# Post-Industrial Agriculture

by Luther Tweeten and Carl Zulauf

The "industrialization of agriculture" has become a catchall phrase to describe a set of changes occurring in agriculture during the 1990s (for example, see Boehlje and Drabenstott). These changes feature large-scale production and marketing units characterized by mass production, vertical coordination, and specialization. We, however, contend that the current changes result mainly from post-industrial factors rather than from industrialization. Viewing the current changes in agriculture through the prism of post-industrialization rather than through the prism of industrialization leads to a richer understanding of the emerging economic and social trends within the sector. After briefly stating our case for a post-industrial perspective, we highlight some key economic and social implications.

## Industrialization versus post-industrialization in agriculture

Industrialization is closely related to "Fordism," referring to large-scale mass production of homogeneous products for a mass market (Kenny et al., p. 135). Agribusiness input supply and marketing sector firms, as well as crop and livestock farms, not only are becoming larger, they are adopting key industrial manufacturing concepts of systemization, routinization, concentration, and specialization (see Boehlje). However, modernization is more a manifestation of the application of science and technology than of industrialization.

The term "post-industrial" traces to Daniel Bell's 1973 book *The Coming of the Post-Industrial Society: A Venture in Social Forecasting*. Bell noted the rise of service industries and argued that "The critical person is the professional, for he [she] is equipped, by his [her] education and training, to provide the kinds of skills which are increasingly demanded in the post-industrial society." Delauney and Gadrey expressed a similar view when they observed that knowledge is the essence of post-industrial society and that "scientific knowledge, the basis for innovation, becomes the ultimate strategic resource." In short, a post-industrial society is based on knowledge embodied in education, science, and technology.

A post-industrial knowledge-based economy also is recognized for a preponderance of service industries and occupations. Services account for approximately 75 percent of all jobs and 90 percent of new jobs in the United States. In a post-industrial economy, service activities are critical even in primary extractive and manufacturing industries such as agriculture and agribusiness. For example, farm operators and spouses are spending a smaller proportion of their time in the field, barn, or shop, and a larger proportion of their time in service activities, such as information gathering, management, marketing, finance, and asset acquisition.

Given this perspective, our argument for a post-industrial view of agriculture traces to the seminal work of T.W. Schultz and his disciples. They recognized that the massive productivity gains in farm output that began in the 1930s were due to the

nonconventional or knowledge inputs of education, research, and extension. These nonconventional inputs were embodied in new inputs such as hybrid seeds, as well as in traditional inputs such as fertilizer and mechanical implements. In fact, agriculture is one of the first post-industrial sectors: scientific principles, often generated by land grant colleges, formed the basis of a new agriculture.

To illustrate the impact of these nonconventional inputs, in 1997 the U.S. harvested 9.4 billion bushels of corn from 73.7 million acres. To produce that output using the technology of the 1920s, 350 million acres would be needed, or almost as much total cropland as the U.S. harvested in 1997. This increased production did not come about because of systemization, routinization, and specialization of 1920s technology, but because science created and applied knowledge to develop new technologies. Furthermore, the farms and agribusinesses that survived and prospered were those which excelled at acquiring, evaluating, and adopting these new technologies and their imbedded information.

We end this brief overview by summarizing the key differences between industrial and post-industrial agriculture:

### Prominent characteristics of agriculture viewed from industrial and post-industrial perspectives

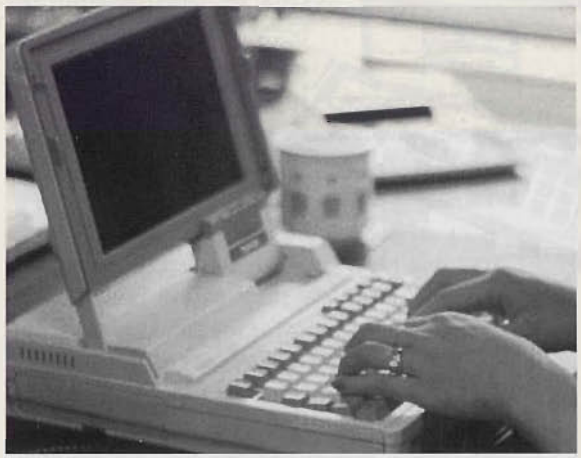
*Industrial*
- Large-scale (often factory) farms
- Mass production (routinization)
- Specialization by enterprise and job
- Concentration of crop or livestock enterprise within firms and regions
- Differentiation (separation of labor, management, capital)
- Vertical coordination

*Post-industrial*
- Knowledge-based (evident in education, science, and technology)
- Focus on service activities (marketing, management, finance, etc.)
- Importance of information systems
- Specialization by service
- Importance of niche markets
- Institutional interactions (taxes, environmental programs, etc.)

## Implications

Mastery of service activities will determine whether farm and agribusiness managers will succeed or fail financially. Provision of applied economic and agribusiness skills and analysis will be critical service activities. A post-industrial agriculture has the following implications, among others, for service activities in general and economic and business service activities in particular.

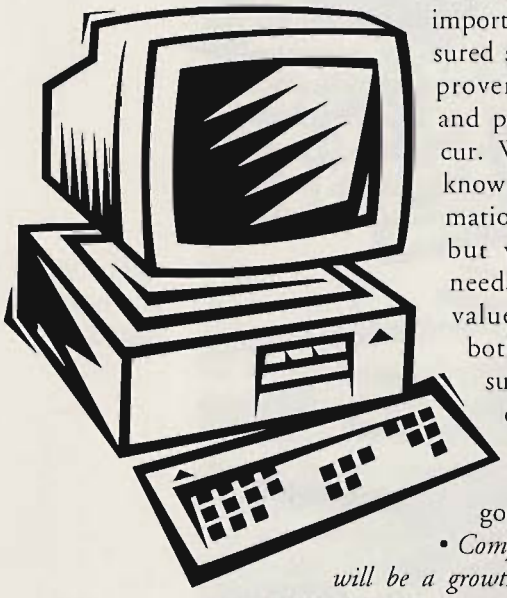
• *The growing importance of information services means that productivity growth in information generation and management will need to improve in order for overall productivity growth in agriculture to improve.* Services have a reputation for slow productivity growth, but the record is mixed. For example, the performance of common schools has been especially disappointing: while achievement tests indicated declining performance of common school graduates from 1960 to 1990, real schooling costs were rising on average 3.9 percent per year (Hanushek). Performance of agricultural research has been better, with aggregate crop and livestock output increasing over 2 percent per year since 1960 and rates of return on agricultural research (and extension) investments typically ranging from 30 to 50 percent (see Tweeten and Zulauf, p. 269). While agricultural research and extension output has had a high payoff to society, the output of services per scientist per year probably has increased slowly.



A full treatment of how to improve service productivity is too large a topic to treat adequately here, but it is appropriate to begin by pricing information services at their marginal cost where possible. For example, tests showed that students at Oklahoma State University learned as much from principles of economics courses taught by television as by a live professor. Television teaching was discontinued because students said they preferred to be taught by a live professor. But students were not charged marginal costs—if they had been, low-cost television teaching might have had great appeal and increased the productivity of educational services.

• *Contributions to productivity of major technological innovations in service activities are difficult to measure, but measurement of information productiv-*

*ity will be a major preoccupation in the future.* The computer provides an example. Despite a virtual explosion in computer use in the latter half of the 1960–96 period, output per hour of U.S. workers increased only 1 percent annually from 1978 to 1996 after increasing 3 percent per year from 1960 to 1978 (Council of Economic Advisors, p. 338). Assuming that firms are making rational decisions regarding the adoption of computers, the above data raise doubts regarding the measurement of outputs and/or inputs. We predict that as information grows in importance, a prominent activity of managers will be the measurement of information inputs and outputs. This prediction follows from management guru W. Edward Deming's core observation that, if something is important, it needs to be measured so that continuous improvement in productivity and product quality can occur. We do not pretend to know how to measure information service productivity, but we offer that output needs to account for the value of information for both production and consumption. For many operators, the computer is both a production and consumption good.



• *Computer-based expert systems will be a growth industry.* Information overload causes low information productivity. The generation of new information is accelerating (Zulauf and Meir). Each new piece of information is a double-edged sword: it can help to better manage existing resources, but it may also cause confusion. Computer-based expert systems can handle large amounts of information. They can help sort worthwhile information from the bewildering flood of information available on the Internet and elsewhere. Expert systems are already available to lawyers, doctors, and architects. Existing tax software is a low-level example of expert systems for businesses. Expert systems will not eliminate the human factor in sorting worthwhile information, but they will allow us to codify the best attributes of humans for handling and analyzing information.

• *The forces for change in a post-industrial economy will make for fewer and larger firms in a given market activity, but a richer array of firms engaging in a wider array of activities.* Ability to allocate time properly among production activities and the varied finance, real estate, tax, management, risk strategies, and other information- (knowledge-) intensive services will be critical to a firm's economic vitality. Furthermore, the high fixed costs associated with gathering, organizing, and analyzing information must be averaged over a large output for a firm to be competitive. The specialization of firms, and the associated hiring of needed services, enhances opportunities to capture the full effect of unique abilities and to achieve economies of scale and scope in handling information. Thus, fewer firms will provide a given product or service, but more products and services will be provided, causing the total number of firms to increase.

• *Time management will become very critical for farmers and other agribusiness managers.* For farmers and other small business operators, information management competes for time working in the field, barn, or shop. Even using computerized information services, acquiring information for an efficient-size farm (firm) often will require a full-time information specialist. To efficiently use time, valuation of the benefits and costs of hired services will become an important management function for farmers and small agribusiness managers. Another emerging trend shows large family farms operating as partnerships, for example, one individual responsible for marketing, another for livestock, another for crop technology, another for financial records and arrangements, another for machinery, and another for strategic planning. In contrast, opportunities for small farms to be economically viable without off-farm earnings will narrow.

• *Input suppliers, marketing firms, cooperatives, and integrators will supply some farm information needs for no or nominal direct charges as an enticement to use their products.* The bundling of information services and physical products will grow in importance, and this presents an alternative to extension agents and consultants as sources of advice. Vertical coordination, especially production contracts and integrated ownership, provides another avenue for the management of information. Producers and growers enter into production contracts partly to reduce risk and capital requirements, but also to gain access to veterinary, marketing, and organizational management services. Integrators gain economies of size and control over the production process and its end products. Producers gain access to information because economies of size and scope make its acquisition more affordable. However, even integrated operations will utilize consultants. These trends call for continuing adjustments in the role of extension in agriculture as noted below.

• *Information quality is a potential problem for users of information services.* Users may only belatedly discover that information sellers have peddled unreliable data. The objective evaluation of the accuracy of private information sources is a poten-

tially important future activity for the Cooperative Extension System, a service it already provides in many states (through varietal seed trials, for example). This and the proceeding point underscore the ongoing challenge of finding the appropriate mix of private and public information services.

• *More research in agriculture will shift to the private sector.* The pivotal role of knowledge and science will increase the private economic value of knowledge creation and dissemination, other things being equal. Firms will be able to capture more economic benefits from research than in the past because of a broadening definition of intellectual property rights. Activities once deemed as basic research and public "goods" are increasingly reclassified as business research and development.

Even information services which fail the test of being a market "good" (rival, exclusionary, and transparent) will be provided by private firms, although probably at a less than socially desired level. The fast pace of innovation will allow firms to capture "nonexclusionary" monetary rewards before their competitors can catch up. In other cases, firms will be large enough to capture favorable payoffs solely within their own operations, knowing they cannot recoup development costs by selling a nonexclusionary improved livestock or seed variety in the marketplace. Biotech firms will virtually integrate to realize benefits of their research even without patent protection.

The traditional argument for public research will continue to be valid in certain instances; however, the share of goods that can be classified as public goods is falling. As a result, land grant colleges will have a tougher time competing for and justifying public dollars for agricultural research, causing the nature of research at land grant colleges to change. Public universities will perform more research paid for and utilized by private firms, raising issues of conflict of interest and crowding out basic public research. While large farm and agribusiness firms will do more of their own research, smaller firms will continue to seek research output from land grant colleges and other public institutions. But the case for assisting smaller firms will diminish along with their economic power.

• *While many research and extension activities will migrate to the private sector, universities will continue to remain key centers of education, especially for young adults.* The virtual university and its potentially low marginal cost of delivery will stiffen the competition for *in-situ* education providers. However, we believe that universities will rise to the challenge by emphasizing their advantages in providing the human interface elements of education, such as the transmittal of life-long learning and research skills. In addition, universities provide a more disciplined system of education for those not yet ready to handle the free-form, self-motivated strictures of the virtual university.

## Twenty-first century managers

The destiny of agriculture and agribusiness rests with managers who will spend much of their time pursuing knowledge by first acquiring, then evaluating, and, eventually, integrating information into their business operations. Essential finance, management, and marketing skills can be taught in colleges of business as well as agriculture. Nonetheless, production skills cannot be ignored. That is why colleges of business are less qualified than colleges of food, agriculture, and natural resources to serve the needs of the post-industrial agricultural complex and, thus, determine who will guide it in the twenty-first century. ■

## ■ For more information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