International Food and Agribusiness
Management Review 5 (2002) 87–103

International Food and Agribusiness Management Review

Capturing value in the supply chain: the case of high oleic acid soybeans[☆]

Mark A. Darroch[a], Jay T. Akridge[b,*,1], Michael D. Boehlje[b]

[a]*Agricultural Economics, School of Agricultural Sciences and Agribusiness, University of Natal, Natal, South Africa*

[b]*Department of Agricultural Economics, Center for Food and Agricultural Business, Purdue University, 1145 Krannert Building, West Lafayette, IN 47907-1145, USA*

Abstract

The oil produced from high oleic acid soybeans (HOS) offers benefits to both consumers and food manufacturers. It is lower in saturated fat and more heat-stable than commodity-grade soybean oil. Optimum Quality Grains L.L.C. is working with seed distributors, elevators, and crushers across the Midwestern U.S. to develop a new supply chain which keeps the HOS and the resulting oil separate (identity preserved (IP)) from commodity-grade soybean oil. This case illustrates the challenges and key issues facing three players—an agricultural inputs dealer, a grain elevator, and a soybean crusher—that must decide whether to join the new supply chain as the HOS reach commercialization. The case can be used to create a discussion about how each player can create and capture value from this specialty crop. The case works well either as part of an undergraduate capstone course or a graduate course in agribusiness, or in an executive education course, especially such a course aimed at managers from seed and life sciences companies.

© 2002 Elsevier Science Inc. All rights reserved.

☆ This case study was developed to illustrate the challenges facing supply chain participants as output trait products like HOS reach commercialization. Many of the details provided in this case are based on current events and activities. However, certain information has been disguised to protect confidentiality, and fictional relationships and characters have been developed, based on interviews with industry participants, to create a case study that presents the key issues involved in taking an output trait to market. Do not consider all information in this case factual. Do not rely on information provided in this case for decision-making purposes unless confirmed through other sources.

* Corresponding author. Tel.: +1-765-494-4327; fax: +1-765-494-4333.

E-mail address: akridge@agecon.purdue.edu (J.T. Akridge).

1 A teaching note that suggests a case teaching approach and provides some answers to the case questions is available on request from the authors.

1096-7508/02/$ – see front matter © 2002 Elsevier Science Inc. All rights reserved.
PII: S1096-7508(01)00074-X

1. Introduction

Consumer demand for healthier foods has driven plant biotech companies to develop new specialty crops that contain less saturated fat. One of these products, high oleic acid soybeans (HOS), was released in 1997. The oil produced from HOS offers benefits to both consumers and food manufacturers. First, HOS oil is 30% to 40% lower in saturated fat than commodity-grade soybean oil. Second, this oil is naturally more heat-stable, and so needs no hydrogenation for use in frying or in spray oils that extend the shelf life of foods. Hydrogenation forms *trans*-fats, which recent studies suggest may contribute to heart disease. Attachment 1 describes the composition and market potential of HOS, and how *trans*-fats may be linked to heart disease.

Optimum Quality Grains L.L.C. is working with seed distributors, elevators, and crushers across the Midwestern U.S. to develop a new supply chain for HOS and HOS oil. Interested food companies are also using the oil in test runs. Optimum was formed in 1996 as a joint venture of the DuPont Company and Pioneer Hi-Bred International, Inc. Optimum intends to create and coordinate a supply chain that keeps the HOS, and HOS oil, identity preserved (IP), or separate from, commodity-grade soybeans and soybean oil. To accomplish this, the firm will need the co-operation of a number of different players along the supply chain. And, if they are to play a role in the HOS supply chain, each player will need to decide that the expected returns from participating in the chain are greater than the expected costs of handling and processing the crop.

The rise of Optimum is further evidence that major changes are underway in the marketing of some grains and oilseeds in U.S. agriculture. Many farmers trying to manage low margins on commodity-grade grains and oilseeds are becoming less commodity-oriented and more customer-oriented. They have become more interested in producing specialty crops, such as HOS, which meet specific end-user needs, and promise higher margins. Supply chains that deliver these new products to end-users may require innovative alliances between various players in the chain. Attachment 2 gives more background on U.S. specialty grains and the HOS supply chain, as well as some of the key factors to success in the IP crops business.

This case presents the challenges and key issues facing three players who must decide if they will participate—and what role they will play—in the new supply chain as the HOS reach commercialization:

- an agricultural inputs dealer,
- a grain elevator, and
- a soybean crusher.

Should they get involved with this product? How will their systems that were designed to handle commodity-grade soybeans need to change? What role should they play? How can they capture value in the HOS supply chain? Who should they align themselves with? These are challenging questions for three players to answer in a rapidly evolving marketplace . . .

2. Hos player 1

2.1. The agricultural inputs dealer: Irwin Agronomy Services Company

Irwin Agronomy Services Company (IrCo) is a mid-sized, independent regional agricultural inputs dealer based in Northern Iowa. The firm operates eight retail locations across a seven county region. IrCo holds about 15% of the local market for agronomic inputs in these counties. It markets crop inputs—fertilizer, herbicides, pesticides and seed—and a full set of agronomic services to farmers. Dave Irwin, the founder and owner of IrCo, sees the firm's mission as 'making our customers more profitable than our competition can'. An energetic 42-year-old entrepreneur with a degree in agronomy, Dave has over 10 years experience selling agronomic inputs and affiliated services.

Always looking to grow his business, Dave had recently gone to a workshop on ''Finding Links in the Output Trait Value Chain'' held in Des Moines, Iowa, to learn more about new specialty crops. There, he learned that Optimum Quality Grains L.L.C. was likely to expand a HOS program into IrCo's marketing area over the next 2 years. Dave thought this might be a new business opportunity and a nice fit with the high service strategy he used in his business. Moreover, IrCo needed to do something to offset falling agricultural chemical sales caused by the release of new herbicide and insect resistant crops. Keen to explore the matter further, Dave, switched on his Toshiba laptop and started typing in his thoughts ...

Over the last year, about one-third of IrCo's marketing area was planted to new herbicide tolerant Roundup Ready® soybeans and insect tolerant Bt corn. The firm's gross herbicide and insecticide sales (dollars) were down about 20% as a result. Local farmers that had spent $30 per acre on a traditional herbicide program for soybeans now spent about $15 per acre if they used Roundup Ready® soybeans. Dave had recouped some revenue by focusing more on post-emerge herbicides (which IrCo applied), and on specialty chemicals for broad-spectrum weed and grass control. He had also really stepped up his service marketing efforts.

IrCo had been in the seed business for about 4 years. And, the firm's seed sales had been growing steadily over that time. IrCo currently handled corn and soybean seed from two regional firms. One of their seed suppliers was Wyffels, and they had done well with the Wyffels high oil corn program. Due to this success, Dave was considering a major investment to strengthen IrCo's position in the value-enhanced seed market. He was also thinking about hiring a full-time seed salesman who was quite knowledgeable about IP crops like high oil corn. If hired, this person would help IrCo's sales people to 'get up to speed' on the agronomics of these new crops. Dave believed that such a technical background was a necessity if a salesperson was to be successful in presenting these new specialty seed lines to farmers.

Dave felt that IrCo's local identity and reputation for high-quality service would help it enroll growers if it chose to participate in the HOS effort—provided that local elevators offered more HOS contracts. Initially IrCo would most likely market the high oleic A233HO soybean variety developed by the Asgrow Seed Company. Dave had read in the trade press that while Pioneer would be the preferred seed supplier for products developed by Optimum in the future, Optimum is talking to other interested seed companies about distributing HOS seed. IrCo already marketed DuPont herbicides and insecticides, and Dave hoped that IrCo could also benefit from the seed promotion support given by Optimum. How all this would impact his relationships with his current seed and chemical suppliers was another issue?

IrCo could capture value from selling HOS seed to complement the commodity and specialty corn and soybean lines that it now marketed in Northern Iowa. Of course, Dave would only do this if Optimum could guarantee farmers attractive premiums to offset higher seed prices, the extra costs of IP on-farm storage and delivery, and any yield drag (possible lower yield compared to commodity-grade soybeans) for his customers. He needed to contact area elevators working with Optimum to find out the terms under which farmers would grow the HOS. He also had to figure out how the new seed line might affect IrCo's current profits—Dave wanted to add value without 'cannibalizing' the sales of other products. Equally important, with seed product life cycles shrinking rapidly, how quickly would net gains, if any, from the new HOS line erode? And, what new HOS products or other value-added traits were in the pipeline?

Dave's experience had taught him that many, especially larger, farmers were prepared to pay for information to evaluate increasingly more complex seed products and improve their specific crop production systems. Information technologies like precision farming and the Internet were also being more widely used by farmers. In response, and as another strategy to counter lower chemical sales, IrCo had recently employed three Certified Crop Advisors to help farmers to profitably apply these new technologies.

Precision or 'site-specific' farming uses satellite and computer technology to manage crop production on small, specific tracts of land, as opposed to managing inputs on a field by field basis. Using precision agriculture, planting rates and fertilizer, weed and pest control practices can be 'fine-tuned' to achieve better returns. IrCo offers farmers a range of precision agricultural services. These services include yield monitor data analysis, soil sampling and field mapping with a geographic information system (GIS), and variable rate application technologies (VRT) that adjust input levels based on site-specific fertility data. IrCo captures value by charging fees for these various services.

Dave thought that IrCo could differentiate itself from other retail dealers and add further value by becoming more of an 'information center'. His vision was to offer local farmers and crop consultants a unique technical/economic support system giving information on precision agriculture and value-added crops. This would help farmers and consultants to better integrate elements of precision agriculture into the production systems of the marketed seed lines. Depending on their needs, clients could adopt one element of precision agriculture, additional elements over time, or the entire package of services. Dave had acquired a software package for IrCo to keep records on individual fields and products to meet restricted-use pesticide laws. With such historical data and record-keeping systems in place, the firm was well suited to collecting precision agriculture data, and developing contacts with potential growers of HOS.

In Dave's mind, this set of services and the resulting information would not only have value for producers—he felt IrCo could add value for firms like Optimum as well. For example, the type of data collected could help Optimum in identifying the 'kinds' of growers with the 'kind' of production management skills that fit their needs.

This thought raised a new set of issues: could IrCo only capture value from HOS—and other IP crops—from the additional seed sales, service sales, and associated sales of fertilizer and agricultural chemicals? Or, were there other options—should IrCo become more aggressive on the contracting side? Should they focus on crop management and provide quality control services for IP contractors? What type of contracts would be used? What were the pros and cons of these options? How would they affect current relationships for the firm? What new relationships would need to be established?

Dave turned off the laptop, and mulled over his past few hours work. It was apparent that IrCo would need to develop alliances and trust with the seed suppliers and potential contract growers. An appropriate information system was going to be critical to monitor product flow along the supply chain. Long-term agreements could be a way of ensuring commitment from all players and of developing a consistent supply of high-quality HOS. While the major issues were clear, Dave needed to take a careful look at his options. He also wanted to hear what IrCo's advisory panel of top local farmers and crop consultants thought about such a venture.

But, there was no point in going forward unless Asgrow and Optimum were interested in what IrCo could bring to the supply chain. He jotted a note to himself—tomorrow's first item of business was a couple of important phone calls . . .

2.2. *Questions*

1. What value can a firm like IrCo add in the supply chain for an IP crop like high oleic soybeans? Be as specific as you can.
2. Assuming this type of firm either has or can create a role in the chain, what are their possible options—i.e., what are the specific roles that IrCo can pursue?
3. For each of the roles you identify in question 2, what are the pros and cons? Assess how each fits with IrCo's core capabilities. What are the costs of assuming the roles? How will IrCo generate revenue in each role to offset the costs?
4. In your opinion, what role should they play? Why? For this role or position, identify what you see as the key success factors. What relationships will be key, who should they align with, what resource investments will be required, what risks will need to be managed, etc.?
5. What further information—both quantitative and qualitative—does Dave Irwin need to collect and evaluate before he can decide whether or not IrCo will participate in the HOS supply chain?

3. Hos player 2

3.1. *The grain elevator: GrainLoc Elevator Company*

Jim Giggs, the general manager of GrainLoc Elevator Company in Central Iowa, sat back from his computer monitor and thought about the new wave of specialty crops described on the Optimum Quality Grains homepage. Jim, who was 38 years old and married with two children, had just been promoted to his new post after 5 years of outstanding service in the company. Jim had ag-engineering and MBA degrees, and had worked in the grain industry for most of his professional career.

Jim had an ambitious goal of increasing company profits by 15% annually. After starting rigorous cost-control programs at GrainLoc's elevators, he was now looking for other ways to boost profits. Specialty grains offered one option that he was looking into. And, just yesterday one of Optimum's regional managers had called him to see if GrainLoc was interested in contracting HOS. Jim was to return the call today.

Jim's thoughts drifted for a moment ... Ironically, Jim's father had died of a heart attack—possibly the result of a poor, high fat diet. As a result, Jim was more health conscious than the average consumer, and he was often the only elevator manager at industry meetings eating just a salad. His personal interests had led him to find out more about HOS, and when these specialty soybeans were first planted as a contract crop in the area, he had closely monitored their performance.

He reached for a pen and paper and started jotting down the main issues for GrainLoc to consider in making a decision to handle a specialty crop like HOS. The company currently operated six elevators ranging in storage capacity from 272,000 to 2,600,000 bushels of grain. One of these elevators has facilities for processing corn into animal feed. To date, GrainLoc had shied away from anything that limited their marketing freedom or increased their costs. Margins were tight, and grain merchandisers needed to maintain as much control over marketing as possible. However, times were changing and GrainLoc needed to evaluate any promising opportunity.

If GrainLoc were to handle IP crops, they would obviously need to make several changes to their present system of sourcing and handling commodity-grade grains and oilseeds. First, the HOS would need to be kept separate from commodity-grade products in order to preserve the trait. Some specialty crops such as high oil corn are produced in sufficient volume to permit a greater degree of bulk handling. However, given the relatively small volume of HOS expected, and despite the forecast for increased demand longer term, more stringent IP handling and separate storage practices would be needed—especially in the early years. The company could possibly make the needed facility changes at one of their smaller elevators where Jim had first worked after joining GrainLoc. That facility stored 650,000 bushels, and currently operated a single soybean dump with loading capacity of 3,000 bushels per hour.

Jim wondered if GrainLoc could find farmers interested in producing HOS and who would guarantee that the HOS would be IP? On-farm storage could be critical and in his market area it was still somewhat limited. If farmers were assured that there was a long-term opportunity, they might be willing to invest in more on-farm storage facilities. And, there had been some increase in on-farm storage in the area recently due to relatively low commodity prices (farmers were storing rather than selling crops, hoping for higher prices). This trend could continue. Jim believed that interested growers would have the integrity to not blend commodity soybeans with HOS. Of course, the lack of on-farm storage and IP handling capacity could be another opportunity for GrainLoc—maybe the firm should expand storage capacity, and do so with the IP markets in mind. This might mean investing in more, smaller volume grain tanks and additional dump capabilities.

Jim assumed that market contracts would be used to ensure that volume delivered and crop quality standards matched end-user needs. Contracts would need to specify items like HOS storage options, delivery dates, 'buyers call' provisions (buyer expects delivery upon request), pricing methods, who bears freight charges, HOS delivery specifications, and discounts. Growers must also be able to segregate the HOS crop, permit Optimum staff or agents to make regular field inspections and laboratory testing to monitor continued identity preservation, and use clean equipment to harvest, store and transport HOS. This would be new to many producers who might be concerned about ''surrendering'' their freedom in decision-making when signing these contracts.

Grower premiums would also be a key issue. The regional manager from Optimum had told Jim that the grower premium for HOS would fall from \$0.65 in 1998 to \$0.50 per bushel in 1999. This kind of decline made Jim wonder—what would happen to the grower premium in 2000? In 2001? He certainly had to consider this premium issue whether he was talking to producers about HOS, or he was evaluating long-term investment decisions for GrainLoc.

Another issue was that only one variety of HOS seed was currently available in the market. Contract growers would not be able to choose among several options to find a variety that might better fit their specific farm conditions. Yield data for HOS from 1998 indicated close yield parity with commodity soybeans, but there were mixed reports about results in 1997. Also, there was some uncertainty as to which seed companies would be offering product, and how seed might be distributed. Jim wanted to make sure interested growers could get their seed and that it would perform.

Jim concluded that potential growers, seed companies, and GrainLoc would have to closely coordinate production, supply and handling. He had read on the Optimum homepage that elevators working with Optimum in 1998 kept track of grower contract obligations using the Optimum Sales Connection and Resource (OSCAR) system, an on-line contracting service from e-markets. This system allowed elevators to access grower information on those contracts set to deliver to their own facility, and to shift acreage allocations around if someone is short on product. New databases in the OSCAR system for the 1999 contracting season would help elevator operators understand the quality of the grain to be produced based on the seed selected by each contract grower. Jim would have to know more about the system before he was comfortable. He did not want other elevators to have access to GrainLoc specific information and he wanted to be sure information was secure. Coordination was important, but he needed to keep close tabs on the information he shared.

GrainLoc and their alliance partners could ask the Optimum regional manager to coordinate their activities. Optimum's regional managers were intended to be a strategic link between the contract producer and grain handler. Communications between all players and managing coordination would add transaction costs to the extra costs of IP handling and storage. GrainLoc could reduce the transaction costs of dealing with interested growers by contracting with fewer farmers that could guarantee larger quantities of HOS supply over the long-term.

Because HOS must be assessed for oil content at delivery (in addition to moisture content, condition and foreign material), investment in new measurement and information technology and skills would be needed. Elevators in Iowa currently measure high oleic acid content using near-infrared (NIR) technology based on calibrations developed by Optimum Quality Grains L.L.C. GrainLoc personnel had not used such technology before, and needed to understand how accurate and time-consuming it was and what investment was required. This training would add to the costs of learning how to use the OSCAR system. Of course, if this was the direction the market was going, the extra costs and resulting experience gained now might have long-term benefits.

Another issue concerned the processing of HOS—which soybean crusher should GrainLoc align with? Most of Jim's thoughts had centered on his growers and his business, but how would GrainLoc work with the processor? GrainLoc would need to commit to invest in the right testing and storage facilities, and provide information to verify that the HOS were IP. Was there some way for GrainLoc to add value for the processor or Optimum? This was a very intriguing avenue that Jim had not pursued before. Could GrainLoc act as a "chain coordinator" for Optimum to ensure an orderly flow of HOS from the growers to the processor?

Finally, GrainLoc's ability to compete in the IP market for HOS would depend on the costs and benefits of handling HOS. Jim estimated that costs for items like extra storage, instrumentation, OSCAR fees and staff training were about 6 cents per bushel. But, was there enough volume, given the extra 10 cents per bushel over commodity-grade soybeans that Optimum was offering to elevators, to justify participating in this market?

Jim put down his pen and glanced up at the clock on his computer monitor. It was after 4:00 p.m. and he needed to call the regional manager at Optimum back . . .

3.2. Questions

1. What value can a firm like GrainLoc add in the supply chain for an IP crop like high oleic soybeans? Be as specific as you can.
2. Assuming this type of firm either has or can create a role in the chain, what are their possible options—i.e., what are the specific roles that GrainLoc can pursue?
3. For each of the roles you identify in question 2, what are the pros and cons? Assess how each role fits with GrainLoc's core capabilities. What are the costs of assuming the roles? How will GrainLoc generate revenue in each role to offset the costs?
4. In your opinion, what role should GrainLoc play? Why? For this role or position, identify what you see as the key success factors. What relationships will be key, who should they align with, what resource investments will be required, what risks will need to be managed, etc.?
5. What further information—both quantitative and qualitative—does Jim need to collect and evaluate before he can decide whether or not GrainLoc will participate in the HOS supply chain?

4. Hos player 3

4.1. The soybean processor: CenOil Mills

Jesse Paxton, general manager of a CenOil Mills plant in Central Iowa, smiled as she placed her cellular phone down on the seat in her truck. She had just received a call from a regional manager at Optimum Quality Grains L.L.C., asking if CenOil wanted to crush HOS. The call was timely, as CenOil's senior management had recently asked Jesse to look at the pros and cons of diversifying by crushing specialty soybeans. An agribusiness major in college, Jesse was 34 years old and thrived on the challenge of evaluating new business projects. Over the last 7 years with CenOil she had overseen major capital projects like mill expansions and start-ups, but this HOS proposal was something completely different. Upbeat and still facing an hour of 'windshield time', she switched on her micro tape-recorder and started to capture her thoughts . . .

In the present commodity-oriented system, soybeans are accumulated, co-mingled and shipped to a relatively small number of large crushing plants to realize economies of scale in crushing. These scale economies had to be traded off against increases in other costs, like transportation of the crop over long distances, multiple changes in ownership, and in-and-out loading costs.

To keep the HOS IP, several additional steps would be required, including thoroughly cleaning trucks, grain storage facilities and train cars between each load. Large mills operating on a continuous flow basis cannot efficiently clean their crushing equipment after each operation. At least initially, the HOS will be low in volume, which probably makes them very expensive to crush in large plants. At the same time, a smaller facility might be used for specialty crushing. The cost of doing this would depend on factors such as the cost of separating the grain, the number of specialty products being crushed, and the volume of each. In addition, the impact of co-mingling on the quality of the resulting high oleic oil would need to be considered. If demand for these IP products were to increase, taking a first step into the market could help position CenOil nicely for the longer term.

CenOil currently operated three large mills that might be affected by such changes. It was unlikely that the company could afford to dedicate one mill to crushing HOS. However, an alternative was the "temporal option"—the handling/processing operations at one plant could be rescheduled to free up time for cleaning equipment and crushing the HOS at harvest, prior to starting the processing of commodity soybeans.

Jesse had read about another crushing option—smaller, local crushing mills owned and operated by farmers or farmer cooperatives. According to industry sources, new small-scale crushing equipment did not require the solvent extraction process, using the solvent called hexane, which is used in large plants. Smaller plants might be competitive with larger scale chemical extraction plants because of the lower transaction costs, particularly if they are located close to production sites. These types of plants could be added on to an existing grain handling business, and could be replicated in multiple processing units to meet specific volume needs.

There were many uncertainties on the revenue side of crushing output trait soybeans. The few reported studies of the economics of crushing low volume specialty crops estimate premiums on some high-quality protein soybean meal of $25 to $30 per ton relative to conventional meal. However, such premiums on meal were not available for HOS, as the HOS trait at present is not stacked with a meal-enhancing trait. A stacked product with both higher value meal and oil would certainly be more attractive to CenOil. In the end, Jesse found that there just was not much information out there about what revenues and costs could be expected from crushing a specialty soybean.

Jesse concluded that large crushing mills were likely to be supplemented by small-scale systems that could tailor the processing of specialty soybeans to meet the unique needs of end-users. Perhaps CenOil could 'piggy-back' small-scale systems onto an existing crushing plant, or pursue the temporal option. Or, perhaps they could partner with local growers and jointly invest in a small local crushing mill. Whatever the choice, the supply chain must deliver consistent and reliable supplies of HOS and HOS oil. To create mutual respect and trust, and ensure that they all worked towards this common goal, CenOil and the other players had to make a commitment to the chain, and invest the needed resources.

Since there was no commercial HOS oil product currently being sold, but forecasts of growing demand, Jesse needed to find out what premium Optimum would pay for crushing HOS oil. Her hunch was that without a commercial HOS oil product, Optimum would probably negotiate individually with crushers in the short term to set a figure. There was also the key question of what volume of HOS oil end-users were likely to demand over the next 5 to 10 years. The current market was for oil that was more heat-stable for frying and edible spray applications. Would CenOil be able to add further value if the oleic acid oil residue left in the soybean meal after crushing was of value to livestock feeders? Or, could the firm add more value by further refining the HOS oil?

It seemed that a future goal of the end-user would be to produce a non-*trans*-fat margarine using HOS oil. Jesse had heard about a product called Benecol—a *trans*-fatty acid-free margarine launched in Finland in November 1995—on the evening news. Benecol contained plant stanol esters obtained from tall oil, a by-product of the wood pulp industry, and from vegetable oil sources which have been proven to lower cholesterol. It had become a leading brand by sales volume in the Finnish market, selling for about $9 a pound, with 1996 sales of $17 million to a population of 3 million people. In 1998, Benecol was priced up to six times more than regular margarine. Although Benecol uses a different process to be *trans*-free, its success suggests that consumers would adopt a higher priced item if the health benefit is clear. Jesse wondered if this experience could be replicated in the U.S. with other products.

Jesse had some final thoughts: what personnel training would be required to handle an IP crop? What information system was needed to track product flow? Could CenOil perhaps capture value by integrating backwards and offering growers on-farm storage facilities and/or contracts to deliver specialty crops like HOS direct to the company's mills? Bypassing the grain elevator would cut costs for CenOil, but the company would then have to apply for a grain handler's license.

Jesse switched off the micro tape recorder and reviewed her thoughts. She had covered the pros and cons of crushing HOS, but needed more data on the costs and revenues. She made a mental note to call CenOil's chief engineer and the regional manager from Optimum, with some questions in the morning . . .

4.2. Questions

1. What value can a firm like CenOil add in the supply chain for an IP crop like high oleic soybeans? Be as specific as you can.
2. Assuming this type of firm either has or can create a role in the chain, what are their possible options—i.e., what are the specific roles that CenOil can pursue?

3. For each of the roles you identify in question 2, what are the pros and cons? Assess how each role fits with CenOil's core capabilities. What are the costs of assuming the roles? How will CenOil generate revenue in each role to offset the costs?
4. In your opinion, what role should CenOil play? Why? For this role or position, identify what you see as the key success factors. What relationships will be key, who should they align with, what resource investments will be required, what risks will need to be managed, etc.?
5. What further information—both quantitative and qualitative—does Jesse need to collect and evaluate before she and the senior management can decide whether or not CenOil Mills will participate in the HOS supply chain?

4.3. Attachment 1: a note on high oleic acid soybeans and trans-fat issues

4.3.1. Composition and market potential of high oleic acid soybeans

Oil from HOS has an oleic acid content that is over three times greater than that of normal (commodity-grade) soybean oil (see Fig. 1). High oleic acid oil also has 30% to 40% less saturated fat, and contains no *trans*-fatty acids. Oleic acid is more stable (less prone to oxidation) than polyunsaturated (linolenic and linoleic) fatty acids that are the main component of commodity-grade soybean oil. The HOS oil, therefore, is more heat-stable than commodity-grade soybean oil, both for cooking and for edible spray applications that are used to extend the shelf life of snacks and cereals. Specialty crop enthusiasts speculate that 20% to 25% of U.S. soybean acres (about 71 million acres of soybeans were planted in 1997) could be planted with HOS and other value-added soybeans in the next 10 to 15 years. Other industry observers are more conservative.

The HOS oil is a substitute for hydrogenated soybean oil; a common product used for frying and in margarines that require stable oil that remains solid at room temperature. The chemical process of hydrogenation makes commodity-grade soybean oil stable enough for high temperature use in cooking, and less prone to causing off-flavors in food. Hydrogenation costs are currently relatively low at \$0.01 to \$0.03 per pound of soybean oil, depending on the volume of oil and which type of hydrogenation process is used. The

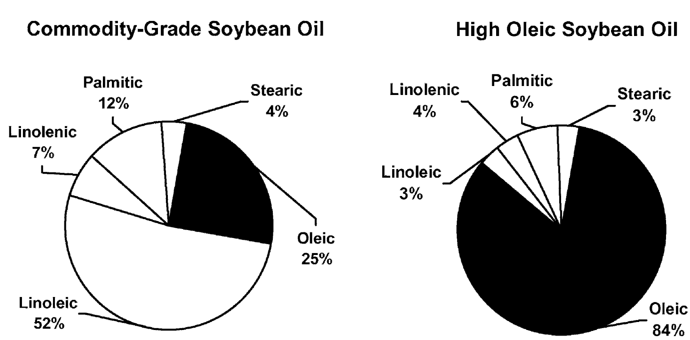

Fig. 1. Fatty acid composition of commodity-grade and HOS oils.

annual hydrogenated soybean oil market is about 4,400 million pounds, which is almost 50% of all soybean oil used for food purposes. Assuming an average soybean oil yield of 11 pounds per bushel of soybeans, this is equivalent to some 400 million bushels of soybeans (about 15% of the 1998 soybean harvest). Some reports indicate that there is also potential for HOS oil to substitute for olive oil in smaller markets.

4.3.2. Link between trans-fats and heart disease

Hydrogenation changes soybean oil from a liquid (at room temperature) into a solid, and forms *trans*-fatty acids. Any food with hydrogenated oils or partially hydrogenated oils, like cookies and margarine, contains *trans*-fatty acids. Experts explain that the body has trouble breaking down and eliminating *trans*-fat molecules. This increases the risk of coronary heart disease because *trans*-fats raise the levels of low-density lipoprotein (LDL) and reduce the levels of high-density lipoprotein (HDL) in the blood.

Since LDL is less efficient than HDL in carrying cholesterol through the bloodstream on its round-trip between the liver and body cells, cholesterol builds up and clogs the arteries. Many experts contend further that *trans*-fatty acids can create more health problems than saturated fats do. Oils which are high in mono-unsaturated fatty acids (like oleic acid) are now being recommended for use in cooking, since these acids raise HDL levels which in turn flush out LDL. These issues have received sufficient credibility that the U.S. Food and Drug Administration (FDA) will require mandatory labeling of the *trans*-fats content in foods by January 2000.

4.4. Attachment 2: a note on U.S. specialty grains and the HOS supply chain

4.4.1. DuPont's high oleic trait

DuPont originally developed the high oleic trait in soybeans and worked with Asgrow to incorporate the trait into the soybean variety A233HO, the only HOS variety currently on the market. DuPont retains control over the trait and the breeding agreement with Asgrow may limit other seed partners in the future.

4.4.2. Today's output trait players

In 1998, Optimum Quality Grains L.L.C. was the only company actively developing a market for HOS oil. Optimum was founded in 1998 when DuPont agricultural products joined their Quality Grains group with Pioneer Hi-Bred International's Nutritional and Industrial Markets group. The resulting joint venture company aims to develop, produce and market quality trait grains and oilseeds (specialty grains) that meet specific needs for food and feed end-users.

The Optimum joint venture had a 'first mover advantage' in that at that time no other company had been formed with this specific mission. However, while Optimum was celebrating its 6 months anniversary, Monsanto announced a similar joint venture with Cargill. All of these players bring strengths to a quality trait system. DuPont and Monsanto are major agricultural chemical manufacturers, while Pioneer has a major share of U.S. markets for corn and soybean seed. Cargill brings a dominant grain merchandising infrastructure and direct access to food markets. Novartis and Cenex/Land O'Lakes have also recently formed a joint venture in Wilson Genetics (formerly Wilson Seeds), to develop quality traits for animal feeds. This was followed by Dow AgroSciences forming Advanced Agritraits, which aims to produce seeds with improved oil profiles and enhanced nutritional qualities. Of course, in an emerging, high-risk market, success cannot be guaranteed for any of these groups.

4.4.3. Input traits and other output traits

Output, or quality, trait crops are the ‘second wave’ of transgenic crops that are being commercialized. The ‘first wave’, led by Bt corn in 1996, produced crops with input traits for herbicide, disease, and pest resistance. The key players in output traits were also the primary movers in the input trait markets.

Bt corn is tolerant to the European corn borer, and was planted on about 5.5 million acres in the U.S. in 1997. Estimated acreage in 1998 hit 16 million, or about 20% of the 80 million acres of corn planted in the U.S. Nearly all seed companies offer a Bt corn product. However, there are different Bt traits available and Monsanto’s YieldGard® trait has proven to be the most effective and widely used. Technology fees collected for 1998 and 1999 were $30 and $24 per unit, respectively. Growers of Bt corn have reported netting up to $27 more per acre due to input cost savings and higher yields.

Liberty Link corn was developed by AgrEvo and launched in 1997. This trait is based on the insertion of one of two genes (pat or bar) that enable the plant to convert Liberty herbicide (glufosinate) into a non-toxic form. The Liberty trait is also available in a number of Bt hybrids as a result of the bar/pat gene being used as a marker for the YieldGard®Bt trait. These stacked trait hybrids make up nearly 65% of the Liberty tolerant seed supply. AgrEvo has spread the trait broadly across the seed industry, and 95 seed companies offer Liberty tolerant products. In 1997, some 2 to 3 million acres of Liberty tolerant hybrids were planted. In 1998, the estimated acreage was 3 to 5 million, with much of this planting being driven by the stacked Bt trait. Seed premiums, rather than technology fees, are charged for Liberty tolerance.

Roundup Ready® corn was introduced by DeKalb in 1998 with tolerance to Roundup herbicide produced by Monsanto. The trait was developed by DeKalb, which is now a subsidiary of Monsanto. Estimates put the 1998 acreage at 350,000 to 900,000 acres, with Monsanto planning for 4 million acres in 1999. The Roundup Ready® trait comes with an $18 per unit technology fee.

Roundup Ready® soybeans are the major input trait crop, and were planted on nearly 26 million acres in 1998. Introduced by Monsanto in 1996, the rapid growth in their acreage shows that growers will adopt transgenic crops if there are economic advantages. Reports indicate that soybean growers can reduce herbicide costs by up to 50% using these soybeans. Technology fees for Roundup Ready® soybeans were $5 per bag in 1998 and about $6.50 per bag in 1999. The higher technology fee for 1999 was accompanied by a reduction in the price of Roundup herbicide.

STS soybean varieties, with the non-transgenic STS trait, were planted on about 3 million acres in 1997, although available supply would have allowed up to 5 million acres. DuPont developed the STS trait, which provides tolerance to Synchrony® and Reliance® herbicides. Growers are not charged a technology fee for STS tolerance.

High oil corn is the leading quality trait crop, with about 2 million acres planted in 1998. This corn has 50% to 75% more oil than commodity-grade corn, and it adds value via feed cost savings for livestock farmers due to its higher energy content, increased protein, and improvements in essential amino acids. About one-third of all high oil corn is exported from the U.S. Growers of high oil corn can currently net up to $25 per acre more compared with commodity-grade corn. Other output trait corn crops being developed include high-lysine and high-phytate corn. The high-lysine corn substitutes for synthetic lysine, primarily in swine feed, and can reduce feed costs by up to 12 cents per bushel. The high-phytate corn substitutes for supplemental phosphorous in swine and poultry rations and could save producers up to 10 cents per bushel in feed costs.

Soybeans in this second wave of transgenic crops include low-saturate soybeans, HOS, high-protein soybeans, high-sucrose soybeans, and low-phytate soybeans. Grower premiums offered for low-saturate, HOS, and high-sucrose soybeans were $0.65, $0.40 and $0.70 per bushel, respectively in 1997.

Looking beyond the year 2000, industry players predict that two further waves of ag-biotech products are in the pipeline. The ‘third wave’ is likely to bring further health and nutrition related benefits, and will likely be led by high-beta carotene canola oil to combat Vitamin A deficiency. A potential ‘fourth wave’ of products includes non-food industry applications like colored cotton to reduce dying costs, and plant-produced plastic to substitute for fossil fuel.

4.5. New dilemmas: competing for grower acres, and the game of stacking traits

Companies have captured value from input traits via technology fees and seed premiums, but now face new management dilemmas. For example, very high yields from Bt corn in 1997 meant that high oil corn contractors had to compete for acres with Bt corn. Secondly, under suitable growing conditions, output trait crops may have to compete with input trait crops for grower acres. Determining premiums for output trait crops is a complex exercise: any yield drag (lower yield) compared to commodity-grade crops must be considered, as well as the cost of keeping the output trait crops separate (IP) from commodity-grade crops on the farm. Companies have to evaluate the growers’ net benefits after premiums, compared to the net benefits growers would get from input trait crops like Roundup Ready® soybeans.

The ability of seed companies to combine or ‘stack’ traits is one key to the future success of specialty crops. The Monsanto Technology Agreements that were signed by nearly 200 seed companies in 1997 establish sales goals and incentives for products that contain Monsanto technology, specifically related to YieldGard® for Bt corn and Roundup Ready® for both corn and soybeans. These agreements require that the seed companies seek Monsanto’s approval for trait stacking. Executives from some small seed companies report that Monsanto has given verbal approval for any quality trait stacking with an input trait. Others are more skeptical and expect conflicts with Monsanto if the quality trait to be stacked comes from another company.

Plant breeding programs take time to get a new trait, or additional stacked trait, into a variety, but each year new and better varieties are being developed. The high oleic acid trait in HOS cannot be stacked with the Roundup Ready® trait, which is not a typical situation. A STS/high oleic stacked variety could be released by Optimum's research alliance in the year 2000. But, a commercial HOS seed that stacks a high-lysine (essential amino acid) or other value-enhancing trait for soybean meal is still about 4 years away.

4.6. The supply chain: a high oleic acid soybean example

The supply chain for any industry encompasses all activities associated with the flow and transformation of goods from the raw materials stage (extraction), through to the end-user, as well as the associated information flows (Handfield and Nichols, 1999). Materials and information flow both up and down the supply chain. Players in the supply chain will only deal with an output trait crop if they can 'add value'—that is, if what they earn from handling the crop exceeds the costs of doing so. A key factor in adding value for most output trait crops is to keep the crop, and its downstream products, IP from commodity-grade crops and products. Shortening the supply chain by forming strategic alliances can lead to tighter coordination between players, and ensure identity preservation.

Fig. 2 shows the IP supply chain for HOS—the system of activities that convert high oleic trait technology into the high oleic acid desired by specific end-users. The chain starts with trait development: DuPont scientists used genomics technology to identify the gene responsible for the high oleic trait. Asgrow then inserted the gene into plant material and developed new commercial HOS seed. Next, the new HOS seed was supplied to the grower who produced high oleic soybeans that the elevator then collects and stores. Downstream from the elevator, the HOS are processed by a soybean crusher into soybean meal and high oleic acid oil for end-users. The crusher or another firm may also refine the high oleic oil if desired. There would also be links for oil storage and transportation after crushing and refining, depending upon the needs of the end-user.

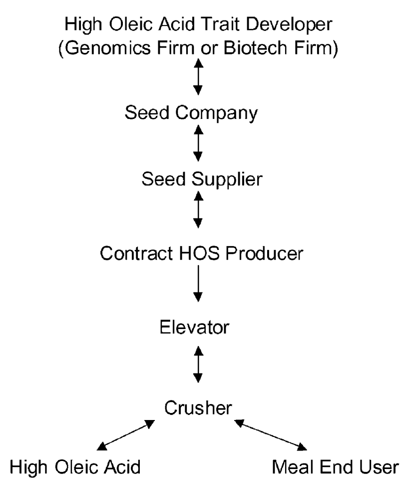

Fig. 2. The HOS oil identity preserved supply chain.

5. Current high oleic acid soybean moves

Optimum Quality Grains L.L.C. is currently developing the first HOS supply chain across the Midwestern U.S. as part of its Optimum® Oilseed Value Network. Optimum has established or facilitated agreements with contract growers, seed companies, and seed sales representatives, and is currently working with elevators and soybean processors to see if they can handle/crush HOS and other added value soybeans. The goal for the HOS program is to establish an appropriate IP infrastructure and supply chain to assure a sufficient volume and a consistent supply of high oleic acid oil for potential end-users. Optimum does not yet have a commercial high oleic acid soybean oil product available, but interested food companies are using the HOS oil in pilot facilities and test runs.

During 1997 and part of 1998, Optimum contracted with farmers in Northern and Central Iowa to plant HOS on a specified acreage under bailment contracts, with participating elevators acting as agents for Optimum. The bailment contracts granted growers the use of a proprietary seed to produce HOS, but Optimum owned all seeds, growing crops, grain, tissues or molecular components, and the harvested crop. Contract acreage was relatively small when compared to total soybean crop size, but significant when considering the resulting oil was being used for test runs. In 1997, Optimum contracted 10,000 acres of HOS and then they contracted about 18,000 acres in 1998.

The bailment contract was replaced after the summer of 1998 with a licensing agreement whereby the farmer, rather than Optimum, owned the crop, while Optimum owned the technology traits. Acreage under HOS is forecast at 30,000 acres in 1999, as there are plans to move acreage into Northern Iowa, Michigan and possibly to parts of Northeast Iowa. Asgrow, CropLan Genetics (Cenex/Land O'Lakes) and Pioneer. currently produce and license A233HO. These companies licensed A233HO to contract growers in 1998 at prices ranging from $14 (CropLan) to $17.95 per unit (Pioneer).

It is unusual for Pioneer to market a non-proprietary product, as the company has previously only marketed products that contained 100% proprietary Pioneer genetic material. Optimum reports that from 1999 forward, CropLan will no longer offer HOS seed, and that only Asgrow and Pioneer will sell A233HO. Over the longer term, it is likely that both companies will have their own varieties and that Optimum will coordinate production under contract. Current plans are to develop new HOS varieties with longer maturities. It is unlikely that small, independent seed companies will breed new HOS varieties before 2003. They may, however, have opportunities to distribute Asgrow and Pioneer HOS seed products.

Grower premiums for HOS in 1998 were $0.65 per bushel if the high oleic acid content was at or above 80%. In 1999, the grower premium was lower at $0.50 per bushel for these same oleic acid levels. The high oleic trait in soybeans is extremely stable and is not influenced by environmental conditions, as are some other traits. The risk of not achieving an 80% level is extremely low, and if levels fall below 80%, it is likely that the grower blended commodity soybeans with the HOS.

5.1. Competing for grower acres

Growers in Iowa who planted HOS for the first time in 1997 estimated that they increased their net returns by between $2 and $15 per acre, depending on weather conditions. Yields for HOS ranged from 33 to 55 bushels per acre, compared to the average commodity-grade yield for Iowa of about 47 bushels per acre. Growers were apparently satisfied with the 1998 performance of A233HO, despite some claims that A233HO had a yield drag of 10% to 15% compared with commodity-grade soybeans.

5.2. *Trait stacking*

As shown in Fig. 2, there are two critical end-use products in the HOS supply/value chain—soybean oil and soybean meal. And, when assessing the market for value-added products, both must be considered. A soybean is typically about 18% oil and 80% meal, so an improved oil profile alone may not be able to carry the costs of an IP product, unless the oil has considerable relative value. Stacking a meal-enhancing trait with the high oleic trait could thus be critical to the long-term success of HOS, as this would spread development costs over more 'output' traits. Stacking could also make HOS more attractive for growers, who could realize more value from the meal.

6. Key success factors

Key success factors in moving a product like HOS from the laboratory to the market include the following:

- Market demand for the products produced from HOS;
- Sufficient volume of high oleic acid oil in the supply chain;
- The ability to combine or 'stack' traits, which enhances the value of the HOS;
- The ability to reduce lead times to commercialize HOS;
- The ability to identity preserve the HOS at each level in the supply chain;
- Access to appropriate distribution channels; and
- Mutual respect and trust, commitment, co-operation and information sharing between all players in the supply chain.

Acknowledgments

We would like to extend our appreciation to Tray Thomas and Karen Coaldrake of Context Consulting, West Des Moines, IA, for their ongoing assistance in developing this case study. In addition, we would like to thank Ken Harling and participants in the Maple Leaf Conference, May 19-20, 1999, Toronto, Canada for comments on an earlier version of this case.

Reference

Handfield, R. B. & Nichols Jr., E. L. (1999). *Introduction to supply chain management* (p. 2). Upper Saddle River, NJ: Prentice-Hall.