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Industrialization of U.S. Agriculture: Policy, Research, and Education Needs

Peter J. Barry

The industrialization of agriculture refers to the continued consolidation of farms and to the growing use of production and marketing contracts and vertical integration among input suppliers, lenders, agricultural producers, processors, and distributors of food and fiber products, domestically and globally. Industrialization is strongly affecting the structure and performance of farms and agribusiness firms; the distribution of risk, returns, and the ownership and control of resources in the food and fiber system; locations of production; competitiveness in international markets; the effectiveness of agricultural policy; business activity, income, family welfare and employment in rural communities; and environmental quality and control. Research is urgently needed to measure these effects, understand the complex underlying factors, and evaluate policy alternatives that influence and are influenced by the industrialization of agriculture.

The industrialization of agriculture refers to the increasing consolidation of agricultural production units, and to vertical coordination (contracting and integration) among the stages of the food and fiber system. Increasing industrialization of the food and fiber system in the U.S. is profoundly affecting the system's market, financial, and ownership structures, as well as overall economic performance. Dairy production, seed, commercial fruits and vegetables, turkeys, eggs, and broilers have long experienced some form of vertical coordination. For pork and beef, contract production between feeders and processors has grown rapidly to about 15 to 20 percent of total production. Further reductions in government programs for farmers (i.e., contracting with the federal government), along with processor interest in specific input characteristics, will bring greater coordination to crop production as well.

Consolidation and coordination are not new developments. R.L. Mighell and L.A. Jones, and Harold Briemyer were leaders in identifying and analyzing these structural issues. The topic has received substantial attention over the years (e.g., Marion; Sporleder; Reimund et al.; Kilmer; Schraeder; Who Will Control . . . ; U.S. Depart-

ment of Agriculture; Office of Technology Assessment; Hurt et al.; Manchester; Rhodes). However, the current developments represent some major changes in motivation and direction for the organization of the agricultural sector. The implications for the design of research and education programs in the USDA/Land Grant system are significant. Various analysts have addressed these recent developments, including the recently formed Council on Food, Agricultural, and Resource Economics (C-FARE). C-FARE's goal for this topic is to highlight the important features of the industrialization process, and to inform the professional leaders of other agricultural disciplines, administrators, and policy makers about the need for the research, education, and policy agendas to more directly reflect the industrialization issues. Included among C-FARE'S recent activities have been the publication of a white paper on the industrialization topic; sponsorship in May 1994 of an Industrialization of Agriculture symposium in Washington, D.C.; distribution of the symposium proceedings; and communication with the priority setting processes of the U.S. agricultural research and education system.

In this article I will draw upon the materials and results of the C-FARE initiatives to identify the forces at work in the industrialization process; show their relationship to current agricultural, resource, consumer, and rural development issues; and summarize the implications for research and education.

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Structural Change in Agriculture

Structural change is a dynamic characteristic of U.S. agriculture. Structure generally refers to patterns of (Penn; Hallam):

- Resource control
- Resource organization
- Size configurations
- Legal forms of business organization
- Risk sharing arrangements
- Ease of entry
- Manner of wealth transfer to succeeding generations
- How firms acquire their inputs and market their products
- The scope and boundaries of a firm's operations

The last two points (market relationships and firm boundaries) involve the vertical alignment of firms within the food and fiber system. These points have been prominent features of structural change and increasing industrialization of U.S. agriculture in the 1990s. They are the focus of the following discussion of vertical coordination, although many of the other structural features are also involved.

Concepts of Vertical Coordination

Historically, open markets with clear price signals for traditional commodities linked together input suppliers, farmers, processors, distributors, retailers, and consumers. However, the open market system has increasingly given way to hybrid arrangements involving different contractual arrangements among these stages and to vertical integration in which two or more stages are controlled by a common entity. Moreover, these arrangements often extend across international borders. In reality, the arrangements yield nearly a continuum of coordination possibilities, rather than a discrete set (Mahoney). Joint ventures, strategic alliances, informal consortia, cooperatives, franchises, and other organizational arrangements characterize the range of options.

The conceptual framework for addressing these developments has experienced transition as well. The focus has expanded from the conventional theory of markets, prices, and levels of competition predicated on a firm's production function, a consumer's utility function, and market power to include the economics of organizations. In the new economics of organizations framework, the minimization of transaction and agency costs along with incentive and information effects determine

the optimal governance structure across stages of a system, and thus the ultimate boundaries of firms (Barry, Sonka, and Lajili; Sporleder). The work of Ronald Coase, Oliver Williamson, Michael Jensen and William Meckling is in the vanguard of these theoretical developments. Included as components of the economics of organizations are asymmetric information, misaligned incentives of principals and agents, opportunistic behavior, asset specificity, uncertainty, completeness of contracts, and performance monitoring. A substantial literature has developed to further enrich and test the economics of organization framework (e.g., Mahoney; Milgrom and Roberts), and evaluate its relationship to other concepts of vertical coordination, including market power phenomena discussed in the next section.

Power Balance and Imbalance

A less understood factor in the industrialization of agriculture is the balance of power among units in the vertically sequenced food and fiber system. Often, integration seems to reflect the mutual consent of equals in a case of "bilateral negotiation." In fact, however, the restructuring of the food system is not the coordination of units at similar levels of power. Rather integrators and integratees have different degrees of power. In poultry (perhaps the most mature "industrialized food sector"), the integrator was always a large, powerful firm—typically a feed company in the early days of transition. In the later days of the transition, the integrator typically has been a poultry meat product marketer. Only a few parts of the sector were integrated early in the transition—production inputs (feed, pharmaceuticals, disease control, etc.), production, and assembly. The feed company could effectively coordinate those parts. Later in the transition, marketers of poultry meat products and exporters integrated the earlier set of activities as well as genetics, hatching, slaughter, packaging, and marketing.

The integrational theme in the poultry experience changed as time passed, becoming more comprehensive and complex. The motivation of the theme—whether arising from improved production technology, marketing strategy, or simply potential synergism—armed the integrators with power. Integratees then are given a choice involving a share in the benefits of the system in exchange for a loss of freedom in action. There is probably a hierarchy of themes, although the order of the hierarchy is difficult to identify. Marketing themes may be superior to production oriented or financial themes. The really large systems in the food in-

dustries (Nestle, Philip Morris, etc.) tend to be marketing firms. They buy and sell production technology as needed, while the reverse is less frequently observed. In addition, strategic management in the large food conglomerates tends to be in the marketing function rather than production. Upstream experience is not as crucial for executives as downstream experience.

The traditional focus on the theory of the firm in a market setting and on changes in consumer demands is largely unable to explain or predict the coordination/integration process as a consequence of the balance of power. Even the study of market structure has been limited in breadth—mostly, although certainly not completely, focused on monopolization. Some work has been directed at studying the behavior and motivation of large food industry firms. Galbraith's *New Industrial State* portrays the characteristics and behavior of a manufacturing firm which chooses to emphasize development and introduction of new products—including this firm's tendency to abstract itself from the market. Handy and Padberg applied this pattern in the food industry where the stage must be shared with large integrative firms in distribution as well as manufacturing. Using material adapted from Porter, Marion and co-workers reflected in his book have further developed Strategic Groups in the food industry which describe some of the major themes. In setting out the development stages of the food manufacturing and distribution sectors, Padberg and Rogers identify the important themes. Management case studies have also elaborated various themes in analyses of strategic management. The Harvard Business School case study of Grand Metropolitan provides an excellent discussion of the theme which likely stands at the top of the hierarchy for food industry management, as well as suggesting a pattern of relative strengths for the components of the coordinated system.

Recent Developments in Vertical Coordination

The recent growth in vertical coordination in agriculture is attributed to a complex set of domestic and international factors (Barkema and Cook, 1993a and 1993b; Barkema, Drabenstott, and Welch; Schertz and Daft):

- Changes in consumer characteristics
- Institutional change in the food system
- New technologies in production
- Growing importance of information
- Quests for efficiency

- More effective risk management
- New financing arrangements

Major changes in consumer characteristics have reflected accelerated lifestyles, nutrition and health awareness, needs for greater convenience, and a more diverse population (Senauer, Asp and Kinsey). These changes have led to a widening variety of food products, and greater emphasis on targeting food products to clearly defined market niches. Greater emphasis by retailers and processors on quality-related specifications of agricultural production also is occurring.

Large, multi-national food manufacturing conglomerates play a major role in influencing consumer demands (Padberg). They contract extensively with agricultural producers, develop and implement new technology, introduce new products, engage in major advertising programs, seek feedback from consumers through focus groups and other means, and influence private label products produced by many smaller firms. Their size and expertise in food and communication technologies give them a significant leadership role. Wholesale and resale distributors also exert significant influences in a vertically coordinated food system.

To a large degree, consumer preferences and needs for food products and services, aided by these food testing activities of processors and nutritional labeling regulations, have become more specific than traditional price signals in open markets can convey. Greater emphasis on contracting and vertical integration is one approach to more effectively transmit consumer preferences throughout the food system, and ensure that product specifications coincide with these demands.

Advances in technology have enabled the broiler industry, the pork industry, and other agricultural sectors to better tailor production to new consumer characteristics through various types of contractual arrangements. In the case of pork, the product engineering process begins at the hog production level. Improvements in measurement techniques, quality control, health systems, reproductive technologies, nutrition, and other computer-based technology have led to consistently leaner, more uniform, and similar sizes of animals (Barkema and Cook, 1993a). These new technologies are leading to further economies of size in livestock production. Even some technologies considered "size neutral" (e.g., growth hormones) are more likely to be used effectively by larger producers with more sophisticated production and management systems. These developments are spurring the trend toward fewer, larger farms, and more

concentrated production (Barkema and Cook, 1993a).

The products from increasingly large-scale farms and feeding units are carried through food processing systems that are striving to improve efficiency and productivity in their operations. Closer linkages with fewer suppliers, who provide products with specific attributes, is one means of achieving greater efficiency. Contract production and other forms of vertical coordination are intended to accomplish these goals. It is more efficient for processors to have a few contracts with large producers than many contracts with smaller producers, although excessive contract concentration could be risk increasing (Barkema and Cook, 1993a).

Greater globalization in agricultural production and trade is also bringing increased emphasis on contracting and integration. Processors need a steady supply of known inputs to consistently utilize their plants at optimum capacity and to seek expansion in product markets, both domestic and international markets. They must also deal with high fixed costs and inflexibilities in scheduling related to wage contracts and broader based distribution plans. Fewer sources of supply resulting from consolidation will increase the importance of continuous marketing relationships with large producers. Some types of risk (e.g., price risk, production variability) may decrease while others, associated with increased size and specialization, will increase. The latter effects will reflect high capitalization requirements, specialized assets, higher and more rigid labor and management compensation, and reduced flexibility in production plans. These increased risks are contributing to a more coordinated market structure.

Financing requirements for acquiring capital assets, operating inputs, managing inventories, and other purposes also are influencing vertical coordination (Barry, Sonka, and Lajili). Contract production is characterized by a shift of ownership and financing of operating inputs and the related production and marketing risks from the grower to the contractor. In turn, ownership and financing for buildings and other capital assets remain with the grower.

The reductions in production and marketing risks help to secure longer-term financing for growers. However, both lenders and borrowers may experience new uncertainties about the length and other terms of the contractual relationship, and about arrangements for dealing with disputes, quality problems, legal liabilities, and other contingent events. The larger size and greater risk bearing ability of most contractors give them easier

access to larger lenders in domestic and international financial markets and to other sources of equity capital. Some contractors may even provide financing directly to growers. In general, the options in vertical coordination interact with the costs and availability of financial capital to determine the ultimate patterns of coordination.

Implications for Agricultural Producers

Industrialization and the related vertical coordination will increasingly extend into agricultural production. Increasing consolidation of production units will occur as well so that vertical coordination and horizontal integration are closely linked. These developments will result in changes in the optimal boundaries of farms, more centrally controlled coordination within the food system, and the emergence of new signals from food processors, input suppliers, and other contracting entities that will change the optimal output mix of production units (Cook, C-FARE 1994b). Geographic shifts in some types of production will continue as well in response to state regulations and to other economic factors.

At the same time, however, some agricultural production will still have a traditional commodity orientation. In these cases, vertical coordination will mostly occur among the processing, distribution, and retail stages. Finally, a mixture of large and small production units will continue, especially when the smaller farms serve specialty markets and/or have access to off-farm employment. The general result will be a tri-model distribution of production units in agriculture: 1) Industrialized units characterized by contract production and integration; 2) Independent, large-scale family or multi-family units; and 3) Small, part-time farms heavily dependent on non-farm income.

Implications for Resources and the Environment

One of the biggest problems in natural resource management is still the inability of analysts to value the costs and benefits of environment change. According to David Ervin (C-FARE, 1994b), this difficulty is compounded in agriculture because a diverse array of farms generally emit non-point source pollution, making it almost impossible to identify the source of pollution and its regulation. Ervin believes that industrialization could improve technology innovation and adoption in response to environmental programs because of

better management and easier access to capital. The new structure of agriculture could also bring greater government regulation because larger, more integrated producers are viewed as corporate farms, not family farms. Potential regional shifts in environmental problems resulting from industrialization are unclear, although these problems will tend to follow regional shifts in production. In general, these structural trends may simplify the processes of environmental regulation and compliance; however, concerns about determining ownership and liability responsibilities in contract arrangements will continue.

Implications for Rural Development and Communities

Greater consolidation and coordination among the stages of the food system is expected to continue to influence the economic vitality and social well-being of rural communities. Many rural areas have themselves experienced substantial industrial transformations over the last 25 years so that farming, farm-related industries, and agricultural policies now have a reduced role in rural employment and income generation. In other areas, however, the economic health and structure of local agriculture continue to strongly influence rural economic vitality. In these areas, some communities will grow and revitalize their rural labor force, while others will decline as a result of increasing consolidation and coordination (Barkema, Drabenstott and Welch). Proximity of coordinated agricultural production to metropolitan centers will also influence the rural community effects.

The nature of changes in rural economic activities will depend on the geographic origin of coordination. If production contracts and integration are initiated from outside rural areas, there will likely be an initial increase in economic activity and jobs. However, management expertise, input acquisition, financing activities, and part of the income would flow from rural areas to non-local beneficiaries, including some residing in other countries. Such transfers could leave rural communities more vulnerable to future economic hardships. Alternatively, locally based agricultural producers and agribusinesses could organize themselves in order to initiate coordination with processors and other food companies, and to seek greater power in the process. Such initiatives could involve the functions of cooperatives, strategic alliances, or other approaches. The goals would be to retain local expertise, higher skilled jobs, income, and financing, and thus permanently stim-

ulate and stabilize local economic activity. While both models have been followed to date, it is clear that additional research and education are needed for the local-based approach to compete effectively.

Implications for Consumers

The current industrialization movement is strongly influenced by consumers' preferences for safe, nutritious, convenient, diverse, and affordable food products and services. Greater coordination among the stages of the food system is intended to respond directly to these preferences, and is achieving these goals in many ways. However, various costs and other negative effects may occur as well. Kate Clancy (C-FARE, 1994b) observes that at the individual level, as opposed to a collective level:

“The problem most closely related to industrialization (besides jobs) is probably food safety. . . . Microbial contamination of poultry, antibiotic residues in animal products, and unnecessary food additives are prime examples of food safety risks related to industrialization and centralization. These problems are linked to practices used in industrialized systems such as confined animal production.”

Clancy questions the necessity of such practices when studies have shown that many consumers are willing to pay more for foods that are produced in ways that make them safer, preserve their quality, and benefit local businesses. Indeed, continued use of these practices, product proliferation, excessive advertising, and other possibly wasteful practices call into question the attribution of industrialization to consumer demand alone.

Implications for Policy

The on-going structural changes in agriculture yield a dilemma for public policy in which the loss of traditional small farms must be balanced against the economic benefits to consumers of higher quality, lower cost products. The traditional focus of agricultural policy at federal and state levels has implied an open-market, commodity based system. In this system, ownership, management and risk bearing are concentrated in the hands of individual farmers and farm families. On occasion this focus has severely restricted vertical coordination and outside investments in agriculture, and altered the geographic location of production. Current expansion of contract production in the swine indus-

try is a clear example (Wall Street Journal). These restrictions may run counter to economic, institutional, market, technological, financial, and consumer forces that are encouraging greater coordination and more of a product-based focus than the traditional commodity focus.

What does the persistence of commodity programs mean in an industrialized food and agricultural sector, in which the largest growth in exports is in value-added food products, not commodities? How will producers who contract with processors respond to farm policy incentives and/or disincentives if, through the contracting terms, these producers have lost part or all of the control over how they produce? Why should public programs continue to be a major option in risk management by agricultural producers when other options in risk management, including those offered by vertical coordination are increasingly available? Under industrialization, how can broader public interests be brought into the agricultural policy decision process? Examples of public interests include environmental protection, food labeling and safety, competitive food prices, and rural development. These policy questions and many others are directly attributed to the industrialization process.

Thus, greater consolidation and vertical coordination, which changes the traditional boundaries of agricultural firms, call for a new perspective on policy formulation and performance measurement for the food and fiber system. Moreover, an integrated approach to agricultural, food, rural development, and environmental policy is needed to properly account for the strong, long-term, and sometimes conflicting linkages among these important issue-driven areas.

Implications for Research and Education

To be effective, the agricultural research and education agenda must reflect the integrated nature of the effects of industrialization and their relationships to social goals for consumers, agriculture, natural resources, and rural areas. The aims of research and education are to understand, evaluate, and respond to the socio-economic implications of the growing industrialization of U.S. agriculture, and to build upon the professional contributions of past work. The problems embrace, yet go beyond matters of productivity, new technology, value added, and more comprehensive plant and animal systems that are high on the agendas of the biological and physical sciences.

The unanswered questions and issues for research and education include the following:

- Identifying and measuring the effects of vertical coordination alternatives on levels of income, jobs, funds flows, and wealth creation in rural areas.
- Identifying how changes in the structure of the food and fiber system are related to environmental consequences and policies.
- Evaluating the compatibility of industrialized agriculture and sustainable farming systems.
- Identifying and evaluating needed changes in public policies and programs to accommodate the changing structure of the U.S. food and fiber system.
- Evaluating how industrialization affects trade patterns and the ability to compete in world markets.
- Identifying changes in institutional arrangements needed to support, promote, and monitor a more industrialized agricultural system.
- Identifying and informing the public about the relationships between industrialization and food safety.
- Understanding the effects of industrialization on competitiveness and power of food companies at the consumer level and within the food and fiber system.
- Measuring efficiency gains and size economies resulting from vertical coordination and consolidation.
- Projecting the future structure of the agricultural production sector, and the ability of independent producers and small farms to remain viable as structural change continues.
- Evaluating how industrialization will influence the needs for, and sources of, financial capital for agricultural production.
- Evaluating the effects on distributions of income, risk, and decision control of alternative business organizations, including cooperatives, within the food and fiber system.
- Considering how industrialization will influence the development and adoption of new technology, and the roles of the public and private sectors in funding these developments.
- Understanding how industrialization will affect agricultural input sectors, including land markets.

Large firms and the balance of power are pivotal in the transition to an industrialized food system. Their role in this transition must be better understood. Further development of expertise about the motivations and behavior of multinational food manufacturers and distributors is needed by agricultural economists and other analysts in order to enhance this understanding.

Concluding Comments

The forces shaping future structural changes and continued industrialization of U.S. agriculture are profound and likely long lasting. They will significantly affect agricultural production, food consumption, natural resources and the environment, and rural development. These developments call for an expanded scope of analysis across the agricultural disciplines. Social scientists can take the lead in broadening the scope and providing a meaningful analytical framework for interdisciplinary analysis. An integrated approach to policy analysis and problem resolution is also needed, in which the relationship among agriculture, consumers, the environment and rural development are directly considered. The issues involved should be high on the agendas of the U.S. agricultural research and education systems. More education is needed, both within and outside the agricultural establishment, to enhance public understanding.

Public sector funding of the research and education agendas is appropriate in light of the public good nature of the issues involved. The results of research and education will have broad applicability; they will not provide benefits only to a small number of firms or organizations. Let's strive to put these issues more firmly on the research and education agendas—and then do the work in our research and education programs.

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