BIOLOGICAL MANUFACTURING AND INDUSTRIALIZATION OF PRODUCTION AGRICULTURE

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Abstract

Farming is in the midst of a major transformation—not only in technology and production practices, but also in size of business, resource control and operation, business model and linkages with buyers and suppliers. Both the livestock and grain sectors are changing from an industry dominated by family-based, small and modest size, relatively independent firms to one of generally larger businesses following an industrial business model that are more tightly aligned across the value chain. We describe some of the fundamental concepts and characteristics of biological manufacturing and then illustrate these characteristics with a brief description of three modern farming businesses. The characteristics include: attribute driven or differentiated products, a total systems and process control approach to production, a purchasing agent approach to sourcing inputs, more precise technology, sustainable closed loop systems, merger and acquisition growth strategies, and contracting and new business models.

Key words: biological manufacturing, closed loop systems, process control, precision technology.

JEL Codes: Q12,Q120

Biological Manufacturing And Industrialization Of Production Agriculture

Farming is in the midst of a major transformation—not only in technology and production practices, but also in size of business, resource control and operation, business model and linkages with buyers and suppliers. The forces driving this transformation are many and widespread including increased quality, safety and traceability demands of processors and consumers of food products; implementation of information and process control technologies that facilitate biological manufacturing of crop and livestock products; adoption of technologies and business practices that exploit economies of size; increased use of leasing and other outsourcing strategies to foster growth and expand options for resource control; and wider adoption of contracting, strategic alliance and cooperative business models to facilitate more effective and efficient vertical coordination in the production/distribution value chain (Boehlje, et. al. (1999). Both the livestock and grain sectors are changing from an industry dominated by family-based, small and modest size, relatively independent firms to one of generally larger businesses following an industrial business model that are more tightly aligned across the value chain.

What are these industrial business model concepts being more commonly used in production agriculture? We will describe and discuss some of the fundamental concepts and characteristics of biological manufacturing and then illustrate these characteristics with a brief description of three modern farming businesses. The characteristics include: attribute driven or differentiated products, a total systems and process control approach to production, a purchasing agent approach to sourcing inputs, more precise technology, sustainable closed loop systems, merger and acquisition growth strategies, and contracting and new business models.

Concepts of Biological Manufacturing

Attribute Driven Products

The transformation of crop and livestock production from commodity to attribute driven or differentiated product industries is driven in part by consumers' desire for highly differentiated food products; their demands for food safety and trace-back ability; from continued advances in technology; and from the need to minimize total costs of production, processing, and distribution. Food systems may attempt to differentiate themselves and their products by science and/or through marketing. Ways to differentiate through science include gaining exclusive rights to genetics through patentable biotechnology discoveries; by exclusive technology in processing systems; or by superior food safety integrity. Differentiation may occur not only in terms of the attributes of the product, but also in terms of process. Agricultural raw materials may be different because they are grown in different ways (for example free-range poultry) or with different technologies (for example non-GMO corn or organic vegetables) as well as their nutritional value or chemical composition. Marketing may include: branding, advertising, packaging, food safety, product quality, product attributes, bundling with other food products for holistic nutritional packages, and presentation of products in non-traditional formats. Figure 1 summarizes attribute driven opportunities for differentiation in the agricultural industry.

Figure 1: Attributes in Agricultural Products for Specific Consumers or End Users.

Special Attribute	Reason for Added Value	Possible Consumer/End User
Nutrition value	High for any of many possible nutrients	Health-conscious consumer
Palatability	Higher	Elderly Babies
Chemical composition	Higher, lower, or specific type of Starch Protein Fiber Sugar	Diet-restricted & medical-needs consumers
Texture & process properties	Ease or speed for processing	Processing plants with compatible equipment
Volume & availability	Larger number of lots Uniformity of lots Available as needed	Processing plants with high volume, specialized equipment &/or employees
Freshness	Produced or grown close to users	Gourmet-conscious consumers
Timing of delivery	Supply schedule meets delivery demand	Processing plants which then can operate at full capacity
Grown/produced with or without noted attributes	Chemical free Pesticide free Additive free	Diet- or medical-restricted consumers
	Welfare-sensitive raising of livestock	Consumers with religious concerns and beliefs

Product differentiation is an important and particularly unique phenomenon for the production sector of agriculture. Much of the production sector has focused on commodity production in the past, and these commodity products are typically produced in large volumes by numerous producers in an increasing number of geographic locales in the world. Consequently, margins for commodity production are under constant pressure because of market forces that encourage increased production when prices and margins increase even slightly. In contrast, differentiated products are sufficiently unique that they cannot be produced everywhere by everyone. And differentiated products generally have more intrinsic value because they have additional attributes that consumers and end-users want. So the margins for differentiated products are generally higher and are less easily eroded by market forces compared to commodity products.

Systems Approach and Operational Procedures

Systemization and Routinization -- One of the characteristics of the manufacturing process is systemization and routinization. With increased understanding and ability to control the biological production process, routinization becomes increasingly possible. Tasks become more programmable. Routinization generally fosters more efficient use of both facilities and personnel as well as less managerial oversight and overhead. Hourly work schedules that identify specific tasks to be done at specific times on specific days are but one example. Precision crop farming is another example. In essence, agricultural production is becoming more a science and less an art. Systemization and routinization fosters precision production which uses science and technology to "real time monitor" the production processes and exercise control over those processes through biotechnology and nutritional technology. Farmers are adopting technology and management practices (Standard Operating Procedures or SOPs) to standardize, routinize, and generally manipulate and control the biological processes of crop and livestock production. These procedures accommodate the increased expectations from end-users for conformance quality and quantity assurance.

Scheduling and Process Control -- A further implication of the manufacturing paradigm in agricultural production is increased emphasis on facility utilization, flow scheduling, and process control. In the past, variability associated with the delays in adjustment of output to current and expected prices and inherent lags in the biological production processes have made facility use and scheduling and process control difficult if not impossible. Many production units have in essence maintained excess plant capacity (for example, excess planting or harvesting capacity) as one means of accommodating the uncertainty of the output of the biological production process. Undoubtedly, rainfed crops will still be subject to weather variability, but increased knowledge of biological production should facilitate prediction as well as control of production processes. With increased ability to predict and control the biological production process, facility use can be more accurately scheduled, and process control concepts to improve efficiency and reduce cost are more applicable and useful than in the past.

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

System Cost Control -- Although cost control is critical in any production process, the manufacturing approach focused on end-user products recognizes total production and distribution systems cost as being more critical than the cost in each stage of the chain. As noted earlier, this approach has the potential to eliminate some of the significant inefficiencies in the chain. And as more resources are purchased from others, the cost structure of the business changes with a higher proportion of the cost being variable (i.e. costs change directly as a

function of output) and a lower proportion fixed (i.e. do not vary with output). With this changing proportion of fixed and variable cost, each stage becomes more responsive to changing end-user demands and competitive pressures. In the short-run the costs that influence production adjustment decisions are variable costs -- the smaller proportion that variable costs are of total costs, the more prices must decline before firms reduce output. Consequently firms with a high proportion of fixed costs are slower to adjust to lower prices than they are to expand when prices increase. In essence, an industry in which more firms have a higher proportion of their total costs that are variable is more responsive to changing market conditions.

Raw Material Acquisition

Purchasing Agent -- Part of the manufacturing mentality is a purchasing agent or specification buying approach to acquiring inputs or services. This approach involves the specification of input requirements and in many cases requesting alternative suppliers to bid for the business based on the contract specifications. This purchasing agent approach puts more emphasis on ability to fulfill contract specifications at a competitive price than the personal relationship based purchasing behavior of many agricultural producers. Note that the relationship is not unimportant in a purchasing agent approach to acquiring inputs; instead the relationship is more explicitly defined in the context of meeting and enhancing the features and characteristics the buyer wants as reflected in the contract specifications. A purchasing agent illustrative bid sheet is shown in Figure 2.

Optimal Input Packages -- With the increasing capacity to control and understand the biological process through biotechnology and genetic engineering techniques, producers will be more capable of developing optimal input combinations that match chemical and biological attributes to obtain the optimum quality and characteristics of output. For example, crop genetics are being matched to pesticides for optimal pest control – as exemplified by Roundup weed control and Roundup Ready soybean and corn seed. In this situation, the classic mix and match strategy of the past where producers could buy chemicals from one firm and genetic material from a second may become less effective. In some cases the grower will purchase pre-specified input packages that are optimized in terms of their biological and chemical characteristics; in other cases the grower will be warned that certain plant nutrient and genetic inputs respond better when used together and their performance may be sub-optimal if used in other combinations. But this matched inputs strategy has risks -- the risk of reduced flexibility to adjust if supplies of an input decrease and/or prices increase.

Technology

Three types of technology are critical in biological manufacturing:
1) monitoring/measuring and information technology, 2) biotechnology and nutritional technology, and 3) process control technology.

Monitoring/measuring and information technology — The focus of this technology is to trace the development and/or deterioration of attributes in the animal and plant growth process, and to

Figure 2: Purchasing Agent Specification Sheet

Farm Name:_____

Agribusiness Name:_____

Address:_____ **Phone Number:**_____

Date:_____

1. Product Performance_____

   _____

2. Price:_____

   _____

3. Quantity or Volume Discount:_____

   _____

4. Delivery Time and Conditions:_____

   _____

5. Local Contact:_____

   _____

6. Application Services:_____

   _____

7. Financing Terms:_____

   _____

8. Warranty:_____

   _____

9. Technical Documentation:_____

   _____

10. Complaint Response Time:_____

    _____

11. Technical Support:_____

    _____

12. Information Services:_____

measure the impact of controllable and uncontrollable variables that are impacting that growth process. In crop production, yield monitors, global positioning systems (GPS), global information systems (GIS), satellite or aerial photography and imagery, weather monitoring and measuring systems, and plant and soil sensing systems are part of this technology. In animal production, systems to monitor humidity, temperature, air quality and other characteristics of the feedlot or building environment along with systems to monitor feed formulations, water characteristics, and animal waste and feed ingredient composition are included. In future years, in-animal sensors to detect growth rates and disease characteristics may be part of such information and monitoring/measuring systems. And these systems will be tied to growth models to detect ways to improve growth performance, as well as to financial and physical performance accounting systems to monitor overall performance. The computer technology to manipulate the massive amounts of information is readily available; new monitoring/measuring technology including near-infrared (NIR) and electromagnetic scanning is now being developed to measure a broad spectrum of characteristics of the animal and plant growth process.

Biotechnology and nutritional technology — The focus of biotechnology and nutritional technology is to manipulate the attribute development and deterioration process in plant and animal production. An improved scientific base to understand how nutrition impacts not only growth but attribute development is providing additional capacity to manipulate and control that process. And biotechnology is advancing our capacity to control and manipulate animal and plant growth and development including attribute composition through genetic manipulation. By combining nutritional and biotechnology concepts with mechanical and other technologies to control the growth environment (temperature, humidity and moisture, pest and disease infestation, etc.), the process control approach and thinking that is part of the assembly line used in mechanical manufacturing becomes a reality in biological manufacturing.

Process control technology — The concept of process control technology is to intervene with the proper adjustments or controls that will close the gap any time actual performance of a process deviates from potential performance. For example, servo mechanisms in a hog building automatically turn on the ventilation system, the coolers or a heating system if the temperature deviates from what is desired for optimal animal growth. Greenhouse production increasingly utilizes such technology to manipulate sunlight, humidity, temperature, and other characteristics of the plant growth environment. Irrigation systems are an example of this technology with respect to field crop production; modern irrigation systems tied to weather stations and plant and soil sensors automatically turn irrigation systems on when moisture becomes a constraint to plant growth, and automatically turn the systems off when moisture levels are adequate for optimum growth. In confined livestock production, any-time intervention technology to impact the growing environment, change the nutritional regime, or prevent disease outbreaks are conceivable and will likely be commercially available in the near future.

Sustainable Closed Loop Systems

The industrial model has increasingly emphasized recycling, capturing value from all products (and by-products) produced and closed loop sustainable systems. Livestock producers have redefined manure as a waste product to be disposed of at the lowest cost into a plant

nutrient product that needs to be efficiently transported and applied to cropland to create the most value.

And the biorefinery revolution is taking this recycling and closed loop production system concept a step further. Closed loop systems, or 'integrated biorefineries,' convert manure from cattle into methane to power an ethanol plant, and distillers grains leftover from the ethanol-making process into cattle feed. While the cattle or dairy cows create beef and milk, the ethanol plant creates fuel at a much lower cost thanks to the 'recycled' power source (cow manure); if a plant doesn't need all the energy from its digester, it can sell to the local power grid creating yet another profit stream. Closed loop technology allows livestock farmers to feed many more animals because they will no longer be limited by the amount of land they have in proportion to the amount of manure they must disperse. Clearly these concepts are essential to organic production which is increasingly moving from small scale to large scale farms where the fixed costs of complying with the rules and regulations of organic certification can be spread over more output.

Besides the benefits of lower costs and increased revenue streams, self-sustaining systems typically use less fossil fuels, reduce environmental concerns from manure loss, and help large-scale operations expand within pollution restrictions. Increasingly the mindset of the industrialized farmer is to move from a disposal mentality to a create and capture value mentality.

Growth Strategies

Much of the expansion of agriculture in the past can be described as that of incremental expansions -- producers would add an additional 40 acres to their 240 base acreage for example. But increasingly expansion is of the large-scale new venture variety. These new venture projects require substantial capital investments (often in excess of a million dollars) and frequently require significant labor and managerial resources as well to be successful. This new venture approach to production agriculture is a dramatic change in the way of doing business compared to the incremental expansions of the past.

Furthermore, more and more of today's expanding farmers are adopting the common business strategy of mergers and acquisitions compared to buying assets as in the past. Thus, farmers are buying businesses or acquiring the package of assets (including leased land) rather than purchasing individual parcels of land or pieces of equipment. And in fact, an increasingly common growth strategy for some growers is to approach a current operator with say 1000 to 1500 acres of farmland, who is near retirement, offer to buy the "farm business," and retain the current operator and his/her machinery to operate the equipment on that acreage. In essence, the acquiring farmer obtains control of not only the owned but also the rented acreage of the current operator, and also increases his capacity to farm this additional acreage by outsourcing some of the machine and other operations to a skilled grower who likely is uniquely qualified to farm that particular acreage. This strategy of acquiring businesses rather than acquiring assets usually involves obtaining control over a larger asset base, and thus accelerates the rate of growth and consolidation of large scale operations.

Capitalization and Business Model

The traditional approach to agricultural production has been that of an independent producer who purchases inputs and sells products through various market mechanisms to other independent businessmen. And this business was financed with the producer's equity and only limited amounts of debt.

Increasingly, producers are joining or partnering with other resource suppliers in various ways to expand volume with limited capital outlays. In crop production this is occurring through the growing use of contracting for machinery services, leasing of land, and custom farming. The critical dimension of such partnering or alliances is that more resources and services are obtained from others if that is a less expensive technique for acquiring production inputs, and more linkages along the chain to the food or industrial product end-user are used to capture value in additional stages of that chain. Creative financing arrangements that combine equity from investors and "permanent" as well as traditional amortized debt with the farmers/entrepreneur's equity investment in an "optimal capital structure" are increasingly common.

Farmers are also using management strategies and new business models to more fully utilize their machinery and equipment. One of those strategies is multi-site production. Growers are increasingly producing in more than one locale, and in many cases are choosing those locales based on both weather patterns and transportation/logistics capacity and systems. They then move equipment from site to site, in essence allowing them to not just increase the utilization and lower the cost of machinery operations, but to again relax the timeliness constraint on size of operation without investing in additional machinery or equipment. Another newer business model for many growers is the use of operating leases or machinery sharing to cost effectively acquire additional machinery services. Precision farming combined with creative ways to schedule and sequence machinery use including 24 hour-per-day operations, moving equipment among sites and deployment based on weather patterns has the potential to increase machinery utilization and lower per acre machinery and equipment costs as well.

The "Leading Edge of Industrialized Agriculture:" Some Examples

The following descriptions illustrate the increasing number and importance of large "leading edge" farming organizations that epitomize the industrial farming model. The three farm organizations were purposefully chosen in crop agriculture and dairy since these are the industries that are perceived to be the least dominated by the industrial model today. Certainly, these farming organizations do not represent today's mainstream U.S. or European agriculture. To be sure, the majority of farm businesses particularly in the U.S. continue to be modest size 1 – 2 person sole proprietor operations. However, the case studies below provide a view of the potential future structure of agriculture in the U.S. and in the world as the industrial model becomes more commonplace.

Fair Oaks Farms

Since 2000, rural Newton County Indiana has been transformed into a leading diary producing county in the U.S. Both the Fair Oaks dairy (partially owned by the Bos family) and the Bos Dairy have been expanding dairy production on both sides of Interstate 65 between Chicago and Indianapolis during this time period. As of 2007, the combined dairies have approximately 70,000 cows in the area. The two operations are contiguous and share similar attributes but are managed separately. Here we will describe the Fair Oaks dairy operation.

Fair Oaks was started in 2000 with three dairy milking units milking 3,000 cows each on a 9,000 acre block of land. Since 2000, the farm has expanded to 10 milking units milking 30,000 cows using 72-cow circular milking parlors milking 24 hours a day 7 days a week. Fair Oaks estimates that they produce 4 million glasses of milk each day at the farm. There are a number of interesting features of this operation including a grass-to-glass concept of managing everything from production of crops for feed, to cow comfort, to energy production from waste materials. In addition, the farm has a cheese production facility, ice cream production facility, and a tourist department focused on educating people of all ages about the production of milk.

The farm's original marketing plan focused on producing fluid milk for consumption in Southeastern U.S. markets. The farm was strategically located on Interstate 65 to allow for efficient transportation of raw milk. The milk was transported to a processing facility in Louisville, KY. By processing the milk in Kentucky rather than Indiana, the farm enjoyed a substantial premium for its milk because the milk marketing order (MMO) for Kentucky was the Southeast MMO while Indiana was in the North Central MMO. This premium amounted to almost $2.00 per hundred weight at times. In addition, Fair Oaks focus on efficiency allowed the milk to be turned through the processing facility and placed back on the Interstate in time to reach grocery store shelves in places such as Tampa, Florida in 36 to 40 hours; faster than most dairies located in the Southeast could achieve.

Fair Oaks continues to pursue the Southeast market for a portion of its product. However, because management is concerned that the advantage created by the MMO's could disappear with changes in farm policy, they have diversified their product portfolio to include many of their own branded items including ice cream and cheese. Fair Oaks also plans to build a fluid milk processing plant; currently they sell their branded products to wholesale distributors. This form of vertical integration is a classic industrial management technique that large scale farms are increasingly pursuing.

Fair Oaks is an excellent example of the replication strategy being pursued by the cutting-edge farm managers of today's agriculture. The management team has determined that the most efficient plant size for milk production is a 3,000 cow milking plant. Each plant or pod has stalls and a milking parlor located in one footprint. The facility is self contained with its own animal housing, feed formulating and waste management facilities. The facility is also highly mechanized and computerized with each individual cows' feed intake, milk output, and critical medical history being tracked daily by computer. The farm uses the information to real-time diagnose problems with cow comfort and health to intervene at the earliest possible stage; much

like a manufacturing plant would use process control charts and systems to mange production processes.

This highly linked production system for 3,000 cows is replicated as the farm makes expansion decisions. That is, this farm considers expansion of its production capacity in 3,000 cow increments. Each time it expands the exact same footprint is copied, cutting the learning curve time, construction costs, and time from concept to production substantially. The 9,000 acre block of land has room for multiple replications (10 already in place). This resource coupled with the management team's strong relationships with crop producers in the area to grow additional feedstuffs for the dairy operation under contract allows the organization to pursue continued growth.

Fair Oaks Farms is also pursuing the idea of the closed loop production systems. In addition to using the dairy waste for crop nutrients, Fair Oaks is also one of the largest dairies to currently employ a methane digester to produce a portion of the dairy's energy needs. In addition, they are in the planning process to build an Ethanol Plant on site that would allow them to create ethanol from the corn production and then use the wet distiller's grains as the feed for the dairy. The idea is to use every resource on the farming operation as efficiently as possible.

El Tejar

An intriguing and innovative application of the industrial business model to production agriculture in a global context is the Argentine based agricultural production company El Tejar. El Tejar's roots are in Argentina, and the principals have been involved in production agriculture and farming operations for three generations. But El Tejar is not a "typical" farming business – it owns no land, it owns no machinery and equipment, it is not geography bound, and its strategic positioning and operational performance is more dependent on the intangibles of human resources/people and relationships than tangible/physical resources as is typical for most traditional farming operations. In essence El Tejar optimizes the application of the industrial concepts of outsourcing, process control, and international operations to production agriculture.

To be more specific, El Tejar is a "contract farming" company that operates in four South American countries – Argentina, Brazil, Bolivia, and Uruguay. Primary crops are soybeans and corn with limited acreage of cotton, and other row crops. Total hectares farmed are 120,000 hectares (296,400 acres) in Argentina, 17,000 hectares (41,990 acres) in Brazil, 8,000 hectares (19,260 acres) in Bolivia, and 34,000 hectares (83,980 acres) in Uruguay. As is typical in much of South America, the actual physical farming activities (i.e. tillage, planting, harvesting, etc.) are accomplished by production companies that own and operate the machinery and equipment on a per hectare or similar fee basis for the production management company. This business model is a variation of the contract farming business arrangement used in the US where farm land owners or management companies pay machinery owners and operators a specific fee for the full set of machinery operations to plant and harvest a crop.

El Tejar has contracts with approximately 250 machinery/equipment operating companies to farm their approximately 200,000 hectares (approximately 500,000 acres). One of the keys to their success is to choose and train the workforce of these operating companies as

well as to facilitate their access to the latest machinery and equipment technology. Considerable resources are devoted to training sessions and educational programs for machinery and equipment operators to help them develop the skills to be more timely and efficient in operations. In the spirit of the application of process control concepts, detailed records are kept on machine operations as well as cost to monitor and improve performance. Standard operating procedures for all land preparation, planting, pest control, harvesting, and other machine operations are used to implement efficient and effective operations. The El Tejar management team is adamant that the relationships with these machinery and equipment owners and operators is a critical component of their sustainable competitive advantage and long-term success, and they work very hard at maintaining and improving these relationships. Some of the machinery/equipment owner/operators have been partners with El Tejar for 10 or more years.

Consistent with a focus on intangibles and relationships as a source of competitive advantage, El Tejar also expends considerable effort in developing and maintaining relationships with land owners, suppliers of production inputs such as fertilizer, seed and chemicals as well as grain merchandisers and others who buy their products. The company has relationships with in excess of 200 land owners. As one might expect, the size of the El Tejar operation allows it to obtain sizeable discounts on purchased inputs as well as preferred prices in selling products.

El Tejar uses the classic risk management strategies of many farming companies such as futures and options based on the Chicago Board of Trade to manage product price risk. But instruments such as crop insurance are not available, and forward pricing contracts for inputs as well as for most products are also limited in availability. Political instability, changes in government export and tax policy, and exchange rate fluctuations are significant risks for the company – more so than for most North American or Western European farming businesses. Operations that are dispersed across different climatic zones of four countries in South America does diversify weather/production risk as well as political/government policy risk to some degree.

Production scheduling models that sequence and optimize machinery/equipment operations are part of the process control procedures used in the business. Where appropriate, GPS, satellite imagery, and yield monitoring technology is used to collect information and monitor productivity, efficiency and operations. Standard information/data display and analysis techniques used in the manufacturing industries such as control panels and dashboards are used to real time assess operating performance compared to plans so as to quickly detect gaps or deviations that merit managerial intervention.

A critical focus of the El Tejar organization is on quality control in terms of products and operations, environmental stewardship, and employee/contractor relationships. The company is ISO 9001 compliant with respect to both the products produced as well as the processes used to produce those products. Furthermore, El Tejar was certified as ISO 14001 compliant in 2003 – these regulations refer specifically to environmental practices and outcomes as well as the sustainability of the production practices used in the business. And in 2006, the company was certified as OHSAS 18001 compliant – these rules and regulations refer to the safety of the working conditions and operational procedures as well as the health standards for both employees and contractors. Compliance with these high standards for product/process quality,

environmental and sustainable production practices and worker/contractor safety and health are commonplace in the industrial sector and manufacturing industries, and are increasingly being adopted by farming and production agriculture companies that desire to improve efficiency and respond to more demanding consumers and end-users in an increasingly competitive global market.

Christiansen Land and Cattle Company

Christiansen Land and Cattle Company is a 35,000 acre operation based in Kimball, South Dakota. The farming and ranching operation was established earlier this past century by Helen and M. Dewey Christiansen – Helen managed farmland as part of her legal practice, and M. Dewey was a successful cattleman. The operation is currently managed by Christine Hamilton, the daughter of Helen and M. Dewey, and her veterinary science professor spouse, Eddie Hamilton. Approximately half of the acreage is used for crop production including 5000 acres of wheat, 10,000 acres of corn and soybeans, and 1500 acres of alfalfa and prairie hay. The ranch and cattle operation includes approximately 1,000 cows as well as a 1000 head feedlot, backgrounding calves, and managing 500 cows for other owners. The work force consists of a crops manager and 5 employees for the cropping operation and a livestock manager and 2 employees for the cattle and ranching operation.

Christiansen Land and Cattle Company illustrates the industrialized agricultural business model in three important dimensions. First, the operation has embraced managerial accounting procedures to better understand the sources of profit and improve the operational management of the business. The operation includes ten production cost centers for the different crop and livestock activities in the business. In addition, seven additional cost centers support these production centers by providing equipment, supplies, a labor force, etc. These cost centers contribute resources to five separate profit centers: live beef sales, process beef sales from finishing, crop sales, horse sales, and land rent. Detailed allocation of expenses and income to these cost and profit centers provides information to make critical strategic and operational decisions. Hamilton indicates that recent strategic production and marketing decisions such as late fall grazing on winter wheat, custom finishing of cattle rather than finishing of their own calves, and early season contract selling of calves from the cow herd – all very profitable decisions that are not typical for most South Dakota cattle operations – could not have been made without the detailed cost and margin information from their managerial accounting system.

A second common business practice used in the manufacturing industries that has been adopted by Christiansen Land and Cattle Company is the use of professional consulting services to provide analytical support for critical decisions. Hamilton has retained Centrec Consulting Group to assist her in making critical decisions including crop insurance coverage, marketing strategies, staffing and personnel management, succession and business continuity planning, implementation of a managerial accounting system, capital investment analysis and negotiation of machinery and equipment purchases, leasing arrangements and rent negotiation. This standard business practice used in the manufacturing and industrial sector not only provides improved analysis and information for critical strategic decisions, it also gives an additional perspective to the decision process since the consulting company works with other family based businesses in the production agricultural sector throughout the U.S. and can thus leverage those relationships

into a broader set of experiences that enhance the decision making process for the Christiansen operation.

Finally, similarly to the industrial sector, Christine Hamilton has positioned Christiansen Land and Cattle Company to be involved in a number of stages of the food production and distribution value chain. Hamilton has been a leader in South Dakota's initiatives into value added agriculture including ventures in dairy development, meat packing, and biotech industries. Her core farming businesses include the vertical alignment of feed production, livestock breeding and production, livestock feeding, and further processing. Additional related activities in the Hamilton business portfolio include livestock management services, meat wholesaling, and venture capital investments. In essence, the Christiansen operation, which traditionally focused on cattle ranching and grain production, is now vertically aligned through ownership and contracts in numerous additional stages of the agricultural production and distribution value chain.

A Final Comment

In the future agriculture is expected to be a significant supplier of raw materials for: (1) food and nutrition products, (2) energy and industrial products including synthetic fibers, plastics, wall coverings, and other products that have historically been derived from the petrochemical industry, and (3) health and pharmaceutical products. Thus, agriculture is being transformed from an industry that produces and processes commodity products to one that biologically manufactures specific attribute raw materials for a broader set of end uses.

As agriculture is transformed from a commodity to a differentiated product business, competition becomes multi-dimensional – it is not just being cost competitive that will lead to financial success. Differentiated products typically have a broader spectrum of quality features than commodities, and those quality dimensions or features are expected to improve over time – for example, consumers are expecting food products to exhibit continuous quality improvement much like they experience in other products. In differentiated product markets producers not only compete with respect to cost, they also compete with respect to quality attributes of their products and with respect to the speed or response time to introduce new products as consumer demand and market conditions change. And speed of entering new value added or differentiated product markets may be critical not only to obtain the best premiums, but also because those who attempt to enter the market later might find that it is adequately supplied.

This new agriculture profoundly changes the competitive environment in production agriculture. In the commodity agriculture of the past, farmers had to compete only in terms of cost. A low-cost producer who did not expand beyond his/her sustainable growth rate of the business could expect to survive and maybe even thrive in the long-run. In the new agriculture that includes differentiated products and more tightly aligned marketing/distribution systems with producers being raw material suppliers for industrial manufacturers and food processors, competition includes quality features and responsiveness or time to market as well as cost. In the agriculture of the future, farmers will need to be <u>better</u>, <u>faster</u>, and <u>cheaper</u> to have a sustainable competitive advantage.

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