, as economic valuation of nonmarket resources gains in precision and acceptance, the relative economics of industrial methods will also change. According to Markandya, in addition to "right economic valuations," sufficient conditions for achieving sustainable development are an "appropriate legal and social framework" and "environmental accounting or monitoring."

Conway defines sustainability in agriculture as "the ability of an agroecosystem to maintain productivity when subject to a major disturbing force" (p. 101), which we refer to here as "Conway sustainability."[1] Examples of "major disturbing forces" include frequent pesticide applications, a new pest, the cumulative effects of salinity or soil erosion, and the sudden rise of an input price such as the oil price increases of the 1970s (Conway). This leads us to the following proposition:

PROPOSITION 1. *To the extent that, the larger the farm, the greater the natural ecosystem it displaces or landscape it dominates, large farms individually and collectively create greater ecological "disturbance."*

It is not difficult to visualize, for example, the disruption that could result from a (new or old) pest outbreak on a large, specialized farm. Further, one of the reasons why agriculture has become increasingly viewed as unsustainable is because farms have tended to become closed, self-contained units—something fostered by the "industrialized" concept of agriculture.

Before examining whether or not small farms can be part of the solution to putting agriculture on a more sustainable track, it may be useful to profile small farms, both domestically and globally.

The Nature of Small Farms

Using a conventional definition of a small farm as one that grosses up to $40,000 in annual sales, almost seven in 10 U.S. farms can be classified as small (table 1). While small farms together account for only 10% of gross sales (which translates into an annual monetary value of $16 billion in 1992), they control a third of the value of all farm assets (including 30% of all U.S. farm land). Two percent of small farms are minority owned, 70% are operated by full owners, with the remainder operated by part owners and tenants.

In an extensive profile of U.S. small farms, Thompson found (*a*) great geographic disparity, (*b*) no typical small farm, and (*c*) a great number of small farms that grossed well under $40,000 annually. It is true that, on average, small farms allocate a greater *proportion* of their operating budget than large farms to purchased inputs, such as fertilizer, chemicals, and energy, and much less to labor. However, Thompson (among others) attributes this to the fact that larger farms tend to have labor requirements that cannot be met by family members alone.

It is true that the total number of farms in the U.S. has shown a declining trend. In addition, the number of small farms also has been declining. It

[1] The idea underlying this term originated with what Common and Perrings refer to as "Holling sustainability." A system is said to be "Holling-sustainable" if it is resilient enough to retain its basic structure even when subjected to external shocks or strains. Thus, "Conway sustainability" and "Holling sustainability" are operationally similar concepts.

Table 1. Profile of U.S. Small Farms[a]

Item	Value in 1992	Percentage Relative to Large Farms	Change in Value, 1982–92 (%)	Change in Value, 1987–92 (%)
Number (1,000)	1,386	66	−20	−13
Gross Cash Income (billion $)	19	10	7	6
Net Cash Income (billion $)	−0.6	—	−216	−134
Gov't. Payments (billion $)	1.1	12	48	−47
Assets (billion $)	296	34	3	−23
Debt (billion $)	35	25	−13	−20
Debt/Asset Ratio (average %)	11.6	72	−16	0
Minority-Operated[b] (1,000)	34	—	N/A	−5
Part Owners and Tenants (1,000)	409	—	−16	−9

Sources: USDA/Economic Research Service; U.S. Department of Commerce (1994a, b).
[a] Small farms are defined as farms with annual sales not exceeding $40,000.
[b] Under $25,000 in annual sales.

appears that the latter has declined by an average of 13% between consecutive census years (figure 1).[2] On the other hand, it also appears that the number of mid-size and large farms together (defined as over $50,000 in annual sales) has increased in all but one census year, by an average of 81% between consecutive census years. However, when the effects of inflation are factored in, the decline in small farm numbers does not appear to be as pronounced; as it turns out, many farms that appear to be "mid-sized" (particularly during the relatively high inflationary period of the 1970s and 1980s) are, in fact, "small" farms (figure 2).[3]

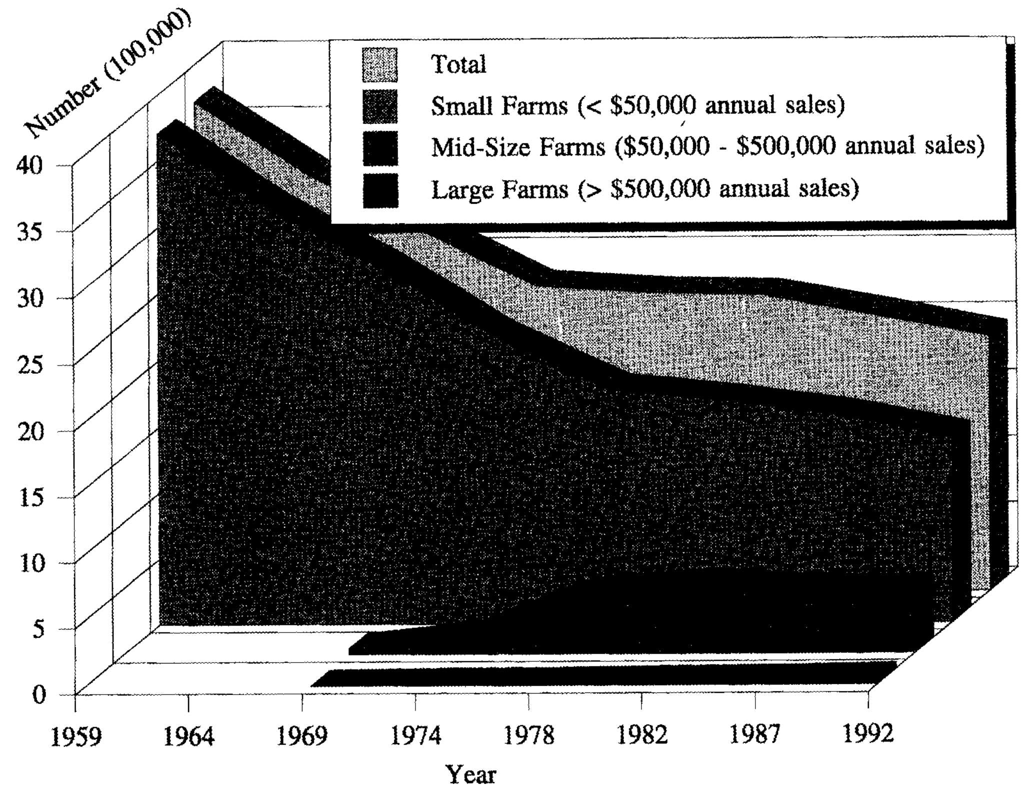
While aggregate gross cash income of small farms is positive, sizable, and has been increasing, net cash income of small farms in the aggregate is negative and in a steep decline (table 1). However, to the extent that many small farms have relied heavily on off-farm income, history would indicate that the lack of aggregate net cash income, in and of itself, does not appear to threaten their survival as a group. Glover and Kusterer identify a major goal of small farm operators to be to increase the "security and income of their families while retaining their independence as owners and operators of a farm enterprise" (p. 1). This goal provides a motivation that might ensure their long-term economic sustainability, even if cash returns fail to cover total costs.

Globally, statistics on small farms are less readily available. Wharton (as cited in Valdes, Scobie, and Dillon, p. 168) reports that "about half the world population is dependent on subsistence farming, about 40% of total cultivated land is worked by small farmers, 60% of all farmers are small, and they account for less than 40% of all agricultural output." Peasants are said to account for a "major proportion" of basic food crop production in most developing countries (Valdes, Scobie, and Dillon).

In a study of contract farming, Glover and Kusterer found, contrary to expectations, that at the global level, agribusiness growth has not displaced small farms and is not likely to do so in the foresee-

[2] Because of the nature of the data available, $50,000 in annual sales (instead of $40,000) is used as the cut-off point for this particular comparison.

[3] Because of the size increments in which the *U.S. Census of Agriculture* (U.S. Department of Commerce 1994b) data are reported, the inflation-adjusted number of small farms (calculated in terms of purchasing power parity) is not exact, but a (fairly conservative) estimate.



Source: U.S. Department of Commerce (1994b).

Figure 1. Change in number of U.S. farms by size group, 1959–92 census years (value of sales not adjusted for inflation)

able future. One reason is that agribusinesses do contract with small farmers because of political reasons. Such contracting is motivated in part by access of small farmers to concessional credit schemes and the propensity of small farms to produce better materials when extremely high quality is necessary.

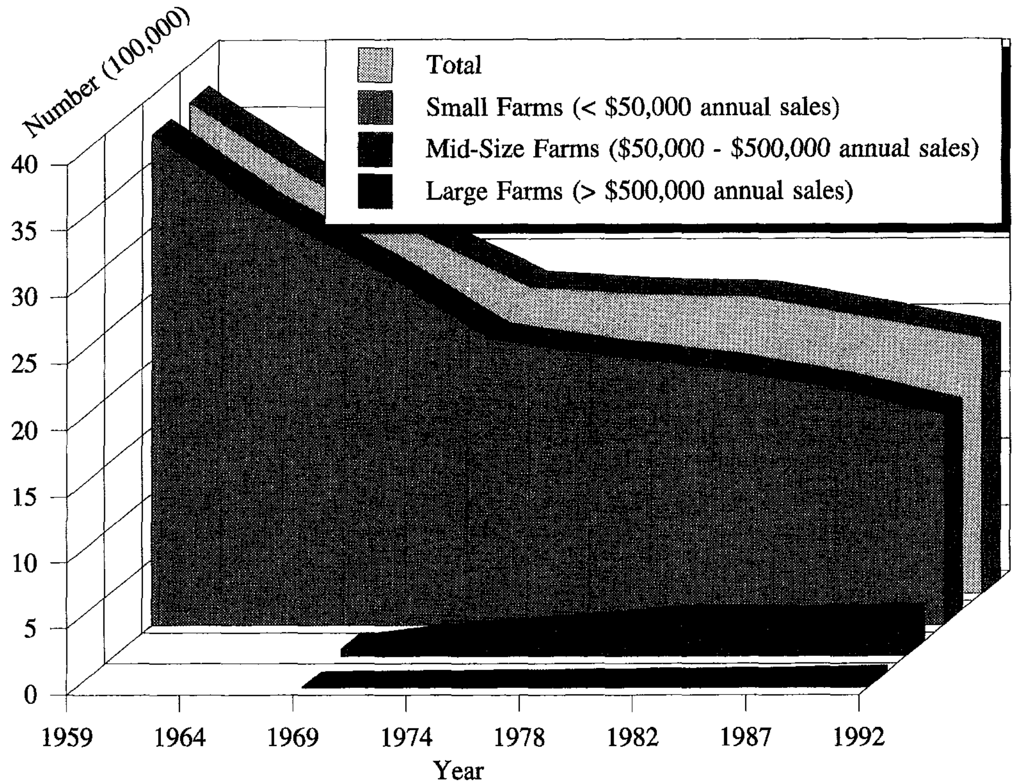
One way to examine the contribution of small farms to sustainability objectives is to explore the scope of societal "benefits" and "costs" of small farms as a group, at least qualitatively—which we now proceed to do.

Societal Benefits of Small Farms

Whatever they are called (small farmers, peasants, or subsistence farmers), they have several characteristics other than size that commonly distinguish them from their larger counterparts. Among these are: (*a*) the intensity of the man-nature relationship, (*b*) the diversity of plant and animal life, and (*c*) the diversity of income sources on small farms relative to large farms. This leads to another proposition:

PROPOSITION 2. *If environmental sensitivity, biodiversity, and income diversity, in turn, are among the necessary conditions for sustainable agricultural development, then small farms could, individually as well as in the aggregate, contribute both to economic and environmental sustainability.*

One way to explore the contribution of small farms to sustainability objectives is to match the characteristics of a sustainable system with those of small farms and large farms, respectively. Tisdell associates the following characteristics with sustainable systems: (*a*) the maintenance of intergenerational economic welfare, (*b*) existence of human beings indefinitely, (*c*) sustainability of production and economic systems in terms of their resilience



Source: U.S. Department of Commerce (1994b).

Figure 2. Change in number of U.S. farms by size group, 1959–92 census years (value of sales adjusted for inflation)

and other properties, (*d*) sustainability of community, and (*e*) maintenance of biodiversity. The characteristics of small farms have previously been alluded to.

Following Tisdell, characteristics of "modern" or "industrialized" agricultural systems include: (*a*) high energy-using, (*b*) high chemical-using, (*c*) requiring intensive management, (*d*) placing a high premium on uniformity rather than diversity of both products and environments, and (*e*) appearing to depend on the results of continuing research for the maintenance of their productivity.

Based on these listings of characteristics, it would seem that small farms match the characteristics of sustainable systems more so than large ones (assuming the synonymity between large farms and industrialized ones). Table 2 summarizes this matching of characteristics.

Thompson notes the following specific benefits of small farms within a sustainability context:

- *Act as buffers against urban encroachment.* Thompson points out that the number of small farms in a community is directly proportional to the economic vitality of that community. This is attributed to the fact that small farms, particularly in urban states, do not depend substantially on income from farming, and therefore do not face the same economic pressure to sell land for development as their larger counterparts. As it turns out, small farmers own a relatively high proportion of farm land in the eastern states, where urban pressures are also greatest.

- *Provide scenic attributes.* Although difficult to quantify, the aesthetic appeal of small family farms to tourists as they drive around clearly exists. Thompson cites the case of Lancaster County in Pennsylvania, where the "attraction" is the large concentration of Amish and Mennonite farms. He adds that this is the most productive

Table 2. Properties of Sustainable Systems and Consistency with the Goals of Small-Scale Farming and "Industrialized" Farming

Properties of Sustainable Systems[a]	Consistent with Goals of Small-Scale Farming?	Consistent with Goals of Industrialized Farming?
Maintenance of intergenerational economic welfare	yes	no
Maintenance of existence of human species indefinitely	?	no
Sustainability of production and economic systems in terms of their resilience	yes	no
Sustainability of community	yes	no
Maintenance of biodiversity	yes	no

[a] Properties as defined by Tisdell.

farm county east of the Mississippi, with gross sales of $700 million annually from farming, and an estimated $250 million annually from tourists. Thompson also finds small farms fulfilling a role as "goodwill ambassadors" from the farm sector to the public by virtue of the roadside markets many of them operate.

- *Lower intensity of land use.* Small farms tend to use their land less intensively than large farms, which potentially is less environmentally damaging. For example, larger proportions of land are devoted to woodland on small farms (17% versus 5%); less cultivable land is actually cultivated and harvested on small farms (50% versus 80%); a greater percentage of cropland is used for pasturing livestock (31% versus 8%); and small farms maintain almost twice as much cropland (although accounting for only a small fraction) in cover crops, legumes, and other "soil improving uses" (Thompson). Small farms tend to involve more "site specificity" and are more in tune with peculiarities of the landscape of which they are a part.

- *Greater reliance on conservation practices.* Thompson points out an interesting dichotomy. On the one hand, an implication of the lower intensity of land use by small farmers is that they may be contributing less to soil erosion than larger operations. For example, in a comparison of soil degradation under small holder farming and large-scale irrigated land in Nigeria (Eussiet) over a 13-year period, it was confirmed that soil degradation, qualitatively and quantitatively, was more severe on the large farms. On the other hand, there is the possibility, in the aggregate, that small farm cropland is more inherently erodible, necessitating its maintenance in pasture or cover crops to minimize erosion. On balance, Thompson argues that small farmers "*must* be better land stewards than their larger counterparts" because small farmers tend to be less dependent on row crops that are inherently more erosive, they farm fewer acres, and can devote more time to caring for them.[4] The last characteristic is consistent with the "management-intensive" nature of sustainable systems.

- *Intergenerational transfer of practices.* This element is associated more with small farms, indigenous peoples, and so-called "developing" countries. In general, these practices rely more on natural phenomena and are more sustainable from an ecological standpoint.

Societal Costs of Small Farms

Although it is argued that small farms are less efficient and slower to adopt new technologies in com-

[4] Thompson makes an interesting, and apparently important, distinction between *part-time* small farmers and *full-time* small farmers: The author expects the latter to use their land similarly to their large-scale counterparts.

parison to larger farms, these perceived costs may actually be benefits when viewed from a societal perspective.

- *Inefficiency.* It is generally recognized that economies of size accrue in farming. However, to the extent that environmental and other social costs are excluded from conventional efficiency measures, the economies of size are overstated. Then there is an argument that is sometimes advanced that large, commercial farms are more "efficient" than their smaller counterparts because the commercial farms make decisions based primarily on economic considerations. Therefore (for example), they would not use more than the "necessary" level of inputs such as fertilizers and pesticides. Even if this were true, it does not ensure that commercial farms are sustainable in the long run. In fact, to the extent that the short-run and cumulative environmental consequences of management decisions are ignored, it would likely ensure the long-term unsustainability of such operations. This would be true, albeit on a different scale, of small operations that ignored social production costs as well. To the extent that small farms tend to depend more on off-farm income, the buffering effect associated with such income can, in fact, be viewed as an advantage that would make small farms more competitive while contributing to food supply and keeping food costs to society lower than they otherwise would be.

- *Slower adoption of technologies.* Large farmers are generally the first to adopt new technologies (Bieri, de Janvry, and Schmitz) because of their easier access to credit, particularly for large-scale innovations (Price). However, while technological use can be economically beneficial—especially in the short run to early adopters—technical change can be immiserizing to society as a whole in the presence of distortions including externalities (see Alston and Martin, for example). Thus, slower/lower adoption of technologies by small farmers as a group may actually be a benefit from a societal standpoint.

Benefits and costs notwithstanding, is it possible for a community to meet its food needs from small-scale production units? Examples can serve to illustrate that it is possible.

An Example

The "ultimate" small farm, of course, is a kitchen garden. It must be stressed that it is impractical for an "advanced" society to revert to kitchen gardens for the population as a whole, and this is certainly not being advocated here; however, it serves as a useful vehicle to illustrate the relatively benign effect small-scale production has on the environment. Thus, in a kitchen-garden setting, equipment needs are greatly reduced, and so is transportation. Use of manure and composting, and recycling in general, is quite common in such settings.[5] At the other extreme, "industrialized" farms rely heavily on a transportation and retailing infrastructure that is energy- and capital-intensive, that potentially contributes heavily to environmental degradation, and that requires constant investment in infrastructure, including new technologies. While perhaps consistent with the Solow or Hartwick view of sustainability, the industrial model of farming is inconsistent with the Holling (and Conway) view of sustainability.[6]

While reverting to individual kitchen gardens to meet our food needs is not a practical solution, a system that is both community-based and comprised of several small-scale units working cooperatively is more so. An example of such a system is the "community-supporting agriculture" (CSA) which is becoming increasingly popular under a variety of names in many areas of the country. The basic idea is for small farms in the community to market their products, often "organically" produced, to other CSA members, which consist of farmers and others in the community. In one western Maryland CSA, members buy "shares" at predetermined prices, entitling them to a "subscription" of a market basket comprised of fresh fruit and vegetables, beef, and flowers or other selected commodities at regular intervals throughout the

[5] This point was made by Dave Finnie in an electronic mailing to multiple recipients of the internet online discussion group, "AGROECOLOGY" (on LISTSERV@WVNVM), dated 23 August 1995.

[6] Solow or Hartwick sustainability refers to constant consumption over infinite time as long as the Hartwick rule (rents deriving from exploitation of exhaustible resources must be reinvested in non-exhaustible resources) applies. Holling sustainability is defined in footnote 1.

growing season. This is an example of a system that can meet the needs of the local community in a manner that potentially is both economically and environmentally sustainable.

Looking to the Future

In the 21st century, the dovetailing of several problems and new opportunities is going to mean a transformation of the way agricultural production takes place. Blum, for example, cites (*a*) increasing competition for space for food production brought about by "exponential growth" of urban spillover and socioeconomic problems into adjacent rural areas, (*b*) competition between food production and groundwater production, and (*c*) reduction of biodiversity through "large-scale monocultural approaches" that are likely to severely constrain large farms. Blum also cites factors such as decreasing land surfaces in many developing countries due to increasing soil erosion as well as "sealing of fertile land for infrastructural development" that, in the future, are likely to translate into more small-scale farms—perhaps reversing the declining trend of the last few decades.

Ikerd sees the role of public policies in moving agriculture toward a sustainable path as being either to (*a*) impose environmental constraints on producers, or (*b*) provide incentive payments or targeted subsidies to encourage adoption of sustainable practices. Targeting the full-time, small-scale farmer is likely to prove especially beneficial. The benefits of moving toward full environmental costing have been expounded elsewhere, and so will not be repeated here.

Impacts of the Delaney Clause—which requires a zero-risk standard for carcinogenic pesticides "that concentrate during processing" (Kuchler and Ralston)—are likely to increase the comparative advantage of small farms. In a recent ruling, the Supreme Court declared that the Delaney Clause must be interpreted literally, resulting perhaps in the Environmental Protection Agency (EPA) having to curtail or eliminate the use of many common pesticides.

It is obvious that farmers in general, and across the entire size spectrum, for a myriad of reasons, are paying closer attention to the environmental impacts of their farming practices—earlier with an emphasis on soil quantity, and more recently on water quality. D'Souza, Cyphers, and Phipps, for example, found that water quality surrounding the farm is significant in a producer's choice of agricultural practices. Much uncertainty remains about the effectiveness of many practices in controlling pollution as well as the fate and transport mechanisms of agriculturally-caused pollution sources themselves. What is less uncertain is the existence of (*a*) an upper bound to the waste-absorption capacity of the environment, (*b*) a lower bound on the natural capital stock needed to sustain life, and (*c*) a near-zero elasticity of substitution between natural capital and produced capital.

Can Small Farms Compete?

Small farms have some clear ecological advantages over large farms, but will small farms of the future be able to compete economically? After all, the trend toward more specialized, larger farms has been driven by competitive forces of the market place. If the industrial era of human development were just beginning, or was even in its prime, there might be little hope for smaller *farms,* or smaller *firms* in general, into the foreseeable future. However, there is growing evidence that past trends toward larger, more specialized, industrialized enterprises are slowing, stopping, and even reversing.

Toffler, for example, observes that many forecasters simply present unrelated trends, as if they would continue indefinitely, while ignoring how the trends are interconnected or the forces likely to reverse them. He contends that the forces of industrialization have run their course and are now reversing. The industrial models of economic progress are becoming increasingly obsolete. Old notions of efficiency and productivity are no longer valid. The new "modern" model is not mass production, but to produce customized goods and services aimed at niche markets, to constantly innovate, to focus on value-added products and specialized production.

Toffler adds that "the most important economic development of our lifetime has been the rise of a new system of creating wealth, based no longer on muscle but on the mind" (p. 9). Further, he contends that "the conventional factors of production—land, labor, raw materials, and capital—become less important as knowledge is substituted for them" (p. 238). Toffler also provides some insights into the nature of knowledge-based production. He states that separate and sequential systems of production are being replaced with synthesis and simultaneous systems of production. Synergism is replacing specialization as a source of production efficiency.

The view that society has shifted to a knowledge-based order is shared by Drucker (1989), who subsequently dramatically describes the "sharp transformation" that has resulted in society (Drucker 1994). Reich—like both Drucker and Toffler—believes that power and wealth of the future will be created by mind work, rather than by routine production.

Drucker (1989) points out an important fundamental difference between knowledge work and industrial work. Industrial work is fundamentally a mechanical process, whereas the basic principle of knowledge work is biological. He relates this difference to determining the "right size" of organization required to perform a given task:

> Greater performance in a mechanical system is obtained by scaling up. Greater power means greater output: bigger is better. But this does not hold for biological systems. There, size follows function (p. 259).

It would surely be counterproductive, for instance, for a cockroach to be big, and equally counterproductive for an elephant to be small. Drucker concludes that differences in organizing principles may be critically important in determining the future size and ownership structure of economic enterprises. Other things equal, the smallest effective size is best for enterprises based on information and knowledge work. "'Bigger' will be 'better' only if the task cannot be done otherwise" (p. 260).

So what does all this say about the future of small farms? It says that farms of the future may need to be smaller, rather than larger, if they are to remain productive and competitive in the post-industrial, knowledge-based era of economic and social development. But if this is true, why are we currently seeing the rapid industrialization of some sectors of the agricultural economy?

Barker points out that new paradigms (including developmental models) tend to emerge while, in the minds of most people, the old paradigm is doing quite well. Typically, "a new paradigm appears sooner than it is needed [and] sooner than it is wanted" (p. 47). Consequently, the logical and rational response to a new paradigm is rejection. New paradigms emerge when it becomes apparent to some that the old paradigm is ineffective. Aging paradigms may also be applied in situations where they are ill suited, creating major new problems while contributing little in terms of new solutions. Industrial pollution of the natural environment is a prime example.

The industrialization paradigm appears to have outlived its usefulness, at least with respect to agriculture. This paradigm requires one to separate, sequence, analyze, and organize as a matter of standard operating procedure. Integration, simultaneity, synthesis, and spontaneity are missing from its problem-solving tool box. Thus, it automatically leads to specialization, never to synergism, as a logical solution, regardless of the nature of the problem. Consistent with this paradigm, problems caused by industrialization must be addressed by more sophisticated industrial methods, because there are no logical alternatives.

American agriculture provides a prime example of overapplication of the industrial paradigm. The early gains of appropriate specialization in agriculture lifted people out of subsistence living and made the American industrial revolution possible. But, the potential societal benefits from agricultural industrialization were probably largely realized by the late 1960s. More recent "advances" in agricultural technologies may well have done more damage to the ecologic and social resource base of rural areas than any societal benefit created by more "efficient" food production.

A new post-industrial paradigm for American agriculture is emerging under the conceptual umbrella of sustainable agriculture. The sustainability paradigm has emerged to solve problems created by the industrial model, primarily pollution of our environment and degradation of our natural resource base. This new paradigm seems capable of creating benefits the industrial model is inherently incapable of providing, such as greater individual creativity, dignity of work, and attention to social equity.

Concluding Comments

The potential "benefits" of small farms appear to outweigh the potential "costs" when viewed in a sustainable development context. Further, the characteristics of small farms seem to most closely resemble those of sustainable systems. This leads us to the preliminary conclusion that whether or not small is sustainable—a related issue, but not the primary focus here—small is more sustainable than large.

Although not dominant in production terms, small farms are numerically significant and an integral part of the rural community. Furthermore, small farms are consistent with both the Conway view of sustainability and the Holling view of sustainability. In general, they are not large enough to threaten the stability either of the system as a whole or of key components of the system. In contrast, the larger a farm, in general, the greater the geographic impact on the natural ecosystem, and therefore the more likely it is to interfere with ecosystem stability. It would be premature to conclude that *all* small farms are sustainable and *all* large farms are not; however, we should, at a minimum, recognize the existence of tradeoffs between size and efficiency *as currently measured* on the one hand, and sustainability on the other.

In the past, public policy has been the "villain" of sustainable development. In the future, policy needs to be virtuous instead. Changing from a commodity- or acre-based system to an ecological- or landscape-based system may be necessary to accurately capture the essence of the relationship between a farm and the ecosystem of which it is a part. After all, a major reason why agriculture has become viewed as unsustainable is because of the artificial separation between the farm and surrounding landscape bestowed by many years of pursuing an "industrialized" concept of agriculture.

The sustainable agriculture paradigm is also consistent with the visions of Toffler, Drucker, Reich, and others of a post-industrial era of human progress. Sustainable agriculture is management intensive and, inherently, information and knowledge intensive.

Complexity, interdependence, and simultaneity are fundamental elements of the sustainable model, which is clearly biological rather than mechanical in nature. For such systems, size must follow function. In biological systems, individual elements must conform to their ecological niche. Big farms will be sustainable only if their "niche" is equally large. It is readily apparent that many of today's large farms are degrading both the natural and human resource base as they have expanded beyond their ecological and societal niches. It will take "mind work," not physical or economic muscle, for farmers of the future to find a niche where they carry out their function by means that are ecologically sound, economically viable, and socially responsible. The vast majority of those niches will likely be smaller than today's "commercial-sized" farm.

Can small farms compete? Other things equal, the smallest effective size will be the most competitive size, for farms as for other information- and knowledge-based enterprises of the future. The logical future trends in U.S. agriculture will be toward smaller, rather than larger, farms as we move through the great transformation toward the post-industrial era.

We began this analysis by questioning what role farm structure plays in sustainable agricultural development. To more fully and conclusively understand the role of small farms in sustainable development, we should perhaps begin future work in this area by posing the question differently. For example, what is the best path to sustainable agricultural development? What characteristics must a farm possess for it to be sustainable? What is the optimal size farm—and how should size be measured—in the sustainability era? Can a farm that adopts sustainable practices be sustainable regardless of its size?

Such questions do not have easy answers. They do, however, reveal some of the shortcomings of this analysis and can guide further work in this area.

References

Alston, J. M., and W. J. Martin. "Reversal of Fortune: Immiserizing Technical Change in Agriculture." *Amer. J. Agr. Econ.* 77(1995):251–59.

Barker, J. *Paradigms: The Business of Discovering the Future.* New York: Harper Business, division of Harper Collins Publishing Co., 1993.

Bieri, J., A. de Janvry, and A. Schmitz. "Agricultural

Technology and the Distribution of Welfare Gains." *Amer. J. Agr. Econ.* 54(1972):801–08.

Blum, W. E. H. "Sustainable Land Use and Environment." Paper presented at the Symposium on Management of Land and Water Resources for Sustainable Agriculture and Environment, Indian Society of Soil Science, New Delhi, India, 1994.

Common, M., and C. Perrings. "Towards an Ecological Economics of Sustainability." *Ecological Econ.* 6(1992):7–34.

Conway, G. R. "The Properties of Agroecosystems." *Agr. Systems* 24(1987):95–117.

Drucker, P. *The New Realities.* New York: Harper and Row Publishers, Inc., 1989.

———. *Post-Capitalist Society.* New York: Harper Business, division of Harper Collins Publishing Co., 1994.

D'Souza, G., D. Cyphers, and T. Phipps. "Factors Affecting the Adoption of Sustainable Agricultural Practices." *Agr. and Resour. Econ. Rev.* 22(1993):159–65.

Eussiet, E. U. "A Comparison of Soil Degradation Under Smallholder Farming and Large-Scale Irrigation Land Use in Kano State, Northern Nigeria." *Land Degradation and Rehabilitation* 2(1990):209–14.

Glover, D., and K. Kusterer. *Small Farmers, Big Business.* New York: St. Martin's Press, 1990.

Ikerd, J. "Policy and Sustainable Agriculture." *Agr. Outlook* (January/February 1993):14–16.

Kuchler, F., and K. Ralston. "Impacts of Delaney Clause Ruling." *Agr. Outlook* (January/February 1993): 29–32.

Markandya, A. "Criteria for Sustainable Agricultural Development." In *Environmental Economics: A Reader,* eds., A. Markandya and J. Richardson. New York: St. Martin's Press, 1992.

Price, B. L. *The Political Economy of Mechanization in U.S. Agriculture.* Boulder CO: Westview Press, 1983.

Reich, R. B. *The Work of Nations.* New York: Vintage Books, Random House Publishing Co., 1992.

Thompson, E., Jr. *Small Is Bountiful: The Importance of Small Farms in America.* Washington DC: American Farmland Trust, 1986.

Tisdell, C. A. *Economics of Environmental Conservation.* New York: Elsevier Science B.V., 1994.

Toffler, A. *Power Shifts.* New York: Bantam Books, 1990.

U.S. Department of Agriculture, Economic Research Service. *Economic Indicators of the Farm Sector: National Financial Summary, 1991.* USDA/ERS, Washington DC, 1992.

U.S. Department of Commerce, Bureau of the Census. *Statistical Abstract of the U.S.* Washington DC: Government Printing Office, 1994a.

———. *1992 Census of Agriculture: U.S. Summary and State Data.* Washington DC: Government Printing Office, 1994b.

Valdes, A., G. M. Scobie, and J. L. Dillon, eds. *Economics and the Design of Small-Farmer Technology.* Ames IA: Iowa State University Press, 1979.

Weatherspoon, D. D. "Industrialization and Sustainable Development: Are We Ready? Discussion." *J. Agr. and Appl. Econ.* 27(1995):39–42.

Wharton, C. R. "Subsistence Agriculture: Concepts and Scope." In *Subsistence Agriculture and Economic Development,* ed., C. R. Wharton. Chicago: Aldine Press, 1969.