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VALUE CHAINS IN THE AGRICULTURAL INDUSTRIES

by

Michael D. Boehlje, Steven L. Hofing, and

R. Christopher Schroeder

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Department of Agricultural Economics

Purdue University

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VALUE CHAINS IN THE AGRICULTURAL INDUSTRIES

by

Michael D. Boehlje*, Steven L. Hofing** and R. Christopher Schroeder**

Preface

The U.S. agricultural industry is in the midst of major structural change — changes in product characteristics, in worldwide production and consumption, in technology, in size of operation, in geographic location. And the pace of change seems to be increasing. Production is changing from an industry dominated by family-based, small-scale, relatively independent firms to one of larger firms that are more tightly aligned across the production and distribution chain.

And the input supply and product processing sectors are becoming more consolidated, more concentrated, more integrated.

Agriculture in the 21st Century likely to be characterized by: 1) adoption of manufacturing processes in production as well as processing, 2) a systems or food supply chain approach to production and distribution, 3) negotiated coordination replacing market coordination of the system, 4) a more important role for information, knowledge and other soft assets (in contrast to hard assets of machinery, equipment, facilities) in reducing cost and increasing responsiveness, and 5) increasing consolidation at all levels raising issues of market power and control.

These profound changes in the agricultural industry present new challenges and new opportunities that require new opportunities that require new ideas and concepts to analyze and implement. The require new learning and thinking. Some of those new ideas and concepts are presented here, not as empirically verified truths, but as "thoughts" to stimulate different and better thinking. They have been developed based on observations, analysis and discussions with numerous managers and colleagues in agribusinesses in North America and Europe. This series focuses on Value Chains in the Food Production and Distribution Industries; companion series are also available on Farming in the 21st Century (Staff Paper 99-9), and Financing and Supplying Inputs to the 21st Century Producer (Staff Paper 99-11).

Our purpose in sharing these "thoughts" is to invite discussion, dialogue, disagreement — in general to encourage others to develop better "thoughts".

Keywords: Value chains, value decay, product differentiation, information, structural change

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Biological Product (Agricultural) End-Use Markets and Supply Strategies *

The significant changes that are occurring today in the types of products produced by agricultural producers are in part a function of changing end-use markets and the development of different strategies to supply those end-use markets. What are these changes and how will they impact the agricultural industry?

End-use Markets

Historically, the agricultural production sector has focused on producing generic commodities for the feed, and to a lesser extent, the food market. More recently, the industrial use of agricultural products, including ethanol and other previously petroleum based products, has been expanding rapidly. Like the feed market, the industrial market has obtained most of its raw material from generic commodities.

More recently, the food and industrial end-use markets are demanding component specific rather than generic commodities. Component specific commodities are distinguished from generic commodities in that they are differentiated on one or two basic characteristics or components. These components sufficiently enhance the generation of end-use attributes such that a premium is paid for component specific commodities compared with generic commodities. But the premium is modest and if it becomes too large, generic commodities can be processed at a lower cost than paying the premium for component specific commodities to obtain the desired end-use attribute.

The third production alternative is the design and production of specific attribute raw materials for unique end-uses in the food or industrial markets. For example, for some food uses one starch source may be as good as another. But rice starch is superior to other sources of starch for baby food. Waxy maize is better for some types of starch production than typical commodity corn. A partial listing of the specific attributes that might be important depending upon end-use includes chemical composition such a starch, protein, fiber, and sugar content; nutritional value; palatability; texture and processing properties, volume and availability; freshness and timing of delivery. Such characteristics as the process used in producing and growing the raw material (i.e., chemical free or pesticide free for crops and additive free and animal welfare sensitive for livestock) and the attributes that are excluded as well as those that are included may also be of interest.

Specific attribute raw materials are characterized by a broader spectrum of the attributes noted above compared with component specific commodities, which may contain only one or two of those attributes. In this context the types of products identified form a continuum from generic to specific without definitive delineations between the three classes identified. As

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*Adapted from Boehlje, Michael and Lee F. Schrader. "Agriculture in the 21st Century", *Journal of Production Agriculture*, 9(3):335-340, 1996.

illustrated in Table 1, the demand for component specific commodities and specific attribute raw materials is expected to grow, whereas the use of generic commodities will probably decline.

Table 1. End-use markets.

	End Uses		
Types of products	Feed	Food	Industrial
Generic commodity	Decline	Decline	Decline
Component specific commodity	Growth	Growth	Growth
Specific attribute raw material	--	Growth	Growth

Supply Strategies

Four fundamentally different strategies can be used to supply the end-use markets identified. The first strategy and the one most commonly used in the generic commodity markets is that of blending. The basic concept of blending is to acquire commodities with various characteristics (moisture content, foreign material content, weight per unit of volume, etc.) from various suppliers, and blend these products from different sources into a single product that meets specified commodity standards. This is the common supply strategy for the feed end-use market as well as for numerous industrial end-uses such as ethanol.

The second strategy we will call the segment, select, and sort strategy. The basic premise of this strategy is to recognize and use the variation in biologically produced raw materials by identifying various segments of the end-use markets that can efficiently use agricultural products with different characteristics. As noted earlier, higher protein wheat may have more value in certain food products, or higher starch content corn may be more valuable in some industrial markets. The approach of the segment, select, and sort strategy would be to first identify these various end-uses that could use the natural variation in agricultural products (segment), and then select, sort, and separate the product by source in such a fashion that it can be targeted to these segmented end-uses. The concept here is to exploit the variation rather than attempt to reduce the variation in biologically produced raw materials; the challenge is to find those segments that will generate value for different levels of an attribute. Low quality products may provide a unique challenge — developing a way to capture higher value from porcine stress pork (PSS) or damaged grain rather than simply in salvage markets may be a challenge with significant economic payoff.

The third strategy for supplying particular end-use markets is to acquire only raw materials that have the desired attribute. This approach is quite different than the segment, select, and sort approach in that a single or limited number of end-use markets are identified, and only those raw materials that have the specific attributes to fulfill the characteristics demanded in that

end-use market are purchased or grown. Acquiring specific attribute raw materials might occur by selecting only those raw materials that meet certain attribute specifications; more commonly obtaining these raw materials occurs through contract production with genetic material and cultural practices to produce or enhance the attribute desired. Products that don't meet these contract specifications are rejected or diverted to a generic commodity or other lower value end-uses. The fundamental philosophy of this strategy is to reduce the variation of specific attributes in the raw material supplies rather than to accept and exploit that variation.

The final supply strategy is the biomash strategy. In essence, the biomash strategy involves the separation of commodities into components, and then recombining these components to supply a specific end-use market. The concept is to use processing technology including extracting and extruding techniques to manipulate generic or component specific commodities to produce the attributes desired in the end product. With significant advances in processing technology, including those that will come from biotechnology, the opportunities for using a biomash strategy to obtain specific end-use attributes may increase significantly. This is particularly of interest in highly seasoned, highly sauced snack foods and similar end-uses in the food market, and in the industrial end-use market where taste and texture attributes are not critical to consumer or end-user acceptance.

Value Chains in Agriculture: Why and How Fast Will They Come?*

Agriculture is increasingly following the manufacturing industries in the formation of more tightly aligned value or supply chains. Why is this occurring, and how quickly will more tightly aligned value chains develop in various segments of agriculture?

Incentives for Formation

As evidenced by both the poultry and pork sectors, the pressures for chain formation appear to surface in a three phase sequence: 1) capturing efficiencies and controlling costs, 2) reducing risk (quality, quantity, and food safety), and 3) responding to consumer demands for attributes.

Efficiency/Lowering Cost High — High fixed costs at all stages of agricultural production and distribution provide a strong incentive to stabilize volume processed. Flow scheduling and capacity utilization are essential to cost control. Plants and animals bred or engineered for specific end uses will also require production practices tuned to the specific end use. Conformance to specific quality standards may be accomplished at a lower cost with a contract or integrated system compared to a market coordinated system. Compliance with regulations on the use of drugs and chemicals also requires a greater degree of coordination of activities at more than one level of the food system. Some technologies, such as pelleting feeds may not be economical at the scale of a single firm. Numerous other examples could be provided and are well recognized by those analyzing and actually forming food supply chains.

Managing/Allocating Risk — Risk has been a hallmark of the agricultural sector, and strategies to reduce risk have significant structure and coordination implications. One risk is that of prices of inputs or products. A common strategy is to reduce the risk of high prices for inputs by contracting for supplies. A related strategy is to reduce the price risk exposure on products by contracting product sales. Some firms reduce price risks by vertically integrating into the input supply or product distribution channels. These coordination methods attempt to reduce the impact of market fluctuations that are part of the open market spot pricing system.

A second source of risk is related to quantity and/or quality features. Tighter coordination may be required to obtain particular quality characteristics which may not be available in predictable quantities in open, spot markets. The coordination needed to ensure both quality and quantity for efficient operations may be better achieved through contracts, ownership of more than one stage, joint ventures, or similar arrangements in the food production and distribution chain.

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*Adapted from Boehlje, Michael and Lee F. Schrader. "Agriculture in the 21st Century", *Journal of Production Agriculture*, 9(3):335-340, 1996.

A third source or type of risk in the food chain that has become more serious in recent years is that of the safety/health risk in food production. 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. System coordination to implement traceback or HACCP (Hazard Analysis Critical Control Points) systems to reduce or control these risks may be in part a response to the broad sweep of product and environmental liability law as well as maintaining brand value.

Responding to Consumers — One of the prime arguments for chain formation is the reward from responding to increased specificity in consumer demand. Richer consumers are more demanding consumers. They expect quality control and products with specific characteristics to be available when desired. Product diversity is increasing. Products are differentiated based on what they do not contain as well as what they do. Low fat, low salt, and low cholesterol claims are common. Some attributes are achieved through processing, others in production. Consumers are also specifying how products are produced — examples include free range chicken and organic vegetables and grains. Given the expected continued increase in standard of living and increased ethnic diversity of markets, the trend toward product diversity will continue.

Convenience appears to be increasingly important to US and European food consumers. Higher income consumers in particular tend to be less price sensitive — more willing to pay for higher quality, variety, and convenience. Demand for take-out, fast-food, and home delivered foods is increasing. Less time is being spent preparing meals eaten at home, in part because equipment such as micro-waves are more readily available. The food products that maintain quality and taste when prepared with a microwave oven may require different characteristics of the protein, starch, fat or carbohydrates in raw agricultural products.

One reason the process of chain formation appears to follow the sequence of first focusing on cost reduction, then on risk reduction and finally on consumer responsiveness is the relative ease of capturing value and generating results from each of these motivations. In general, reducing costs from chain formation is the easiest to accomplish of the three motivations. Opportunities for cost reduction are easier to measure and more obvious, and techniques to accomplish those cost reductions are more easily identified and implemented. Reductions in risk from chain formation are not only more difficult to measure and identify, new risks including contractual or more generally relationship risk may be introduced as more tightly aligned chains are formed to reduce traditional price, quality and quantity risk. Thus, the total risk reduction benefits may be ambiguous, and the reallocation of those risks between participants in the chain may discourage tighter alignments.

Finally, increased responsiveness to the consumer may be the most difficult to measure and improve. Consumers may not be consistent in their signals or their behavior, and thus give mixed messages as to what they are really willing to pay for. Even though more tightly aligned chains may improve the content, accuracy and speed of messaging, the natural variation of biological production processes may still make it difficult for producers to respond efficiently

and effectively to consumer and end-user signals. Thus this objective of chain formation may be the most difficult to accomplish and the most unpredictable of the incentives for chain formation.

Speed of Formation

Given the incentives for chain formation, the timing and rapidity with which supply chains will be formed in a fragmented, market coordinated sector depends in part on the windows of opportunity for structural change. These windows of opportunity are a function of: 1) the investment life cycle and the replacement of obsolete facilities and equipment; 2) the human life cycle and the transformation from a late career core of entrepreneurs and managers to an early to mid-career core of managers; 3) the technology life cycle which involves a rapid, intense period of technological change and 4) the product life cycle and the transformation from a commodity to a differentiated product. Individually these cycles provide windows of opportunity for structural change in an industry; when they converge, as they have in the swine industry, structural change is dramatic.

Investment Cycle — A significant portion of the current plant capacity (particularly in the production stage of the pork industry) — specifically in the Corn Belt of the U.S. — is in need of replacement or modernization if it is to remain productive. Many Midwest facilities, particularly those owned by small and mid-size producers, are of a size and technology that can continue to produce if capital and investment costs have already been recovered, but will likely not be profitable if major remodeling or upgrading investments are necessary to remain in operation. Many of these production facilities (which embody the technology of the early 1980s) are likely to be phased out of production rather than upgraded and modernized in place because of technological, size, environmental or managerial conditions and limitations.

Manager/Producer Life Cycle — Until recently, most pork production has occurred in owner/operator firms where the entrepreneur provides most of the labor and management for the production enterprise — the classic family farm. For many of these family farms, the human resources as well as the physical resources are aging. For example, the recent Census reveals that 40.5 percent of Iowa family farmers are 55 years of age and older. Unless the firm has plans for managerial succession, producers of this age logically have a shorter planning horizon than those who are younger when considering major expansion and/or replacement decisions. Particularly with small and modest size livestock operations, fewer family members or others are available and/or interested in taking over the business. For a number of small and moderate size family farmers the logical strategy is to sequence the human and physical resources so that they can wear out at the same time — that is, when the farmer is ready to retire, the building and facilities can be shut down with the investment costs fully recovered.

Technological Life Cycle — Dramatic changes have occurred in the technology of pork production, processing and distribution. Genetic and nutrition technology now allow pork producers to produce those specific attributes that consumers want. Until recently, the knowledge and technology were not available on a practical, commercial scale. Technical change in

production facilities and structures in the last five to seven years has been profound. The traditional approach has been to integrate the farrowing, nursery, growing and finishing phases of pork production in one inter-connected plant at a single location. Modern technology (primarily for disease control and bio-security) suggests that the farrowing facilities should be physically separated from the nursery facilities with the growing/finishing facilities at a third site. Production of breeding stock may occur at a fourth location. Physical separation of the facilities and the economic stages of production facilitates (but does not require) that separate firms be responsible for each of the stages of production. Additional technological advances such as split sex feeding, all-in-all-out production, feeding different rations during different phases of the growing/finishing process, etc., renders much of the technology embodied in production facilities constructed even in the late 1980s obsolete.

The Product Life Cycle — Pork has been fundamentally a commodity product with most of the preferred consumer attributes added in the sorting and processing activity. Increasingly, certain attributes such as leanness and specific size portions such as loin eyes are difficult to obtain efficiently through processing. A more efficient way of obtaining these attributes may be by changing the raw material — the live animal. This transformation of the pork product from a commodity to a specific attribute raw material (SARM) provides the opportunity for (or requires) new coordination options and structural change to most efficiently source and merchandise this new product.

Critical Dimensions of Value Chains

The agricultural sector is increasingly characterized by more tightly aligned supply or value chains from genetics through producers and processors to end-users and consumers. The adoption of supply chain and qualified supplier approaches in the agricultural sector is a relatively new phenomena; understanding some of the critical dimensions of a supply or value chain will help us understand the implications of this new way of organizing the food production and distribution system.

The fundamental concept of a supply or value chain is to explicitly specify the value creating activities in the production-distribution process, and to provide an explicit structure for the linkages among these activities or processes. For example, in the grain and oilseed production and distribution industry, the value chain might have the activities or processes and the participants depicted in Figure 1. Thus, the first task in specifying a value chain is to identify the processes or activities that are necessary to create the attributes or products that will be demanded or used by the end-user or consumer.

The second critical dimension of a value chain is the specification of the product flow features of the chain. These features would include the transportation and logistics necessary to move products between processes, the details of flow scheduling to make sure that products are available at various stages of the process without accumulating excessive inventory, the enhancement and maintenance of various quality attributes, and the full utilization of plant and equipment in all stages of the value chain to reduce down-time or bottle-necks. At the same time, a critical issue in managing the product flow in a supply chain is managing slack or flexibility to accommodate unexpected interruptions or events. Concepts of statistical process control, inventory management, and logistics management are critical to understand this product flow dimension of a value chain.

The third important dimension of a value chain is the financial or cash flow across the participants and processes. Recent development of electronic funds transfer technology has improved the efficiency of financial and funds flows compared to earlier systems of billing and check-writing. An additional element of this dimension is the sharing of financial performance information across the stages or processes and participants in the chain. Such information is typically presumed to be proprietary in nature, but more open sharing of financial information between chain participants may be critical to improving the financial and physical performance of that chain.

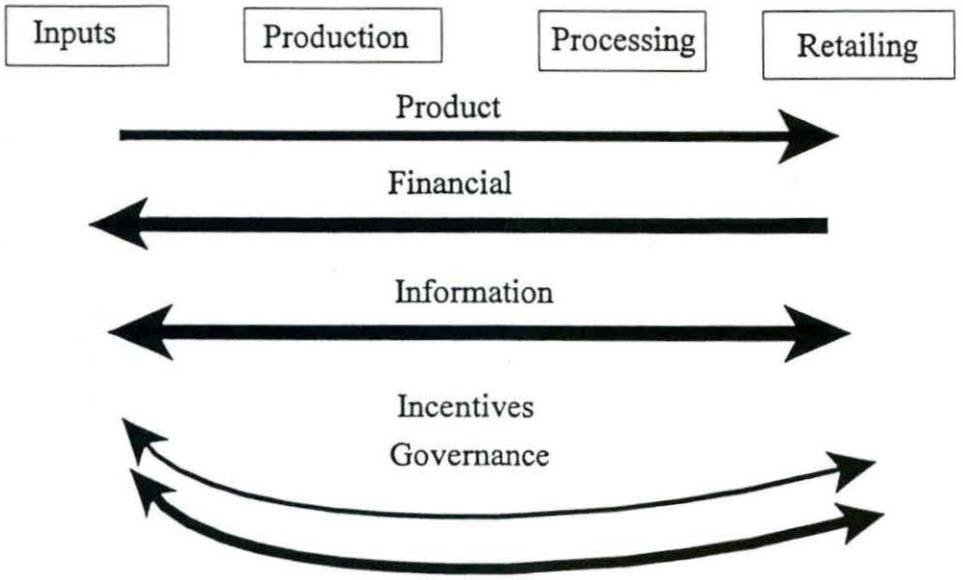
A fourth critical dimension of a value chain is the information flow across the chain. Important elements of this dimension are the accuracy of messages (whether messages are signals or noise), the strength of these messages, the cost of messaging, the speed of transmitting and receiving messages, and the openness to sharing rather than retaining critical information among participants. The information flow characteristics of a chain are becoming increasingly critical to its performance.

A fifth important dimension of a value chain is the incentive systems that are in place to reward performance and share risk. Such systems might include price premiums, profit sharing, minimum pricing arrangements, window contracts, cash flow or financial assistance contracts, loan guarantees, qualified supplier recognition programs, cost sharing arrangements, long-term commitments, and knowledge or market access. Increasingly, the conflicts encountered with more rigid contract and similar incentive systems that do not adjust with market conditions and consequently result in inequitable sharing of losses and profits are likely to result in the development of more flexible incentive systems such as contribution based percentage sharing of final product gross revenue.

A sixth and final dimension of a value chain is the chain governance/coordination system. Alternative governance or coordination systems might include open access markets and various forms of contracts, strategic alliance, joint ventures, franchising arrangements, networks, cooperatives and vertical ownership. The choice of governance/coordination system will have a significant impact on who has power and control in a value chain and how risks and rewards are shared.

Figure 1 provides a visual representation of these six critical dimensions of a value chain.

Figure 1 Critical Dimensions of a Value Chain



Drivers, Competencies and Barriers in Forming Supply Chains*

More tightly aligned supply chains are increasingly becoming common-place in the food production and distribution industries. As one looks at the formation and performance of these chains three fundamental questions arise:

1. What drives the formation of more tightly aligned supply chains?
2. What are the core competencies in chain formation?
3. What are the key barriers to chain formation?

What drives formation of tightly aligned supply chains?

The fundamental drivers of more tightly aligned supply or value chains in the food production/distribution industry are four fold: demand and consumption, productivity and technology, government regulations and policies, and resources.

Demand and Consumption — Consumers are becoming more discriminating in the food products they consume; different consumers want different characteristics and they increasingly have the ability to pay for these unique characteristics. Some of the dimensions of the changing consumption pattern of consumers that are driving the formation of more tightly aligned supply chains are:

1) healthfulness and safety ,
2) taste and variety,
3) convenience and freshness,
4) anytime availability,
5) price and quality,
6) international sourcing and selling,
7) origin of product,
8) animal welfare and environment,
9) processing method.

Productivity and technology — Advances in technology in the food production and distribution system are facilitating or enabling the formation of more tightly aligned supply chains. These improvements in technology and productivity include:

1) information technology,
2) biotechnology,
3) monitoring and measuring technology,
4) transportation and logistical technology,
5) environmental technology,
6) economies of scale,

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*Adapted from Agri Chain Competence Foundation DECANTHUS project at www.akk.nl/project/prjb-106.htm

7) efficiencies of specialization.

Government regulations and policies — Changes in the role of governments worldwide to simultaneously reduce subsidies and protection from international competition, and to increase regulation with respect to consumer concerns is resulting in increased pressures to form more tightly aligned supply chains. Important changes in government policy that encourage supply chain formation include:

1) food safety regulations,
2) reduced farm subsidies,
3) harmonization of trade regulations,
4) increased privatization,
5) shift from market protection to global market access.

Resources — Finally, the shift in the resources essential to compete in global markets is resulting in pressures to form more tightly aligned supply chains. These resource pressures include:

1) more sophisticated research and development,
2) increased importance of knowledge and information,
3) a more efficient distribution channel,
4) a more skilled labor force,
5) more sophisticated technology,
6) more globally accessible capital and finance,
7) global access to all resources from all locales.

What are the core competencies in chain formation?

Forming more tightly aligned supply chains requires skills or competencies that may not be part of the traditional production and distribution systems in the agricultural industries. One means of determining what skills are important is to study the successful supply chains in other industries as. Furthermore, it is quite possible that the more successful supply chains may be formed by those who are less tradition bound, and maybe even those from outside the traditional agricultural industries. For example, Wal-Mart has been successful in implementing supply chain concepts in retail merchandising; now they are bringing that same set of skills and competencies to food distribution.

Some of the core competencies that are essential in successfully forming and managing more tightly aligned supply chains include:

1) increased focus on product and process development,
2) emphasis on market flexibility to meet changing consumer demands,
3) improved ability to respond and customize products to end-user needs,
4) continued focus on cost control and efficiency,
5) more emphasis on risk management,
6) optimization of the logistics and transportation/distribution system,
7) a focus on holistic systems that integrate the entire supply chain,

8) increased emphasis on quality and quality assurance along the chain,
9) more emphasis on information and information sharing,
10) increased skill in negotiation and joint decision-making,
11) development of cooperative/collaborative attitudes and perspectives,
12) capacity to trust and to be trust-worthy.

What are the barriers to change formation?

As a logical follow-on to the core competencies needed to form successful supply chains, there are some critical barriers that may make it difficult if not impossible to be successful in the formation or functioning of more tightly aligned supply chains in the food production and distribution industry. These barriers or constraints are not impossible to overcome, but must be mitigated if more tightly aligned supply chains are to be successful. Some of these barriers include:

1) mutual trust by chain participants,
2) communication and information flow across chain participants,
3) commitment and willingness to invest in chain infrastructure,
4) awareness of the benefits and costs of more tightly aligned supply chains,
5) equitable sharing of the risk and rewards in a supply chain,
6) an acceptable governance system with equitable sharing of power and control,
7) capacity of the chain to be flexible and adaptable,
8) a policy environment that does not constrain or limit chain formation,
9) an organizational structure that allows implementation of chain and systems approaches,
10) willingness to adopt a collaborative vs. competitive business approach.

Evaluation of these three important issues in supply chain formation and management — drivers, core competencies, and key barriers — will be helpful in assessing the opportunities for success of supply chains in various segments of the agricultural industries.

Product Differentiation and Formation And Power In Supply Chains

Agriculture has been dominated in the past by commodity production, but a significant trend in today's agriculture is the development of differentiated products with some of that differentiation occurring within the farm gate. More tightly aligned supply chains facilitate product differentiation, and opportunity to differentiate provides incentive for chain formation. The need for diversity, exacting quality control, and flow control will tax the ability of open commodity markets to coordinate production and processing effectively. Markets increasingly encounter difficulty in conveying the full message concerning attributes (quantity, quality, timing, etc.) of a product and characteristics (including services) of a transaction. Where open markets fail to achieve the needed coordination, other options such as contracts, alliances, integration, or joint ventures will be used.

In general, negotiated coordination results in more rapid transmission of information between stages and enhances the ability of a system to adjust to changing consumer demands, economic conditions, or technological improvements. The higher the specification of end-user attributes, the higher the level of accurate, responsive, messaging needed, the higher the need for a more tightly coordinated supply chain. The ability of the agricultural production and distribution system to be more responsive and to adjust rapidly to changing conditions is increasingly important because the rate of change in economic and social systems worldwide has increased.

The ability to respond quickly to changes in the economic climate is critical to maintaining profit margins as well as to extract innovator's profits. Likewise, quickly recognizing erroneous decisions and making appropriate adjustments are essential. Market coordination of systems characterized by biological lags cannot respond to changing conditions as quickly as an integrated or contract coordinated system. That is, the response at one stage can be initiated only after price signals the need for change, and the change in quantity or quality is realized only after a full production cycle. By their nature, negotiated coordination systems require more frequent and direct communication between the decision makers at each stage on a wider variety of product/service characteristics than is typically possible with more traditional spot markets. Improved information flows and more rapid adjustments allow negotiated coordination systems to function more effectively in rapidly changing markets.

Thus, three interdependent trends in the modern food production and distribution system encourage the movement away from open markets to more tightly aligned supply or value chains: 1) increased specificity of consumer and end-user demands, 2) increased opportunities to produce differentiated products throughout the food chain, and 3) increased complexity of the production process or the opportunities for potential mistakes. As illustrated in Figure 1, increasing specificity of consumer demands and increased opportunity for product differentiation both encourage more tightly aligned value chains, whereas open markets can perform very successfully when the industry is characterized by both low specificity and low differentiation.

The higher the specification of end-user demands, the higher the potential payoff from product differentiation. And the fewer stages or places in a chain where this differentiation can occur, the more important it is to have control over those few stages. Furthermore, these stages also have the most power to capture value in the supply chain. Alternatively, the more the number of stages or places where the product differentiation can occur or where specific attributes desired by end-users can be added, the more the opportunity for substitution and the less critical it is to control each of these stages.

The third dimension of complexity of production is not unrelated to consumer specificity and differentiation. More differentiation and specification in general requires a more complex production process and thus the potential for more errors or mistakes in that process. With increased complexity and potential errors, more structured systems of control are essential to reduce those potential mistakes. And this increased control is easier to obtain in more tightly aligned supply chains in contrast to open access markets (Figure 2). The systems necessary to implement quality control or food safety and traceability throughout the entire production/distribution process from genetics to end-user is but one example of the necessity for tighter alliances and linkages throughout the stages of the chain to obtain expected performance.

As one attempts to evaluate what stages of the chain need to have tighter alliances with other stages, this concept of complexity or alternatively the ease of programming specific decisions is again relevant. Thus, where the probability of obtaining the most mistakes or errors is higher, the larger the incentive for tighter chain linkages including ownership. In contrast. if the production processes are not particularly complex and can be easily monitored and controlled, outsourcing or market systems of coordination may be as or more effective than tight alliances or ownership.

These arguments suggest that in traditional commodity markets where specific attributes are not demanded, supplies are fully adequate and can be obtained from various sources, and information flows between the various stages is minimal, traditional spot commodity markets can function quite effectively and efficiently. As one deviates from these conditions -- which is increasingly the case with more specificity in raw materials and information flows, and with fewer potential sources of acceptable supplies -- various forms of negotiated coordination systems become more effective and necessary for efficient functioning of the production and distribution system.

Figure 1. Product Differentiation and Supply Chain Coordination

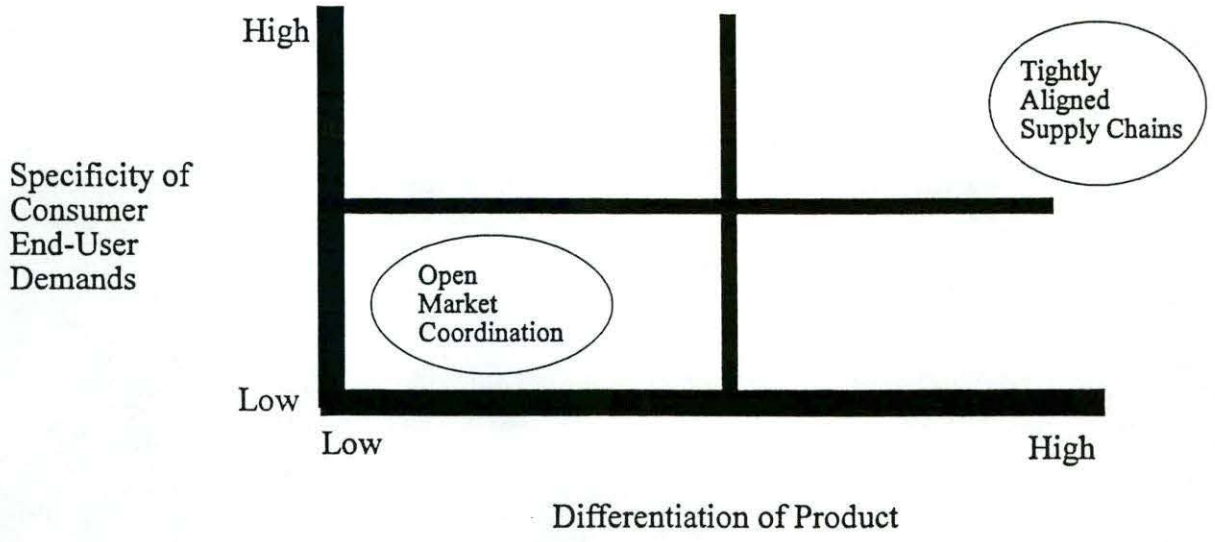
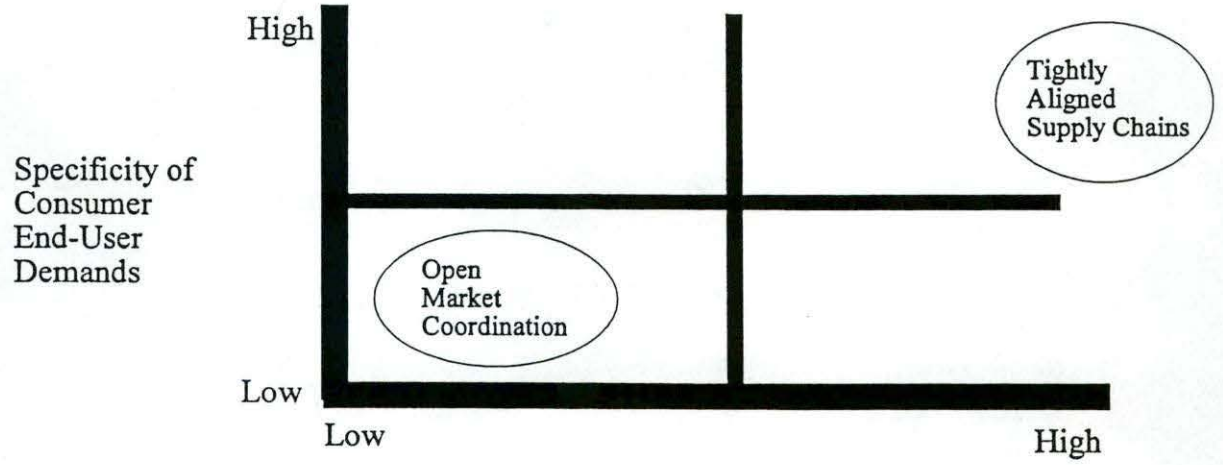


Figure 2. Complexity of Production and Supply Chain Coordination.



Value Capture and Value Decay in Value-Added Agricultural Production

With the recent increased interest and opportunity to significantly modify both the agricultural production process and the characteristics or attributes of the products produced through biotechnology, nutritional technology and other technological innovations, the fundamental issue of capturing value from these innovations has become paramount. The biotechnology industries in particular have struggled in recent years with commercialization of their products and recouping the substantial R&D investments that are necessary to develop innovative new products. In fact, the financial performance of many biotech companies has lead some industry observers to conclude that the opportunities for payoff from these substantial R&D investments are sufficiently limited that significant discounts must be applied to the earnings prospects of such companies. To better understand the potential for capturing value from new technological or product innovations, it is useful to understand not only how value is created, but the sources of value decay in a dynamic market environment.

Value creation is not new and it is not just a technological phenomena. The basic principle of value creation is to produce or provide a product or service that has sufficient value for customers or end-users that they will pay for that product or service. In production agriculture, this value creation process has traditionally focused on production of commodities with relatively generic characteristics; because of the nature of commodity production, competitive market forces have typically resulted in the cost of producing these products (the cost of creating value) sufficiently close to the value created that profit margins have been relatively thin. One of the appealing dimensions of some of the new technologies from genetic manipulation is the potential to enhance various attributes of these agricultural products, and in the process convert them from commodities to differentiated products that have enhanced value to end-users in the food and industrial product industries. Hopefully, the result is higher producer profit margins. Whether it be in the form of differentiated or commodity products or services, the concept of creating value is the same — generating something that someone else is willing to pay for.

But once value is created, it does not stay constant over time. In dynamic markets where new innovations are constantly occurring, the value of a product, attribute, or service will change over time. And the typical direction of that change is a reduction in value or value decay. From a individual company's perspective, there are five fundamental sources or causes of value decay.

Loss of property rights — Essential to benefitting from value creation is the opportunity to capture that value. Value capture is significantly dependent upon the property rights that one has in an attribute or a product or technology. These property rights may disappear for various reasons including litigation or expiration of licensing agreements or patent rights. For example, the patent on RoundUp herbicide will expire soon, resulting in significant value decay for this technology. And litigation in the biotech industry concerning property rights and licensing agreements for seed technology has increased the uncertainty of who owns these technologies, again resulting in the potential for significant value decay.

Substitution — A major source of value decay is the potential for substitution. This substitution can be in the form of products that are already in the market, or from the development of new products and services over time. For example, the value of high oil corn in feed rations is significantly dependent upon its ability to compete with fat in ration formulation. As fat prices decline with increased fat production from livestock, fat can be substituted for oil in feed rations and the value of high oil corn declines.

Replacement — Another source of value decay is that of replacement. New technological advances may make old technologies less valuable; for example Bt corn has the potential to substantially replace or displace insecticides that have traditionally been used to control corn borers. Chemical weed control has to a significant degree replaced or displaced mechanical weed control of the past. In fact, one of the most significant opportunities for value creation in the biotechnology industry has been the replacement of mechanical and other means of insect and weed control with biological controls. Yet future advances in biotechnology have the real potential to replace or displace current biotechnology created products, thus resulting in significant value decay for those current products.

Commodization — Almost all products exhibit a typical product life-cycle that is characterized by a single or few suppliers at the early stages of that cycle and increasing numbers of suppliers as the market matures over time. As the number of suppliers increases, competitive pressures result in lower prices for a and value decay. The speed with which a product moves through this commodization process depends to a significant degree on the ability to maintain uniqueness and protect differentiated characteristics from being replicated by competitors. But over time, competitors figure how to produce the same product or service, and frequently at a lower cost, which then puts pressures on prices and margins, thus resulting in value decay.

Mitigation— A fifth source of value decay is mitigation — the process by which buyers attempt to find better products or ways to obtain the same attributes at a lower cost. Companies involved in down-stream processing in the agricultural industries have the incentive to mitigate the attempts that those further up the channel are making to add value and charge higher prices for inputs or raw materials. For example, if high lysine corn or high oil soybeans must be sourced at a higher cost to processors, they will have the incentive to develop new technologies or processes that will reduce the need for these attributes in the raw material and alternatively create what the end-user wants in the processing stage. Thus, those down the chain have an incentive to mitigate the attempts of those further up the chain to create and capture value, and this incentive increases as the price of the raw material increases. Mitigation strategies by down- stream processors can be a significant source of value decay.

Power and Control In Supply Chains*

More tightly aligned supply or value chains will replace impersonal open markets in much of the industrialized segment of agriculture. These chains will be coordinated by negotiation rather than markets. A fundamental issue in any negotiation based coordinated system is the point (or points) and source of power or control. Who dictates or has the most control over the performance of the system, of the sharing of risk and rewards? Who has the power to resist or encourage change; to influence the acceptance and rate of adoption of new technologies and ways of doing business? And what is the source of that power or control?

In any supply chain, the source of power and control in that chain is to a significant degree a function of the most unique or least substitutable resource. In essence, the owner of the least substitutable resource has the most power to capture rents, transfer risk to others and have significant impact on what the chain does or does not do. A simple way to understand this concept is that the most unique resource is the most indispensable and has the potential to exercise "hold-up" power because of this uniqueness or indispensability.

In food chains where commodities dominate, the most important resources (i.e. those that have the most value and are the least substitutable) are generally those that will generate the lowest cost. Typically, these resources are the traditional capital and labor resources that dominate economic analysis. Assets and people that are properly positioned in terms of location and skills are unique, and provide those individuals or firms that own those assets with significant power in the chain. This is one reason why larger scale merchandising and food processing companies (such as Cargill, IBP, Continental, ADM, etc.) have had such a dominant role in the chain in the past — they have had the most unique or least substitutable resources to generate the lowest cost in the production and distribution of commodities.

As one moves to differentiated products with specific attributes, physical and financial resources become less important relative to information in terms of their uniqueness or indispensability in generating what the end-user of these differentiated products wants. Information about what the consumer wants is unique, and thus gives firms that have that information a unique position of power in the chain. And information about how to produce those attributes, either through processing or through genetics, is also unique and provides firms that have that information a unique position of power in the chain. Thus, the position of power changes in differentiated product markets from those resources that will lower cost to those that add value in the supply chain. The resources that add value in differentiated product markets are more in the form of information, research and development, knowledge, new technology, etc. (the soft assets), rather than the hard assets of plant, equipment and employees that are unique or indispensable and therefore a source of power in the commodity markets.

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*Adapted from Boehlje, Michael and Lee F. Schrader. "Agriculture in the 21st Century", *Journal of Production Agriculture*, 9(3):335-340, 1996.

Thus, there are two fundamental points of control and one fundamental source of power in a negotiation based coordinated food production and distribution system. The first point of control is the end-user or consumer and those firms that have intimate contact with the consumer. Consumers are more discriminating in their food purchases, want a broader spectrum of attributes in their food products, and increasingly have the purchasing power to convert wants into effective demand. It is not news that the consumer is the ultimate determinant of the attributes that food products must contain. And industrial product end-users will be similarly demanding in the attributes they require. Those firms that are close to the consumer and understand the increased specificity of his/her demands have a unique capacity to communicate and/or dictate those demands to the rest of the food chain. This knowledge of consumer wants, needs and purchasing capacity is a source of power and provides one point of control in the food production and distribution system.

The second point of control in the food production and distribution system is the raw material suppliers. 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 degree of substitutability for their input or contribution to the production/distribution process. Labor is substitutable for capital (although imperfectly); fertilizer is substitutable for land and vice versa. Machines can substitute (again imperfectly) for chemicals and labor for money. The one input with the fewest substitutes — that is in essence the most essential in the food production/distribution chain — is the genetic material in plant and animal production, the seed and breeding stock. Biotechnology and increased predictability and control of genetic manipulation provides additional power to those who control genetic material. But at the same time processing technology is also advancing such that it can, in some cases, produce those attributes at both a lower cost and with a shorter time to market. Thus, one should be cautious to not conclude that the ultimate source of power on the supply side comes uniquely from genetic material.

Note that the points of control in the food production and distribution chain may be at the beginning and the end — the genetics and the consumer. The source of this control is knowledge in both cases. At the consumption end, it is knowledge of the ultimate consumers' wants and needs which can be communicated through the chain; at the opposite end it is knowledge and information about and the ability to manipulate the genetic material that will produce the specific attributes for which consumers are willing to pay. By the very nature of their business, retailers and genetics companies have better access to information at these points. Given that the source of control is knowledge and information (not physical resources, not capital, not land), then the only way a firm between the end points of the consumer and the genetics company can obtain control is through superior information. The implication is that it is very difficult for those in the intermediate stages including producers and processors to obtain superior information and thus the power base for control of the system.

Presently, food systems coordination in the U.S. is accomplished primarily by processors when not by open markets. Recent indications of weakening brand loyalty have been attributed to a lessening of real product differences and a consequent emphasis on price. This shift positions the retailer for a larger role in non-market coordination. Fast food restaurant firms already exercise extensive system coordination and control for their major supplies reflecting consumer preferences. Diminished brand loyalties may diminish the power of processors to extract extraordinary profits; however, the processor is likely to continue to play an important role even as power shifts to genetics firms and toward the consumer.

The arguments presented here concerning the critical role of knowledge and information as a source of power and control in the food chain are an extension of the asset specificity concepts well understood in strategic management. In essence, unique knowledge and information is a specific asset that facilitates task programmability and encourages contractual/ownership vertical linkages. And the firm/individual with the most unique knowledge and information (with the greatest asset specificity) relative to other firms/individuals in the chain has the most relative power and control of the system.

Knowledge, Information and the Structure of Agriculture*

Significant structural changes are occurring in agriculture -- not only in size and ownership of farm firms but also in the linkages/coordination of farm production activities with input suppliers and product purchasers. More and more of these linkages are occurring through personal negotiated/contractual/ownership arrangements rather than impersonal open markets. Although numerous forces and drivers are contributing to these structural changes, information and knowledge play a significant role. As in other industries characterized by negotiated/personal linkages, those individuals with unique and accurate information and knowledge have increasing power and control in the food production system. And with power and control is the capacity to garner profits from and transfer risk to others with less power.

The increasing role that knowledge and information play in obtaining control, increasing profits and reducing risk is occurring for two fundamental reasons. First, the food business has become an increasingly sophisticated and complex business in contrast to producing commodities as in the past. This increased complexity means that those with more knowledge and information about the detailed processes as well as how to combine those processes in a total system (i.e. a food chain approach) will have a comparative advantage. The second development is the dramatic growth in knowledge of the chemical, biological and physical processes involved in agricultural production. This vast expansion in knowledge and understanding means that those who can sort through that knowledge and put it to work in a practical context have a further comparative advantage. Thus the role of knowledge and information in success in the agricultural industry is more important today than ever before. The measurement and monitoring systems that are at the core of precision farming are the key elements of this information system in crop production.

The logical question for individuals in the food manufacturing chain is how to obtain access to this knowledge and information. Historically, particularly for the independent producers in the farm sector, this knowledge and information has been obtained from public sources as well as from external sources such as genetics companies, feed companies, building and equipment manufacturers, packers and processors, etc. In general, independent producers have obtained knowledge and information from external sources in much the same fashion as they have sourced physical and financial resources and inputs. In contrast, ownership/contract coordinated production/processing/distribution systems have sourced their knowledge and information from a combination of internal and external sources. Many of these 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.

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*Adapted from Boehlje, Michael. "Information and Technology Transfer in Agriculture: The Role of the Public and Private Sectors." *Privatization of Information and Agricultural Industrialization*, ed. Steven A. Wolf. Chapter 2, pp. 28-38, 1997.

Furthermore, the research and development activities in coordinated systems are more focused on total system efficiency and effectiveness rather than on only individual components of that system; it is focused on integrating the genetics, equipment design, fertilizer program, pest control, marketing strategy, etc. rather than on these areas or topics separately. And in addition to more effective research and development, such alliances or integrated firms have the capacity to implement technological break-throughs more rapidly over a larger volume of output to obtain a larger volume of innovator's profits. In the case of a defective new technology, ownership/contract coordinated systems generally have more monitoring and control procedures in place and can consequently detect deteriorating performance earlier and make adjustments more quickly compared to a system with impersonal market coordination.

With the increased context specificity and decision focused nature of information in recent years, it has become more valuable. And as information becomes more valuable, the incentive for the private sector to provide that information and capture some of that value increases. Consequently, growth in the private sector data gathering and information service firms is not surprising given the growing value of information.

Because of the increased value of information and the expanding role of the private sector in providing it, the issue of the proprietary nature of and access to data and information becomes more important. With the increasing value of information and its use as a strategic competitive advantage, there is less free exchange of data and information. And the issue of who owns the data and information becomes critical. For example, with respect to site specific soil characteristic information, who owns it — the grower who paid for it or the service company that gathered it? Can a grower obtain this information from one company such as a fertilizer or chemical dealer and then provide it to a competitor who might have a lower price on fertilizer or chemical products? Does it make a difference if a grower pays for the service and how much she/he pays, or if the information service is provided as part of a bundled package with the product? If coordinated production systems have the potential to obtain superior information, how can a producer that is not part of that system obtain access to similar information to remain competitive? Will a producer have to become part of the system — "in the loop" — to obtain latest information to be competitive?

As knowledge and information become more valuable and more important as a source of strategic competitive advantage, those who have access to them will be more successful than those who do not have access. Given the declining public sector funding for research and development and knowledge and information dissemination, which has been the major source of information for independent producers, the expanded capacity of integrated systems to generate proprietary knowledge and technology and adapt 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 or contract coordinated production system compared with the system of independent stages and decision-making.

In a broader context, the public policy issue of intellectual property rights and the role of the public sector in making information a public good that is broadly available to all potential users becomes critical. The intellectual property rights debate has historically focused more on research and development and innovations protectable under patent or copyright law. Particularly in agriculture, the public sector has played a major role in the research and development activity and thus provided broad access to new technology and ideas. In this context, part of the public purpose was developing and disseminating new ideas in a sufficiently broad fashion that a wide spectrum of users benefitted, so that individual firms could not restrict access and capture the value associated with the new idea. The public sector role was that of leveling the playing field so that all participants competed on the same grounds vis-a-vis access to new ideas and information.

But as more and more of the research and development, and thus new ideas, come from the private sector, and more of the information dissemination system becomes privatized, individual firms have more potential to capture value at the expense of end users. They have the potential to restrict access to new ideas and information to particular users, thus favoring some producers and excluding others from the ideas, technology or information necessary for them to be competitive. 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 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 with other resources as a source of strategic competitive advantage.

On Organizing Supply Chains*

More tightly controlled supply chains are becoming a common part of agriculture today, and many farmers and their suppliers are concerned about issues of organizing and controlling the supply chain. The issues of implementation and organization of a supply chain must be separated from those of power and control in a chain. More specifically, the power and control held by those who know the consumer does not necessarily imply that they will play a role in actually organizing or coordinating the chain. The "controller" may simply set the standards or the rules of the game, and negotiate with someone else to enforce and monitor performance against those standards or rules. In fact, the preferred strategy by a "controller" might be to have someone else perform this organizing and implementing function so as to minimize their transaction cost. For example, even though power in the pork chain may be held by the retailer or processor and the genetics companies, they have given the integrator the responsibility to organize the pork supply chain. In essence, implementation and organizing the chain may be done by a separate party than the one who has power and control.

With respect to organizing the chain, two issues are paramount: 1) transfer pricing and risk allocation, and 2) logistics management and time competition. Transfer pricing and risk allocation are related issues in chain organization. Emerging chains in the U.S. pork sector, for example, rely on reported open market trading extensively as the basis for transfer prices. However, as chain differentiation proceeds, the residual open market becomes thinner and less reliable as a value indicator. Furthermore the prices generated in the residual commodity market have less relevance for the specific attribute products in the chain. Lack of trust among participants limits the use of multi-stage profit maximization and profit and risk sharing arrangements.

Given the difficulty of establishing profit sharing arrangements that are perceived as equitable by all participants, one finds a tendency for one firm in the chain to take control as contractor with others in the chain. Usually the chain manager also become the residual claimant on profits from the chain as well as assuming a major share of price risk. Failure to find a pricing arrangement that provides appropriate incentives and is perceived as fair also encourages ownership integration of stages by one firm.

With respect to logistics and time competition, more demanding consumers combined with pressures to lower costs in the supply chain will result in the implementation of efficient consumer response (ECR) principles not just in retail markets, but through the entire supply chain. With more limited opportunities to develop a competitive advantage solely around product performance or price, or around the provision of services, an increasingly important technique for establishing competitive advantage is responsiveness and cycle time. Just-in-time (JIT) inventory

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*Adapted from Boehlje, M., L. Schrader and J. Akridge. "Observations on Formation of Food Supply Chains", Proceedings of the *Third International Conference on Chain Management in Agribusiness and the Food Industry*, Wageningen Agricultural University, May 1998.

systems, faster product development cycle times, and supply chain integration are all techniques to be more timely and responsive throughout the chain. Increasingly, time competition will replace product, price, and service competition in the agricultural input supply and distribution markets.

Delivering a time-based advantage through effective logistics is a complex undertaking with a number of key processes. One set of these processes encompasses marketing related activities; assessing the product and service requirements or attributes desired by specific customer segments; and developing a distribution system that minimizes cost, provides competitive levels of service, and is customer responsive. Another set involves system coordination: developing the appropriate channel linkages and level of integration to efficiently and effectively supply exactly what customers want.

An additional set of these processes focuses on more traditional logistics management activities: choosing materials handling and storage technologies which will provide the desired level of customer service with optimum levels of investment in facilities and equipment; implementing inventory management procedures to simultaneously minimize potential stock out problems and reduce the cost of excessive inventory; and controlling and/or reducing transportation and warehousing costs in both the short- and long-term through strategic positioning of processing and warehousing facilities and better flow scheduling to reduce inventories. A final step involves implementation of an information system that conveys accurate messages with respect to consumer satisfaction, product flows and system efficiencies, quality characteristics of both product and service, and overall financial performance.

The Dynamics of Supply Chain Governance

A major transition is underway in the agricultural industries from using open market mechanisms for coordinating the various economic stages of the value chain from genetics to consumers to negotiated coordination involving governance forms such as alliances, joint ventures, contracts, franchising agreements and ownership. A critical question being asked by many farm and agribusiness managers is what form this non-market coordination or governance system will take in the future. Will ownership integration as is common-place in the poultry industry dominate the other agricultural industries? Will less hierarchical structures such as strategic alliances, joint ventures and contracts predominate? And once a governance system is in place, is it stable or will it evolve over time?

Three critical trends in the food production and distribution industries appear to be encouraging and facilitating the formation of more tightly aligned value or supply chains. First, consumers are increasingly specific in their end-use demands. The higher the specification of end-user attributes required, the higher the level of accurate, responsive, messaging needed, the higher the need for and payoff from a more tightly coordinated supply chain. Second is the development of differentiated products with more of that differentiation occurring across the chain rather than primarily in food manufacturing and marketing. Increased differentiation across the chain again requires better messaging -- more accurate information. More tightly aligned supply chains result in more accurate and rapid transmission of information between stages and enhance the ability of a system to adjust to changing consumer demands, economic conditions, or technological improvements.

Furthermore, more differentiation and specification in general results in more complex production/manufacturing processes and thus the potential for more errors or mistakes in those processes. With increased complexity and potential errors, more structured systems of control are essential to reduce those potential mistakes. This increased control is easier to obtain in more tightly aligned supply chains in contrast to open access markets. Thus, more tightly aligned supply or value chains are encouraged by: 1) increased specificity of consumer and end-user demands, 2) increased opportunities to produce differentiated products throughout the food chain, and 3) increased complexity of the production process or the opportunities for potential mistakes.

The hierarchical nature of the governance structure for food supply chains depends on a number of factors. Mahoney suggests that the form of coordination or business linkages will be a function of three characteristics of the transactions and the industry: (1) asset specificity, (2) task programmability, and (3) task separability. Asset specificity refers to the specialized nature of the human or physical assets that are required to complete the transaction; the more idiosyncratic the asset, the stronger the linkage or bond required for the transacting parties to invest in that asset. Task programmability indicates that a transaction is well understood by all parties and often

repeated, thus not requiring intense discussion or negotiations and easily accomplished by impersonal coordination mechanisms. Separability refers to the ability to determine and measure the value of the contribution and thus the reward that should be given to each participant in the transaction. If that can be accomplished easily (and thus the transaction is separable), coordination systems that are less hierarchical such as joint ventures or contracts are relatively more efficient and effective than when separability does not exist. Based on these arguments a taxonomy of expected governance mechanisms can be developed as summarized in Figure 1.

Figure 1. Predicting organizational forms of alternative business linkages

Factors	Low programmability		High programmability	
	Low asset specificity	High asset specificity	Low asset specificity	High asset specificity
Low nonseparability	Spot market	Long-term contract	Spot market	Joint venture
High nonseparability	Cooperation (strategic alliance)	Cooperation or vertical ownership	Inside contract (hybrid)	Vertical ownership

Source: Martin, L., R. Westgren, L. Schrader, L. Cousineau, N. LeRoc'h, R. Paguaga, and V. Amanor-Boadu. "Alternative Business Linkages: The Case of the Poultry Industry." Working paper 10-93, Food Industry Research Group, George Morris Centre, University of Guelph, June, 1993..

Barney argues that the form of governance (hierarchical structures such as ownership or majority equity investments vs. non-hierarchical structures such as open markets, licensing agreements, contracts, etc.) chosen by firms in an uncertain environment will be determined by four objectives:

1. Minimize the threat of opportunism,
2. Maximize flexibility,
3. Learn about the value of an uncertain investment, and
4. Secure property rights to capture investment value.

As summarized in Figure 2, if the threat of opportunism is high, transactions cost theory suggests that a more hierarchical governance structure will be chosen to reduce that threat; if the threat of opportunism is low or limited, non-hierarchical structures are appropriate. If flexibility is to be maximized, real options theory suggests that a non-hierarchical governance structure is preferred; flexibility will be limited with a hierarchical structure. If organizational learning is

endogenous (i.e. from learning by doing and tacit, subtle knowledge unique to the arrangement), organizational learning theory suggests that a hierarchical governance structure is preferred; if organizational learning is exogenous (i.e. from common, public knowledge external to the arrangement) a non-hierarchical arrangement is preferred. Finally, if value is to be secured and value decay minimized, property rights theory indicates that unless secured by endogenous learning or other mechanisms, value is better protected with a hierarchical governance structure; if value is secured otherwise (for example through endogenous learning, patents or copyrights, etc.), a non-hierarchical governance structure is preferred.

Figure 2. Governance Choices Under Uncertainty

Concept and Theory	Hierarchical Structures (Ownership, majority equity investments)	Non-Hierarchical Structures (Open markets, licensing agreements, joint ventures, strategic alliances, contracts)
Concept: threat of opportunism Theory: transactions cost	Reduce threat	Limited threat
Concept: degree of flexibility Theory: real options	Minimize	Maximize
Concept: nature of learning Theory: organizational learning	Endogenous (private knowledge/information, learning by doing)	Exogenous (common/public knowledge/information)
Concept: value capture/decay Theory: property rights	Protect insecure value; minimize value decay	Secure; immutable; not easily duplicated

Adapted from: Barney, Jay B. and Woonghee Lee. "Governance Under Uncertainty: Transactions Costs, Real Options, Learning and Property Rights." Fisher College of Business, The Ohio State University, Ref# 124140, 1998.

Irrespective of the incentives to use various governance structures, a second critical question is whether this governance structure is stable over time. Following Barney's arguments, the form of coordination structure is likely to change overtime -- as more is learned about the value of an investment for example, a strategic alliance or minority investment or licensing agreement might evolve into a merger or acquisition. Or an increased threat of opportunism might result in a licensing agreement being converted to a majority equity investment to manage or reduce that threat.

An additional argument that suggests dynamic evolution of the governance structure is related to the information and logistics systems and the incentive mechanisms that must be put in

place to capture the benefits of a tightly aligned supply chain. The argument is that it is very difficult to get integrated inter-firm information and product/logistics flow systems in place. Computers won't talk to each other, accounting systems are incompatible, people don't communicate or fight about turf and responsibilities, equipment doesn't interface -- all forms of conflict can develop in putting together inter-firm, inter-stage coordination. Consequently it may be that the only successful way to accomplish this inter-stage coordination is to own the stages -- to use a hierarchical decision structure to resolve the conflicts and put the inter-stage information and product/logistic flow systems in place.

But it is not always the case that ownership can provide the right incentives for an inter-stage system to perform efficiently and effectively over time. The incentive structure associated with entrepreneurship is critical for continued innovation, and some times this entrepreneurship is stymied in hierarchical structures. So a natural evolution for a hierarchical, ownership structured value chain over time would be to transition to a set of interrelated entrepreneurial firms that are tightly aligned through strategic alliances, qualified supplier programs, and other similar governance structures. In essence, the argument is that the ownership phase of value chain formation is necessary to get the systems in place and train the people and personnel to operate in a truly integrated supply or value chain structure, but once that is accomplished, the incentive and innovation benefits of entrepreneurial ownership favor the evolution of this ownership, hierarchical structure to a tightly aligned system of entrepreneurial firms coordinated through joint ventures, strategic alliances, franchising arrangements, qualified supplier programs, and similar less hierarchical governance structures.

Analyzing Structural Change*

The dramatic structural changes that are part of today's agriculture have been well documented. But what will the future hold; how can we make concrete predictions concerning the questions that are now only the focal point of speculation in most discussions concerning the future implications of the structural changes in agriculture? Concepts from various fields of behavioral science may provide useful components of a conceptual framework to study changes in structure and coordination systems. These fields include: (1) transaction cost and principal-agent theory, (2) strategic management, (3) negotiation/power and performance incentives, and (4) organizational learning. The challenge is to integrate the appropriate concepts into a comprehensive analytical framework, and to use an appropriate methodology to assess and predict the future.

The historical approach to discovering truth — to do research — in the agricultural economics profession has been to follow the fundamental principles of the scientific method. Thus, agricultural economists generally have identified a problem or issue, developed testable hypotheses, collected data to verify or refute these hypotheses with econometric or other statistical techniques, and then have drawn conclusions based on the statistical characteristics of these tests.

An alternative approach that is implicit in much of the strategic planning literature and now being embraced by some economists has been referred to as that of "final cause". This approach to discovering truth in essence argues that future mission or vision drives current actions, which then generate current and future outcomes. In essence, the fundamental perspective of this approach to discovering truth about current and future events is that most outcomes result from purposeful decision making on the part of agents (consumers, producers, agribusiness managers, government policy makers, etc.) who have an objective or vision of the future and will attempt to accomplish that vision. In environments where great structural changes are occurring which are outside the boundaries of the historical data, and when the reasons for these structural changes may be in part the strategic decisions of agents who have a future vision or mission that they are attempting to accomplish, a purpose — focused final cause approach to discovering truth may have much promise.

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*Adapted from Boehlje, Michael and Steve Sonka, "Structural Realignment in Agriculture: How Do We Analyze and Understand It?"The Proceedings of Economic and Policy Implications of Structural Realignments in Food and Ag Markets: A Case Study Approach, The food and Agricultural Marketing Consortium 1998 Research Conference, July 31-August 2, 1998.

Consistent with the purpose-focused, final cause methodology of analysis, obtaining evidence to refute various propositions or hypotheses may differ from that used in traditional economic analysis. As has been noted earlier, most economic analyses use historical data to test cause and effect relationships that have been specified as testable hypotheses. Purpose focused final cause analysis requires documentation of current decisions along with future directions that agents have specified as part of their mission or vision; it involves specification of intent. But intent may not show up in actions or actual performance, so final cause analysis also requires event or scenario assessment to determine the consequences of alternative actions as well as the potential interaction or mitigation of agent actions and competitor response or environmental constraints. Although such analyses may be judged to be suspect by many economists, they are increasingly acknowledged and utilized by not only business firms but even government agencies such as the financial regulators who commonly use various forms of probalistic stress-testing techniques to assess the vulnerability of financial institutions and insurance companies as well as public insurance agencies such as the federal insurance programs for banks and savings associations to defaults and financial stress resulting from management decisions and changes in the business and economic climate. In reality, these analyses are based on purpose — focused final cause simulation models that project future events based on current actions. No doubt these analyses draw on historical information and relationships in part for specification, but they are not limited to history if new relationships and determinants of the future that are not part of history have become part of the decision nexus and economic environment.

A further challenge in obtaining evidence and measuring the future results of current structural realignments in the agricultural industries is that much of the data needed to understand this phenomena is not part of the accounting or measurement systems used for most economic or financial analyses. Much of this structural realignment we see in the agricultural industries today is not the result of realigning the resources within a firm, but results from realigning the relationships between and among firms. The focus of this realignment is not within firm or within stage performance, but on the transactions that occur between the economic stages in the food production and distribution system. The performance within a firm or stage is not unimportant, but within stage or firm optimization is easier to analyze and understand using the traditional concepts of economics than between firm transactions which can be best analyzed with transaction analysis concepts as discussed earlier.

Our data sets for doing the former analysis are well developed and include such measurements as those found in standard financial statements and secondary data sources; they include primarily physical product and financial flows as illustrated in column one of Table 1. But the structural realignments that focus on transactions between stages or firms require and understanding of relationships and information flows as well as physical product and financial flows. The focus here is on the human or interpersonal dimensions of transactions. As reflected in the second column of Table 1, useful measures of efficiency or effectiveness of relationship and information flows include such phenomena as trust, accuracy of messages, flexibility, commitment, speed of response, strength of signals, equatability of sharing cost/revenue/risk,

adaptability and cost. Developing cardinal or ordinal measurements systems to quantify these important determinants of interfirm or interstage linkages and transactions will be crucial to understand and predict or project the structural realignments currently taking place in the agricultural and food distribution industries.

Table 1. Measurement of Economic Performance

Physical Product/Financial Flows	Relationships/Information Flows
1. Quality	1. Trust
2. Yield/input-output/physical efficiency	2 Accuracy of messages (information)
3. Economic value	3. Flexibility
4. Market or transfer prices	4. Commitment
5. Time to market	5. Speed of response
6. Errors/mistakes	6. Strength of signals
7. Cost	7. Equitability (fairness)/distributional issues
8. Profits	- cost
9. Return on assets	- revenue
10. Cash flows	- risk
11. Capital turnover	8. Adaptability
	9. Cost

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