INDUSTRIALIZATION OF AGRICULTURE

What are the Implications?

by Michael Boehlje

The agricultural sector, particularly the livestock industries, are in a period of major change and transition. This transition is commonly referred to as the industrialization of agriculture—the application of modern industrial manufacturing, production, procurement, distribution, and coordination concepts to the food and industrial product chain. Since Tom Urban popularized this term in an often-cited article in *Choices*, many have asked what industrialization portends for the future. The past history of this transformation in other natural resources and manufacturing industries suggests some of the future changes in agriculture.

In contrast to the old agricultural system, the new industrialized agriculture moves more toward *(a)* manufacturing processes, *(b)* a systems approach to production and distribution, *(c)* separation and realignment of the stages in the food chain, *(d)* negotiated coordination among those stages, *(e)* new kinds of risk, *(f)* concerns about system power and control, and *(g)* a more important role for information.

Manufacturing processes

Manufacturing food products versus producing commodities. Much of agriculture is changing from a commodity industry to one with differentiated products. The "produce-and-then-sell" mentality of the commodity business is being replaced by the strategy of first asking consumers what attributes they want in their food products and then creating or manufacturing those attributes in the products. This may in fact require changes in how the raw material is produced (free-range chickens, for example) and what it doesn't contain (chemical residues, for example) as well as what it does contain.

Systemization and routinization. The manufacturing process systemizes and routinizes. With increased understanding and ability to control the biological production process, routinization becomes increasingly possible. Tasks become more programmable. For example, hourly work schedules are now being used in some of the modern hog farrowing and finishing barns. Routinization generally fosters more efficient use of both facilities and personnel as well as less managerial oversight and overhead. In essence, agricultural production is becoming more of a science and less of an art.

Specialization. Business firms and individual employee tasks are now more specialized. This specialization facilitates systemization and routinization and can result in significant gains in efficiency and reduce costs.

Scheduling and utilization. Manufacturing processes in agricultural production and distribution will increase emphasis on facility utilization, flow scheduling, and process control. Many production units maintained excess plant capacity in the past to accommodate the uncertainty of the biological production processes. But again, as a result of their increased ability to predict and control those processes, managers can more accurately predict and control facility use.

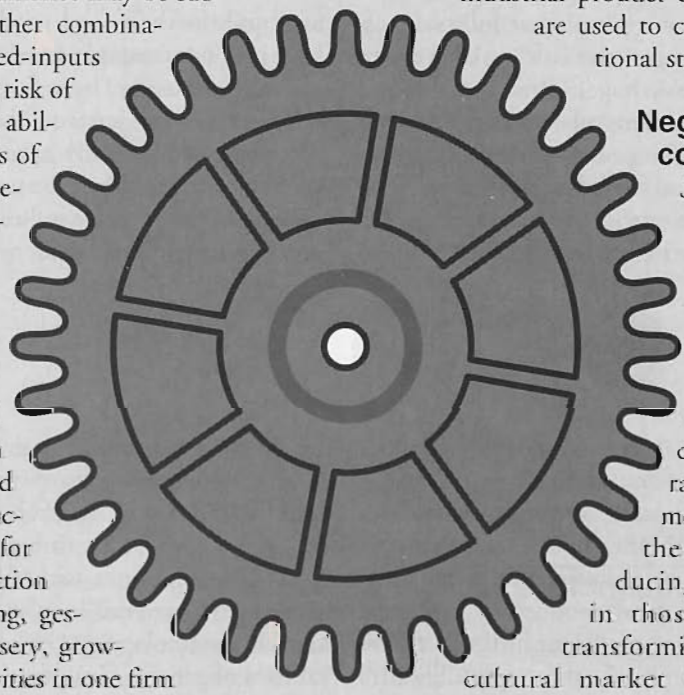
A systems approach

Systems/process flow. The manufacturing process places increasing emphasis on the entire food system or value chain from raw materials supplier to end-user. This system, rather than stage or segment focus, reduces the chances for inefficiencies or losses because stages are not well matched in terms of product flow, characteristics, quality, or other critical attributes.

Systems cost. Although cost control is critical in any production system, the manufacturing approach recognizes that the total production and distribution systems costs are more critical than the cost in

each individual stage. Firms frequently purchase more of their inputs so that a higher proportion of costs become variable. Firms with a higher proportion of variable costs are more responsive to changing market conditions.

Input packages versus mix and match strategies. Producers will increasingly use inputs that match chemical and biological attributes to obtain the optimum quality and characteristics of output. For example, biotechnologists and chemists have jointly developed plant varieties and herbicides to better control weed problems. In some cases the producer will purchase input packages for their combined biological and chemical effectiveness; in other cases the producer will be warned that certain nutritional and genetic inputs respond better when used together and their performance may be suboptimal if used in other combinations. But this matched-inputs strategy has risks—the risk of reduced flexibility and ability to adjust if supplies of a required input decrease and/or prices increase.



Separation and realignment

Separation of production stages. The old methods of production agriculture combined various stages of production within one firm; for example, swine production combined the breeding, gestation, farrowing, nursery, growing, and finishing activities in one firm at one location, and integrated these activities with feed production and processing. The new industrialized swine operations separate the ownership, operation, and geographic location of many of these stages of production. Production agriculture outsources more assets; for example nonoperators own 41 percent of the farmland today compared to 22 percent in 1945. Geographic and stage separation, in turn, frequently implies larger scale and more specialized capital, labor, and management resources at each individual plant site or facility location. Implications of separation for flexibility are unclear; more specialization in resource use decreases flexibility, but participation in only one stage may increase the options for negotiating with other partners in other production/distribution systems if other systems are in the market.

Partnering and alliances. At the same time that industrialization is separating the ownership, operation, and location of various production activities, industrialization also links these activities with new alliances. Increasingly, producers partner with other resource suppliers in various ways to expand volume with limited capital outlays. In livestock production this phenomenon often occurs through contracting arrangements; a hog integrator may own the breeding, gestation, and farrowing facilities but contract out the nursery and growing phases. In essence the integrator leverages volume by investing funds in only part of the total fixed assets needed to produce hogs while maintaining a high degree of control over the other phases through the ownership of the livestock and the specification of the growing conditions. More resources and services are outsourced, and more linkages up the food or industrial product chain to the end-user are used to capture value in additional stages of the chain.

Negotiated coordination

Spot markets. Production agriculture in the past has focused primarily on commodity products with coordination through impersonal spot markets. The increased specificity in raw material requirements combined with the potential for producing specific attributes in those raw materials is transforming part of the agricultural market to a differentiated product market rather than a commodity product market. Examples include waxy maize, white corn, high oil content soybeans, high protein wheat, free-range chicken, and antibiotic/chemical-free beef. The need for greater product diversity and more exacting quality and flow control will tax the ability of spot markets to coordinate production and processing effectively. Open spot markets often cannot adequately convey information about the quantity, quality, timing, and other product characteristics wanted by users.

Information flows. Spot markets also convey information more slowly and less effectively. In general, negotiated coordination results in more rapid transmission of information between the various economic stages and helps insure that the system adjusts to changing consumer demands, economic conditions, or technological improvements.

This ability to respond quickly to changes in

the economic climate is critical to maintaining profit margins as well as extracting innovator's profits. Likewise, quick adjustment to erroneous decisions helps assume survival and success.

Risk

Sources and strategies. Industrialization of agriculture is both a result of and has implications for the business strategies that will be used to reduce risk. A common business strategy of "industrialized" firms reduces the risk of high input prices by contracting for supplies. A related strategy reduces the risk of low product prices by contracting product sales. Some firms reduce price risks by vertically integrating into the input supply or product distribution channels.

Food packaging and processing unit costs have become very sensitive to operating at full plant capacity. Integration reduces the risks of uneven input flows (for example, hog finishing capacity is better matched with packing plant kill capacity, or turkey grower space with processor dressing capacity). Furthermore, some food distribution channels may require particular quality characteristics which may not be available in predictable quantities in open spot markets.

Increased concerns about food safety and health also add risk to the production process. This risk has two dimensions: the health risk of foodborne disease; and the risk of polluting water, air, and land resources in the food production processes. These risks can result in significant direct costs and liability exposure for not only the responsible firm in the food chain, but also for firms that supply related inputs and purchase products from the "responsible" firm in the case of strict (joint and severable) environmental liability related to chemical use. Thus, system coordination and trace-back capacity to reduce or control these risks may be, in part, a response to the broad sweep of product and environmental liability law.

Relationship risk. The expanding use of contractual and other forms of negotiation-based linkages, and the decline in impersonal market-based transactions, reduces price and other risks but increases relationship or contractual risk. For example, the financial failure of a turkey processor is a significant risk for the contract turkey grower.

Niche market. Segmented or niche markets for some food and industrial-use products can appear and disappear rapidly. For many agribusiness firms in the food processing and distribution business, the risk of changing consumer preferences or a food safety scare may be more important than the risk of price variability. Contractual arrangements to source raw materials reduce price and availability risk as well as food safety risk from chemicals, and simultaneously obtain the attributes needed in the final product from the specific-attribute raw material.

Power and control

Position power. Traditionally, concern about power or control in an economic system has focused on monopoly or monopsy power. The increasing importance of information in economic decision making combined with more negotiated coordination systems may also lead to market power.

Points of control. Consumers now choose their foods more carefully, want a broader spectrum of attributes in their food products, and increasingly have the purchasing power to convert wants into effective demand. Those firms that are close to the end-user and understand the increased specificity of consumer demands have a unique capacity to communicate and/or dictate those demands to the rest of the production and distribution chain.

Raw materials suppliers maintain the second point of control. But not all raw material suppliers have the same degree of power and control. In essence, the relative control of raw material suppliers depends upon the substitutability of other inputs. The one input with the fewest substitutes is the genetic material in plant and animal production. Biotechnology and increased predictability and control of genetic manipulation provides additional power to those who control genetic material.

Knowledge and information. Note that the points of control in the agricultural production and distribution chain are at the beginning and the end—the genetics and the end-user/consumer. The source of this control is knowledge in both cases. By the very nature of their business, retailers or food processors and genetics companies have better access to information, and, with this information, more control over prices and production.

The role of information

An increasing role. Knowledge and information have become increasingly important resources. Manufacturing food and industrial products has become more complex, and those who understand this complexity will have a comparative advantage. They must be able to sort through huge amounts of new chemical, biological, and other information and put

it to practical use.

Access to information. Historically, both public (extension services, universities, government agencies) and private sources (genetics and chemical companies, feed companies, machinery and equipment manufacturers, packers and processors) provided information to producers. In contrast, many of the new integrated firms or alliances of firms have internal research and development staffs to enhance their knowledge and information base. And the knowledge they obtain is obviously proprietary and not shared outside the firm or alliance; it is a source of strategic competitive advantage.

Integrated systems. The research and development activities in coordinated systems focus more on total system efficiency and effectiveness than on individual components of that system; they focus on *integrating* the nutrition, genetics, building and equipment design, health and disease control programs, and marketing strategy rather than on improving these production and marketing components separately. And in addition to more effective research and development, such alliances or integrated firms have the capacity to implement technological breakthroughs more rapidly over a larger volume of output to obtain larger innovator's profits.

The expanded capacity of integrated systems to generate proprietary knowledge and technology and adopt it rapidly enables the participants in that system to more regularly capture and create innovator's profits while simultaneously increasing control and reducing risk. This provides a formidable advantage to the ownership/contract coordinated production system.

Public policy. As more of the research and development comes from private sector firms, and more of the information dissemination system becomes privatized, individual firms have more potential to capture value from information and have a sustainable competitive advantage. They may, in order to enhance their own profits, restrict access to new ideas and information to particular users. The concepts of intellectual property rights, including patent and copyright law as applied to agriculture, were developed in an era of domestic markets and national firms; a relatively large public sector research, development, and information dissemination system; and a limited role of information as a critical resource. These intellectual property right concepts should be reevaluated in the current context of global markets and multinational business firms, the shrinking role of the public sector in research and development and disseminating information, and the increasing importance of information compared to other resources as a source of strategic competitive advantage.

Dramatic change ahead

The structural changes that will occur within the agricultural sector over the next decade will be profound. These changes will include both technological innovations and institutional innovations. Production agriculture has readily accepted technological innovations; farmers have generally been eager to try new hybrids, new chemicals, new tillage practices, new feeding regimes, and new equipment. Institutional innovations or new ways of doing business have met with more resistance, possibly because they change relationships and frequently substitute interdependence for independence in the decision-making process. But the economic benefits of the combined technological and institutional innovators will likely result in a rapid movement of the livestock sectors (particularly pork) followed by the grain sectors to an industrial model of production and distribution. ◘

■ For more information

Barry, P. "Industrialization of U.S. Agriculture: Policy, Research and Economic Needs." *Agr. and Resour. Econ. Rev.* 24(April 1995):128–35.

Drabenstott, M. "Industrialization: Steady Current or Tidal Wave" *Choices*, Fourth Quarter 1994, pp. 4–8.

Goldberg, R. "New International Linkages Shaping the U.S. Food System." *Choices*, Fourth Quarter 1993, pp. 15–17.

Hurt, C. "Industrialization in the Pork Industry." *Choices*, Fourth Quarter 1994, pp. 9–13.

Urban, T. "Agricultural Industrialization: It's Inevitable." *Choices*, Fourth Quarter 1991, pp. 4–6.

Michael Boehlje is professor in the Department of Agricultural Economics at Purdue University.