FOREWORD

Important concerns are being raised across Iowa and the nation over rapid and pervasive changes in the structure of the agricultural sector. Not only are farm operations growing in size and complexity, but the input supply and food production systems are undergoing dramatic changes. Control of input supply, especially genetic material, is rapidly being concentrated in the hands of a few very large producers, who control one end of the supply chain. The output end of the food supply chain is also becoming more concentrated with increased integration back to the producer.

The magnitude and pace of these changes is a matter of concern for producers, traditional agribusinesses and rural communities. What does the future hold for Iowa farmers, rural agribusinesses and communities? How can producers position themselves to take advantage of the changes that are occurring? How can they make an opportunity out of the challenges they face in production agriculture? What can individual producers do, and how can groups of producers position themselves, to exert more control over the food supply chain?

With growing public concern and such questions being posed, members of the Iowa State University Department of Economics spent the summer and fall of 1998 meeting with producers and rural agribusiness leaders. They compiled information on changes occurring in the food supply chain in Iowa, and how restructuring input and output markets would impact the food supply chain in the future.

This publication includes outcomes of the seminars that were conducted, surveys of the literature and research that should help inform the discussion on the changing structure of Iowa agriculture. These articles also should be helpful to producers, rural agribusinesses and communities as they position themselves to address future structural changes in agriculture.

We hope this effort will play a useful role in helping rural Iowans deal with the changes on the horizon, and in evaluating options for exerting more control over the food supply chain.

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AGRICULTURE IN THE 21ST CENTURY—SURVIVING AND THRIVING

Chapter 1
RECENT TRENDS IN INDUSTRIALIZED AGRICULTURE

By John Lawrence and Michael Duffy

The trend toward industrialized agriculture has been under way for several decades. Midwestern agriculture has moved from diversified farms and an agrarian society to increased specialization with greater use of capital inputs. These specialized farms tend to be larger and produce greater volume of commodities, often at smaller margins.

It is difficult to distinguish between an industrialized and a non-industrialized farming operation. Many of the practices associated with industrialization, such as replacing labor with capital, standardized production practices, and separation of labor and management from ownership, may be adopted individually on existing farms. Yet it is possible to look at some commodity sectors and see clear-cut trends towards more industrialized production.

Livestock and Poultry

One of the early examples of industrialization in animal agriculture occurred in egg production. In the late 1950s, Iowa was the number one egg producing state. Eggs were produced predominately on smaller, diversified farms, assembled at cooperatives and creameries, and shipped to population centers. But new technologies and production practices, such as battery cages, environmentally-controlled buildings and automated feed systems allowed for a reduction and standardization of labor.

These new technologies provided the ability to more intensively manage hens for optimal egg production and improved feed efficiency, reducing the cost per unit produced. It became advantageous to build these modern production units near population centers such as California and ship the grain from the Midwest to where the hens were located.

More recently, these large volume egg buildings have moved to the Midwest. Iowa is now the fastest growing egg producing state in the nation. It leads the nation in processed eggs, and it now is possible to put Iowa-grown table eggs in downtown Los Angeles cheaper than from California layers. This has come about by combining technology and industrialized production methods with the low-cost feed of Iowa. Now Iowa is number three in egg production, and growing rapidly.

Cattle feedlots are another example of industrialization in the livestock sector. Again, Iowa was number one in cattle production from 1968 to 1971, feeding more than four million head of cattle a year, or about 18 percent of all U.S. cattle on feed. These cattle were fed in thousands of small farmer lots. Technologies such as computerized projection models more effectively predicted the growth of cattle based on feed intake, and irrigation brought low cost feedstuffs into an otherwise arid climate. So there was a movement to the high plains region of the Texas Panhandle through to central Nebraska.

Feedlots expanded, managing several pens of cattle that were fed specific diets for optimal performance on a year-round basis. Ownership of the feedlot was separated from ownership of the cattle as professional managers began providing customized feeding services to individuals, treating cattle feeding as an investment. These specialized feedlots gained market share, particularly during the time of rising grain prices in the early ‘70s when many Iowa farmers found it advantageous to sell grain rather than feed it.

As Iowa farmers became more specialized in grain production, the high plains feedlots became more specialized in cattle feeding. The packing infrastructure also began to relocate in the new cattle feeding regions. In recent years, some Iowa feedlots have adopted many of the same management practices, such as weighing all feedstuffs, specialized diets, the use of consultants to more accurately monitor nutrition and health of the animals, and computerized projections to more accurately predict marketing dates and cost efficiencies. Research has shown that combining these technologies with the low feed cost of Iowa makes Iowa the low cost place to feed cattle.

Milk production also has become more industrialized. Wisconsin, Minnesota, northeast Iowa and northern Illinois have been the predominant dairy belt for years. But industrialized dairies have made California the leading milk producing state. Many of these have 1,000 to 5,000 cows, whereas average dairy size in Wisconsin would be less than 50 head. Technologies that improve the efficiency of these specialized dairy farms include the use of artificial insemination and embryo transfer to gain rapid genetic improvement, the use of consultants to optimize production, and computerized models to formulate least-cost rations from a multitude of different feedstuffs available on the West Coast.

Recently, other states have begun to increase dairy production as many large scale California dairies are being crowded by urban sprawl. Texas, New Mexico and Idaho have grown rapidly in milk production using the industrialized model. Some displaced California dairies are moving to the Midwest and are combining technology and management skills with low-priced feedstuffs. Milk prices in the Midwest are higher than in California and feedstuffs cost less. So the cost price advantages are enough to offset potential adverse weather effects in the Midwest.

Pork production is the most vivid example of industrialization in Iowa. Iowa remains the national leader in pork production, but it is second in the number of pigs farrowed. There has been rapid consolidation of pork production into fewer, larger and more specialized production firms. As in the earlier examples, technology is leading the change. The traditional farrow-to-finish enterprise has been replaced by three-site production, with the breeding herd and very young pigs on one site, nursery pigs on a second and finishing on a third. The pigs are typically owned by the same individual but may be raised on contract by other farmers. The farrowing site may be owned jointly by a group of farmers who take their share of pigs home to their independently operated farms.

Modern hog farms are capital intensive and rely on a high level of throughput to reduce overhead cost-per-unit produced. They also rely on standardized production practices, facilities and labor to simplify management. Finding, hiring and motivating employees is a much greater challenge for these firms than for the individual farmer who is the primary owner, labor supply and decision maker. The single-purpose farms also allow for greater specialization of labor and management.

As in other livestock sectors, modern pork production has increased its reliance on technology. Superior genetics result from buying gilts from genetics companies rather than raising them on the farm. Artificial insemination has increased dramatically particularly among the largest operations. High speed, single species feed mills running on a continuous basis delivered in large truckload lots reduces the cost of feed.

There also has been growth in contract production of hogs. Previously, the farmer provided equity capital, borrowed capital, all labor, made all management decisions and stood all the risk. Contracting allows the individual to reduce the reliance on employees and brings nontraditional capital into the pork industry.

Though contract terms differ, most production contracts are similar. While the owner of the hogs may own some facilities (typically the breeding herd facilities and maybe a portion of the finishing facilities), the facilities and labor are contracted. The grower provides a building site and building, land for manure management, and the day-to-day labor to operate the building and care for the hogs. The owner of the hogs provides the management decisions regarding type of facility, genetics, nutrition, and marketing, and pays the grower a contract fee for the use of the capital in the facility and labor provided.

The hog owner then can invest more in liquid assets such as inventory and operating expenses rather than into fixed assets such as facilities, leading to rapid growth. The grower has invested in the fixed assets (facilities) but is typically able to realize benefits from contracting by marketing available labor and equity that may otherwise go unused and, if combined with a cropping operation, reduce the cash expenditures for fertilizer.

Terminology within the modern hog production sector reflects industrialization. Terms include optimal throughput, just-in-time inventory deliveries of feed, scheduled pig flow to optimally utilize facilities, and transportation logistics of moving animals between facilities and to harvest. There is greater use of contractual relationships between input suppliers and producers, and between producers and processors.

The movement to industrialization in the livestock and poultry sector was driven at least in part by early adopter profits. Technology adoption improved the efficiency of firms and increased the profitability of these early adopters. Because the ownership and management were separated from labor, these profits were often reinvested into the standardized production systems to grow the firm. As long as existing or new technologies mean cost of production is below that of the marginal producer, there is an opportunity to reinvest adopter profits. While profit margins may be narrower, the increased volume of industrialized farms generates larger annual return than traditional farms.

There are emerging examples of post-industrial management practices in the livestock and poultry sectors. Instead of relying on large volumes of commodities using standardized production practices, some firms are beginning to produce animals for specific markets using prescription production practices to add value and optimize profits.

Post-industrialization management in the pork sector uses computers to manage the environment within a facility. Contract finishing buildings linked by modem to a centralized control center can be monitored for feed intake, water usage and temperatures. While this may reduce the management skills required by the grower, it also allows greater control and risk-management by the pig owner.

Within the beef industry, electronic identification is available to identify individual animals that can be managed and marketed to allow traceback from conception to consumption. Databases on these animals enable management decisions based on factual real-time information about animals in a herd. This emerging technology shifts the focus from capital intensive industrialization of a commodity to management intensive individualization of the animal product. It provides early adopters of this technology the ability to more effectively manage their operation.

As with the move to industrialization, early adopters of emerging technology gain the greatest profits in the post-industrial era.

Crop Production

Cropping systems have undergone changes towards industrialization similar to livestock. The changes have occurred in all phases of crop production and have been underway for centuries. However, the pace has accelerated over the past few decades.

Labor use in crop production practices vividly illustrates the move toward industrialization. For the period 1945 to 1949 the USDA estimated it took 19.2 hours per acre for corn and eight hours per acre for soybeans. A 1996 survey of cropping practices in Iowa revealed that for corn following corn, the hours of fieldwork per acre had dropped to 1.2, the hours per acre for corn following soybeans had decreased to one, and the labor for fieldwork for soybeans had decreased to just under one hour.

The labor use per unit of output shows the changes even more dramatically. For the 1945–1949 period it took an average of 53 hours per 100 bushels of corn and 41 hours per 100 bushels of soybeans. Using the current Iowa average yields of 138 bushels for corn and 44 bushels for soybeans, the average time for corn has dropped to 45 minutes per 100 bushels of corn and 2.2 hours for 100 bushels of soybeans.

The crops planted in Iowa have changed dramatically. In 1950, 94 percent of the farms had corn and corn represented 30 percent of the acres of cropland in the state. By 1992, corn was planted on 75 percent of the farms and the percent of cropland devoted to corn had increased to 40 percent. Soybeans were planted by 28 percent of the farmers in 1950 and were on just 4 percent of the cropland. By 1992, soybeans were planted by 62 percent of the farmers and represented 26 percent of the acres of cropland. This means that corn and soybeans have gone from being planted on just one-third of the acres in 1950 to almost two-thirds of the acres in 1992. Oat plantings showed the biggest drop. In 1950, 81 percent of the farms planted oats on 17 percent of the acres. By 1992, just 18 percent of Iowa farms planted oats on only 1 percent of the cropland acres in the state.

Changes in fertility and pest management are the primary reasons for changes in cropping patterns. Nitrogen fertilizer was used on 80 percent of the corn acres in 1965, at an average application rate of 45 pounds per acre. In 1996, nitrogen was applied to 98 percent of the corn acres, at an average rate of 132 pounds per acre.

In 1954, 11 percent of the corn acres were treated with a herbicide. Today 98 percent of the corn acres and almost 100 percent of the soybean acres receive a herbicide application.

Changes in herbicide use are reflected in the use of row cultivations as a means of weed management. In 1989, 85 percent of the soybean acres were row-cultivated at least once. By 1996, only 49 percent of the soybean acres were row-cultivated at all. The decrease in row cultivations for corn has not been as dramatic, but it has been substantial. In 1989, 88 percent of the continuous corn acres were row-cultivated and in 1996, 76 percent were cultivated. For rotated corn, the percent of acres row-cultivated at least once was 88 in 1989 and 65 in 1996.

Insecticide use remains low on soybeans with something less than 5 percent of the acres treated annually. But for corn, the use of insecticides increased from 4 percent in 1954 to a peak of 41 percent in 1986. The latest estimates are that 21 percent of corn acres receive an insecticide application.

Pesticide application methods is another area that shows the shift towards industrialization. In 1996, 47 percent of the pesticide applications to corn and 43 percent for soybeans were done by custom operators.

Overall machinery use has shifted considerably over the past few decades. For example, in 1989, 23 percent of the continuous corn acres and 7 percent of the rotated corn acres were moldboard plowed. By 1996 only 10 percent of the continuous corn and 2 percent of the rotated corn acres were moldboard plowed. On soybeans the use of the moldboard plow has decreased from 25 percent of the acres to 7 percent from 1989 to 1996. Other operations have shown similar changes in use.

Planting methods also have changed over the past few years. In 1989, just 2 percent of the soybean acres were drilled. In 1996, 28 percent were drilled.

The average size of farms has nearly doubled from 169 acres in 1950 to 325 acres in 1992. Correspondingly, the number of farms has dropped by over half from 203,159 in 1950 to 96,543 in 1992.

These Census of Agriculture statistics do not give an entire representation of what is happening with respect to the structure of agriculture. A 1997 survey of Iowa farms found that 56 percent had sales of less than $50,000, the amount the USDA uses as the cutoff between commercial and non-commercial farms. There were 37 percent of the Iowa farms with sales between $50,000 and $250,000 in sales. The USDA Small Farms Commission defined a small farm as one with sales less than $250,000. Using this classification scheme, the non-commercial farms farmed an average 179 acres, the small farms had an average of 509 acres and the large farms had an average of 1,002 acres. Note that the large farms, which are 7 percent of the Iowa farms, averaged more than three times the number of acres as the Census average farm.

There has been an increase in the percentage of farmers who do not consider farming their principal occupation. These people fall into several categories including retired persons who either continue to farm or start farming. There also are part-time farmers, many of whom are able to farm considerable acreage by using custom operators and farming on the weekends or evenings. In the five years from 1987 to 1992, the percentage of farmers who consider farming their principal occupation dropped by 11 percent, while the percentage of farmers who consider something else their principal occupation dropped only 1 percent.

Future changes to crop production promise to be as dramatic. The biotechnology revolution will primarily lead the changes. Biotechnology applications have dramatically changed the pest management options available. Herbicide resistant genes have been inserted into both corn and soybean plants. These traits allow farmers to pursue pest management options that have not been available in the past.

There are many other applications to which biotechnology has been and is being applied. There are applications that increase the desirable traits of certain crops. There are other attempts to use the growing crop simply as a production site for non-food uses. For example, there is work under way to create insulin from crops.

On one hand things seem to point to continued consolidation and decreases in farm numbers. However, market segregation may provide niche opportunities for producers who are willing to keep their product segregated and sell based on specific attributes rather than in bulk. Indeed, the fastest growing segment within the cropping sector is organic production.

The big key will be how much we continue to rely on bulk with tight margins versus relying on smaller, higher value production. Studies of data from the Iowa Farm Business Association suggest that the low point in terms of cost of production per unit of output occurs somewhere between 400 and 600 acres. The increases in size that occur beyond this point are driven by income considerations, not decreasing costs.

The changes through industrialization in cropping have produced higher yields, but have come at a cost. Farmers are producing more but the increased production comes with the increasing use of external resources that increase the cost of production. These external resources are such items as fuel, pesticides and fertilizers. Their increasing share of cost of production can be seen in the change in net farm income as a percent of gross farm income. In the 1950s, net averaged 35 percent of the gross. Over the last decade, net as a percent of gross farm income has averaged less than 20 percent.

Contracting also promises to change the face of cropping practices perhaps more so than in the livestock industry. Contracts for specific attributes or production methods already exist.

In some cases the farmer shifts from being an entrepreneur to being a contract laborer providing equipment and land, but bearing no risk, making few management decisions and earning a lower return. In other cases, the farmer will take on more of an entrepreneurial role developing the markets as well as doing the production.

Change is inevitable in livestock and cropping practices, just as in anything else. What is not inevitable is the direction of the change. There is work underway to look at widening profit margins by increasing the value of the production and/or decreasing the costs of production. Some of the methods are scale neutral but other methods may actually lead to a reversal of the current trends.

Chapter 2
THE ROLE OF RESEARCH & DEVELOPMENT AND OF NEW TECHNOLOGIES

by Wally Huffman and Giancarlo Moschini

Iowa agriculture has undergone steady and seemingly relentless technological change during the 20th century, particularly in the post-war period. The adoption of increasingly mechanized techniques, the use of new chemical inputs such as herbicides, pesticides and fertilizers, the availability of genetically improved crops and animals, and countless other technical and organizational improvements have dramatically changed the way agriculture is practiced in the state of Iowa and elsewhere. The dawn of biotechnology, the promises of precision agriculture techniques, and the widespread diffusion of new information technologies have accentuated the sense that the change in structure affecting Iowa agriculture has a lot to do with technological change.

The Roots of Change

Technical change in agriculture during the post-World War II period has been primarily science-based. Scientific research, both public and private, leads to new discoveries or the creation of knowledge that drives technological change. With successful research and development (R&D) activities, discoveries occur, new technologies are commercialized, and farmers adopt the ones they find profitable or that enhance their goals. However, advances in technology also creates a demand for additional scientific research to solve unanticipated problems, to counter biological erosion of past advances, and to refine the scientific basis of some of the new technologies that are successful. With R&D being a continuing process and producing a steady stream of new innovations, the structure and organization of agriculture is under steady pressure to change.

Public agricultural research is conducted largely in the agricultural experiment stations and USDA laboratories, and is a major source of discoveries in basic and pre-technology sciences that ultimately benefit Iowa farmers. The periodic strengthening of intellectual property rights has broadened the areas of research the private sector finds profitable, and the public sector has accommodated this private sector expansion by focusing largely on complementary research in the basic and pre-technology science areas. The private sector, however, continues to find applied research in some areas unprofitable, such as genetic improvement of most open-pollinated crops, food safety and human nutrition, agricultural and rural policy, natural resource and environmental issues. Some research in these areas is socially worthwhile, and it continues to be an important area for public applied research.

The private sector has long been an important player in the production and marketing of innovations to the agricultural sector. In fact, the private sector has been the leader in the marketing of two broad classes of innovations – mechanical and chemical – that have been a major factor in shaping the current structure of Iowa agriculture. Mechanization and chemical inputs have allowed production techniques that economize on labor. In fact, the migration of labor from the agricultural sector to the rest of the economy has been the most striking feature of post-war U.S. agriculture.

In recent years the importance of private agricultural research has grown considerably, relative to public research. One estimate for 1995 puts total U.S. private agricultural research at $3.8 billion, roughly 30 percent more than the entire budget of U.S. public agricultural research. This is probably a conservatively low estimate, and there is considerable evidence that private agricultural research expenditures are increasing faster than U.S. public expenditures. What is perhaps more interesting is that the new trend in private research is concentrating on biological innovations, an area that was traditionally dominated by publicly sponsored research. Two main factors are responsible for this development. First, the dawn of biotechnology, which has opened up opportunities that were simply not there in the past. Second, an institutional change in the law governing intellectual property rights that has increased the incentives for private capital to invest in the development of biological innovations. This second development is crucial to understanding the economic implications of what the future may bring.

Protecting the products of human ingenuity so as to create incentives for inventiveness and progress is a well-established principle in the U.S. legal system. Such protection takes the form of patents, copyrights, trademarks and trade secrets. The patent right is perhaps the most powerful means of protecting intellectual property, essentially endowing the patent holder with monopoly rights on the innovative product/process for a limited time period (usually 20 years from filing). But biological innovations for a long time did not fall within the statutory domain of utility patents. Because patents are not meant to apply to 'products of nature,' the output of agronomic and biological research was offered a different kind of intellectual property protection through the Plant Patent Act of 1930 (for asexually reproduced plants) and by the Plant Variety Protection Act of 1970 (for sexually reproduced plants).

The legal protection of biological discoveries useful for agriculture was drastically changed by the 1980 Supreme Court decision in *Diamond v. Chakrabarty*, and reinforced by a 1985 Patent and Trademark Office ruling. The end result is that an array of genetically modified plants and other living organisms are now in the statutory domain of utility patents. Transgenic farm animals can be expected in the near future, and transgenic plants have already been produced and patented. In addition to the increased relevance of utility patents, trade secret laws offer further protection of intellectual property relevant to plants. This is particularly important for hybrid varieties (virtually all corn, for example), where commercialized F_1 seeds ensure hybrid vigor only for the first generation of plants. As the case of *Pioneer v. Holden* demonstrated, trade secrets laws can effectively protect intellectual property for hybrid corn.

In summary, the institutional setting in the United States and other developed countries has been steadily moving toward strengthening intellectual property rights for innovations, not only in the private sector, but also in the public sector. The USDA always had a policy of patenting innovations, although until 1980 it required that they be licensed on a non-exclusive basis. This policy changed in 1980, and it is now possible for federally owned patents to be licensed on an exclusive basis. Since 1984 it is also possible to seek private patents for research partially funded by the federal government. Patent protection is now routinely being sought for many innovations developed by land grant universities, primarily to keep discoveries from public research in the public domain. All of this means that the flow of technological advances that have changed the structure of Iowa agriculture cannot be expected to slow in the foreseeable future.

Innovations in Agriculture

These R&D activities have resulted in a stream of innovations that have been adopted by Iowa agriculture. One of the main effects of innovations is to increase the productivity of inputs used in the production process. A widely used measure in this context is that of Total Factor Productivity (TFP), which attempts to measure how much output is generated by the totality of inputs under the control of farmers. Roughly speaking, if the same amount of inputs generates increasing levels of outputs, then TFP is increasing and that is taken as evidence of the size of technological change that has taken place.

Table 1 reports productivity measurements for Iowa agriculture for the period 1960-96. The peri-

Table 1.

Aggregate performance indicators for Iowa agriculture

	1960-80	**1980-96***
Total Output	1.8 %	0.8%
Crops	3.5%	1.4%
Livestock	0.4%	-0.6%
Total Inputs	0.8%	-2.1%
Materials	1.4%	-2..0%
Capital	1.5%	-2.2%
Labor	-1.5%	-2.3%
TFP	1.0%	2.9%
Number of farms	-2.2%	-1.2%

** preliminary* *Source: USDA, ERS*

od 1960-96 is split into two sub-periods, 1960-80 and 1980-96. TFP growth of Iowa agriculture has been positive and sizeable over both periods. During 1960-80, total output grew at an annual average rate of 1.8 percent, and total input at 0.8 percent, giving TFP growth of 1 percent. During 1980-96, total output and input grew at slower rates, 0.8 percent and -2.1 percent, respectively, giving a TFP growth rate of 2.9 percent for the latter period. Thus, although Iowa agricultural output grew at a faster rate during 1960-80, the productivity gains of Iowa agriculture, in terms of TFP growth, have been faster during the post-1980 period.

Such increases in productivity are usually not achieved in a “neutral” fashion. Perhaps the most common effect of an agricultural innovation is to change the mix of inputs used to produce a given output. For example, chemical inputs and mechanization have allowed the development of agricultural production techniques that require far less labor to produce a given level of output. Thus, this “technology push” is a possible explanation for the massive exodus of farm labor suffered by the U.S. agricultural sector in the last 50 years. An alternative explanation is that labor moved out of agriculture because of higher wages in the non-farm sector, and that new technologies were developed to substitute for this loss of labor. No conclusive empirical evidence exists as to which of these explanations is more relevant.

Agricultural innovations also change the mix of outputs that are produced in a given farm or region. Because innovations may result in cost savings that are not evenly distributed among alternative enterprises, a farmer may find that the relative profitability of alternative products is affected by the introduction of new production techniques. But, most importantly, many innovations are likely to have a “scale bias” because often the benefits to the farmer of adopting a new technique can be amplified by increasing the size of the operation. Mechanization provides the quintessential example of a set of innovations that have favored the development of larger farms, but many other innovations arguably have a direct scale bias. Other agricultural innovations would seem to have no direct bearing on farm size as far as the immediate effects of their adoption. For example, a new and more productive hybrid variety of corn would seem to be equally attractive to small and large farms, and therefore to be scale neutral. Even in such a case, however, important indirect economic effects are possible. Because the more productive variety will tend to increase total supply, it may depress output price, which in turn may have unequal effect on the profitability of farms of different types. Such indirect feedback effects may turn out to be crucial for the long-run structure of agriculture.

The changing composition of inputs and outputs in Iowa agriculture is also illustrated in table 1. Crop output has been growing relative to livestock output. (Note that all crop output in a given calendar year is assumed to go into inventories and all on-farm feed fed to livestock and grain sales are assumed to come from inventories, so crop output is gross output.) During 1960-80, crop output grew at an annual average rate of 3.5 percent and livestock output at a much slower 0.4 percent. During 1980-96, crop output grew more slowly at 1.4 percent and livestock output had a negative growth rate of -0.6 percent. Therefore, the ratio of crop output to livestock output increased 94 percent between 1960 and 1996—a fairly dramatic change in output mix.

As for the inputs, there are three major categories: materials (consisting of fertilizers, pesticides, fuels, seeds, feed, etc.), capital (land, buildings, machinery, equipment, and breeding stock), and labor (the sum of operator, family, and hired labor). Materials grew at 1.4 percent and capital inputs grew at 1.5 percent during 1960-80 as Iowa agriculture generally used increasing amounts of agricultural chemicals and made net investments in new and larger farm equipment and machinery. During 1980-96, the trend changed dramatically as farmers reduced agricultural chemical use and other annually purchased inputs, and disinvested in farm machinery, equipment, and buildings by letting depreciation and obsolescence exceed gross investment in these durables. The Iowa agricultural labor input declined -1.5 percent per year for the 1960-80 period and faster during 1980-96 at -2.3 percent. As for the relative trend in input use, during 1960-80 the materials-to-labor ratio increased at an annual average rate of 2.9 percent, but during 1980-96 it slowed to only 0.3 percent. The capital-to-labor ratio also increased rapidly during 1960-80 at 3.0 percent but only slightly during 1980-96.

The technical change that has occurred in Iowa agriculture has resulted in production becoming increasingly concentrated on farms that specialize in producing a particular commodity or commodity group. U.S. Census data for Iowa farms by type in 1974, 1982 and 1992 shows that the share of all cash grain sales produced on specialized cash-grain farms increased 2.2 percent between 1974 and ‘92, of all livestock and livestock products produced on specialized livestock farms increased 10.9 percent, of dairy products produced on dairy farms increased 9.2 percent, and of poultry and eggs on specialized poultry and egg farms increased 14.8 percent. During the same period, the share of output produced on general farms decreased slightly. Thus the increased specialization of production on Iowa farms has resulted from "specialized farms" becoming more specialized in producing the commodity or commodities associated with their type-classification rather than from a dramatic reduction in the share of the commodity produced by the general farm types.

Economic Benefits

The notion that technological change is "good" is widely accepted. That is why we often refer to it as "progress." New technologies allow us to get more output from a given resource base or, alternatively, require fewer inputs to produce the same level of output. Quite clearly, and barring considerations of externalities and other market failures, technological change brings economic benefits to society as a whole. A number of studies have consistently shown high economic benefits to society at large from agricultural innovations. But because the adoption of new technologies changes the equilibrium of the market system, it does not follow that technological change benefits everyone.

Because farmers are the immediate users of new agricultural technologies they are in a position to benefit directly from the productivity-enhancing attributes of agricultural innovations. Early adopters of new technologies are believed to benefit the most by enjoying increased productivity at pre-innovation prices. Yet adopting new technologies is inherently a risky undertaking because the "wrong" technology may be adopted, or because the "right" technology may be adopted too soon, such that early adopters may pay significantly more for the new technology than later adopters. Some farmers may face climate, soil or size disadvantages with respect to adopting a particular technology. What is optimal for one farmer may not be optimal for another. But perhaps the most important implication of increased productivity is that agricultural output tends to increase in the aggregate. Equilibrium in agricultural markets then implies that this expanding agricultural output tends to decrease agricultural prices. The decline in output price that results from the introduction of new technologies reduces the benefits to farmers. Early adopters may see their profit margins reduced, and later adopters may have no benefit at all. The lower price of the output sold by farmers is the main vehicle by which agricultural innovations benefit consumers. Processors and retailers may benefit as well as the product is moved "from the farm to the table."

The adoption of new production techniques has implication on the input side as well. In fact, because most innovations are embodied in new and improved inputs, farmers may have to pay extra to access new technologies. In other words, some of the benefits of more productive techniques may be captured directly at the source by the suppliers of agricultural inputs (new seeds, herbicides, pesticides, machinery, breeding animals, integrated feed, etc.). This consideration is particularly pertinent when suppliers of a new technology enjoy a monopoly position because patents protect their innovation. In such a case the price of a new technology will not necessarily reflect the cost of producing the new or improved input, but will reflect the productivity-enhancing attributes of the innovation. A clear example of the importance of this argument is offered by the recent introduction of biotechnology innovations, such as Roundup-ready soybeans and Bt corn, which featured a technology fee.

At given output prices, such monopoly input pricing is unlikely to extract all of the benefits of new technologies from farmers. However, because of the increased presence of the private sector in the production of agricultural innovations, and because of the increased legal protection offered to intellectual property, the potential for the input-supply sector to appropriate a larger share of the benefits from innovations may be a source of concern.

The foregoing discussion suggests that farmers may not be the primary beneficiaries of productivity gains made possible by new agricultural technologies. Although farmers as a group seem likely to get some of the "surplus" created by innovations, changes in the profitability of farming in the long run are capitalized in the asset value of fixed resources, particularly land. This may be good news for farmers who leave the agricultural industry. But when technological change leads to higher land prices, there is a cost to farmers remaining in the industry, and to new farmers. In an industry where land ownership is increasingly divorced from the ownership of the farm business, the benefits of innovations to farmers would seem to be likely only for those who are successful as early adopters of new technologies.

Chapter 3
ENVIRONMENTAL TRADEOFFS

By Bruce A. Babcock

What is the environmental price of the coming changes in agriculture? To some, the price seems high. Large livestock operations can pollute rivers and streams and create strong odors, decreasing the quality of life in rural areas. Ever-larger crop farms increasingly rely on pesticides instead of cultural practices such as crop rotation and cultivation to control insects and weeds. The need to cover more ground in a timely manner means less chance to tailor farming practices to a field's special attributes, thus leading to uniform treatments of seed, tillage, fertilizers and chemicals. Greater emphasis on efficient utilization of land resources means less use of conservation practices such as terraces, windbreaks and grass waterways, resulting in increased loss of soil.

But others argue that the environment will actually improve from the coming changes in agriculture. New seeds that are insect and disease resistant decrease the need for pesticides. New insurance products help lower the risk of adopting environment-friendly production practices such as integrated pest management. And the greater control over livestock manure on new, highly-capitalized livestock operations means greater utilization of manure nutrients.

Clearly the environment will be affected by the agricultural revolution occurring in Iowa. But because there are so many dimensions to the environmental changes, there is no clear-cut method for determining whether the net change will be positive or negative. Many of the changes coming to agriculture have the potential of both hurting and helping the environment. For example, herbicide-resistant soybeans encourage farmers to increase their reliance on herbicides, which can lead to increased concentration of residues on crops and in water. But more herbicide use decreases the use of tillage to control weeds, a change that reduces soil erosion. So there is an environmental tradeoff — greater risk of herbicide residues and reduced risk of soil erosion.

The two dominant trends in agriculture since 1900 are a decrease in the number of farmers with a resulting increase in farm size, and rapid technological change. While the future environmental effects of these two trends is uncertain, it's possible to look at some likely scenarios. We begin first by looking at the environmental effects of increases in farm size on the crop and livestock sectors.

Effects of Larger Crop Farms

How can putting more cropland under a single farming operation lead to environmental changes? After all, the vast majority of Iowa farmland will continue to be devoted to corn and soybeans regardless of how production is organized. So if there are any environmental effects from increases in farm size, they must result from changes in the way corn and soybeans are grown.

One of the key factors that determines if a producer achieves top yields in a given year is whether field operations are accomplished on time. Late planting, late herbicide applications, late cultivation and late harvest all can cut yields. A farmer with 5,000 acres of cropland faces much greater timing risk than one who is responsible for 500 acres. There are steps the larger farmer can take to reduce this risk. The most obvious step is to invest in machinery with much larger field capacity. Not surprisingly, USDA reports indicate that large farmers have higher capital-to-labor ratios than smaller farmers. The second step farmers can take to reduce timing risk is to eliminate field operations. Planting and harvesting must still go on, but reducing the number of tillage operations in the fall and spring creates more time for critical planting and harvesting operations.

Tillage operations include all field operations where the soil is disturbed and/or the amount of soil covered by crop residue is reduced. Such operations occur in the fall after harvest when farmers disk their fields, in the spring when farmers work their soil in preparation for planting, apply soil-incorporated herbicides and plant, and in the summer when fields are cultivated. One of the primary benefits of these tillage operations is weed control.

Farmers can reduce or eliminate their tillage operations by investing in new equipment (for example, no-till planters), and by relying on herbicides for weed control. Since the early 1980s farmers have been able to reduce tillage operations on corn and soybeans with an application of pre-emergent herbicides in the spring and one or more applications of post-emergent herbicides in June. Now soybean farmers have the option of eliminating the application of pre-emergent herbicides by relying solely on post-emergent applications, especially if the soybean variety is herbicide tolerant.

Because chemical control takes less time to complete than a combination of chemical and mechanical control, farmers who place a premium on saving time will tend to opt for chemical control. Also, recent experience suggests that chemical control of weeds can save farmers money by reducing the number of trips across a field. These cost savings arise from reductions in fuel and labor use, and reductions in the size of machinery needed. These savings can be substantial, particularly when a farmer places a high value on his or her time. Thus, as farm size increases, farmers will continue to move towards chemical control of weeds and away from mechanical control.

The environment will be affected in two ways. More fuel and herbicides will be used to produce crops but less soil will be washed and blown away. The primary means of reducing soil erosion is to cover soil with crop residues. Tillage operations reduce this residue cover, thereby increasing soil erosion. As farm size grows, we should expect to see use of no-till and reduced-till farming practices increase, which will tend to reduce soil erosion rates. Given the trend towards larger farms, the only way future soil erosion will increase is if these farms reduce their use of other soil-conserving practices, such as installation of grass waterways and terraces.

Whether the environment is a net winner or a net loser from the tradeoff of chemicals for soil depends on society's valuation of chemicals and soil. Traditionally, soil conservation has been the primary objective of environmental programs in agriculture, which suggests that society values this objective highly. But society seems to be placing more weight on reducing chemical use in agriculture. Herbicide residues are the most common agricultural chemicals found in Iowa drinking water supplies. Increased use of herbicides generally will mean greater chemical residues but less sediment. To those who value reductions in chemical use more than saving soil, the move to larger crop production units in Iowa may be viewed as detrimental. But those who want to guarantee that Iowa's soil productivity will be maintained for the next 100 years may view increased herbicide use as a favorable development.

Effects of Larger Livestock Farms

The trend towards larger livestock operations continues unabated. The environmental problems of livestock operations people are most concerned about arise from increased concentration of livestock rather than a total increase in livestock numbers. In Iowa, total livestock populations of hogs, cattle, and poultry are lower in 1998 than they were in 1958.

Increased concentration means that fewer locations have livestock, but the ones that do have far more of them. From 1992 to 1996, 58 percent of Iowa's counties lost more than 20 percent of their hog populations; 33 percent of counties had hog populations that did not change by more than 20 percent; and 9 percent of counties experienced more than 20 percent growth. The total hog population in Iowa fell by 16 percent. So most Iowa counties lost a significant proportion of their hogs in a short time period. But during this time period, the environmental effects of hog production came to the forefront of agricultural and environmental policy debates in Iowa. One can only conclude that at least a portion of the concern about environmental damage arises solely from increased concentration of livestock, rather than overall livestock numbers.

Often the initial public concern over large livestock operations results from increased odor emissions. Increasing the number of animals on a site, or putting livestock on a new site, increases total odor emissions. People who live or work near a new or expanded livestock facility may be harmed by the increased odor.

But concluding that increased concentration of livestock results in increased damages from odor ignores the fact that increased concentration implies odor reductions for people who live in areas that have lost livestock. As noted earlier, nearly 60 percent of Iowa's counties lost significant numbers of hogs from 1992 to 1996. There must have been a reduction in odor in many parts of these counties.

Are the benefits that accrue to those who are no longer exposed to odor greater than the harm suffered by those in the areas with more hogs? Put another way, would there be less total harm if all counties had the same number of hogs or if half the counties had all the hogs? The answer to this question depends in part on whether most of the damage from hog odor occurs at low hog numbers or high hog numbers. If most of the damage occurs at high hog numbers, then total odor harm to Iowa citizens is lower if hogs are dispersed widely throughout the state because then nobody suffers a great deal. However, if a large proportion of harm from hog odor occurs even at low hog numbers, then total odor damage will be reduced by eliminating hogs from as many counties as possible. This is not to say that the residents in the counties that receive the extra odor are not worse off. It is just that the residents in the counties who lose the hogs gain more than the losers lose.

This simple analysis does not consider a number of factors that affects total damage from odor. For example, if counties that gain hogs have fewer residents than those counties that lose hogs, increased concentration would tend to be favored because total damage from a given number of hogs in the more populated county would be greater than in the less populated county. Also, if larger production facilities invest more per hog in odor-reduction technology, total damage will tend to increase at a decreasing rate if increasing hog numbers in a county are raised on large units.

But the basic point remains. There are odor winners and losers from increased livestock concentration. Residents in counties that lose livestock benefit from a reduction in livestock odor. Whether the population as a whole benefits from increased concentration depends on whether these benefits are greater than the losses borne by those who live and work in areas where the livestock is concentrated.

Livestock operations can pollute surface and groundwater from either the production site or from farm fields where manure is applied. Many cattle and hog operations manage manure by “scraping and hauling.” Solid manure is scraped into piles and periodically hauled to application fields. Barriers often are used to prevent solids from moving into waterways. Larger operations must follow EPA regulations and capture liquid and solid runoff in ponds or lagoons. Smaller operations do not have to capture the liquid runoff. Thus, traditional livestock operations are a source of small, chronic losses of manure from production sites.

One impetus for the movement to hog confinement operations in the late 1960s and early 1970s was to exert better control over manure. Deep-pit systems capture all solids and liquids, thus reducing the chronic losses of manure from production sites. Today, most large hog operations in Iowa use either a traditional deep pit system or store manure outside the confinement buildings in either earthen storage basins or storage facilities formed from concrete or steel. Typical storage capacities of new facilities are 12–18 months of manure. Thus, manure is usually hauled to fields once a year.

Capturing and storing manure reduces the chronic contamination caused by relatively small losses of manure from traditional livestock operations. But many argue that this benefit is small when compared to the risk of storing large quantities of manure on-farm. Failures of manure storage structures happen. According to Iowa Department of Natural Resources records from 1992 to 1997, at least 26 manure spills occurred in Iowa. Most of these spills involved manure overflows. Others involved leaks from concrete pits, collapse of an earthen pit wall, or accidental release of manure as it was being pumped out of storage.

Water quality in Iowa would improve if all livestock were produced in confinement systems and there was no chance of accidental spills. However, because there is a risk of spills, and there are no regulations or management practices that can lower the risk to zero, the movement to large confinement operations in Iowa involves another environmental tradeoff. That is, less chronic water pollution and greater risk of a large pollution event. Tighter construction regulations, more inspections and larger fines can lower the risk of large spills, making the tradeoff a positive one for many. But some people are not willing to accept this tradeoff, regardless of the size of the risk.

The other source of water pollution from livestock operations is runoff from fields where manure is applied. The most serious field runoff occurs when heavy rainfall follows manure applications. The most severe losses occur when manure is broadcast on the surface and not incorporated into the soil. Do producers have an incentive to soil-incorporate their manure?

There are two costs of incorporating manure. The first is the direct additional machinery and labor cost. Putting soil on top of manure takes specialized equipment and energy. The other cost is indirect. Soil incorporation disturbs crop residue cover. Crop farmers who want to maintain a high level of crop residue to control soil erosion will be less likely to want to soil-incorporate manure.

The benefit of incorporating manure is that it conserves the nitrogen in the manure. Typically 50 percent of applied nitrogen is lost if manure is not incorporated. Thus crop farmers who want to replace commercial fertilizer applications with livestock manure are more likely to incorporate than those who do not.

Producers have an incentive to incorporate manure when the benefits outweigh the costs. Crop producers who want to replace commercial fertilizer applications with manure and who do not have soil erosion problems are the most likely to soil-incorporate. Livestock operators who view manure as a waste product have the incentive to minimize the cost of waste disposal so they will typically not incorporate manure. Large crop farmers will move towards replacing commercial fertilizer applications with manure only if they can locate a supplier with large quantities of manure available at the time nutrient applications need to be made. Large manure stocks will only be available from large confinement operations. Thus the increase in the size of livestock operations is conducive to greater utilization of manure nutrients by soil incorporation. This will lead to less manure runoff from farm fields because the manure from large facilities is more likely to be incorporated.

Incentive for Environmental Regulations

Many observers wonder why agriculture is not subject to the same tough environmental regulations that other businesses face. There are two explanations. The first is that agricultural pollution is typically a nonpoint source of pollution, which means it comes from many sources scattered widely across the landscape. No single source causes significant damage by itself, but environmental quality can be affected when small amounts of damage from all sources are added together. Implementation and enforcement of agricultural pollution regulations would be extremely costly, or simply ineffective, because monitoring of nonpoint sources of pollution is so difficult.

But even if the problems of regulating nonpoint source pollution could be overcome, there is another reason why agriculture does not face the same regulatory environment that other firms face. The reason is the traditional political power of farmers. This political power results from farmers' effective lobbying organizations that take advantage of the deeply rooted, positive feelings most Americans have about farmers.

This reluctance to regulate farmers could erode once the same organizational structures that are used in modern manufacturing facilities are applied to the business of producing food and fiber.

This erosion of sympathy for farmers has political consequences that already are being felt by the livestock sector. A reluctance to pursue regulation is being replaced by a push to treat agricultural firms more like non-agricultural firms when it comes to environmental quality. Many Americans are concluding that farm firms should meet the same environmental standards as non-farm firms.

But this push for regulation should recognize that controlling non-point sources of pollution is much more difficult than controlling point sources. Well-intentioned efforts may lead to adoption of regulations that are costly to implement, unenforceable, and that ultimately may not improve environmental quality.

The increase in size of operations and the transfer of modern business management practices to the operation of agricultural firms could lower the cost of implementing agricultural regulations. Modern farm organizations track planting decisions, fertilizer and chemical applications, purchase decisions, feeding practices and manure applications. Documentation of these practices and decisions make implementation and enforcement of, for example, a comprehensive nutrient management plan, more feasible. And an increase in size means regulators will need to keep track of fewer operations that are keeping better records, thus effectively lowering the cost of implementing new regulations. Ironically, adoption of the modern business practices that make new environmental regulations in agriculture more politically feasible also make new regulations more practical to implement and enforce.

An alternative to direct regulation that the agricultural sector might consider is the development and adoption of voluntary mechanisms that would reduce nonpoint source pollution. For example, if a market for manure were to develop, livestock producers would have an incentive to conserve manure nutrients and crop farmers would have an incentive to take proper nutrient credit and reduce their commercial fertilizer applications. As a result, nutrient losses from farm fields would be reduced because total nutrient applications (manure nutrients plus commercial fertilizer) would be decreased. A prototype of a manure market is developing in north-central Iowa where Heartland Pork is receiving approximately $20/acre for delivered and applied hog manure.

Another example of a voluntary mechanism is the development of nitrogen insurance products. The Iowa Department of Economic Development has formed a research consortium with four Iowa-based insurance companies to develop new insurance products to reduce the risk to farmers who adopt nitrogen management practices that can significantly lower nitrogen fertilizer applications. Farmers who follow the best management practice but suffer a nitrogen-related yield loss because of circumstances beyond their control would receive compensation from the insurance policy. A similar insurance product is being offered in 1999 for farmers who follow best management practices for corn rootworm control.

Impacts of New Technologies

The biotechnology revolution promises to change both the types of crops farmers grow and how they grow them. The important biotechnology products currently affecting crop production in Iowa have been those that change farmers' pest management decisions. Biotechnology has affected pest management decisions in two ways. First, companies have engineered crops to be tolerant of a single broad-spectrum herbicide. Second, companies have engineered crops to express the insecticide Bt.

Farmers who grow a herbicide-tolerant crop will control weeds by substituting the herbicide that the crop tolerates for their previous weed-management methods. There can be both direct and indirect environmental impacts from this substitution. The direct effects occur from differences in the characteristics of the herbicides used in crop production and the rates at which they are used. If the herbicide that the crop tolerates is less toxic to the environment than the herbicides used previously, the environment benefits. Also, the environment could benefit if the total amount of herbicides applied is lower. This might occur if farmers reduce their use of pre-emergent herbicides and rely more on the post-emergent herbicide the crop tolerates.

Because of the numerous weed control methods used in Iowa corn and soybean production, it is not possible to quantify the direct environmental impacts that occur as farmers adjust their herbicide use in response to herbicide-tolerant crops. But to the extent that companies engineer crops to be tolerant to environmentally-benign herbicides, the environment should benefit from lower toxicity from adoption of herbicide-tolerant crops.

Use of herbicide-tolerant crops can also have indirect environmental benefits if farmers reduce their use of tillage to control weeds. As discussed above, better control of weeds through herbicides will result in farmers decreasing their use of tillage and relying more on herbicides. This movement away from tillage will result in reduced soil erosion. Use of broad-spectrum herbicides that can be applied after the crop is up reduces the need to use pre-emergent herbicides that must be soil-incorporated before planting. It also reduces the need for field cultivation after the crop is up. Thus the increased weed-control that farmers can receive using the broad-spectrum herbicide and a herbicide-tolerant crop should reduce the total amount of tillage used in Iowa. This can result in increased soil savings.

Crops that express Bt is the other category of product that is used widely by farmers. Bt corn is currently being use to control European corn borers. On corn acreage that received insecticide applications to treat corn borers, adoption of Bt corn will result in reductions in insecticide use and the associated environmental benefits from this reduction. However, typically less than 10% of U.S. corn acreage has been treated with pesticides to control corn borers. Thus the direct environmental effects from Bt corn are small.

Information Technology

Farmers often apply "insurance" amounts of fertilizer and pesticides to guard against unexpected yield losses caused either by random weather events, unexpected pest infestations or spatial variability in a field. If unexpected yield losses could be eliminated, then the incentive for insurance applications of nutrients and pesticides would be reduced. For example, farmers who apply a single rate of nitrogen fertilizer to a corn field with substantial yield variability have an incentive to increase the rate to make sure that all parts of the field have adequate fertilizer. If the farmer could move to variable rate applications of fertilizer, then each portion of the field would only receive the amount of fertilizer that is needed to achieve top yields.

Lowering fertilizer and pesticide use by reducing uncertainty or moving to variable-rate applications will lead to environmental improvement by reducing the loss of nutrients and chemicals from farm fields. One way farmers can accomplish this reduction in uncertainty is to invest in information technology. Aerial photography, yield monitors, soil testing, mapping software, scouting and other precision-farming techniques are ways farmers can substitute information for insurance applications of fertilizer and pesticides.

Farmers will have the incentive to invest in information if the cost of acquiring and processing the information is less than the value created by the information. With some technologies, the primary cost of acquiring information is labor cost. For example, soil tests to determine the expected nutrient level and the spatial pattern of nutrient availability on a field involve hiring somebody to drive to a field, walk around the field and take as many as 100 soil cores. Each core may take five to 10 minutes to collect. Also, only applying pesticides when pest numbers are above an economic threshold can decrease pesticide use. But to determine if the threshold has been reached requires somebody to go out in a field and scout for pests—count weeds, collect insect numbers, or count mold spores—which are all labor-intensive activities.

For soil samples, fertilizer applications must be taken after the nutrient status has been revealed. Insecticide applications must be made after insects have been scouted. So not only must the information be acquired in a timely manner, but it also must be processed into an information strategy that can be acted on in a timely manner. The need to acquire, process and use information in a timely manner means that some information technologies will be best suited for those farmers who have additional time and the flexibility to alter the timing of pesticide and fertilizer applications. Farmers who are struggling to complete all their field operations on time will not be willing to delay for a system that might reduce input applications by five to 25 percent. Thus development of time- and labor-intensive information technologies will likely not be attractive to the larger crop farmers of the future. These farmers will be more interested in information technologies that use capital to reduce the labor and time needed to collect, process and use information to alter management decisions.

Conclusions

Whether the environment wins or loses as the structure of agriculture changes is not an easy question to answer. The types of changes affecting agriculture involve both environmental winners and losers. Increased concentration of livestock operations means increased odor for some and decreased odor for others. Increases in farm size likely means increased chemical use but decreased soil erosion. Larger manure-holding capacity on hog confinement operations means greater risk of catastrophic manure spills but increased utilization of manure nutrients in crop production, which leads to less chronic pollution problems.

How society values these environmental tradeoffs will determine whether the environment is a net winner or loser. Is a ton of soil saved on a farm more valuable than a pound of herbicide ingredients kept out of the water supply? Is a modest reduction in odor for 50,000 people more valuable than the harm from a significant increase in odor for 1,000 people?

Although scientists can help define what tradeoffs are involved as agriculture continues to change, the answers to whether a particular tradeoff should be made depends on individual value systems—not on science.

One choice is to let the private profit motive define which tradeoffs occur. Producers will select management practices and technologies that best fit their farm operations within the existing regulatory framework. The upside of this choice is that Iowa agriculture will continue to produce low-cost, abundant food. The potential downside of this choice is that the particular set of environmental tradeoffs involved may not be the ones Iowans prefer.

Chapter 4
IMPACTS OF TECHNOLOGICAL INNOVATIONS ON LAND VALUES AND RENTS

By Robert W. Jolly and Sergio Lence

Structural and technological changes in agriculture may influence land values, rents and rental arrangements in Iowa and across the United States. This issue is important because changes in land values and rents determine, in part, who benefits from structural change. Factors that increase land values increase the wealth of landowners and increase production costs for tenants. Redistribution of income often precipitates public policy changes. In the case of land, the consequence of structurally-induced value changes might be altered restrictions on foreign or corporate land ownership, changes in taxation, changes in rules governing estate transfer, or subsidies to reduce barriers to beginning farmers.

Land Value Determinants

For starters, let's look at land as a stock – an asset that generates current returns, but also can earn capital gains and losses. This is a reasonable approach because, in theory at least, when you buy land, you are purchasing the rights to a random income stream that will continue into perpetuity.

The value of land is influenced by government's agricultural and environmental policies, changes in production technology and changes in demand for agricultural products. This is true because such factors influence the rental rates or the returns to land use, and the potential growth of that income stream. Because they affect the attractiveness of land as an investment, such factors are key determinants of the value of land.

Macroeconomic conditions in the United States also are important determinants of land values. Landowners and potential investors evaluate the expected rate of return to land relative to other investments available. If the rate of return to land is comparatively high, investors will find it attractive to invest in farmland. In the process of bidding for land, they will cause values to increase until the rate of return to land is in line with other comparable risky investments. If rates of return to land are comparatively low, land values will fall as investors seek out alternatives. This relationship links the value of land directly to macroeconomic conditions.

There are many other factors that potentially may affect the value of land. Land may be demanded for collateral purposes. Because land is a store of value for the owner, the owner's equity position increases with the value of the land. Equity increases the risk-bearing ability of the business and permits additional borrowing. Land can also provide a source of diversification in an investment portfolio. Owning land ensures more control of its use than would be possible through a rental agreement. This creates an option value for land. Also, land in some areas may be in demand for use in urban development or other non-agricultural purposes. Finally, some investors may derive satisfaction from land ownership, which would attach value to owning land above and beyond the income stream generated by land.

Land rent increases benefit owners by increasing their current income as well as their wealth, because rents are bid into land values. These income and value increases come at the expense of tenants and new entrants. Table 1 gives a recent estimate of the tenure of farmland ownership in Iowa. More than 90 percent of farmland is owned directly by individuals or through their estates or trusts. Corporations — for the most part family farm corporations — own 7.6 percent. However, only 50 percent of Iowa's farmland is operated or farmed by its owner. The remainder

Table 1. Tenure of Land Ownership in Iowa, 1992
(Percent)

	Non-Corporate	Corporate	Total
Owner/operator	49.0	61.7	50.0
Landlord/tenant	50.7	38.3	49.8
Cash rent	28.0	14.3	26.9
Share rent	21.9	21.4	21.8
Other	0.8	2.6	1.1
Total	**92.4**	**7.6**	**100.0**

Source: Schultz and Harl, 1992.

is rented. This suggests that a typical farm business would own half and rent half of the land it operates.

The reported occupation of Iowa farmland owners is shown in Table 2. Note that slightly less than one-third of all owners considered themselves to be farmers or farm managers. The largest occupational group was women employed on the farm or in the home. Table 3 gives a breakdown of farmland ownership by gender and age. The role of farmland as a form of pension for retired farmers is clearly evident. It is likely that in the future farmers will rent significantly more land than they own. Land ownership will remain fragmented and diverse. Consequently, increasing rents and the associated increase in land values likely will be reflected in production agriculture as increased costs rather than increased wealth.

How Change Impacts Land Values

Let's suppose a new crop production practice similar to conservation tillage is introduced. It reduces both the time required for field operations and the machinery investment. The offsetting factor is that per acre herbicide costs increase. An individual farm operation would adopt this new practice if it was believed the returns to the operation would increase relative to current practices and if the additional return was in line with the accompanying level of risk. In this case, the new technology would permit more land to be farmed by an individual. Variable costs per acre would increase. Fixed costs would fall. If net returns to the operation increased, the manager might attempt to rent or buy more land. To do this, he or she would have to bid land away from other farmers, thereby increasing rents, and in the long term, land values.

After the dust settled, the farmer would be paying more for rent, and running a larger business with greater volume and tighter margins. If a sufficient number of farmers made this same decision, land values, rents and rental arrangements would change as a consequence of this new production practice. Those operators whose returns for land use were below the higher rental rates would eventually quit farming. On balance, the remaining operators should be at least as well off as they were prior to adopting this technology. If not, they would make adjustments by bidding less for land or shifting to an alternative production practice. Note, too, that landowners — operators as well as landlords — also benefit from this technological innovation. Both groups benefit because their earnings increase as does their equity in owned land.

This simple example illustrates the linkage between technology and land values. It also shows that value created by the innovation is shared, in this case between landowners and the most efficient crop producers. Exactly how the value is divided between these two groups depends on their bargaining position and the degree of competitiveness in the industry.

Now let's expand this idea a little and consider the entire value chain in an agricultural industry (Figure 1). At each stage in the value chain, value is created as inputs are transformed into outputs and raw materials are further processed into final goods. As with the landlord-tenant example, how much of the value added is retained or captured and how much is passed up or down the value chain depends on competition, the nature of the technological or organizational innovation, property rights and other factors. The extent to which farmers are able to create and capture value from this entire chain will determine land rents and values.

Relatively little research is available to establish reliable linkages between emerging technologies, organizational change and land values. However, we can examine a few representative structural changes and speculate how this might impact value creation and capture by farmers.

Impact on Crops

Since the end of World War II, Iowa farmers have experienced an unprecedented increase in crop productivity. Advances in plant breeding,

Table 2. Principal Occupation of Iowa Farmland Owners, 1992 (Percent)

Farmers/farm managers	29.6
Farmwives/housewives	33.6
Professional/technical	12.0
Clerical	4.3
Farming/employed elsewhere	2.0
Other	18.6

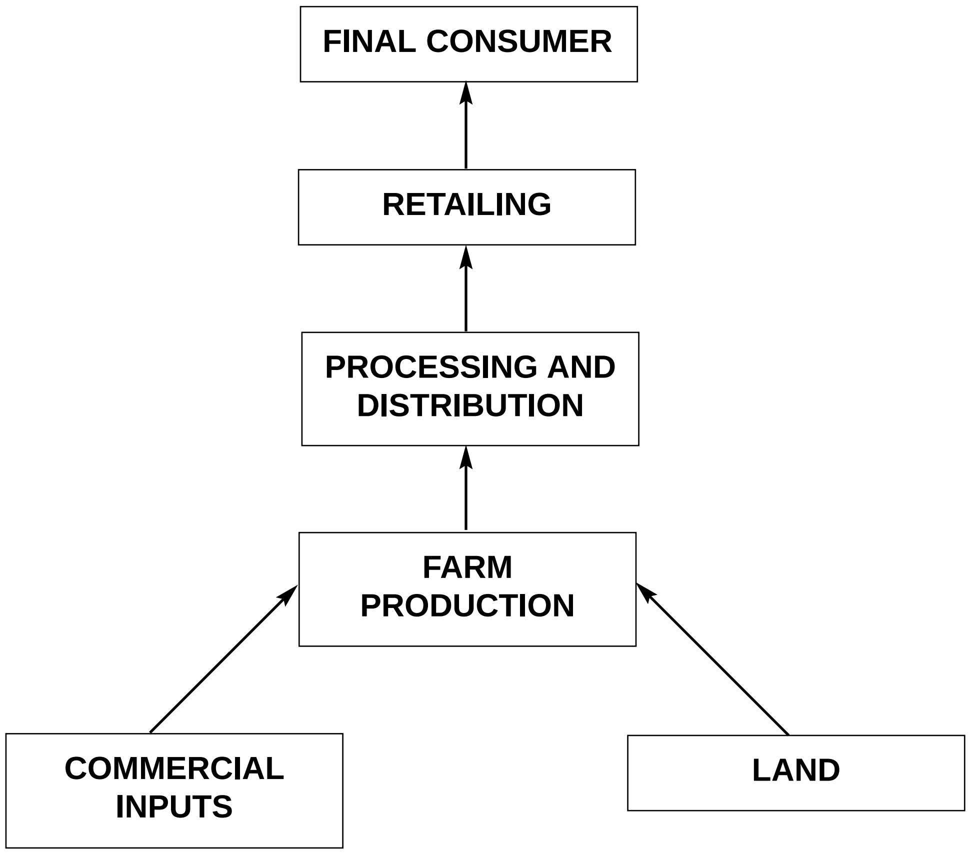
Source: Schultz and Harl, 1992.

Table 3. Age and Gender in Iowa Non-Corporate Farmland Ownership (Percent)

	Age			
	Under 35	35-65	Over 65	All
Males	3.8	28.5	18.9	48.3
Females	2.8	21.9	23.5	51.0
Total	6.6	50.4	42.4	99.3

Source: Schultz and Harl, 1992.

Figure 1. Agricultural Value Chain



tillage systems, harvesting and storage technologies, pest management and fertility have been the driving factors. Whether the result of output-enhancing or input-conserving technologies, the result has been an increase in the production efficiency of bulk, undifferentiated commodities. Many of these technologies were the result of public research. And most of the technologies were made available through simple market mechanisms.

Molecular biology has changed this picture significantly. Very high cost, risky research by the private sector has led to the development of institutional innovations that allow firms to potentially capture value along the entire supply chain. This is accomplished largely through the use of patents, contracts and licenses, as well as through direct ownership of the supply chain.

If we can estimate how much value farmers create, along with their ability to retain or extract value over the breadth of the supply chain, then we can say something about the impact of structural change on land values. To begin, let's separate emerging crop technologies into three broad categories – input traits, output traits and information.

One class of crop technologies introduces genetic input traits into existing varieties. These traits may include, for example, resistance to specific herbicides or particular insects. Farmers will adopt these technologies if they are more profitable than existing or alternative technologies. Part of this increased income, or reduced risk, will be bid into rents and land values. How great the impact is depends on the profitability of the new technology and the performance of alternative technologies.

Consider Monsanto's Roundup Ready gene in soybeans. Farmers acquire this technology by paying for the seed plus a technology fee for Roundup resistance soybean seed, agreeing not to save seed and by purchasing patent-protected Roundup herbicide. They gain simple, effective weed control, and reduced herbicide costs compared with conventional weed control. The time required for weed control also may be reduced, thereby permitting larger acreages within the constraints dictated by machinery capacity and managerial inputs. Increased timeliness, reduced herbicide costs, net of the technology fee and investments in machinery and skills could increase farmers' bids for land. However, the increased returns need only be sufficient to bid farmers away from alternative or existing practices. The acquisition cost of the technology is controlled by a life science firm, which has a strong incentive to exercise monopoly power to keep the value generated by such technology. In all likelihood, the increased returns to land from this technology would be modest and, as a consequence, impacts on land values and rents would be modest.

The preceding example suggests that, when analyzing each input trait technology in isolation, the technology developer would likely capture the value created by it. Land in this example is no longer the "residual claimant" to the value chain. Rather a patented bundle of genetics and pesticides now may play this role.

A second group of emerging crop technologies, also genetically based, alters the output traits of grains and oilseeds. Examples include higher oil content in corn or altered fatty acid composition, seed coat color or size in soybeans. More exotic examples include crops that contain genetically engineered pharmaceuticals or other high-value compounds. Two methods of supplying these technologies are available. One approach uses identity preservation to segregate production and distribution of a specialty crop but also to maintain control over the germplasm. In effect, identity preservation relies on a series of contracts to manage production and distribution of the crop along the value chain. The second approach would rely on rapid testing and sorting of bulk commodities for the desired trait at the point of sale. In this approach, production contracts and monitoring probably would not be used. The processing and distribution segment in the value chain becomes the key to serving end users seeking specific crop traits or attributes. Land values and rents will be influenced by output trait technologies if farmers actually create and retain additional value. A few simple examples follow.

Let's suppose a food processing firm identifies a market in Japan for organically grown soybeans. This company owns a soybean variety that has the appropriate traits. The company contracts 500,000 acres within a 100-mile radius of its processing plant to meet the needs of its Japanese customers. Would this innovation influence land values or rents? Assume farmers growing these special beans experienced higher costs, such as yield penalties, increased risk, more labor and managerial effort and/or additional machinery and equipment investment. The food processing firm would be required to offer a contract just sufficient to bid farmers away from their current conventional crop operations. There might be a premium required to reflect unique managerial resources or proximity to the processing plant. It is possible farmers might transform or bid an increased return to management into land values. But in general it would seem likely that farmers would be only slightly better off than before after accounting for all production costs. Further, the acreage needed for this specialty crop is relatively small and in the example, fixed. The net impact on land values from this one innovation likely would be modest.

Consider another example. Suppose a plant breeding company introduces a corn variety that is higher in protein and, therefore, of greater value to livestock producers. This variety is agronomically equivalent to other available corn varieties. No changes in production practices are required. The high protein level can be identified by a simple test at the origination level. Livestock feeders would be willing to pay more for corn if it were competitive with other protein sources. Consumers would be indifferent if the source of protein has no impact on final product traits. They would not, however, be indifferent to price.

The seed company needs to recover its development cost for the variety, plus its production costs. Farmers add no more value to the chain than they do for the prevailing alternative corn variety. Will this output technology impact land values and rents? Again, farmers will not adopt this technology if they are not made better off. However, they need only be offered just enough to shift practices. In all likelihood the additional value will be captured by those firms in the chain that create it — the seed company and the processing and distribution company. Land values will not be significantly affected by this "super commodity" innovation. In fact, output trait technologies of this type are, economically speaking, no different than traditional yield increasing technologies. We have simply increased the yield of a component of the crop. Under these conditions, it seems reasonable that market forces would determine the value added by the innovation and distribute that value along the value chain.

A third group of technologies is that related to information management. For example, precision farming systems that permit monitoring of seed rates, fertility, yields and pests, along with variable application rates, have two important consequences. First, they can reduce per acre costs of production. Second, they also increase the efficiency of managerial inputs, as a single manager can handle more acres. Information technologies also can reduce transaction costs associated with input purchasing, marketing and coordination tasks. Information technologies can allow the development and operation of improved risk management instruments and markets. Many of these technologies seem to require superior managerial skills and the resulting increase in operator returns are partly a compensation for such skills. To the extent that operator returns are greater than necessary to compensate for superior managerial talent, operators are likely to bid them into higher land rents and values.

The preceding analysis focused on each individual technology in isolation, and without considering the aggregate effects of new technologies in crop production. Let's address that issue.

First, consider the realistic scenario in which operators have a menu of new technologies from which to choose. In this situation, the supplier of one of these technologies must compete against suppliers of alternative technologies to have farmers adopt its technology instead of the alternatives. The greater the number of such competing technologies, the more difficult it will be for any single supplier to extract most of the associated value, since such value will be dissipated in the competitive process to have its technology adopted. Therefore, the more competitive the market for new technologies, the more likely the associated value will be extracted by the providers of inputs in relatively fixed supply (e.g., land and managerial skills) rather than by the technology suppliers. As a result, competitive markets for new technologies are likely to translate into higher rental rates, and eventually greater land values. Land values are more likely to increase in the long run as patents for new technologies expire and more providers of the same technology emerge into the market.

Second, consider aggregate effects. For example, consider the case in which new technologies increase the supply of a commodity, but demand for the commodity is inelastic. In this situation, the new technologies will result in lower income for the sector as a whole. The key question is how the income loss is shared within the sector. The answer to this question will depend on more specific characteristics of the technologies. However, under certain conditions it is quite possible to have new technologies translate into lower rental rates and reduced land values in the long run.

Impact on Livestock

The livestock sector in the U.S. has undergone dramatic change over the past two decades. Innovations in building systems, feeding, genetics, herd health and supply chain management have resulted in rapid consolidation and integration in the livestock industry.

The determining factor for land values is what effect structural change in the livestock sector will have on the level and characteristics of demand for feed. An expanding, more efficient, livestock industry will augment feed demand and increase returns to land. Integrated production systems tend to be more efficient in feed usage. However, this unit efficiency increase would likely result in increased overall feed demand as the industry expands.

One would also expect the same results as improved technology and coordination improve product quality, herd health, transportation and logistics. Feed demand increases with an expanding industry driving up feed prices and increasing the returns to land.

Land values also may increase as the demand for building sites increases. This likely will be minimal. There is some evidence that land values adjoining livestock facilities may actually decline. Alternatively, land values could increase as a result of environmental restrictions on manure disposal. In this case, livestock operators would bid for manure disposal rights or easements on cropland. This increased income would be capitalized into land values.

A Numerical Example

It's impossible to obtain a precise estimate of the impact of technological changes on land values. But some possible magnitudes can be explored using a simple capitalization formula.

Table 4. Hypothetical Shares for Technological and Organizational Innovations Cooresponding to $10/acre Value Creation

	Value Allocation ($/acre)		
Scenario	Technology Supplier	Landowner	Land Operator
A	10	0	0
B	5	5	0
C	5	2.50	2.50
D	5	0	5
E	0	10	0
F	0	5	5
G	0	0	10

Table 5. Increase in Land Values Corresponding to $10/acre Value Creation ($/acre)

Capitalization	Value Allocation to Landowner			
Rates	$0/acre	$2.50/acre	$5.00/acre	$10.00/acre
2%	0	125	250	500
4%	0	62	125	250
6%	0	42	83	167
8%	0	31	62	125
10%	0	25	50	100

Let's suppose a technological or organizational innovation is introduced that creates an $11 per acre increase in value across the entire agricultural value chain. This might be due to an input trait that reduces herbicide costs. For simplicity, assume the final consumer captures $1 per acre and the remaining $10 per acre value is shared by the land operator, the landowner and the company providing the technology. Note that we are dividing the roles of the land operator, who can only rent land, and the landowner, who does not operate the land. These roles are combined for many farmers. But for analytical purposes, it is helpful to keep them separate.

Table 4 shows some alternative hypothetical distributions of the $10 value created by the innovation. Assume that each of the three economic agents has the ability to capture all, half or none of the created value. Although some allocations show a zero value, let's interpret this to mean that only sufficient value is shared to induce adoption of the innovation.

One interesting question to consider is the kind of innovation and market structure that might result in the allocation given in Table 4. For example, Scenario A might represent a monopolist holding a patent for an input trait technology without any close substitutes. The technology supplier captures all the value. At another extreme, Scenario G might represent a change that increases the efficiency of fertility management – a cost-saving technology that relies on increasing managerial skill and expertise. At least initially, the farm operator would capture all of the value. Still another extreme is Scenario E, in which the landowner captures all of the value. This might be possible if land possessed some unique attribute, such as proximity to a processing plant. The remaining four scenarios are combinations of these three extreme cases.

The next issue that needs to be considered is whether or not the allocation is stable. Take Scenario D. The value created by this innovation is shared exclusively by the technology supplier and the operator. Would the operator attempt to rent more land, given that the innovation is profitable? What technology or market structure would allow the operator to retain the value share without passing some value on to the landowner?

In Scenario B, the operator receives nothing. The landowner and the technology supplier capture the value. As landowners sell to other investors, the increased value would be capitalized in land prices. But would rents remain unchanged in a competitive market for rental land and land purchase? It is difficult to imagine a technology that would allow the operator to capture all the value at the expense of the landowner. Consequently, Scenarios D and G are probably unrealistic.

The final task to be addressed in this simple example is translating the increase in value from the innovation into an increase in land value. From Table 4 it seems reasonable to conclude that the landowner will capture between zero and $10 per acre.

Table 5 shows the increase in land values associated with a range of capitalization rates. The capitalization rate can be interpreted as the real rate of return earned by comparable alternative investments. The capitalization rate for Iowa farmland has averaged about 6 percent in this century. In this example, we are assuming the value created by the innovation is permanent, and it does not grow in real terms. Despite these rather strong assumptions, Table 5 does give a sense of how sensitive land values might be to the differences in value creation or capture due to technological and organizational innovations, relative to alternative investments.

Conclusion

It is difficult to isolate the impact on land values of a change such as the increased contracting of specialty grains from something such as the impact of increasing global demand for food. The former may have a negligible impact on land values and rents, whereas the traditional forces of growing demand, improved production technology, and macroeconomic conditions will continue to be the determining factors.

It does seem reasonable to conclude that if there are few suppliers of technological innovations, most of the direct value creation will probably be captured by the developers and suppliers of the technology. In this case, it is unlikely that innovations will result in higher rental rates and land values. In contrast, if there are many suppliers of alternative technological innovations, each of them will have to compete for farmers' adoption of its technology. In this case, technology suppliers will transfer at least some of the value creation to farm operators. And operators are likely to bid this increase in returns into higher rental rates and land values.

Finally, land ownership patterns are extremely important in determining who gains and who loses from land value and rent increases. In Iowa, the winners tend to be elderly landowners. The losers would be operators who depend on rented land—in most instances young or mid-career commercial farmers.

Chapter 5
EVOLUTION ON THE DEMAND SIDE

By David A. Hennessy and Helen H. Jensen

The changing consumer marketplace has become increasingly important to the agricultural sector, food industry and related public policies. Several underlying changes have affected the importance of the consumer sector to agriculture. First, food markets, once very much dependent on conditions at the farm level, are today more directly affected by conditions in food processing and distribution, and by consumer preferences for various food qualities and characteristics. In a consumer driven food market, demand considerations guide many producer decisions. Agricultural programs and policies have become more closely tied to changes in food markets and consumer demand.

The food supply has become more varied, with an increasing amount of food prepared and consumed outside the home. Services added by the food industry in processing and distribution channels represent an increasing share of the food dollar. Demand parameters, once estimated by species products (beef, pork, poultry, etc.), fail to account for potentially large underlying changes in the type of product and location of sale. Food safety regulations, originally designed based on carcass inspection, are inadequate to control food safety problems in a more complex food distribution system.

There is evidence that demographic changes away from the "traditional" household to a household with multiple wage earners, single parents, younger single households, greater ethnic diversity and a greater share of older people, have affected food product markets and changes in demand. The result is that factors other than the traditional economic parameters (income and prices of food commodities) are now needed to more fully explain changes in food markets. Changes in wage rate, labor force participation (especially for women), new information on links between diet and disease, and the widespread use of microwave technology in the home lead to greater consumer interest in convenience, nutrition concerns and food safety for food choices.

Finally, international markets and trade in food products have led to a need for new and improved information about international flows of food products, quality of food products in international trade and the international trade in services related to food.

U.S. consumers spent an estimated $629.4 billion on food in 1997, a level that represented 10.7 percent of disposable personal income. Of that number, 61.7 percent was spent on food at home. The remainder was spent on food from away-from-home sources.

The relatively low share of disposable income going to food expenditures has meant that, for many U.S. consumers, there are options for expanding discretionary spending related to food. This would include foods designed with health promoting qualities, greater convenience in packaged and prepared foods sold through supermarkets, and added value in foods for retail and food service, such as exotic fruits and vegetables, high-end coffees and foods with extended shelf life.

Over the last 10 years, sales for food service items increased at an inflation-adjusted rate of 1.7 percent per year, compared to increases for retail food sales of 1.1 percent. Fast-food outlet sales have increased more rapidly than restaurant sales, although both have increased. Two newer areas among fast-food markets are the quick service chains that, although classified as fast-food, offer more traditional service and food choices, and the nontraditional outlets such as push carts, vending machines, concessions in stadiums and contract operations in institutions.

Distribution and Retailing

The organization of food distribution and food retailing has changed dramatically. The dominance of supermarkets and chains in procurement direct from large producer-shippers has greatly reduced the role of wholesale markets and reduced warehouse costs for many products. Mass-merchandisers such K-Mart and Wal-Mart have extended their lines to include food items. Inventory control and management have changed rapidly over the last decade or two. An example is the industry-wide use of Efficient Consumer

Response (ECR) in the grocery supply chain. ECR brings information about product movement at the retail level directly to the producer-shipper level through inventory management and new technologies for tracking product movement.

In the food service area, and even in retail food markets, there has been a trend to reduce labor inputs and transform commodities into products that move more directly from production and processing to a form sold for final use. Examples include cut-up broilers, prepackaged lettuce and salad mix, and frozen-prepared foods. In addition, fabricators supply an increasing share of prepared and semi-prepared foods to restaurants, institutions and retail outlets. Prepackaged, higher-valued cuts, such as pork loins or chicken breasts, are being packaged directly for retail sale. These types of changes in the distribution and retail areas reduce the costs of handling product through the food chain and at the retail level.

International Markets

Increased trade in food products is important to both U.S. consumers and producers. In U.S. markets, food imports have risen in the last 10 years, and in some markets, are relatively important to providing food products year-round and to increasing the variety of foods available. In the 1991-95 period, imported foods accounted for 13 percent of the fresh fruit (excluding bananas), 8 percent of fresh vegetables, 7 percent of red meat, and more than half of the fresh, frozen and processed fish and shellfish available in the U.S. food supply. For some specific products, such as bananas and coffee, imports are nearly 100 percent of the available supply.

Demand for the food product imports is driven by many of the same factors that affect demand for locally produced foods — higher incomes, interest in more variety and a healthful diet, and changes in ethnic composition of the population.

Despite the benefits to the U.S. market in terms of lower prices and more off-season availability, there are concerns about food-borne hazards associated with imported foods. In the last year, the U.S. has increased efforts to test imported fruits and vegetables, and to monitor the growing conditions that may increase contamination of product shipped to the U.S.

Product Quality and Food Safety

Food products vary in their attributes and, when attributes are identifiable and valued by consumers, the price of the product can reflect those different attributes. When consumers can identify differences in products at the market level, they can use the information in making their choice among products. Regulations to protect and inform consumers often address the failure of markets to provide product information to consumers. For example, food safety regulations may be justified by a failure in the market for safety attributes. Because consumers cannot ascertain the safety of meat products, they are unable to express preferences for greater safety in the marketplace. Furthermore, producers or retailers may be unable to determine safety because food-borne pathogens can enter the food chain at several points and can grow over time. The lack or high cost of information about safety and the resulting consequences for public health are the fundamental justifications for public intervention to improve food safety.

Alternative, private market strategies exist to address problems of information or other market failures. Product labels can inform consumers about product attributes that are not easily observed. Examples include nutrition labeling, warning labels on untreated juices and labeling about production methods. The rationale behind labeling requirements is that consumers, with full information, will make product choices consistent with their preferences. The development of niche markets, say for institutions housing susceptible populations, or for those with known allergies or health problems, is another private market approach to improving information in the market. Certification of a quality attribute, through branding, private testing, or contracting with suppliers, allows retailers to command a higher price.

Coordination and Competition

Three broad themes emerge when considering the evolving relationships between upstream and downstream activities in agriculture. These are the organization of incentive structures, the need for coordinated management and the accommodation of evolving demands.

If consumer demands are to be met in a decentralized marketing system, the proper incentive structures need to be in place to direct upstream activities. However, myriad externalities may arise along the marketing chain.

Government regulation of product quality protects consumers for many food products. Yet even without regulation, firms often err on the side of caution to preserve the company's reputation. Branding and franchising also reinforce the incentive to guard against quality failures, as may initiatives by active and responsible industry organizations concerned with developing the demand for a product type. Small firms, on the other hand, may have diminished incentives to protect quality because the implications of their actions on the general demand for products in that market are more clearly external to the firm. Also, the limited liability provision suggests that highly leveraged firms may have the incentive to take risks with quality. The extent of such incentive externalities depends, in part, upon the commercial viability of technologies to measure and track food quality through all stages of the food chain. The advent of such technologies would likely shift investment in quality protection toward the optimum level.

Another incentives-related issue at the retail level concerns the parties responsible for testing and verifying food attributes. A 1996 survey suggested consumers are more trusting of government publications and food labels than of information emanating from the marketing chain. Consumer groups have raised concerns about the integrity of self-regulation during the comments phase prior to implementing HACCP procedures for food processing in the United States. Thus, when it comes to maintaining confidence in the food marketing system, there is a role for testing by government or independent market firms.

Incentive problems also arise in relationships between retailers and consumers after the purchase has been made. Because of the importance of meat handling after the product is brought home, safe-handling labels are now mandated for fresh meats by government regulation. And firms concerned about maintaining brand reputation have an interest in ensuring that the product is handled safely in the home and in a manner that protects product quality. Because a direct caution on the label might scare consumers, less direct means have been used. For example, proper handling techniques may be provided within a suggested recipe given on the label. The Internet provides promising and creative opportunities for nurturing after-purchase relations between the marketer and the consumer. In addition, reducing contamination through improved packaging or irradiation might control at-home problems.

Incentive pricing structures are no more than a decentralized means of coordinating the food processing system. If pricing fails, some players may feel the need to take a more active role in coordinating processes along the value-added chain. The firms that step into such roles are said to be exercising supply chain management. A classic example of supply chain management is the case of Optimum Quality Grains. Founded in 1998 as a joint venture between DuPont Company and Pioneer Hi-Bred International, Inc., it seeks to improve grain and oilseed supply through customer-driven innovation. The joint venture intends to do so by identifying customer demand, and facilitating players in production to meet that demand. Its initiatives to better coordinate the supply chain include the use of the Internet to share data among participants.

While it would seem the market may gain substantially from the existence of such facilitators, it is less clear that the incentives can be put in place to reward the supply chain manager because the value added from management accrues to all players. The most likely candidate for the role of manager is the player whose profitability is most positively impacted by enhanced coordination. Products where strong coordination might be particularly rewarding include meats, where pathogen control may be a major issue, and products where innovations that raise consumer concerns are occurring, such as with the use of Bovine Somatotropin in milk production. Whether informal support networks, contracts or outright vertical integration is the most appropriate means of coordinating activities is an empirical question, and may be determined by the existing structure of the industry. A risk associated with increased coordination is that a system-wide failure might occur. In the area of food quality, widespread panic and associated losses might be the consequence of the breakdown.

One of the most far-reaching ways in which food retailers have sought to accommodate evolving demands has been the development of a mass market for organic produce. This expanding market has required increased coordination, and the level of efficiency in organic produce marketing chains has improved significantly by adapting procedures common in the mainstream food marketing system. At present, distribution is occurring both in the mainstream system as well as through organic food stores.

Concerning innovations in general, dominant firms in other industries have maintained market dominance by learning from the successes of upstarts. This will likely be the path for the major grocers, many of whom have closely observed innovations by Wal-Mart and other non-food retailers. A particularly interesting issue is what use food stores make of the vast quantities of scanner data now available to them. The ever-cheaper costs of data processing and data analyses can facilitate the search for profit-improving market segmentation and pricing strategies.

A final point to ponder on the relationship between the grocer and the consumer is the role of electronic commerce in distribution. E-commerce has expanded rapidly in the books and CD retail sectors, but the potential in the grocery business seems less promising because the consumer would likely have to be at home to take delivery. If e-commerce purchases are to become significant, possible first target segments include the elderly and infirm. User-friendly software might be a prerequisite to developing these markets. Evening deliveries could cater to full-time workers with little time to shop in stores.

Horizontal Integration

Distribution involves warehousing and transporting product in a timely and efficient manner. When the product is perishable, the premium on timeliness is large. When the product is bulky or fragile, the premium on economy in handling is large. Many food items possess all these attributes. Good information management is vital in food distribution, and the advent of cheap computing has had all-embracing implications on distribution. However, realignments in distribution are ongoing, and this function will not stabilize unless the rate of innovation in data processing subsides. To the extent there are fixed cost components to investments in logistics infrastructure, there will be an incentive to consolidate in the grocery business.

Turning to processors, high marketing costs have motivated consolidation in the food sector. Many marketing costs, such as advertising and other costs associated with establishing a brand name, have a high fixed cost component, and can be managed more efficiently by larger firms. In an increasingly global economy, where information faces few barriers and many people are effectively becoming citizens of the world, the positive spillovers onto other markets from establishing a marketing presence in an economy as large as the United States are such that it is worth capturing them. The advent of the European common market may generate similar incentives. While a brand may be licensed to local producers, to safeguard brand goodwill, the brand name owner will likely insist on overseeing the quality of the product.

An increasing fraction of product in the hog and poultry sectors and fruits and vegetables is being produced under contract. There is speculation that similar trends may occur in other agricultural sectors, especially in the grain sector where innovations in biotechnology are creating the possibility of highly differentiated grain products that would not readily flow through regular commodity channels. Product that is grown under contract will likely differ from product that continues to flow through the traditional marketing channels. It will likely be of better quality than the residual flow and so may command better terms from the purchaser.

The shift towards contracts will likely have another, less direct impact on traditional production. Contract production will probably not be as risky due to risk-sharing terms in the contract. Further, the shift towards contract production will reduce the ability of the traditional market to clear efficiently. Liquidity will fall at country delivery points and price discovery will be impeded. Put another way, traditional production likely will become subject to more price risk. This will be true whether or not futures markets or other centralized price risk management instruments are used because the liquidity problem is a local one, and will give rise to larger basis risk. One scenario is that traditional markets for some products will dry up or become the market of last recourse.

Product Development

One of the most profound insights confirmed by discoveries in genetics is that particular species are to some extent historic accidents — evolving partial equilibrium points in the space of genetic vectors. Agriculturists have for millennia nudged that equilibrium through selective natural breeding with the end being to optimize traits that have not necessarily been traits emphasized by Darwinian selection in the wild. Innovations in comprehension and methods have now accelerated our ability to select over genes and to penetrate the species barrier.

The consequences for agriculture are both immense and unclear. Concerning conventional measures of physical productivity, the innovations will likely maintain, if not increase, the rate of growth in yields per unit input. However, the most exciting implications relate to the nature of the outputs. Most agricultural outputs are multidimensional in economically significant attributes, and recent innovations have substantially enhanced the ability of commercial plant and animal breeders to journey through these dimensions. Consequently, a wide variety of innovative genetic products are now entering commercial markets and more are on the horizon.

Focusing attention first upon traditional food products, the more voluminous sets of choices available to genetic input suppliers have caused them to reach out to processors to learn what is in demand. Of course, there is often substantial heterogeneity among users. For example, corn and soybeans enter diets for poultry, beef cattle, hog and dairy rations. In addition, optimum ration mixes vary according to the production stage of the livestock, and might vary by location of production. With traditional commodity feed crops, users took what was available in the market. But this is no longer the case. High oil feed corn is in demand by medium-sized hog producers and by export markets in hot climates. Specialty soybeans are finding outlets in the increasingly fragmented animal feed markets.

Corn and soybean promoters have been quite successful in developing new food markets. Laboratory advances that enabled the commercial conversion of glucose to fructose opened up the food sweetener market to corn products. In the fall of 1997, 5.6 percent of all U.S. corn production was processed into high fructose syrup and associated by-products. More traditional markets, such as corn flour for tortillas, also have been developed in a satisfactory manner. The primary advantage of corn and soybeans is that they are very cheap sources of carbohydrates and proteins. So if some creative food chemistry can render derivatives into products for which a market already exists, cost factors will give the corn or soybean-based product a competitive edge. Given the past success in capturing shares of existing markets, it is likely that this strategy will continue to be followed by corn and soybean promoters.

The future also might see the use of corn and soybeans as a cost-efficient vehicle for naturally sourced micronutrients such as vitamins. Work also is underway to place genetics that produce chemicals that reduce blood cholesterol into field crops. Similar attributes could be introduced into livestock. The possibilities are endless, but adoption will depend on whether costs in agricultural production can match costs in industrial production. In some cases, it may be efficient to grow the micronutrients in situ for products derived from the given crop/livestock. But high extraction costs may make it inefficient to extract the micronutrients from the crop to use as supplements in other products.

Much attention has been paid to the possibilities of using traditional agriculturally grown products as host organisms for cultivating pharmaceutical products at costs far lower than in industrial production. As a source of potential growth for agriculture, at least two qualifiers must be made. First, there is a quality control issue because outdoor agriculture is far from being a sterile environment. Thus, it is likely that major operations will continue to occur in laboratories and rents will be shared accordingly. Second, the very cost and volume efficiencies that make field crops so appealing as vehicles for pharmaceuticals may be such that a negligible amount of growing land will satisfy all the needs of the pharmaceutical industry. Firms that are accustomed to large capital outlays for production facilities and are fastidious about control of the production environment will likely purchase small amounts of land, bypassing many traditional players in agricultural production. But those who possess knowledge of and the rights to plant genetic materials may be in a strong position to benefit from developing these markets.

Other nontraditional uses with continuing potential also have been developed for agricultural commodities. About 2.5 percent of feed corn produced in the U.S. is processed into ethanol and allied by-products. While this market has been developed with the assistance of regulations and subsidies, processing efficiencies acquired through experience, together with possibly higher oil prices, might make corn-based ethanol an aggressive competitor in energy markets.

Role of Information

Information plays a key role in facilitating market exchanges. At the retail level, consumer perceptions may create disincentives to disclose quality even if the information is favorable to the seller. Ideally, consumers would rationally process information provided to them at the retail level and there would be a pricing incentive for firms to verify the quality of their product. There is, however, ample evidence to suggest that when health or safety failures occur with low probabilities, consumers behave erratically. Processors are reluctant to compete on safety because consumers, when presented with information about low probability of being unsafe, may conclude that the product is inherently unsafe.

Thus, there often is need for regulatory intervention to establish minimum quality standards, or to require testing and labeling on product characteristics. A retail-level quality standard will affect incentives at earlier stages of the supply chain even though liability for not meeting the standard is incident upon the last handler. To the extent that the terminal product does not reach the standard, profitability at the final stage will deteriorate and the price of raw materials entering the final stage will fall in the long run. But also the final handler has an incentive to track products back along the chain in order to price based on the likelihood the product will not meet the standard.

Since the retailer may have the incentive to track products, it may not be a major step from there to a more formal role as a coordinator of production. The degrees of involvement that can be observed in the food industry vary from informal advice through engaging in production and marketing contracts to complete vertical integration.

While there are reasons to believe that a more integrated system will enhance the overall quality of food at the retail level, there are countervailing risks. Although a systematic approach to adding value to food may reduce the probability of a quality deterioration, if it does happen it is likely to be a more significant problem. There are roles for food quality regulators in overseeing coordination in production. Since it is in the interests of all to avoid quality problems, there should be little objection to an advisory role for a regulator. But trust is a key issue because an adviser requires information, and in the cases where advice is most needed, the adviser may feel obliged to penalize the firm. The role of regulator as coordinator may also arise if there is a significant quality breakdown because public health officials will need data and insights concerning the flows of production.

Conclusion

Demand-side parameters have become more important in food markets. The movement toward more flexible and market-driven U.S. agricultural production and policy has provided the setting for demand-side signals to be acted upon. New technologies have made processing and distribution more efficient and flexible in meeting final demand and tracking a greater variety of food products. Continued trade liberalization will provide U.S. consumers with wider varieties of product at reasonable prices. Re-invigorated adherence to integrity, transparency and scientific approaches in food quality assurance policy will enable consumers to allocate their food budget in an efficient and informed manner. Further, such an approach to food quality policy will provide the correct incentives for innovators to develop product to meet consumer needs.

Policy also has a role to play in influencing the degree of coordination through all stages of food value-adding activities. For example, policy interventions may occur to direct the tradeoffs between the ability of downstream food firms to guide upstream activities and the degree of independence involved in farming. While other parties will have very strong interests in influencing the nature and extent of such interventions, the role of consumers has increased in importance in the new consumer-driven market for food products.

Chapter 6
CONTRACTS IN AGRICULTURAL MARKETS

By Brent Hueth and Shira Lewin

The environment in which most U.S. farmers operate has undergone dramatic change over the last decade. Advances in agricultural biotechnology and the availability of new "precision" tools have changed the way people farm. At the other end of the market, consumers are becoming more reliant on ready-made food items and are perceived to be more discriminating than in the past. This has led to an increasing emphasis on "value differentiation" and "chain management" among food industry participants.

With these changes has come an increasing reliance on the use of contracts between producers and the people or firms who buy their products. Why has this occurred? And what implications does the increasing use of contracts hold for Iowa's agricultural community?

Why Contracts?

A contract fulfills two roles. It serves as a mechanism for coordinating economic activity and for motivating performance. Recognizing these roles helps us understand why contracts are being used more widely in today's agriculture. In an environment where the basic elements of the agricultural production process are becoming more complex and where consumers are demanding increasingly specialized products, the need for tighter coordination between producers and the firms that handle and market their products has become more intense. Similarly, as the potential rewards from meeting these needs have increased, so has the need for motivating performance and attention to quality.

A contract typically includes provisions that specify items such as particular planting and harvest dates, the use of specific seed varieties, and designation of which agricultural chemicals may or may not be used. A contract might also offer financial incentive in the form of quality premiums. Thus some items are directly specified, while others are specified indirectly through some type of pricing mechanism.

Table 1 lists the generic functions that actual contracts might perform, together with various provisions that can fulfill some or all of these roles. Many of the specific provisions included in agricultural contracts serve multiple functions. Yet the elements of any given contract generally serve either to improve coordination, to motivate performance, or both. Two important elements of coordination are planning and communication. Planning might be directed at short-run issues such as inventory management or at longer-run issues such as investment in a new processing facility. The communication that takes place in a contract can be made more precise than the communication that occurs in a market mechanism.

As indicated in Table 1, some degree of planning might be accomplished by choosing when to sign a contract. In an environment where raw-product supply can be tight at crucial times in the harvest and delivery period, buyers might be willing to sign a contract well in advance of harvest. If some level of payment also is promised at this point, the degree of price risk faced by producers can be reduced. Alternatively, having a contract with one or more farmers can help resolve uncertainty associated with future raw-product supply, thereby allowing greater precision in planning for the future. Although some farmers might not like the idea of being locked in with a specific buyer at a given price, in many cases buyers may be willing to pay a significant premium for contracted production. In this sense, the contract can benefit both parties.

Communication in contracts can take place on a wide variety of issues. In a market mechanism, communication occurs via price signals, but in a contract the interests of the contracting parties can be directly specified. For example, a contractor might indicate approximate harvest and delivery dates, whether or not certain inputs should be used, to what extent quality will be measured, and how the producer will be held accountable for the quality of the product as it moves through the marketing chain.

Motivation is the other function that contracts serve. With any economic exchange, whether it be a market transaction or a contract arrangement, there is a natural tension between sellers (producers) and buyers (contractors). One side would like to sell at a high price, while the other side would like to buy at a low price. In a contract, this tension is more intense because one party typically relies on the other to carry out activities that enhance product value, but are costly to perform. To complicate matters, verification or observation of these activities may be difficult, or even impossible.

In a contract, this tension is reflected in the way price is negotiated, in how incentives are structured and risks are shared, and in what types of monitoring or quality measurement takes place. For example, a large, well-diversified firm might be willing to shield its farmers from most production and marketing risks. However, it might not pursue this strategy, since such an approach would provide insufficient incentives for ensuring quality. In this sense, it is difficult to separate concerns regarding risk sharing from those having to do with providing "correct" incentives.

Table 1 lists a number of provisions that help motivate producers either by providing some form of performance incentive, or by altering the producer's risk environment. For example, by offering a payment based solely on the number of acres planted, a contractor could completely shield producers against production and price risk. Presumably, producers would be willing to accept a slightly lower payment on average for this risk protection, leading to increased profits for the contractor. But in such an arrangement producers would have little incentive to ensure production losses are kept to a minimum, and that their produce is of high quality. For this reason, it may be in the contractor's interest to expose producers to some degree of risk, even if that means providing a higher average payment. Quality measurement and traceback serve similar functions. They expose producers to considerably greater production and price risk, but they also hold producers accountable for their actions.

Contract Structure

The structure of a particular contract is a function of its intended purpose or function, and of the social, technological and market environment in which it is created. For example, financial contracts such as those that govern options or futures transactions are pure risk-sharing devices. These contracts are silent on many of the issues that are addressed, for example, in a contract between a grain processor and farmers of a specific corn variety. Similarly, the social and economic context in which a contract is created can influence its structure. For instance, production contracts for poultry producers in the South are far different from contracts for pork producers in Iowa. Although these are not the same commodities, the difference in contract structure reflects to some extent the differing power structure between producers and processors in these areas.

Table 2 lists some possible determinants of contract structure and their associated consequences for producers. To some extent, the number of contractors for a given commodity influences the level of competition for producers.

Table 1: Contract provisions and their function

	Contract Function			
	Coordination		Motivation	
Contract Provisions	Planning	Communication	Incentives/ Information	Risk Sharing
Timing				
Contract signing	X	X		
Delivery	X	X		
Payment			X	X
Decision authority/ Asset Ownership				
Inputs specified/provided		X	X	
On-farm presence	X		X	
Ownership of output		X	X	
Investments demanded	X		X	
Quality management				
Traceback		X	X	
Quality measurement		X	X	
Payment				
Base payment				X
Pooling across farmers				X
Coverage of shortfall				X
Bonus/dockage		X	X	

Where producers have more than one contractor who would like to purchase their commodity, the ability to bargain for a higher price is enhanced. The availability of alternative outlets for one's products or the existence of collective bargaining can enhance bargaining power. Some products may have substitutes that, although not ideal from a contractor's perspective, can replace a given farmer's produce.

The spatial distribution of producers also can influence the types of monitoring or measuring instruments that are used by contractors. A small meat packer who does business only with local feedlot operators may use quality measurement far less intensively than a large processor who does business with hundreds of producers. Similarly, whether or not a long-term contract is available will depend on the production cycle of the commodity, and if a significant upfront investment is required. In hog operations where contractors often request installation of the latest and most sophisticated rearing facilities, long-term contracts are available to provide growers with the assurance of a home and price for their commodities over a period sufficient to cover at least a portion of their investment.

Finally, the existence of futures markets or of other types of insurance can influence the structure of a given contract. If farmers can hedge price risk with a futures contract or obtain some form of revenue insurance, contractors also may have to offer opportunities for risk protection in their contracts.

Evaluating Contracts

Individual contracts often are difficult to evaluate because they typically include provisions having to do with a variety of factors. For example, a contract might simultaneously address issues such as risk management, planning, investment, marketing and transportation. As a result, determination of the potential benefits or costs of a given contract can be challenging. Such a determination can be achieved only through careful consideration of each provision in a contract, together with an analysis of potential best-case and worst-case outcomes.

In addition to direct incentives, there are often significant non-price costs and benefits associated with contract production. For example, a producer under contract may find that obtaining credit is easier. Or the producer might receive informal credit from the contractor, or obtain access to technology and reduced-price inputs that would otherwise be inaccessible. Valuing these items is sometimes difficult because they may not be part of the written contract.

An important conceptual point is that the distribution of returns (between contractor and producer) in a contract is not normally a zero-sum proposition. That is, the way in which returns are divided can actually affect the level of surplus that's eventually created. Incentive provisions are included in contracts because they are supposed to influence producer behavior. Thus, in analyzing how returns to a producer would be different under alternative incentive arrangements, it's necessary to determine both the level of payment for

Table 2: Determinants of contract form

Determinant	*Outcome*
Number of contractors	A larger number of contractors increases competition; farmers obtain larger share of total surplus.
Outside opportunities for farmers	Outside opportunities enhance farmers' bargaining positions in negotiating contracts; farmers obtain larger share of total surplus.
Collective bargaining	Collective bargaining allows farmers to present contractors with "all or nothing" deal that effectively increases bargaining position of each individual farmer.
Product substitutability	If a contracted product has many substitutes, contractors will be less willing to commit to a price well in advance of harvest; this affords farmers less protection against price risk.
Spatial distribution of production	Highly dispersed suppliers cannot be monitored effectively; increases need for "off-farm" control.
Production cycle	Perennial crops or products requiring significant up-front investment require longer-term contracts.
Other risk protection options (e.g., insurance, futures)	Availability of futures markets or insurance reduces demand for risk protection in contracts; contractors have fewer bargaining tools.

a given output/quality mix and the way in which the new incentives would alter producer behavior.

Is Regulation Needed?

The expansion of contract agriculture has led to many improvements in efficiency. However, there is concern producers will not benefit, and may actually be worse off, due to their eroded economic power. Such concerns have led to attempts to pass legislation regulating contractual arrangements in agriculture.

Discussion of agricultural contracting is rather new. However, we can learn much by comparing this new controversy to the much older and almost identical debate over the regulation of franchise contracts. We find that, under certain conditions, regulation of either institution might be economically desirable. However, misguided regulations may be detrimental if the indirect economic effects are not well understood.

In many contracting arrangements, the grower must incur investments (buildings, equipment, and allocation of acres) which are specific to the relationship. Yet the contractor retains enormous discretion to discipline the grower or to change the terms of the relationship after these investments are already made.

Contracts also often require growers to carry out instructions regarding operations, and thus the contractor has the power to determine contractual conditions after the contract has been signed. A grower who planned to raise hogs in one way may discover—after spending thousands on a specialized building—that other, more costly procedures must be adopted. Alternatively, as in the case of broiler contracts, the contractual term may be very short, or the grower may be dismissed at will. In that case, the contractor can force changes in operations whenever it wishes, since there is no contract to prevent such changes. Broiler growers often complain that these changes are excessively expensive (new ventilation systems, for example), but they argue they have no choice but to comply since they have already incurred large costs.

Despite these arguments, it remains true that contractor opportunism is not a common occurrence. Various studies have shown that the majority of growers are happy with their contracts and plan to continue contract production, and many contractors have waiting lists of growers who wish to obtain contracts. Thus it appears that for the most part the contractual system works well. Yet, the demands for regulation continue.

Those familiar with the history of franchising will notice striking parallels. In a standard franchising relationship, a large party (the franchisor or chain) contracts with a small party (the franchisee) to sell a product or to provide a branded service. In addition to a regular royalty on revenues, a franchisee pays an initial fee to cover training and site development costs, and must also spend thousands of dollars on a facility, such as a restaurant, where the service or product will be provided. Although franchisees usually enjoy long-term contracts (20 years is the norm in restaurants), they also must agree to comply with the franchisor's operations manual which usually "can be changed from time to time."

A franchisee who fails to be "in compliance" risks termination, and in case of termination, the franchisor usually has the "right of first refusal" to purchase the franchisee's property. If, as is sometimes the case, the chain has discretion to define what "in compliance" means, the franchisee risks being terminated by an opportunistic chain that seeks to expropriate the franchisee's site investments. Franchisees are especially vulnerable if they rent from the franchisor, since they must make significant investments in property they do not own. In most systems, franchisor opportunism of the kind described above is rare, because chains normally care about their reputations, and so avoid conflict. Nevertheless, the fear that opportunism might occur colors the relationship between franchisees and franchisors, increasing franchisor power.

The debate over the regulation of franchise contracts has been particularly intense in dealer franchising — an arrangement in which a car manufacturer or a petroleum refinery contracts with independent dealers to market its product. When petroleum franchising began in the 1930s, contract terms were as short as 30 days, and allowed the oil company the right to cancel dealerships at their discretion. As in today's broiler industry, gasoline dealers were assured informally that, absent problems, their contracts would be renewed. However, in the late 1960s, many major oil companies decided to change strategy and sell more gasoline at fewer stations. Thus, many dealers either were closed down or told to close service facilities that had been highly profitable and focus on pumping gasoline instead.

In response to this and other concerns, gasoline dealers organized. Oil companies refused to negotiate with their dealers as a group, and dealers were forced to seek government intervention. In the 1960s, the Federal Trade Commission won consent decrees limiting the use of short-term leases of service stations. In 1978, the federal Petroleum Marketing Practices Act (PMPA) was passed. The PMPA restricts terminations or nonrenewals, requiring that there be a "good business reason" for the decision.

Automobile dealers have conflicted with manufacturers over termination issues, but the issue of forced sales has been equally important. Manufacturers often attempt to force dealers to sell more cars than they wish to sell. Moreover, dealers often complain about competition from new dealerships placed nearby.

Seventeen states had passed protective legislation by 1956. These laws outlawed arbitrary termination and coercion aimed at forcing high sales. Congress passed the "Dealers Day in Court Act of 1956," which requires manufacturers to act "in good faith" with their dealers. This federal statute was interpreted narrowly by the courts, but as it did not preempt state regulations, the National Automobile Dealers Association successfully obtained stricter legislation at the state level. By the mid-1980s almost every state had some kind of restriction on terminating or failing to renew dealer franchises. Some states also prevent manufacturers from placing new dealers in an existing dealer's market area "without good cause."

As of 1995, fourteen states had laws requiring good cause for the termination of franchise contracts. The effect of these laws is to make termination more costly, thus increasing the tenure security of franchisees. Nevertheless, protective laws of this kind can have unanticipated negative consequences.

Lessons for Agriculture

Unlike agricultural contracts, franchise contracts, at least in some cases, are heavily regulated. Although the rationale for regulation of agricultural contracts has not been analyzed theoretically, a large (and quite critical) literature does exist on the consequences of franchise contract regulation.

In a typical franchise relationship, the franchisee is forced to make an investment that is specific to his or her relationship with the franchisor, and the franchisor has the right of contract termination. Although this may seem like an unfair situation from the franchisee's perspective, such an arrangement can be viewed as an efficient solution to a difficult contracting problem. The argument goes like this. Franchisors possess a valuable trademark that must be protected against franchisee negligence. Because litigation to prove negligence is costly, franchisors prefer to have the right of contract termination. However, it is also difficult to distinguish legally between opportunistic and legitimate terminations. As a result, franchisors could behave opportunistically and expropriate specific investments made by franchisees. That is, they could terminate a contract and then offer the franchisee's facility to another individual. An important restraint on this type of behavior is that franchisors value their reputation for treating franchisees well. A franchisor who engages in opportunistic behavior will quickly find it difficult to obtain franchisees.

Franchisees cannot simply be trusted to perform because they are small players with little reputation capital to lose. Thus, the specific investments made by a franchisee constitute an essential "performance bond" posted by the franchisee to guarantee good performance. By agreeing to enter a relationship in which negligence is very costly, the franchisee guarantees performance. Any law that guarantees reimbursement for specific investments makes posting such a bond impossible, and undermines the franchise relationship.

There is little direct evidence of actual cases of opportunism in franchise contracts. But there is some evidence that protective laws produce some perverse effects. For example, cases of termination are more common in states where franchisees have a "right to cure." In those states, franchisors terminate when they can, for fear that if they delay action, a delinquent franchisee may argue that the violation in question is not serious enough to warrant termination (because it was tolerated for some time). Cases of nonrenewal are slightly more common in states requiring good cause for termination. Apparently, franchisors substitute nonrenewal for termination to avoid legal costs.

There also is evidence that laws restricting termination discourage franchising, particularly in industries for which monitoring issues are most pronounced. Yet research also suggests that franchisees do benefit from the regulation. Without the threat of termination, franchisors must use other instruments to motivate performance. One alternative is to increase the rents paid to franchisees so that, although termination is less likely, the expected cost of termination remains constant.

The analogy with agricultural contracting is immediate. Contractors argue they need the power to terminate growers at will. Without such termination power, they could not police grower performance and maintain quality standards. Thus, although anti-termination laws may increase returns to producers, such laws may do more harm than good by increasing the cost of contracting and undermining quality in the industry. And termination rates may actually rise, as appears to have been the experience in franchising.

At first glance, the arguments presented above appear compelling. The primary effect of regulations is not to prevent inefficient hold-up, but to transfer wealth to growers (or franchisees). This transfer occurs at the expense of contractors.

Inevitably, we expect a reduction in contracting to result, since the cost of hiring growers will rise as a result of any regulation. In addition, we have seen that regulations may lead to other perverse effects. Thus, legislators do well to be cautious, since they might not anticipate the indirect effects of attempts to "protect the little guy."

It's important to remember the potential for opportunism can have an enormous influence on contractual relationships even if no actual opportunism occurs. Franchisor opportunism (and contractor opportunism) is quite rare, but the fact that a franchisor could act opportunistically helps franchisors keep franchisees in check. Therefore, in testing for the importance of opportunism, it is not valid to look only for actual instances. If the potential for opportunism acts as a sufficiently effective disciplinary device, franchisors will not need to provide franchisees with large rents. The party that writes contracts will seek those provisions that shift the distribution in its favor, even if some inefficiency results. If franchisors are free to write any contracts they desire, they will choose contracts that make franchisees more vulnerable.

The same argument applies to agricultural contracts. Because contractors can terminate growers or change contractual terms at will, they possess leverage over growers. The greater a grower's potential loss from termination, the more afraid that person will be to go against the contractor's wishes. If such a fear of financial loss were absent, then contractors would be forced to elicit performance in other ways. For example, contractors may need to increase a grower's pay based on measured performance. By forcing growers to incur high investments, contractors can avoid such payments to growers. Therefore, contractors will be biased in favor of investments that are larger and more specific than necessary and which make growers more vulnerable to termination than necessary. If this argument is analyzed rigorously, we also find that this incentive for excessive vulnerability is particularly pronounced when a contractor has high market power, since then contractors will not compete for growers by offering desirable contractual terms.

Does any evidence exist to support the excessive vulnerability hypothesis? Such a question is difficult to answer, since one cannot actually measure how vulnerable growers "should" be. Perhaps the most convincing evidence supporting this model comes from comparing hog contracts with broiler contracts. These industries function in very different competitive environments. When competition for growers is more intense, contracts will provide them with more protection against financial loss. At present, the hog industry is very competitive, as contractors vie for available growers. Not surprisingly, hog growers enjoy some degree of contractual security, and some have contract terms of up to 10 years. There has been a move towards longer-term contracts at precisely the same time that competition for growers has intensified in the hog industry.

In the broiler industry, contractors enjoy a buyer's market, since not all willing growers can find contracts. Also, competition is limited since a grower often is limited to contracting with one or two contractors. Broiler growers enjoy few contractual safeguards and often can be terminated at will.

Can Regulations Help?

We have shown that, under certain circumstances, franchisees and growers can gain from protective legislation. Such legislation may lead to a rise in grower profits. Thus, a role does exist for regulations whose purpose is distributional. However, such regulations also will discourage contracting and, if quality becomes sufficiently difficult to police, grower income might actually fall. So legislation which purports to protect growers may be detrimental if demand for growers is sufficiently elastic and if the effect on quality is sufficiently large. Contractors also might exaggerate grower vulnerability in order to minimize the profits earned by growers. Such a distortion opens the door for potential government regulations that might help growers.

However, if, as required by some suggested regulations, a contractor must compensate a grower for the entire capital loss caused by cancellation, then the investment of a grower will no longer work as a performance bond. Whatever distortion might exist, it cannot be so large to justify such an extreme law that eliminates asset specificity almost completely. When passing laws to protect growers, legislators must be cautious not to eliminate completely the opportunity for using an investment as a bond, for it is this bond that facilitates contracting. Furthermore, contractors may react to regulations by forcing even more specific investments.

Even if conditions are favorable for regulations, any regulation will interfere with attempts by parties to optimize their contractual relationships. So perhaps the best way for a government to intervene in such markets is to facilitate attempts by growers to organize. If growers negotiate as a group, they may be able to obtain contractual assurances without direct regulation. Unlike direct regulation, such an arrangement allows contracts to evolve as contractual needs change. Regulation would restrict such evolution.

Chapter 7
MEETING THE CHALLENGES OF ONGOING CHANGE

By Dermot Hayes and Don Hofstrand

Retail stores display many thousands of products because consumers are willing to pay the costs associated with offering such a wide selection. Farmers are in an ideal situation to provide their customers with a wide selection of products because they operate as small independent businesses. Yet the bulk of U.S. farm products continues to be sold as commodities, with little attempt to offer the customer any variety or added value. This is true because the commodity system is an extremely efficient way of collecting and transporting bulk products. This situation will change when the benefits associated with a differentiated product system become greater than the cost savings associated with the commodity system.

Consider the forces that are altering the balance between the commodity and differentiated systems. First, science has recently increased our capacity to create improvements in grain quality and grain composition. But these improvements are not readily accepted in a commodity system. The commodity system has been good at getting yield-increasing and cost-reducing technologies accepted, but it is not sophisticated enough to accept modifications to the genetic structure of the plant that benefit particular customers.

Second, the ongoing information revolution is reducing the costs of growing, transporting and processing differentiated products. Examples of how this change might affect agriculture can be found in the inventory management system used by some retailers. This technology alerts the manufacturer when customers buy the retail product, making reordering automatic. Another example is the recent successful use of the World Wide Web to organize growers and elevators to produce customized varieties of corn and soybeans.

Third, there is an increased willingness on behalf of consumers to pay for source identification and for a wider selection. This is particularly true in livestock markets where food safety is of great importance.

All of this suggests an increased interest in market systems that better translate consumer needs into signals received by individual producers or groups of producers. For grain markets this means a need for integrated systems that allow grain to be tracked from the seed to the consumer, a feat that is not possible in a commodity system.

If such vertical systems evolve and succeed, they will be more efficient than the existing system. This is true because any integrated system that is less efficient than the existing system will not be profitable enough to survive. Because any new system that succeeds will be more efficient, the average American stands to gain. These benefits may be particularly large in Cornbelt states if downstream biotechnology industries decide to locate near the source of their inputs.

Despite the overall benefits that may accompany a change in industry structure, there is no guarantee today's farmers will benefit. In a competitive market, returns will be based on the value of the skills and the level of risk that are needed from each producer. One can imagine possible scenarios in which the farmer is told what to produce and how to produce it, for a revenue guarantee. The companies involved in this system soon may realize they do not need highly skilled farmers, and returns to those involved in production agriculture may gradually fall to a level that is sufficient to attract a lower skill level. One can also imagine scenarios where farmers are required to use a much higher skill level to ensure quality and to handle complex financial negotiations.

Other ways in which returns to producers might increase would involve farmers being in a position to influence the price they receive, rather than being simply price takers. They might combine to sell output or buy inputs, or form groups that produce a product that is sold in a differentiated marketplace.

At this early stage it is not possible to predict whether the average producer will benefit or lose from these ongoing structural changes. The market is experimenting with several different ways to achieve the same vertical linkages and farmers have the opportunity to influence the ultimate outcome of this competition. Whether farmers will gain or lose is, to a certain extent, in the hands of farmers themselves. With this in mind, it is worthwhile to consider some of the ongoing experimental attempts to form vertical linkages.

Success in the Marketplace

Certain features are critical or at least important determinants of the likely success of any new market structures. First, any successful system will be responsive to the needs of consumers and innovative in its approach to new products and new opportunities. Second, it will be able to respond to these changes in a timely manner. Third, the system will give each person in the chain an incentive structure that encourages maximum effort and which is in the best interests of the system as a whole. Fourth, it will make efficient use of resources and minimize costs. Fifth, the firms in the system should have adequate access to capital. Sixth, the system will be more successful if it can command a price that is higher than production costs.

These criteria seem reasonable, yet may be difficult to achieve. For example, consider the third criterion, which focuses on the incentive structure. What would happen in Iowa agriculture if a large, top-down corporation attempted to grow large quantities of corn and soybeans using paid employees? When spring planting or fall harvesting emergencies arose it would be difficult to get paid employees to work as hard or as flexibly as needed. It is difficult for an outsider to manage small business units such as farms, restaurants and gas stations that rely on the operator's initiative, flexibility and knowledge of local conditions.

Other sectors that have encountered this difficulty have evolved into some kind of franchise arrangement that corrected the incentive system by giving the franchise owner a share of the profits in return for independent management decisions. Or look at the sixth criterion, which deals with market power and product differentiation. Many sectors of the U.S. economy have managed to retain some control over the prices they receive. For example, soft drink manufacturers attempt to create customer loyalty either through marketing campaigns or product differentiation. When this process works, the company can charge a price that is greater than actual production costs, and shareholders benefit through profit levels that are higher on average than those which accrue to those involved in perfectly competitive markets. Unfortunately, this kind of market power is difficult to achieve and the costs associated with marketing campaigns and product differentiation in the U.S. food sector are well outside the range of most producers or producer associations.

Success for Producers

The ultimate success or failure of the systems described here will not depend on how well they treat producers, but it is worth laying out some additional criteria of relevance to producers. First, we need to define what we mean by the term "producers." In this article this term refers to individuals who actually operate the equipment and take the market risk. Many of these are landowners but land ownership is not essential. For example, somebody who rents land to grow a crop is a producer, as are both individuals who participate in a crop share arrangement. However, landlords who rent out or lease their land are not defined as producers. The motivation for this narrow definition is that the economic forces that drive land prices are different from those that drive farm income.

The most important factor impacting success or failure is the level of income or profit producers receive per unit of output. If producers continue to be price takers, then in the long run this income level will be related to the skills and effort they provide. Under some market structures producers may obtain some market power, and income will be related to the extent to which producers can control the prices they receive, as well as to their skills and effort. Other sources of income may come from ownership of some of the upstream or downstream businesses.

A second criterion is the degree of independence or autonomy that producers retain. A third criterion is that the rewards associated with the changes be shared fairly. For example, producers may become frustrated with a system where another industry segment captures all of the benefits associated with the new system even though producer income is maintained at a satisfactory level. This desire is often expressed when producers say they want to "capture some of the premium." Finally, producers are universally interested in lowering the amount of financial risk. Following are four systems that may become the basis for a new agricultural structure. Each is evaluated for success by both market and producer criteria.

Corporations that Contract with Producers

Two of the largest privately owned companies in the U.S. have recently initiated programs to encourage producers to grow grain under contract. Others in the pork and broiler industry have well-established contracting programs. Both of the grain programs will involve company input on the varieties to be grown, and both offer the producer some form of per acre revenue guarantee. One of the programs involves company participation in production and managerial decisions. The benefit to the participating companies is that they can guarantee delivery of particular varieties or characteristics to their customers. They also create producer demand for fertilizer, chemical and insurance products.

Producer Criteria: These contracts will initially be very beneficial to producers. This will be true because companies need to enroll large numbers of producers in particular areas. As greater numbers of producers participate, the return to producers will reflect the skills they bring to the table. The organizing company will determine premiums for participation, and farmers will compete with each other until the rewards from participation are reduced to the minimum level needed to ensure participation. Any rewards associated with the increased efficiency will accrue to the company that created the new structure.

The companies that have initiated this structure have little interest in land ownership. However, a logical extension would be for Real Estate Investment Trusts (REITS) to acquire land and contract the production from this land. From an Iowa producer’s perspective, the worst-case scenario would be for companies located outside of the state to own Iowa land, and the land be managed by others also located out of state. The land would still have to be farmed, but the returns to those who do the farming would be close to the rates earned by custom farming operations. The likely results would be that those who are farming the land today would move into other occupations.

The way the market would encourage skilled farmers to leave production agriculture would be to pay them a return that was lower than these same skills were worth elsewhere. For many producers this would result in very low annual income from farming. A useful analogy can be made to the broiler industry where a similar structure has emerged. Those who now grow broilers under contract are getting paid enough to make it worthwhile. But these same contracts have not proven attractive in Iowa because Iowa producers tend to have a higher level of skill than that which is required to grow broilers under contract. Hog contracts have been more successful in Iowa, in part because the returns to the producer include a payment for disposing of manure, a product that is a nuisance to contractors but which has value to integrated crop/livestock producers.

Market Criteria: This contract system allows transfer of signals from consumer to producer. It also allows identity preservation because the company can contract with a group of producers around a particular elevator and use that elevator to maintain the identity of the product in a cost-effective way. The system is incentive-compatible in that the producer has every incentive to manage production because the producer benefits from good yields. The corporations are very well capitalized and have excellent marketing and transportation skills. The corporations have the research and legal capacity to create new products and to protect their patents where appropriate. They also have the capacity to advertise nationally and to create brand identification. This system does well on all of the market-based criteria, and we can expect to see an ever increasing share of production originate in this system.

Cooperatives that Contract with Producers

Many of the businesses Iowa farmers interact with are cooperatives. These fall into two categories. The largest category consists of locally owned businesses that behave like private businesses. For example, grain elevators are often cooperatives. These businesses pass back any profits in the form of annual dividends to their owners, and ownership is open to those who do business with the cooperative.

Producer Criteria: Traditional cooperatives would seem like an ideal basis from which to launch an initiative to ensure that producers fare well in the ongoing structural changes. Some of the more innovative developments in integrated hog production have evolved from producer-owned cooperatives. With the right incentive structure and an innovative leadership, one can see how local elevators would line up groups of local producers to grow specific varieties under contract with the elevator, and use existing facilities to store and transport these identity-preserved products.

Taken a step further, the elevator also could work with its members to purchase inputs at bulk prices and add value to output via further processing and marketing. Producers should be in a position to capture benefits either through higher farm prices or higher dividends. They also should be in a position to influence the way the industry evolves. For example, they might direct a local cooperative to offer a particularly favorable contract and then hope to force other contractors to improve on their contracts.

Cooperatives, however, have some weaknesses that may hinder efforts in this regard. There is no clear incentive for each member to maximize the profitability of his or her co-op. Dividends, if declared, are often based on financial accounts that are several years old and the size of the payment is not linked to each member's current involvement. Because members feel little loyalty to the co-op, the management is forced to behave like the private sector firms with which it competes. The fact that producers are both owners and customers can make decision making a slow and cumbersome process. And it is often difficult to pay skilled managers as much as they could make in private operations and to collect the necessary capital base to initiate new projects.

A second, newer form of cooperative structure has emerged recently to deal with some of the perceived weaknesses of the traditional model. These "new generation" closed cooperatives charge members an initial start-up fee and distribute profits on the basis of recent financial information and in proportion to the initial capital investment. For example, an egg laying cooperative might sell the right to market corn through the eggs that are sold. Members would buy rights and these funds would be used to construct an egg laying operation. Profits are expressed as a per bushel corn price and taxed only at the producer level.

Market Criteria: Closed cooperatives are very much like limited partnerships. If producer-owners show they are prepared to pay market rates to skilled managers, and to accept top-down decision making, these firms will be ideal for producer response to the ongoing structural changes. They can respond to market signals, offer differentiated and source identified products, and, if properly structured, provide optimal incentives at all points in the production chain. Potential weaknesses are a shortage of risk capital and the difficulty in managing suppliers who also happen to be the owners. This concept is relatively new and as yet untested. However, those firms that have become established seem to be performing very well. The Iowa turkey growers cooperative in West Liberty is an example of how this system can be made to work.

Because farmers own these closed cooperatives, there is some guarantee that profits, whether earned in production or in processing, will revert to the producers. But there is no guarantee these firms will pay producers any more than competing organizational structures. Just as traditional cooperatives have imitated their retail competitors, the new generation cooperatives may be forced to imitate their competitors.

The Seed Company Approach

Seed companies are the obvious basis for input-supplier-driven integration in U.S. grain markets. These firms are sitting on a host of varietal improvements that are not yield increasing or cost reducing and that cannot demand a market premium in a commodity market. These companies are well capitalized and technologically sophisticated. They have excellent marketing skills and management.

An example of how seed firms might drive integration is an Ames-based company called E-Markets. This company uses a Web page to attract and organize producers who wish to grow specialty grains. Producers can find out which varieties are needed in their area, the date the grain should be delivered, and the premium above cash prices they will receive. Buyers can find large numbers of willing growers in a particular area. Funds for this company come from seed companies that charge producers a premium for the seed that is required. E-Markets has grown rapidly and had about 600,000 acres under contract for the 1998/99-crop year. In essence the seed companies have decided to pay a third party to organize the integration process. Once this system is in place, the costs of organizing and managing an identity-preserved system will come down dramatically.

Producer Criteria: As with any of the contracts discussed here, farmers who enroll will do so voluntarily and only if they benefit. The initial adopters will do quite well at first because the other participants realize they have to make things very attractive to get a concentrated group of producers in a specific area to sign up. Once the system becomes established, premiums will adjust so the producer gets paid for the managerial and technical skills required. Producers in this system take the price and yield risk, and do not get paid any premium unless the product meets quality criteria. There is very little managerial or technical input from the seed companies. All of this means that returns to producers should be quite reasonable.

However, they cannot expect any premium above this level. This may prove frustrating to producers if the seed companies discover very valuable traits. The producer will recognize that the pie is larger but will be unable to capture any of the extra benefits because if one producer elects not to participate, another one will. Hence the benefits to participating producers cannot be greater than that which is enough to entice neighboring producers into the system.

Market Criteria: This industry structure is well capitalized and well managed. It transmits signals directly and quickly. All participants in the chain have the correct set of incentives, and as the costs of organizing the system come down and the value of the identity-preserved crops goes up, this concept should expand dramatically.

Franchise Farming

Other similar industries that have undergone transformation have generally evolved into a franchise system. Examples of successful franchise systems include restaurants, hotels, convenience stores, gas stations and fast food outlets. All of these involve relatively small independent businesses, which are best managed by owner operators. All require that the owner take risks and get rewarded for taking those risks, all pay the owner for knowledge of local markets and all require a relatively large capital contribution.

Producer Criteria: Most franchise operations reward their owner operators very well. The parent company has some incentive to share profits with franchise owners. And because owners are required to put up their own capital and accept risk, as well as to manage relatively sophisticated operations, the market rewards them.

This system would seem to have much to offer the typical Iowa producer. This would be particularly true if the value of the owner's land and existing machinery were counted towards the initial capital investment, and if the owners hedged against excess profits by the parent corporation by buying corporate shares.

There is no reason why each of the first three structures described earlier cannot evolve into a franchise form. In fact, some of the weaknesses identified with each of the existing experimental structures are not present in a franchise system. It may be that the first three structures are prototypes, each of which may evolve into a franchise arrangement once the market matures.

Market Criteria: Franchise organizations can respond quickly, can differentiate their product line through research and advertising, and do share profits with their franchisees. In general, the franchise company will own several outlets and the franchise rules will dictate that all outlets, whether owned by the parent company or by a franchisee, be treated the same. This tradition means that franchise owners know the company will not develop policies that work to the detriment of the franchise owners. It also allows the parent company to pass some of the profit back to the franchisees because it owns some of the franchises. The fact the parent corporation is prepared to share in the losses makes franchise owners more comfortable with decisions made by the parent.

As is evidenced by the recent growth and prosperity of the franchise system, the concept has much to offer. Shares can be sold by the parent company and capital also is provided by franchisees, so the system is well capitalized. Senior executives work and get rewarded in a corporate structure, while franchise owners are paid in part based on their day-to-day management skills and knowledge of local markets. All of those involved face the correct incentive structure and all are rewarded for the skills they bring to the table. Signals are transferred efficiently from consumers to producers and marketing campaigns can benefit from economies of scale.

What Should a Producer Do?

If economic forces dictate a change in market structure, it makes more sense for producers to work within the system than to oppose it from the outside. Any of the first three systems could eventually evolve into a system that is ideal from the producer's perspective, but this will be more likely to happen if producers are pushing for changes from the inside. All of the systems will create additional returns for those who adopt the system early. All will improve the competitiveness of U.S. agriculture, and most should benefit Iowa.

Some of the systems may seem too good to be true in that they will offer higher returns for lower managerial input, and it may be wise to view this as a temporary rather than permanent opportunity. Arrangements that require little input from the producer will eventually offer lower rewards. The opportunity to have someone else bear market risk, provide capital, market the crop and make technical decisions will be appealing and may offer short-term opportunities. But in the long run, the producers who continue to conduct these activities for themselves will earn higher rewards.

Producers who work together to coordinate activities will be in a better position to face challenges because they will be able to produce identity-preserved products at cost-effective rates, and can negotiate with input suppliers and integrated operations. Data such as soil quality maps that might seem valueless today may have value in the future as companies look for particular soil types. Producers who work together may be in a position to sell entire counties worth of data, and if they are the only group that possesses this data, they should be able to capture a premium.

Natural places for these coordinating activities to start include cooperatives and commodity groups. Lessons learned from observation of other sectors of the economy indicate that the food system may evolve into a franchise system. If this occurs, producers will give up some of their independence, but as long as they have the managerial and technical skills required to run a franchise they should be in a position to earn a reasonable return for their input. If they are fortunate enough to work with a franchise that captures a market segment, either through product differentiation or brand identification, they should be successful.

A way of summarizing is to say that producers who continue to buy retail and sell wholesale will fail. Those who understand the importance of buying wholesale and selling retail will probably do very well.

Chapter 8
RESPONSES IN THE INPUT SUPPLY SECTOR

By Roger Ginder, David Hennessy, Robert Jolly, Keith Heffernan, C. Phillip Baumel

Long established relationships in the crop and livestock sectors are undergoing rapid and radical changes. To a great degree, the changes are being driven by genetic innovations developed through both standard breeding and biotechnical means. The ability to patent genetics and genetically engineered plants and animals accelerated private research and development (R&D) expenditures. As these large investments begin to pay off in the form of new technological breakthroughs, the value chains on both the input side and the output side are being affected.

Chemical and Seed Industry

Suppliers are placing two unique categories of special trait seeds on the market. The first type bundles input related traits such as Roundup resistance or corn borer resistance with high yields and other desirable production traits. The second type combines enhanced-value, end-user oriented traits with standard high yield hybrids and varieties. Producers have been confronted with a choice between single seed traits in either of these two categories and within each category.

By combining or "stacking" traits from each of the two categories (and in some cases within categories), products can be created that add even more value. Stacking traits would permit further specialization in corn and soybeans for specific end uses while at the same time permitting producers to take advantage of input bundling traits.

The concept of stacked traits is simple and straightforward. Most traditional selection breeding programs have done it for years. However, most scientists would agree that there are still some serious technical difficulties to overcome before stacked biotech or genetically engineered traits can become a widespread reality in the market. For instance, as more traits are added, there is a greater burden on the basic genetics of the plant. Also there may be conflicts between the trait and the end uses for the grain or forage produced.

The addition of one or more altered genes may conflict with other genes in the plant and create undesirable results. These problems are likely to complicate the process of stacking traits into individual seeds and slow progress. It is likely some multiple stacked trait varieties and hybrids will be available over the next several years as a limited number of successful combinations are identified. However, other combinations may prove to be more elusive as breeders attempt to deal with negative biochemical responses to the multiple trait genetic alterations.

Where traits can be stacked successfully with minimal yield penalty and loss of agronomic viability, there is potential for significant increases in the economic end use value of those corn and soybean products. At the present time, there are no established values for stacked traits since the market has yet to be developed. However, industry sources estimate that stacking two relatively simple trait combinations such as high oil corn and high available phosphorus could add 25-50 cents or more to the value of a bushel of corn. Other combinations could result in much higher added values.

Credit

Consolidation in the finance sector is being driven by very large economies of scale and scope. These economies have been made possible by innovations in information technology, deregulation of financial markets, and the linkage of credit with product sales through captive finance companies. Machinery manufacturers, for example, have become major credit suppliers. For some input suppliers, financial services are becoming the profit center, while the inputs simply provide a valid reason to provide financing to the customer.

Seedstock

Animal genetics traditionally have been decentralized and dominated by breeders who sold purebred animals for producers who used them in cross breeding. Since the late 1970s, genetics companies have made steady inroads at the expense of the traditional purebred breeder. The seedstock industry has been fragmented with significant inefficiencies due to coordination failures and the inability to provide large numbers of consistent, high efficiency breeding animals to large-scale producers. It is rapidly consolidating in the hands of a few large genetics companies who are able to achieve economies of scale and scope in genetics improvement and marketing.

Feed

The feed industry also has been fragmented and characterized by excess capacity and high fixed costs. New technologies are reducing the cost of feed production and improving product quality. In many cases, firms that own or have contractual linkages to livestock production are constructing new feed capacity. Traditional independent mills and mills supplying contractors are under increasing pressure as the number of animals in the hands of independent producers dwindles. Further linkages between the seedstock and seed industry for special feeding systems and ingredients are likely. Suppliers of premixes and basic commodity ingredients to large integrated manufacturers are in the best position to grow and thrive. Manufacturers and suppliers of complete feeds for multiple species face the greatest pressure.

Numerous genetic modifications in corn and soybeans are substitutes for existing products. Farmers already produce some of these existing products. For example, increased protein content in corn is a direct substitute for soybean meal. High oil corn is a direct substitute for feed fat derived from livestock and poultry carcasses and from used soybean oil obtained from fast food restaurants. There are at least three effects of these substitutions:

(1) the net values of some genetic modification must be reduced by the loss in value of other products produced by farmers

(2) there is likely to be a transfer effect from one set of producers to another set of producers

(3) there is a direct price impact on the substitute feed ingredient products. For example, if high oil corn reduces the demand for feed fat, there are few alternative uses of feed fat. Since feed fat is not easily disposable, the demand for feed fat is relatively inelastic and the price will fall sharply when the quantity consumed declines. Thus, the lower value of feed fat will induce some animal feeders to shift from high oil corn back to feed fat.

Table 1 shows the likely impact of six modifications of corn on the consumption of soybeans, feed fat, lysine, methionin and dicalcium phosphate in animal feed rations. Soybean and feed fat consumption will decline sharply with increased protein or germ size. Feed fat also will decline sharply with increased starch digestibility. The results in Table 1 assume no price response from the traditional input suppliers. However, it is almost certain that suppliers will respond with lower prices to protect their market shares.

Machinery

Significant consolidation of the farm machinery industry began the farm crisis of the 1980s and advanced through the early 1990s. There will likely be a diminished role for short line manufacturers without R & D capacity as change occurs in genetics, crop protection and production sectors. Heavier emphasis on captive finance companies for financing and leasing in the industry also works against the traditional short line segment. Yield monitors will promote variable treatment of cropland and more precise tillage and application of inputs is likely to change the equipment used and the level of investment required. Expected linkages with information and crop consulting ser-

Table 1. Impacts of selected genetic modifications of corn for feed

Corn modification	Change corn value in cents per bushel	Change in corn consumption in millions of bushels	Change in soybean consumption in millions of bushels	Change in feed fat consumption in thousands of tons	Change in lysine consumption in thousands of tons	Change in methionine consumption in thousands of ton	Change in dicalphytate phosphorus consumption in thousands of tons
Increase protein content[3] 8 percentage points	78	522.0	-628.1	-1,465.1	81.3	-39.7	385.1
Double lysine content[1]	42	1.3	-0.1	0.0	-35.0	0.0	0.0
Increase germ size[3] 16 percentage points	40	172.1	-112.4	-2,448.4	-2.9	-14.0	-3.9
Increase starch digestibility[2] 8 percentage points	30	74.2	-15.1	-2,516.7	0.6	-2.0	-1.8
Double methionine content[2]	9	7.9	-7.3	-25.8	1.0	-39.7	1.6
Double available phosphorus[1]	0	1.5	-0.2	0.0	0.0	0.0	-39.4

1. swine 2. poultry 3. swine & poultry vices for utilizing management information captured through GPS/GIS systems may change production and tillage practices.

Response by Suppliers

Traditional retail farm supply firms are either diversified or specialized. Diversified elevator-farm supply firms combine grain receiving, storage and handling with sales of feed, fertilizer, crop protection chemicals and in some cases, petroleum. The specialized firms occur most commonly in fertilizer/crop protection chemicals and petroleum and although still common, have been declining in number. The advantages of the diversified supply firms are improved labor utilization on the cost side and the bundling of supply and output marketing programs on the revenue side.

Despite generating quite large gross sales volumes, net margins as a percent of sales in supply firms are in the 1-4 percent range and are often less than 1 percent of sales. This is especially true for the diversified grain marketing input supply firms. The narrow profit margins indicate the fiercely competitive market in which they operate. Narrow margins also place severe restrictions on the level of new investments these firms can make. Although the industry as a whole has low margins, the top firms in the system are generating slightly larger net margins. Net cash flow for the most profitable half far exceeds the amount available to the bottom half of the industry. Higher cash flows permit top half firms to make necessary investments in facilities and technology and provide competitive advantage. This disparity has promoted steady consolidation in the industry over the past 25 years.

The Feed Department

Through the past three or four decades, feed products and sales have been an important source of revenue and margins for diversified input supply firms. However, changes in feed customers over the past five years have changed the feed department from a consistent profit source to a problem area for many firms. The concentration of swine, beef and poultry into larger confinement operations and the switch to contract swine production have reduced the feed volume of most diversified input supply firms and created excess capacity. Many mills are running at a low percentage of capacity and have a high average cost per ton.

Competition from new mills built by contractor firms is a major factor in reduced volume since these mills operate multiple shifts with a limited number of formulations at very low cost per ton. One high volume multi-shift mill can displace the market for a number of smaller single-shift mills operated by traditional diversified firms. The loss of the dependable feed business is pressuring margins in traditional supply firms.

The Agronomy Department

The role of fertilizer and crop protection chemicals also has been important to the success of input marketing firms. These products have been a major source of revenue. Agronomy department margins continue to be a mainstay in these firms. However, agronomy departments also are facing significant investment pressures from rapidly changing technologies.

Increasingly stringent environmental safety requirements have meant large investments in facilities and application equipment, especially for crop protection chemicals. As a result, some firms have exited and the remaining firms are serving more acres from fewer plants. Large capital expenditures also have been required in response to producers' demand for precision application and GPS-based fertilizer programs. As precision programs are implemented, there also is a need for more highly skilled employees. Both the capital required and the need for more knowledgeable employees create a need to spread higher costs over larger volumes of product.

The mergers and concentration in the seed and chemical industry will place further pressure on agronomy departments in diversified farm supply marketing firms. As seed products are linked with crop protection chemicals, the agronomy department could lose some control over its margins and sales. For example, the recent decision by Monsanto to increase the technology fee on Round-up Ready seeds and reduce the price of Round-up directly affects agronomy sales and margins.

Beyond that, the linkage of seed to crop protection chemicals may force retailers to select a seed crop protection chemical package and align with a single genetics-chemical supplier in an exclusive agreement. This would be a radical departure from the past where retailers handled products from a number of competing chemical and seed suppliers. Exclusive agreements would split the customer base for many local retailers. Some customers may prefer seed and chemical products from manufacturers other than those with which the supplier has aligned.

The Grain Handling Department

The grain marketing and handling department in input farm supply firms has been a less consistent source of profits for many diversified input supply marketing firms. Yet during government storage periods, these departments are profitable. This activity is viewed by most firms as a necessary part of the business.

The current changes in the seed industry will create further pressures on grain departments in input supply and marketing firms. At the same time, it will provide opportunities for some. Elevators increasingly will be expected to provide testing for characteristics on inbound receipts and identity preservation. Many will be in a position to handle specialty grains as well as the more traditional commodity grains.

Marketing also will become less flexible with specialty grains. Unlike commodity grains, which can be shipped to a wide variety of end-users in desirable quantities, specialty grains will have a more limited array of potential customers. Often sales to customers will need to be arranged beforehand by contract and shipments will have to be timed more precisely. This implies a radical change in grain merchandising practices.

Coordination Opportunities

In the past, there appeared to be very little communication or coordination in the various aspects of the food supply chain. Agriculture has been characterized by fiercely independent and competitive entities developing and marketing products with minimal interaction with one another. Seed companies were unsure of which varieties producers would prefer and buy. Chemical companies were unsure of how various chemicals would affect some varieties of crops and unsure of producer preferences. Processors, for the most part, had little idea of what and how much producers would grow. Retailers and consumers had little input on what the end product should be.

In recent years this trend has changed considerably. The earliest coordination was between processors and retailers. Processors took information gathered by retailers about the preferences and buying patterns of consumers. They then developed products for those preferences.

More recently, there have been numerous examples of coordination between seed and chemical companies. Many chemical companies have purchased seed companies to insure that their herbicides, insecticides and other chemicals are compatible and effective on the new genetics being developed. There is increasing coordination in the development of grain genetics and grain end users including feeders and processors.

Some coordination has occurred because the cost of developing and marketing new products has become so costly that companies want to insure the products they develop will be useful and compatible with other technologies being developed. Other relationships and agreements are developing to insure that these companies are players in the rapid transitions and changes of technology, genetics and biotechnology. These relationships are developing as acquisitions, alliances and contractual agreements occur between entities in the food chain.

Livestock and poultry production have developed through contractual and partnership relationships between producers and processors. To date, the grain production industry has not involved the production or farmer level in a coordinated operation. Although some experimentation has occurred primarily with incentives in the form of premiums to grow specific genetics (high oil corn, edible soybeans, etc.), grain producers have not been viewed as true partners in the process. So it seems this is the new frontier in the near future.

Implications

- Producers will gain to the extent that genetic modifications:
  - ➢ increase yields
  - ➢ increase the value of their output
  - ➢ margins of input suppliers decline
- Producers will lose to the extent that:
  - ➢ capital costs increase to meet environmental and precision farming requirements
  - ➢ identity preservation and additional transport costs increase
  - ➢ yields are less than the best commodity product
  - ➢ there is decreased competition among input suppliers
- Input suppliers will gain from:
  - ➢ increased volume
  - ➢ reduced costs
  - ➢ improved margins
- Input suppliers will lose from:
  - ➢ some firms being forced out of business
  - ➢ some existing facilities becoming obsolete
  - ➢ the loss of some bargaining power in the value chain
  - ➢ decreased volume which increases average total cost
- Rural communities:
  - ➢ will gain if the input suppliers located in their towns survive and grow
  - ➢ will lose if more inputs are imported from outside the trade territory
  - ➢ in some cases, may gain from construction of processing facilites in the area
  - ➢ will lose if their input suppliers become branch locations or close down.

Chapter 9
LEGAL AND INSTITUTIONAL IMPLICATIONS

By Neil E. Harl and Kelvin Leibold

Historically, the role of the legal or institutional structure has been to provide the essential framework for economic and social activity but not to prescribe how or when economic activity is to take place. However, the legal or institutional framework is subject to political influence so increasingly these frameworks are being used to shape the economic system. The legal or institutional system has been used to limit or constrain the operation of the economic system with laws that place limits on economic activity. Thus, law serves as a partial substitute for the market. With the U.S. economy heavily committed to a price or market orientation, rarely does law serve as a total substitute for the market.

This chapter focuses on specific areas in which an effort has been made to influence the structure of the economic system.

Antitrust System

In an effort to assure a higher level of competition in the U.S. economy, the antitrust or market protection system was formalized beginning with the Sherman Act of 1890. Earlier attempts to accomplish similar ends through court decisions arose from anti-competitive practices dating back centuries. Interestingly, the Sherman Act was enacted in part in response to an 1888 study of the meat packing industry.

The Sherman Act outlawed monopolization, attempts to monopolize and intent to monopolize as well as contracts or combinations in restraint of trade. The legislation targeted collusive behavior such as price fixing which has been viewed as illegal per se (meaning there is no defense to fixing price) and efforts to perpetuate or increase the degree of monopoly power held by firms in a relevant market. The legislation also classified as illegal per se market divisions, agreements not to compete and group economic boycotts. Some courts have treated "tying" contracts as per se illegal although the practice of tying a good or commodity over which the seller does not have monopoly power to a good or commodity over which the seller does have monopoly power (such as by patent) may be justified if it can be proved the tying is necessary for the proper functioning of the monopoly item.

The Clayton Act of 1914 was enacted to fill in perceived voids left by the Sherman Act. It targets mergers if the effect is substantially to lessen competition. Horizontal mergers (mergers among competitors) have been the most vulnerable mergers to challenge. Challenges involving vertical mergers (mergers of firms supplying inputs to or processing or handling outputs from the merging firm) and conglomerate mergers (those with little direct competitive tie between the merging firms) have been less successful.

The Clayton Act created the first framework for dealing with discrimination in distribution. This section of Clayton was amended by the Robinson-Patman Act of 1936 to outlaw discrimination in distribution involving goods of like grade or quality except to meet competition or when discrimination was cost justified if the effect is to substantially lessen competition or tend to create a monopoly or to injure, destroy or prevent competition. The Robinson-Patman Act also prohibits selling at unreasonably low prices for the purpose of eliminating competition or eliminating a competitor.

The Clayton Act represented the first attempt at providing exemptions from the antitrust rules. The initial agricultural exemption in the Clayton Act was designed to provide protection for the fledgling farm cooperative movement, which had become endangered by the Sherman Act. Clayton specified that agricultural cooperatives without capital stock and not operated for profit were not subject to the penalties and sanctions of the legislation.

The Federal Trade Commission Act, also enacted in 1914, created the FTC as a second federal enforcement agency (the other is the Antitrust Division of the Department of Justice). The legislation also outlawed unfair, deceptive or misleading acts or practices in commerce. The act targeted, in particular, advertising, promotion and labeling of products.

The Capper-Volstead Act of 1922 was enacted to remedy two weaknesses in the Clayton Act. First, the limitation (in the exemption for agricultural cooperatives) to organizations not having capital stock and two, the failure of the legislation to permit cooperative marketing activities.

The Capper-Volstead Act specified that "persons engaged in the production of agricultural products as farmers, planters, ranchmen, dairymen, nut or fruit growers, may act together in associations, corporate or otherwise, with or without capital stock, in collectively processing, preparing for market, handling, and marketing in interstate and foreign commerce, such products of persons so engaged."

Later litigation established that farmers could collude with each other in cooperatively marketing products but farmers could not collude with nonfarmers such as packers, processors, handlers, distributors or retailers. Thus, in a 1978 case involving the broiler industry, the U.S. Supreme Court held that all of the members of a cooperative must qualify to act collectively; all had to be growers. If some members are not involved as growers, the cooperative loses its exemption.

Section 2 of the Capper-Volstead Act provides that if the Secretary of Agriculture finds that a cooperative organization monopolizes or restrains trade in interstate or foreign commerce to the extent that the price of an agricultural product is "unduly enhanced," the Secretary is empowered to act with a cease and desist order and the Department of Justice is charged with enforcement. Therefore, if producers are successful in raising price (the term "unduly enhance" is not defined in the legislation) the enforcement mechanism is in place for action to be taken against the producers.

A 1976 Capper-Volstead Committee report identified several factors relating to structure and several factors relating to price that should be considered in determining whether price had been unduly enhanced. The Committee report also acknowledged that it is possible that there might be no undue enhancement at the national level but still have local situations of undue price enhancements.

The Packers and Stockyards Act was enacted in 1921 as a broad regulatory statute with numerous purposes with respect to livestock and poultry marketing and the packing industries. Among the more important purposes were to prohibit particular circumstances which might result in a monopoly and to "induce healthy competition;" prevent "potential injury by stopping unlawful practices in their incipiency;" prevent economic harm to livestock and poultry producers and consumers and to protect them against "certain deleterious practices of middleman;" assure fair trade practices in order to safeguard livestock producers against receiving less than the true value of livestock as well as to protect consumers against unfair meat marketing practices; insure the proper handling of funds due sellers from the sale of their livestock; assure reasonable rates and charges by stockyard owners and market agencies in connection with the sale of livestock; assure a "free and unburdened flow" of livestock through the marketing system unencumbered by monopoly or other unfair, unjustly discriminatory or deceptive practices and to go further than prior legislation to accomplish these purposes; and to establish an executive agency with sufficient power to accomplish the intended result. This was the Packers and Stockyards Administration of the U.S. Department of Agriculture.

State Limitations

Beginning with Kansas in 1931, a total of nine states enacted limitations on corporations owning farmland and engaging in farming operations. Those states include Oklahoma, Kansas, Nebraska, South Dakota, North Dakota, Minnesota, Iowa, Missouri and Wisconsin. West Virginia, Texas and South Carolina impose minor limits on organization of farm firms. The most complete limitations, Kansas and North Dakota, were relaxed in 1981 to permit family corporations to own land and engage in farming operations.

The limitations have been extended in several states to limited partnerships and limited liability companies. A few of the states have imposed limitations on trusts. In recent years, Oklahoma, Kansas, Minnesota and Missouri have relaxed the limitations to permit intensive livestock operations. In addition, Iowa acted in 1998 to permit four types of "networking" entities to engage in specified types of farming operations.

With the innovation displayed in recent years in the way firms are organized, imposing limitations based upon method of organization assures that state legislatures will be playing a game of "catch up" as substitutes are developed for the corporate method of organization. Moreover, it is difficult to believe that a particular method of organization is little more than a proxy for features considered undesirable—absentee ownership, separation of ownership from management and large size or scale.

A few states impose limitations on vertical integration or vertical coordination. In Iowa, firms processing beef or pork with more than $10 million of sales at wholesale are prohibited from owning, controlling or operating livestock feeding operations.

About 30 states impose some degree of limitation on ownership of farmland by nonresident aliens or nonresident alien-owned entities. Iowa has the most complete limitation with a near-total ban on acquisition of farmland by nonresident aliens and non resident-owned entities.

Environmental Limitations

In recent years, states have become more involved in imposing various types of environmental limitations with some of the limitations varying by size of operation.

Nuisance provides a remedy if something interferes with the comfortable enjoyment of one's own property. The nuisance concept has been applied in numerous cases involving odors related to livestock operations. Iowa has enacted three major provisions designed to provide a defense against nuisance suits.

• A livestock feedlot law, enacted in 1977, provides a defense against nuisance actions if the feedlot operation is in compliance with regulations of the Department of Environmental Quality and applicable zoning requirements.

• Land within an "agricultural area" (the minimum acreage for an agricultural area is 300 acres) in Iowa has enjoyed protection from nuisance suits if in compliance with federal and state regulations, the nuisance did not result from negligent operation, the injury or damage did not occur before the creation of the agricultural area, and the action did not involve water pollution, overflowing of the person's land, or soil erosion. However, in 1998 that provision was held unconstitutional as a taking of property rights from those unable to seek redress from offensive operations affecting the use of their land.

• In 1995, a provision was adopted which specifies that a livestock operation is not a nuisance unless it is proved by clear and convincing evidence that the operation unreasonably and continuously interferes with a person's enjoyment of their life or property and the injury was caused by the negligent operation of the facility. A 1998 amendment specifies that the nuisance protection does not apply if the animal feeding operation unreasonably (but not necessarily continuously) for substantial periods of time interferes with another's comfortable use and enjoyment of their life or property and the animal feeding operation failed to use existing prudent generally accepted management practices reasonable for the operation. The 1998 Supreme Court decision mentioned above calls into question the legality of nuisance protection in the 1995 legislation.

The 1995 confinement livestock law required producers to have manure management plans which include having adequate land for applying livestock waste. The 1995 law also imposed siting distances from residences, businesses, churches, schools and public areas. The minimum separation distances, as amended in 1998, impose limits on three different size categories of livestock feeding operations.

In response to the March 5, 1998, decision of the Iowa Supreme Court, *Goodell v. Humboldt County*, the legislature further narrowed the authority of counties in dealing with confinement livestock facilities. Section 9 of the act, adding Iowa Code § 331.304A, provides—

"A County shall not adopt or enforce county legislation regulating a condition or activity occurring on land used for the production, care, feeding, or housing of animals unless the regulation of the production, care, feeding or housing of animals is expressly authorized by state law."

The language of the statute eliminates what authority remained in the counties after the Goodell decision.

Zoning can be implemented in Iowa at the county level "at the option of the board of supervisors of any such county." Counties are given authority to regulate land outside the corporate limits of any city. Cities are given broad powers to regulate agricultural operations within the city limits and for up to two miles beyond the city limits except for areas within a county which have adopted an agricultural land preservation ordinance. County zoning in Iowa does not apply:

"… to land, farm houses, farm barns, farm outbuildings or other buildings or structures which are primarily adapted, by reason of nature and area, for use for agricultural purposes, while so used."

Institutional System Favoring Small Firms

Several features of the legal or institutional system display indications that state legislatures and the Congress have, from time to time, been convinced that the legal framework should favor small firms.

For many years, the income tax rates for C corporations have provided a substantially lower rate for small firms (starting at 15 percent). At present, the corporate rate is imposed at a rate of 35 percent on those with the highest income levels. The 15 percent rate is currently imposed on the first $50,000 of corporate taxable income.

Since enactment of the S corporation concept in 1958, where the shareholders rather than the corporation pay income tax, the number of shareholders has been limited. Initially, S corporations could have no more than 10 shareholders. That number has been increased to 75 shareholders.

For several decades, taxpayers have been allowed to claim an extra amount of depreciation (above the regular depreciation allowance) in the year eligible items are placed in service. For 1998, the maximum additional depreciation is $18,500. That figure is scheduled to rise gradually to a level of $25,000 after 2002. And the limit on the amount of eligible property phases out for taxpayers with qualifying property exceeding $200,000.

For more than 75 years, farmers have been permitted to report income and expenses on the cash method of accounting (which offers substantial economic advantages compared to accrual accounting) even though inventories are a material income determining factor. In recent years, cash accounting has not been available for those above $25 million of gross receipts annually and has been barred for those with more than $1 million of gross receipts except for family corporations, S corporations and two categories of corporations in existence in 1976 and "grandfathered" in under the former rules.

Some states with mandatory workers' compensation coverage of agricultural labor impose significant thresholds for coverage. Iowa, for example, requires at least $2,500 of payroll annually before workers' compensation coverage is mandatory.

The Occupational Safety and Health Act, since 1976, has been made inapplicable to farm firms of fewer than 10 employees. That limitation has been contained in the annual appropriations bill for the U.S. Department of Labor.

Several federal estate tax provisions enacted in recent years have favored owners of small firms. A few states have enacted similar provisions for state death tax purposes.

The most recent enactment, in 1997 with major revisions in 1998, is the family-owned business deduction. Under that provision, qualifying family-owned business interests up to $675,000 in value (for 1998) may be deducted for federal estate tax purposes. The property must be held for at least 10 years after death by a qualified heir or member of the qualified heir's family or the tax benefits have to be repaid.

A provision for valuing land in a business at lower than fair market value was enacted in 1976. That provision permits a reduction in valuation of up to $750,000 for eligible land used in a business. Again, a 10-year recapture rule applies if the land is not held by a qualified heir or member of the qualified heir's family.

Small firms enjoy a significant advantage in paying federal estate tax if the estate is subject to that tax at death. For the first $1 million of taxable estate above the applicable exclusion amount ($625,000 for deaths in 1998), the interest rate is two percent for 15-year installment payment of federal estate tax. Above that level, the interest rate is 45 percent of the regular interest rate for underpayment of federal estate tax. To be eligible, a decedent must have an "interest in a closely-held business."

Provisions Favoring Larger Firms

Not all features of the legal or institutional system favor small firms. Some favor larger firms.

For many years, the costs of health and accident insurance and the expenses incurred under reimbursement-type medical plans have been deductible for employee plans. However, until 1989, the same expenses for self-employed individuals were not deductible for income tax purposes. In 1989, Congress enacted legislation allowing a deduction for 25 percent of such expenses. That percentage is scheduled to phase up to 100 percent after 2002.

Group term life insurance is a deductible employee benefit up to $50,000 of coverage per employee. Most states require a minimum of 10 employees for a qualified deferred compensation plan. However, some insurers have developed "baby group" plans which require fewer than 10 employees for qualification.

Theoretically, deferred compensation plans, which involve tax deductible contributions to qualified plans, are available for firms with as few as one employee. However, the fixed costs involved in establishing and maintaining plans tend to discourage small firms from establishing qualified plans.

From a policy perspective, there are several issues surrounding the question of whether the legal or institutional system should be used more aggressively to shape the structure of the U.S. economy.

As noted above, the antitrust system is largely limited to addressing problems related to concentration and anti-competitive practices. That system addresses an important need but is a relatively cumbersome and costly approach to influencing structure.

The effectiveness of state-level efforts at influencing structure have been limited by the fact that innovative minds have produced a veritable explosion of ways to organize and structure firms to avoid the limitations. Indeed, there has been more innovation in institutional arrangements relating to structuring firms in the past two decades than in the prior two centuries. Focusing on choice of organizational arrangement places state legislatures in a position of continually amending the limitations to outlaw certain types of emerging options.

If society ever becomes seriously committed to limiting the size or scale of firms, it would be necessary to influence the cost curves of firms. That could be accomplished by various types of taxes which could have the effect of raising the level of firm costs at higher levels of output. Higher standards imposed on large firms for environmental protection would have the same effect of raising the cost curve at higher levels of output.

Such a move would necessarily have an impact on product costs and, in all likelihood, on costs to consumers. For food products, it has been believed that political support for such a move would be difficult to obtain. In the current political climate, the odds of obtaining support for an effort to influence structure in this way would have to be viewed as quite low.

Winners and Losers?

With structural change occurring in the agricultural sector and more change likely in coming years, a major concern is who will likely gain and who may lose from the shifts that could occur. Several factors are expected to influence that outcome.

• The shift in bargaining power as firms controlling inputs (in particular germ plasm) move closer to monopoly status.

• The fact that purchasers of farm products are unlikely to pay more than is necessary to acquire the needed products.

• The belief that producers are expected to remain in a competitive state in light of the historic difficulty in achieving collective action.

• The extent to which farm products are essentially fungible (the units are freely substitutable—one bushel of number two yellow corn is much like every other bushel of number two yellow corn).

• The extent to which products become differentiated on meaningful and significant bases.

An issue of importance for many years has been the wisdom of conferring monopoly status on patentees and others taking advantage of trade mark or plant variety protection (PVP) legislation. Now developments in establishing a monopoly position in germ plasm are raising the question of whether firms should be required to accept some limitations on their monopoly position where such limitations are in the public interest.

Mergers, alliances, and various other forms of arrangements in input supply, particularly in seed supply, are reducing the number of players—and increasing the level of concentration.

But that's not the whole story. The revolution in ownership of germ plasm is also moving rapidly toward concentration in a few hands. The high profile alliance between DuPont and Pioneer Hi-Bred International, the Monsanto acquisition of a greater interest in DeKalb and the Monsanto acquisition of Delta and Pine Land Co. are examples of how the ownership and control of genetic material in crops are falling into the hands of a few, economically powerful players.

For decades the land grant universities developed the basic genetic lines and made those lines available to the seed industry. Partly because of limitations on university funding and partly because of the near-revolution in genetic engineering, the private sector began pouring more money into basic research.

The U.S. Supreme Court in a 1980 landmark case determined that life forms could be patented. That was another tool—in addition to Plant Variety Protection under federal law and simply shrouding the research efforts with secrecy—to keep competitors at bay for a period.

The effect of concentration in input supply and control by the few resulting firms over germ plasm on contract negotiations with producers depends on the options open to producers who don't like the terms of contracts offered to them. With numerous contract possibilities available from input suppliers, each offering inputs of roughly equal productivity and cost, the answer is perhaps "not much."

But, if there are just a few options—with the next best offering a much less attractive set of inputs in terms of cost and productivity, the answer is "take what you're offered." The outcome is likely to be a tilting of the terms of contracts in favor of the input supplier. The division of revenue from production thus would be expected to shift in favor of the party with the monopoly or near-monopoly position. Seed companies—and other input suppliers—can be expected to drive the best possible bargain which means, in the case of seed, capturing the greatest possible percentage of the value from any yield premium.

The outcome would be a smaller share of the revenue from production going to the producer, resulting in less compensation to the producer and less to capitalize into land values. Seed companies would end up with a larger share of the pie with more to capitalize into the stock of the input supply firms.

The negotiating power of seed firms could well have other impacts. In an effort to control the germ plasm more completely, seed companies are likely to negotiate for ownership of the product with the producer under contract having only a contract right to payment, short of ownership of the crop or livestock involved. Similarly, the contract may contain what would appear at first glance to be an attractive feature—the input supplier bearing the price risks.

These seemingly innocent shifts would mean, however, that the economic position of the producer would be transformed from that of a risk-taking entrepreneur into a relatively riskless world of fixed compensation. Thus, not only would a shift of compensation occur in favor of the input supplier but also a shift of management functions in the same direction. The outcome would be reminiscent of the limited role played by growers under broiler contracts.

In general, one would expect high handed economic behavior by near monopolists to be met by entry of new competitors attracted by the generous terms of contracts in favor of the input suppliers. And that would likely occur if entry were possible. However, the barriers may be fairly high.

One barrier is capital needed to mount the kind of research needed to maintain a product flow similar to that of the firms pressing for monopoly-like concentration levels. The capital needed is very substantial. Also, existing patent and plant variety protection may mean that potential competitors are frozen out of competition for the duration of the patent or PVP certificate.

One possible strategy for farmers is to forge alliances among producers. The push to achieve such countervailing power was the driving force behind the formation of labor unions a century ago. Historically, however, farmers have been unwilling to accept such a disciplined approach to achieving bargaining power.

Another possible area of protection against a sharp tilt in the economic terms of contracts is vigilance by federal (or state) anti-trust agencies. Certainly the FTC and the U.S. Department of Justice should be sensitized to the potential for economic abuses. It’s been well established that firms with monopoly power over a product should not be able to “tie” other products to the transaction and extend the monopoly position.

Such arrangements, which involve tying products over which a firm does not have monopoly power (such as financing, insurance or risk management) to a product over which the firm does have monopoly power (such as a seed variety), are illegal unless it can be demonstrated the product in monopoly status wouldn’t work as well with other firms’ products. That’s rarely the case. FTC and the Department of Justice should scrutinize all seed industry mergers carefully for anti-competitive consequences and all practices by seed companies in tying credit, insurance, risk management or other needed inputs to seed availability.

With public and political support, a more aggressive approach could be taken in influencing the structure of firms and the nature of arrangements in the economy. The rapid and pervasive change expected in the agricultural sector will create an opportunity for a more aggressive stance.

Chapter 10
SUMMARY AND CONCLUSIONS

By John A. Miranowski and C. Phillip Baumel

The average farm size in Iowa has doubled in the last 50 years. After World War II, it took 53 hours of labor to produce 100 bushels of corn. Today it takes 45 minutes. Biotechnology has created genetic modifications of corn and soybeans permitting new insect and weed management options. Such changes increase yields and reduce production costs. Similarly, developments in genetically modified animal breeding stock are occurring and hold even more promise for the future. Such technological developments have critical implications for the structure of Iowa agriculture.

What will these technologies lead to in the future? If we continue to rely on bulk commodities with tight margins, the future points to continued consolidation in production agriculture. On the other hand, if producers shift to specialty, higher valued production (niche markets) the focus will be on segregating product based on specific attributes and consolidation may occur less rapidly.

Contracting will change cropping practices just like it has livestock production practices. But how it will change practices is not totally clear. Producers may shift from being entrepreneurs to contracting their labor, land and equipment services. They may bear little risk, make few management decisions and earn a lower return. Alternatively, the producer may assume more risk and provide management, marketing and financial services and earn a higher return. Much will depend on what services (skills and assets) the producer has to offer and what risks he or she is willing to take.

Responding to Change

Any time there is structural change, there are going to be winners and losers. But it is difficult to determine the outcome in advance. Land values are a case in point. In a more concentrated industry with few suppliers of a technological innovation, a large part of the added value is captured by the developers and suppliers at one end of the food supply chain. Innovations will generally not have significant affects on land values or rental rates. But in the case of many suppliers competing to get producers to adopt their technology, suppliers will transfer more of the added value to producers. Producers, in turn, will bid these increased returns into higher land values and rental rates.

The forces that are creating change in the structure of Iowa agriculture are new technologies including biotechnology, innovative information systems, and consumer demands for improved product quality and traits. If these new technologies and information systems succeed, they will generate greater added values in the supply chain than existing technologies and production methods. The benefits will be distributed in some fashion among consumers, input suppliers, marketing firms and producers. In a competitive market, the producers' share will depend on the value of the skills and the level of risk assumed by each producer. If a system evolves in which the producer is told what to produce and how to produce it, the required skills and the resulting returns will be low. Producers can increase their share of the benefits if they provide skills to insure specific quantities of products and to handle complex financial negotiations.

There are several forces that will determine the success of a new market structure. A successful structure must:

- Be responsive to the needs of consumers
- Be innovative and responsive to new products and opportunities
- Provide an incentive structure that encourages and rewards effort and generates maximum benefits to the entire system
- Make efficient use of resources
- Have adequate access to capital

Possible systems that might evolve to provide a successful structure include corporations contracting with producers, cooperatives contracting with producers, and franchise farming.

Initially, contracts between corporations and producers should be beneficial to early adopting producers because corporations need to enroll large numbers of producers in contracts. As the number of participating producers increases, returns to producers will decrease unless producers are supplying important management, technical and financial skills to the contracted arrangement. Producers' revenues will be lowest if corporations buy land and contract production from the land similar to broiler contracts in the South.

Producers could benefit from higher prices and/or dividends if they contract with cooperatives, especially if dividends are based on current purchases and sales. In particular, the new closed cooperatives require an up-front investment and distribute earnings based on current business and an initial investment. Producers involved in these cooperatives may have some influence on structural change.

Franchise farming can reward owner-operators well. Producers' land and machinery may count as part of the initial investment. If producers have an opportunity to buy shares in the parent corporation, they may have an opportunity to hedge against excess franchise operations.

What can producers do?

• It may make economic sense to work inside a changed structure than to oppose it from the outside.

• All systems or alternatives will generate some additional returns to producers who enroll early and perform services that add value to the final product.

• Natural places to start include cooperatives and commodity groups as well as jointly formed supply networks and alliances.

• Producers who buy retail and sell wholesale will fare less well than those who buy wholesale and sell retail.

Input Supply Sector and Rural Communities

Like agriculture itself, the input supply industry has been changing quite dramatically during the past three decades. These changes will accelerate as seed and chemical companies "bundle" two or more products to sell as a package. Among these changes are:

• Input suppliers providing increased amounts of credit to producers

• New technologies reducing the cost of feed manufacturing and improving feed quality

• Genetic modifications of corn substituting for existing feed inputs like soybean meal and feed fat, which will lose value

• Bundling of chemicals like fertilizers, herbicides, pesticides and seeds and packaged agronomic practices, including machinery and possibly land

Rural communities will gain if the input suppliers in their towns survive and grow but will decline if inputs are increasingly imported from outside the community. These communities will also gain from construction of production and processing facilities in their communities in the short term, and the added value of employment, trade and other economic activities in their community.

Policy Options

Many people are concerned about increased market power of a declining number of firms that provide new technologies and in some cases, may even own their own land and/or market the output. We have identified three basic policy options to deal with these concerns:

• Let the market work. Under this option, public policy would not constrain the activities of firms engaged in technology development, production contracts and marketing of the inputs and outputs. The basic concept behind this strategy is that regulating market structure is very difficult and is likely to result in reduced benefits to society, especially Iowans. Within this approach there may be a role for public compensation or assistance for growers.

• Try to prohibit structural changes in Iowa. While this strategy reduces short term pain for current producers, it is likely to cause greater long term pain to Iowa as other states and countries adopt the changes and capture the benefits of the change. Ultimately, the level of economic activity and profits of agriculture in Iowa will be greatly reduced.

• Shape the change in Iowa. This strategy could include facilitation of producer bargaining rights and rating contracts, compensation and penalties for unfulfilled contracts, prescribed sharing of risks and rewards, and more complete information on trades and transacted prices. The basic problem with this approach is that regulating structure is very difficult because people will develop innovative ways of getting around the regulations. Furthermore, regulations have a tendency to create unintended consequences and introduce distortions into the system that will reduce efficiency and overall benefits to society.

A thorough discussion and understanding of all of the issues and consequences is needed before society decides which course of action to pursue. Hopefully, this book will stimulate and inform the discussion, enhance understanding of the challenges and opportunities, and provide helpful information on the tradeoffs involved.

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Agriculture in the 21st Century—Surviving and Thriving

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