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AGRICULTURE IN THE 21ST CENTURY

by

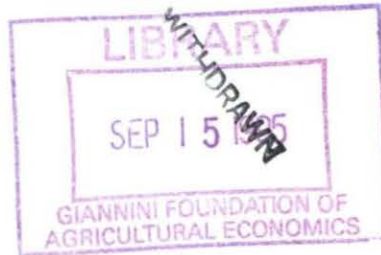
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Staff Paper #94-29



# AGRICULTURE IN THE 21ST CENTURY

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Dramatic changes have and will continue to occur in agriculture during the next decade. The fundamental theme of these changes will be the adjustments required of the agricultural production/distribution system to changing end-use markets. That theme will be developed in this paper by first identifying these specific end-use markets and the strategies that might be used to supply these markets. Then various grower/producer segments and the characteristics of these segments will be identified and discussed. Next two of the fundamental phenomena of industrialized agriculture -- a manufacturing mentality and negotiated coordination of the stages in the production/distribution channel will be reviewed. Finally, the concept of system power and control and the critical role of information in improving efficiency and increasing competitive advantage and market power will be discussed.

## End-Use Markets

The various end-use markets for agricultural products are summarized in Figure 1. 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 sourced most of its raw material feed stock from generic commodities.

Figure 1 End-Use Markets

Types of Products	End Uses		
	Feed	Food	Industrial
Generic Commodity	Decline	---	Decline
Component Specific Commodity	Growth	Growth	Growth
Specific Attribute Raw Material	---	Growth	Growth

More recently, the food and industrial end-use markets are demanding component specific rather than generic commodities. Component specific commodities would include such products as corn with an enhanced starch content, or soybeans with an enhanced oil content or a specific amino acid composition. 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 currently paid for component specific commodities compared to 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 in soup making for example, the starch produced by potatoes is superior to that from corn or wheat. And high sugar corn is better for fructose production than typical commodity corn. A partial listing of the specific attributes that might be important depending upon end-use include chemical composition such as 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/growing the raw material (i.e. chemical free or pesticide free) and the attributes that are excluded as well as those that are included may also be of interest. As noted in Figure 1, the markets for component specific commodities and specific attribute raw materials are expected to provide growth opportunities, whereas generic commodities will likely face declining markets.

### Sourcing 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 source commodities with various characteristics (moisture content, foreign material content, weight per unit of volume, etc.) from various suppliers, and blend these products from the different sources into a single product that meets specified commodity standards. This is the common sourcing strategy for the feed end-use market as well as for numerous industrial end-uses such as ethanol.

The second sourcing 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 and/or sort and separate the product by source in such a fashion that they 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. The quality attribute may provide a unique challenge -- developing a way to capture value from porcine stress pork 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 source the attribute in the raw material. 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 sourced. Sourcing of specific attribute raw materials might occur by careful selection from the market only those raw materials that meet certain attribute specifications; more commonly the sourcing of these raw materials occurs through contract production with genetic material and cultural practices to produce and/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-use. 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 sourcing strategy is the biomash strategy. In essence, the biomash strategy is the blending strategy extended further through the product processing chain. The concept here 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 the highly seasoned/highly sauced fast food 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/end-user acceptance.

### Grower Segments

Driven by these sourcing strategies, growers of agricultural products will likely be delineated into two distinct categories in the future -- traditional growers and industrialized growers. Traditional growers will operate in much the same fashion as family farmers do today. They will be primarily in commodity product production; own a significant portion of the land and other resources used in the operation; manage and operate the business as a family; use impersonal, open markets to sell their products; finance the business with family equity and conventional debt; use modern technology; and operate on a larger scale compared

to today's farmers. As a group, traditional growers/producers will be a declining segment of the industry both in numbers and in volume.

The industrialized segment of production agriculture will include three different types of growers: 1) large-scale commodity producers, 2) large-scale (and some small-scale) contract growers, and 3) managers/deal-makers. These three different types of industrial growers have enough similarities that they may not be easily distinguishable in practice. Large-scale commodity producers will use the manufacturing concepts to be discussed later to produce generic or component specific commodities that will generally be sold in impersonal open markets much like most grain and livestock markets today. The distinguishing features between traditional growers and large-scale industrialized commodity growers will be the much larger scale of the industrialized grower (larger by orders of magnitude of five to ten times), and the intensity of use of manufacturing techniques in production as well as management and organization of the business.

In contrast, contract growers in the industrialized sector will be more focused on specific attribute raw material products, and they will participate primarily in negotiation coordinated markets through contracts, strategic alliances and similar arrangements rather than the impersonally coordinated commodity markets of the large-scale commodity grower. With respect to scale of operation, technology and a manufacturing approach to production, few differences will exist between large-scale commodity growers and most contract growers except as dictated by the attributes of the product produced.

The third group of industrialized growers will be distinguished from the previous two categories only in terms of their method of organizing and actually implementing the



production process. Whereas industrialized large-scale commodity and contract growers own a significant portion of the assets used in production (machinery, equipment and facilities more so than land and buildings), the manager/deal-maker obtains machine services from contractors, service companies or through custom operations; sources labor through hiring independent contractors; and leases the land. In essence, the manager/deal-maker brings few if any physical resources to the table. His(her) strategic advantage is in the negotiation/deal making activity and s/he out-sources most if not all the resources needed for the growing process. The manager/deal-maker might be viewed in some sense as the integrator who negotiates a contract with the end-user to produce component specific commodities or specific attribute raw materials, and then negotiates with those who own the land, machinery, equipment, facilities and labor to produce those specific products. In this context, the value the manager/deal-maker contributes to the value chain is that of coordination; s/he in essence reduces the cost and inefficiencies of coordination between the stages in the value chain (the transaction costs) and his/her reward depends on how large these costs or inefficiencies are and how effective s/he is in reducing them.

In general, industrialized growers will be more important suppliers to the end-use markets noted earlier, more so for the component specific commodity and specific attribute raw material markets. Traditional growers will have a relative advantage (but not necessarily an absolute advantage) in generic commodity production, but competitive pressures will force them to adopt the manufacturing concepts to be discussed later to be competitive with large-scale industrialized commodity growers.

## Grower Characteristics

More specifically, what are the characteristics that growers will exhibit in the future, and what evidence is there that agriculture is moving to an industrialized model of production? Results from two producer surveys provide some insight into how producers expect to manage and operate their business in the future.

The first results are from a survey of commercial producers by the Center for Agricultural Business at Purdue University.<sup>1</sup> Approximately 1000 producers participated in the survey with three-quarters of the participants having over \$500,000 gross income in their primary business enterprise in 1992, and the remainder having a 1992 gross income of \$100,000 to \$500,000.

**Expansion plans** -- Crop producers responding to the survey expect to expand their farming operations by 15-20 percent over the next 5 years. This 3-4 percent annual growth rate seems realistic with increased production efficiencies and improved managerial skills. These expansion plans are fairly consistent across the corn/soybean, wheat, and cotton producers in the survey. But dairy, hog and beef producers project faster rates of growth, with many of them expecting to increase the size of their livestock operations by over 50 percent during the next five years.

**Contract production** -- Contract production is expected to grow in importance in both the crop and livestock sectors. The survey indicated that in 1993 60-70 percent of corn/soybean farmers and 20-25 percent of livestock farmers use contracts. By 1998 the survey respondents expect to be producing almost one-third of their output under contract.

Keep in mind this growth in contract production is accompanied by growth in farm size, so the actual amount of contracting will grow at an even more rapid pace.

**Risk management** -- The respondents were asked what risk management approaches they used regularly in their business. More than 75 percent had health and life insurance, 50 percent of them bought crop insurance and used forward contracting procedures, and less than one-third percent used futures or options markets to manage their risk exposure. Results suggest that producers are more aggressive in using various procedures to manage human/health risks and less aggressive in using procedures to manage production and price risk. Potential growth opportunities thus seem greater in production and price risk management strategies than in human/health risk management strategies.

**Custom farming** -- Respondents were asked what percent of their field activities were custom hired in 1993 and what they projected for 1998. About two-thirds of the applications of fertilizer and pesticides were provided by outside service companies in 1993. Almost one-third of the harvesting but less than 10 percent of the planting/seeding activities or the field preparation activities were done by custom operators.

**Use of consultants** -- In 1993, more than 75 percent of the respondents in the sample used an accountant, attorney, or consulting veterinarian; approximately 40 percent used a consulting nutritionist or a crop consultant; 29 percent used a marketing consultant; 25 percent used a financial advisor; and 7 percent used an environmental consultant. Use of financial advisors, crop consultants, environmental consultants, and marketing consultants is projected by these producers to grow significantly over the next five years, while little growth is expected in the demand for additional services of accountants, attorneys, or veterinarians.

In essence, many growers plan to expand their management team, but without adding permanent employees

**Buying behavior** -- The survey explored a number of dimensions that impact decisions on buying inputs, including the influence of price and service on purchase behavior, the "bundling" or "unbundling" of prices and services, and attitudes about buying directly from the manufacturer.

Producers were asked to allocate 100 points across six factors (service, information, price, convenience, performance and brand) that influence their input purchase decision. Price accounted for only about a third of the decision. Performance followed as a close second and service came in a close third. In fact, when asked what they thought about the statement, "I almost always purchase products based on the lowest price, regardless of the amount or quality of service," three-fourths of the producers in the sample disagreed. This finding suggests that the interest is really in getting a "fair price," which is one that reflects the perceived value of a bundle of products and services -- i.e., a "good value." If the producer believes the value is really there, having the lowest price is not critical.

An important consideration is whether to bundle the price of the product and service together or to unbundle them and charge customers separately for the product and any specific services they use. One-third of the respondents preferred unbundled pricing, one-third preferred bundled pricing and one-third didn't seem to care. The producers who preferred unbundled pricing were slightly more price conscious and more willing to buy directly from the manufacturer than those who were looking for a packaged price.

Buying groups represent another consideration in the input purchasing process. Less

than 15 percent of the producers said they were currently a member of a buying group. Currently, buying groups are more widely used for purchasing feed and livestock equipment than other inputs, but producers indicated that buying groups would be more widely used for animal health products in the future. Buying groups may become more popular, as almost half of the respondents said that they would "consider" joining one in the future, even though they are not currently a member of such a group.

A related issue is buying directly from the manufacturer. Currently, more than half of the producers in the sample said they buy their feed directly from the manufacturer, and another third would like to buy directly from the manufacturer in the future. Among all input industries explored, the feed industry reported the highest level of direct purchases. However, over three-fourths of the respondents indicated that they preferred to purchase locally. Taking a broad look at these opinions suggests that large producers have no inherent bias against the local dealer -- as long as the local dealer is adding value for them.

A second survey reports the results from approximately 100 participants in the 1992 Purdue Top Farmer Workshop.<sup>2</sup> The participants were asked to project various characteristics of their farm businesses to the year 2000; these participants are certainly not typical of all Midwestern producers, but they reflect the leading edge of the industry. Although no statistical data is available, it would appear that this group is typical of the more aggressive and progressive grain producers in the Midwest, probably the top 20 to 25 percent of the industry, in terms of their farm management skills. This progressive group of growers project the following future for production agriculture.

**Rapid Growth** -- Acres farmed by this group in 1992 averaged 1,762 with a range from 200 to 4,500 acres. Farm size is projected to increase to almost 2,900 acres by the year 2000 -- a 65 percent increase during this eight-year period. Currently, 36 percent of the acreage farmed is owned, with the remainder rented or custom farmed. These producers expect to be farming significantly more acres by the year 2000, but their ownership percentage is projected to remain about the same, a little over one-third. Apparently, these producers feel that rental or custom farming is a permanent rather than a transitory part of their farming operation.

**More Contracts on Specific End-Use Products** -- In 1992, 15 percent of the acres farmed by the Top Farmer Workshop participants was for a specific end-use such as seed corn, waxy maize, white corn, popcorn, etc. By the year 2000, these producers expected the percentage farmed with a specific end-use in mind to double to more than 30 percent. Almost 20 percent of the acreage operated by these producers in 1992 was produced with a production contract of some type; that percentage was also expected to double to more than 40 percent by the year 2000.

**Shift to Non-Conventional Tillage** -- Slightly more than 40 percent of the total corn acreage produced by this group was ridge or no-tilled in 1992; by the year 2000, more than two-thirds was expected to be ridge or no-tilled -- a 62 percent increase from 1992. Forty percent of the producers used a paid crop consultant in 1992; this percentage was expected to almost double to 75 percent by the year 2000.

**Bigger Implements, But Little Increase in Power** -- The producers were asked to project future size and number of corn planters, combines, and tractors they expect to use in

their farming operations. In essence, they expected to farm approximately 65 percent more acreage in the year 2000 with only a slight (10 percent) increase in the number of large tractors. They see their largest tractors having the same horsepower in the year 2000 as in 1992. They expect an approximate 10 percent increase in the number of planters with a 35 percent increase in row size per planter, and an approximate 15 percent increase in the number of combines with a 25 percent increase in row size of those combines.

Thus, these producers are expecting to farm significantly more acreage with larger planting and harvesting equipment, but only modest increases in the number of planters, combines, and large power units per farm. They will farm the larger acreage with about the same total labor, but will increase labor productivity sharply with the larger sizes of planting and harvesting tools. They apparently also plan to work their machinery faster or more hours per day to get the job done in a timely fashion. The lack of increase in the expected number and size of tractors is likely related to their transition to non-conventional tillage.

**More Direct Purchase of Inputs** -- The 1992 Top Farmer Workshop participants were sourcing approximately 20 percent of their crop chemicals from wholesalers and manufacturers, with the remaining 80 percent from a local distributor or cooperatives. By the year 2000 these producers expected to be sourcing over 50 percent of their chemicals from wholesalers and manufacturers -- more than a 150 percent increase in direct purchase. This significant shift in sourcing chemicals more directly from the manufacturer or wholesaler has important implications for local dealers and distributors.

**Increased Debt Capital from Input Suppliers** -- Commercial banks provided almost 57 percent of the total credit used by these producers in 1992, and their market share is

expected to be maintained to the year 2000. Almost one-fourth of the credit was provided by the Farm Credit System, and their market share is projected to decline to approximately 17 percent by the year 2000. Probably the most significant change in credit use is for input suppliers. In 1992 input suppliers provided only two percent of the total credit used by the Top Farmer Workshop participants, but they project to be obtaining more than 11 percent of their total credit needs from input suppliers by the year 2000.

**Stable Farm Financial Position** -- In spite of significant growth in farm size, the participants project their debt-to-asset ratio will remain substantially the same in the year 2000 as today, when a little less than one-third of their assets are being supported by debt. Recall that although these producers are planning to expand their operations significantly by the year 2000, almost two-thirds of that expansion is expected to be on rented acreage rather than purchased land that requires significant debt obligations.

**Higher Interest Rates and More Inflation** -- These producers expect interest rates to increase by the year 2000 by approximately 230 basis points compared to the rate they paid in 1992 of slightly higher than 8.5 percent. They expect inflation to almost double by the year 2000 from the rate of just over 3 percent. It should be noted that the survey was taken in July of 1992, and the outlook for interest and inflation may have changed since that time.

**Costs to Rise Faster Than Product Prices** -- Seventy percent of the respondents indicated that they do not expect product prices to keep up with that rate of inflation during the eight year period from 1992 to the year 2000. Approximately 40 percent of the producers expect that the cost of production per bushel will increase faster than the rate of inflation, with the remaining 60 percent indicating that costs will increase at the same or a lower rate



than the rate of inflation.

**Less Government Financial Support of Farm Programs** -- Almost 90 percent of the respondents expected that the government will have a greater influence on their farm in the year 2000 compared to 1992 (apparently in the form of regulations), but 90 percent also felt that government payments would account for a smaller percentage of their gross revenue in the year 2000.

**These Farmers Remain Optimistic** -- In spite of projections of higher interest rates, higher inflation, and higher costs, almost 90 percent of the Top Farmer Workshop respondents indicated that they expect the financial prospects for crop farming to be the same or better in the year 2000 compared to 1992.

### Manufacturing Mentality

The transition of agriculture from a commodity industry to one with differentiated products, combined with a focus on the end-user and a manufacturing approach to production, is a dramatic paradigm shift in the industry. The produce - and - then - sell mentality of the commodity business is being replaced by the strategy of first asking what end-users want, and then creating or manufacturing those attributes in the raw material. As suggested earlier, this may require changes in how the raw material is produced and what it doesn't contain (i.e. chemical residues) as well as what it does contain. This manufacturing mentality has become more predominant and has the potential to be increasingly successful as we learn more about the biological production process and have increased capacity to control and manipulate that

process through genetics, nutrition, equipment and facility design, disease and health management programs, etc. What are some of the characteristics of this manufacturing mentality as applied to production agriculture?

**Systemization/Routinization** -- One of the characteristics of the manufacturing process is systemization and routinization. With increased understanding and ability to control the biological production process, routinization becomes increasingly possible. Tasks become more programmable. Routinization generally fosters more efficient use of both facilities and personnel as well as less managerial oversight and overhead. Hourly work schedules that identify specific tasks to be done at specific times on specific days in the modern farrowing or finishing unit are examples of the systemization and routinization in modern livestock production. Precision crop farming is another example. In essence, agricultural production is becoming more a science and less an art.

**Intensity/Specialization** -- An additional manufacturing mentality concept now being utilized in modern agricultural production systems is that of specialization, not only with respect to business venture and focus but also with respect to individual employee tasks or function. For example, an even larger proportion of the grain, swine, dairy, beef and poultry output is being produced by larger scale, specialized units. And within these units employees are becoming more specialized in their task or functions with some focusing only on breeding, some on feeding, some on feed production, some on health maintenance, etc. This specialization of function of personnel as well as business focus of the firm again is increasingly feasible because of better understanding and control of the biological process.

**Scheduling/Utilization** -- A further implication of the manufacturing paradigm in agricultural production is increased emphasis on facility utilization, flow scheduling, and process control. In the past, variability associated with the lagged dynamics of output response to current and expected prices and the biological production processes has made facility use and scheduling and process control difficult if not impossible. Many production units have in essence maintained excess plant capacity as one means of accommodating the uncertainty of the output of the biological production process. But again as a result of increased ability to predict and control that process, facility use can be more accurately predicted and controlled, and process control concepts to improve efficiency and reduce cost are more applicable and useful than in the past.

**Input Packages vs. Mix and Match Strategies** -- With the increasing capacity to control and understand the biological process through biotechnology and genetic engineering techniques, producers will be more capable of developing optimal input combinations that match chemical and biological attributes to obtain the optimum quality and characteristics of output. For example, crop genetics are being matched to pesticides for optimal pest control as exemplified by Synchrony STS -- a seed/herbicide system. Livestock genetics are being matched to feed genetics to obtain the proper ration and nutrient content to produce the most desired lean and other attributes in the meat product. In this situation, the classic mix and match strategy of the past where producers could buy feed or chemicals from one firm and genetic material from a second may become increasingly difficult. In some cases the grower will purchase pre-specified input packages that are pre-optimized in terms of their biological and chemical characteristics; in other cases the grower will be warned that certain nutritional

and genetic inputs respond better when used together and their performance may be sub-optimal if used in other combinations. But this matched inputs strategy has risks -- the risk of reduced flexibility and ability to adjust if supplies of an input decrease and/or prices increase.

**Systems/Process Flow** -- The manufacturing mentality places increasing emphasis on the entire value chain from raw materials supplier to end-user. This system rather than stage or segment focus reduces the chances for sub-optimization within a stage or sector and dead-weight losses because stages are not well matched in terms of product flow, characteristics, quality, or other critical attributes. Dead-weight losses can be particularly large in biological production processes where variation in many attributes is naturally wide because of variation in genetic and other inputs as well as growing conditions. Thus, there is the potential for a very high payoff if manufacturing processes can be used to reduce the dead-weight losses in the system.

**Geographic Separation of Production Stages** -- The old paradigm in production agriculture has been to combine various stages of production within one firm -- for example in swine production to combine the breeding, gestation, farrowing, nursery, growing, and finishing activities in one firm at one location, and furthermore to integrate these activities with feed production and processing. The new paradigm is geographic separation of many of these stages of production. The advantages of this separation are not only scale economies and specialization of both human and capital resources, but also disease control and improved herd health (in swine production in particular). This geographic separation of the various stages of production does not necessarily imply separate firms, although geographic separation

may facilitate separation of ownership as well. Geographic separation does frequently imply larger scale and more specialized capital, labor and management resources at each individual plant site or facility location. Implications of separation for flexibility are unclear -- more specialization in resource use decreases flexibility, but participation in only one stage may increase the options for negotiating with other partners in other systems if other systems are in the market.

**Stage Coordination through Negotiation** -- As noted earlier production agriculture in the past has focused primarily on commodity products with coordination through impersonal spot markets. The increased specificity in raw material requirements combined with the potential for producing specific attributes in those raw materials is transforming part of the agricultural market to a differentiated product market rather than a commodity product market. This trend combined with the trend to geographic as well as ownership separation of the various stages of production suggests that personal negotiation is a more effective mechanism of systems coordination than impersonal spot markets. Increasingly, impersonal spot markets find it difficult to convey the full set of information about product attributes that characterize these differentiated products. Contract/ownership coordination will become more dominant in the differentiated product markets with impersonal price coordination continuing to dominate the commodity markets.

**Partnering/Alliances to Reduce Investment/Leverage Volume** -- The traditional approach to agricultural production has been that of an independent producer who purchases inputs and sells products through various market mechanisms to other independent businessmen. Increasingly, producers are partnering with other resource suppliers in various

ways to expand volume with limited capital outlays. In livestock production this phenomena is occurring through contracting arrangements; a hog integrator may own the breeding, gestation and farrowing facilities but contract out the nursery and growing phases. In essence the integrator is leveraging volume by investing his funds in only part of the total fixed assets needed to produce hogs (approximately one-half of the investment is in breeding, gestation and farrowing with the remainder in the nursery and finishing) while maintaining a high degree of control of the other phases through the ownership of the livestock and the specification of the growing conditions. The critical dimension of such partnering or alliances is that more resources and services are out-sourced if that is a less expensive technique for obtaining production inputs, and more linkages up the value chain to the end-user are used to capture value in additional stages of the value chain.

**Purchasing Agent** -- Part of the manufacturing mentality is a purchasing agent or specification buying approach to acquiring inputs or services. This approach involves the specification of input requirements and in many cases requesting alternative suppliers to bid for the business based on the contract specifications. This purchasing agent approach puts more emphasis on ability to fulfill contract specifications at a competitive price than the personal relationship based purchasing behavior of many of today's agricultural producers. Note that the relationship is not unimportant in a purchasing agent approach to sourcing inputs; instead the relationship is more explicitly defined in the context of meeting and enhancing the features and characteristics the buyer wants as reflected in the contract specifications.

**New Venture Expansions** -- Much of the expansion of agriculture in the past can be described as that of incremental expansions -- producers would add an additional 40 acres to their 240 base acreage, 20 cows to their current 50 cow dairy herd or an additional 50 sows to their current 100 sow hog farm. But increasingly, particularly in livestock production, expansion is of the new venture variety -- the 600 sow farrowing unit sited on a new location not part of the original farmstead, or the 300 cow dairy operation with new building and facilities. These new venture expansions are driven in part by the fact that some of the newer technologies require significant size to fully exploit them. For example, in hog production the combination of multiple-site production, phase feeding, split-sex feeding, and all-in-all-out technology have made it difficult to obtain all cost efficiencies and volume and premium discounts at smaller scales of operation; in fact, some suggest that the minimum size to obtain all benefits of these technologies is 2,400 sows that would finish approximately 50,000 head of market hogs per year. These new venture projects require substantial capital investments (often in excess of a million dollars) and frequently require significant labor and managerial resources as well to be successful. This new venture approach to production agriculture is a dramatic change in the way of doing business compared to the incremental expansions of the past.

**Cost Control** -- Although cost control is critical in any production system, the manufacturing approach focused on end-user products recognizes total production/distribution systems cost as being more critical than the cost in each stage of the value chain. As noted earlier, this approach has the potential to eliminate some of the significant dead-weight losses in the value chain. And as more resources are out-sourced, the cost structure of the business

changes with a higher proportion of the cost being variable in nature and a lower proportion fixed. With this changing proportion of fixed and variable cost, each stage becomes more responsive to changing end-user demands and competitive pressures. Fixed costs have little impact on how a firm will adjust to changing market conditions in the short-run; consequently firms with a high proportion of fixed costs are quite lethargic in adjusting to changes in market conditions. In essence, an industry in which more firms have a higher proportion of their total costs that are variable costs is more responsive to changing market conditions.

### System Power/Control

As has been noted earlier, negotiated coordination will replace impersonal open markets in much of the industrialized segment of agriculture. 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?

Traditionally, discussions of power or control in an economic system have focused on issues of size and the ability to exercise monopoly or monoposy power as a function of volume or size -- in essence market dominance. with the increasing importance of the role of information in economic decision-making combined with more negotiated coordination systems, the potential of economic power associated with a particular stage in the



production/distribution process has surfaced. In essence, the question is whether there is economic power or control associated with a particular stage in the production/distribution system -- is there position power as well as size power!

The basic argument is that there are two fundamental points of control and one fundamental source of power in a negotiation based coordinated agricultural 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, what 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 end-user 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 production/distribution chain. This knowledge of consumer wants, needs and purchasing capacity is a source of power and provides one point of control in the agricultural production and distribution system.

The second point of control in the agricultural 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 agricultural 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. Thus, the second point of control in the agricultural production and distribution system is the owner of the genetics.

Note that the points of control in the agricultural production and distribution chain are at the beginning and the end -- the genetics and the end-user/consumer. The source of this control is knowledge in both cases. At the consumption end, it is knowledge of the ultimate end-users' 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 end-users are willing to pay. By the very nature of their business, retailers and genetics companies have better access to information at these points of control. 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 end-user 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.

At this early stage in the process of shifting from impersonal markets to contract/ownership coordination, there may be a first mover advantage for organizations such as the very large producers or producers' cooperatives to play the control role. Thus,

initiative now by the intermediate firm level may offset the perceived advantage of firms at the end-points. Coordination by producers' cooperatives has the potential for the more traditional producers to retain a more prominent role. But unless such firms make preemptive moves early in the transformation from open markets to closed systems, the opportunity for control will likely be lost.

Presently, food systems coordination 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 end-user.

Discussions of vertical linkages by numerous analysts emphasize the importance of various characteristics of the firm and industry such as asset specificity, task programmability and performance measurement separability to the type and form of coordination between various stages in the production/processing/distribution chain. The arguments presented here concerning the critical role of knowledge and information as a source of power and control in the agricultural chain production/distribution are an extension of those concepts. 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.

### The Role of Information

Although numerous forces and drivers are contributing to the structural changes that are occurring in agriculture, 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 agricultural production system. And with power and control is the capacity to garner profits from and transfer risk to others with less power, as well as to influence the rate of technological and institutional change in the industry.

The increasing role that knowledge and information play in obtaining control, increasing profits and transferring risk in the agricultural sector is occurring for two fundamental reasons. First, manufacturing food and industrial products 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. the value 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 logical question then for individuals in the food and industrial product 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 and chemical companies, feed companies, machinery 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.

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 nutrition, genetics, building and equipment design, health and disease control programs, 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.

As knowledge and information becomes a more important source of strategic competitive advantage, those who have access to it will be more successful than those that 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/contract coordinated production system compared to the system of independent stages and decision making.

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 the grower pays for the service and how much 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 you need to become part of the system -- "in the loop" -- to obtain access to the latest information to be competitive?

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 new 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, and 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 private sector firms compared to the public 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 multi-national business firms; the shrinking role of the public sector in research and development and disseminating information; and the increasing importance of information compared to other resources as a source of strategic competitive advantage.

#### A Final Comment

Significant changes are occurring in the agricultural production/distribution sector; these changes will dramatically impact the management of production and distribution firms from sourcing of inputs through operations, finance, and marketing to end-users. Most significantly, these changes have profound implications for the skills and knowledge needed to be successful in the future. Without a doubt, technical knowledge and skills will be essential with the growing sophistication of the production process as well as the variety and demands of end-use markets. But technical skills and knowledge are not expected to be the core source of strategic competitive advantage. The skills needed to be successful in the future are more likely the human/personal skills -- skills like negotiation ability; creativity and



innovation; vision and strategic thinking; evaluation and acceptance of new technologies and institutional arrangements; recognition of segments, niches and diversity. These critical skills are more difficult to develop, but those that do so are expected to have a sustainable strategic competitive advantage in the changing world of agriculture.

#### References

1. Center for Agricultural Business, Marketing to the Commercial Producer, 1993 National Conference for Agribusiness, November 1993.
2. Michael Boehlje and Howard Doster, Top Grain Farmers View Farming in 2000, Purdue Agricultural Economics Report, June 1993.
3. Michael Boehlje and Lee F. Schrader, The Industrialization of Agriculture: Questions of Coordination, Staff Paper 94-13, Department of Agricultural Economics, Purdue University, 1994.