Contracting for Biomass: Supply Chain Strategies for Renewable Energy

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Abstract

Cellulosic-based ethanol production is a cornerstone of current and proposed U.S. renewable fuels policy. Indeed, some recent proposals include a nearly five-fold increase in renewable fuels production, the majority of which would have to come from cellulosic ethanol. U.S. farmers will clearly play a significant role in the development and success of this industry. Aside from the technological hurdles, a number of supply chain barriers must also be overcome. One such barrier includes the marketing of cellulosic feedstock (e.g., wheat straw and corn stover) by farmers and the procurement of this feedstock by biofuels refineries. The exchange mechanism for cellulosic feedstock may develop in a number of alternative ways. This research specifically examines some early contracting and procurement strategies by an industry leader, the Iogen Corporation. An understanding of how biomass marketing may evolve will help farm managers better prepare for entering this emerging industry.

Introduction

The potential for renewable energy from agriculture is greatest when it focuses on the non-food portion of crops. The development of renewable energy industries involving such products as cereal straw, corn stover, and dedicated energy crops is complex. There are technical questions concerning the processing technology, seed genetics, agronomics, and environmental impacts. Equally important logistical questions remain unresolved, such as the efficient collection, storage, and transportation of the feedstock. Finally, the ultimate organizational structure of the industry remains in question. Here, we focus on one important aspect of the industrial organization: the relationship and exchange mechanisms that will develop between biomass producers and processors.

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Considerable research effort has been devoted to the technological aspects of biomass production (Klass, 1998; Brown, 2003). The organizational development of the industry has received far less attention by researchers (van Loo & Koppejan, 2003). However, in the biomass sector the organizational concerns are important because row crop waste and energy crop supply chains are far less advanced than that of other feedstock such as corn for ethanol. Hence, it is a very important component of this developing industry; yet, it is far from clear how the cellulosic feedstock market will develop. When are spot markets preferable, and when do more integrated procurement systems better serve emerging renewable energy industries like cellulosic ethanol? Some authors have briefly considered this topic, e.g., Downing et al., 2005; Overend, 1993; but here, we take a detailed look at some early attempts at contracting feedstock supplies within the industry.

Specifically, this paper examines the contracting attempts by the Iogen Corporation as they develop a cellulosic ethanol industry based on cereal straw in Western Canada and the Northern Plain states. Previous research lays the broad foundation for understanding the organization of biomass-based industries (Altman et al., 2007). In this paper the case of Iogen is described based on an example contract, retrieved from a biomass producer in Idaho. An understanding of the terms and conditions of these contracts – and the economics behind them – will help producers prepare for a successful entry into this emerging field of production.

The General Case

From a production cost perspective it is possible that cellulosic ethanol can be competitive with corn ethanol. As early as the mid 1990s scientific research on the technologies revealed that cellulosic ethanol could be competitive with corn ethanol (Lynd et al., 1996; Wyman, 1994). While this research was not based on Iogen's specific technology it does point to the fact that non-technical barriers could be part of the reason that the cellulosic ethanol industry has been slow to develop. If cellulosic ethanol is competitive with corn ethanol why has no cellulosic ethanol been produced commercially, while the expansion of corn ethanol is pervasive? We contend one overlooked explanation for the lack of cellulosic ethanol industry development is the challenge of organization.

One economic theory that focuses on organization is transaction cost economics (TCE). The basic idea of the theory is that the choice of organizational form varies with characteristics of the transaction (Williamson 1996, p.371). Three characteristics of the transaction are identified: asset specificity, frequency, and uncertainty (Williamson, 1979). In TCE special emphasis is placed on asset specificity. Asset specificity is defined as the value of assets in alternative uses or how easily assets can be redeployed.

The types of asset specificity likely to be important in bioenergy industries include:

1. Physical asset specificity and spatial asset specificity of the processing facility;
2. Physical asset specificity of biomass production, transportation, and storage assets; and
3. Human asset specificity of producers' managing efforts.

The degree of specificity of these assets will vary implying that a range of organizational and supply chain mechanisms will be efficient.

Spot markets can be the lowest cost choice in cases where: the processing facility is flexible with respect to biomass quantity and quality and has low spatial asset specificity; and producers already own the physical assets and have the knowledge and experience with necessary production techniques (the case of low asset specificity). However, the processor then must be prepared to compete on price with other uses and other buyers of biomass. Absent these low asset specificity conditions, spot markets are not likely to be the basis for bioenergy biomass exchanges. Once the processor invests in more specialized technology that binds them to a group of producers, or if the producers invest in management and physical assets that are targeted to serving a particular processor, alternative exchange mechanisms will become more attractive than spot markets.

Alternative exchange mechanisms include the use of long term production and marketing contracts as well as various cooperative formations. Cooperatives can be attractive since there could be a single contract between the processor and a supply cooperative instead of with each individual producer. Having one contract between a cooperative and processor can

reduce administrative costs. Complex contracts take resources to negotiate, manage, and enforce, increasing the cost and burden on the industry. Next, we introduce and examine a specific contracting example in the cellulosic ethanol industry.

The Case of Iogen

The Iogen Corporation is a Canadian biotech company that has led the world in scientific research to produce ethanol from cellulose. In this section, we introduce Iogen's supply chain strategy for the procurement of cellulosic feedstock and examine in detail an example contract in their proposed producer-processor relationship.

With any new industry and technology there are various risks and uncertainties. Technological uncertainty is always a concern with new technologies and Iogen's enzymatic hydrolysis process is no exception. How the process will work at full scale is one of many technical questions that Iogen has tried to address in their research and development program.

Beyond the technical uncertainty, biomass supply uncertainty is also inherent in this new industry. Compared to corn ethanol, which had well developed supply chains when corn ethanol technology was being commercialized, cellulosic ethanol faces a much more difficult challenge. Iogen's proposed plants will require approximately 1,500 tons per day of biomass material from 1,000 acres to produce approximately 45 million gallons of ethanol per year (Brown, 2006). The proposed plant has a price tag of $300-400 million, compared to $30-50 million for corn-based ethanol plants. Clearly, the shear volume of biomass required plus the financial investment in the operation requires a consistent source of feedstock.

Adding to the complexity of commercialization is the fact that current exchange mechanisms for agricultural crop biomass such as straw and stover include informal search and advertising in local media, ad hoc exchanges such as bartering, and development of personal relationships. Currently farmers sell their biomass on an ad hoc basis. Some years they could choose not to sell their biomass at all and keep the biomass for soil structure and fertility purposes. Not surprisingly, Iogen and other biomass refiners will want to have more formal relationships with their suppliers.

It is in this context that Iogen's supply chain strategy is examined. Iogen has developed the strategy to sign production contracts with farmers in three locations, two in western Canada and one in Idaho, with the intention of building one processing facility in one of these locations, depending on the financial support and incentives they get from various levels of government (Pratt, 2005). Iogen has attempted to attract guaranteed loans from various levels of government to insure the financial success of their venture.

The main supply mechanism that Iogen has chosen to utilize is a relatively standard production contract signed with individual farmers. A copy of one such contract was obtained from a potential farmer (D. Grant, personal communication, August, 2006). The agreement was approximately four pages, single spaced, and the key components of the contract in regards to producer and processor obligations are presented in Table 1. Here, we review the main points of the contract, focusing on the considerations and impacts on the farm manager.

In the contract's section on Supply, Storage, and Coordination Iogen has a 5-10 year option to buy the producer's straw. Depending on where the plant is ultimately located, Iogen will exercise their option on contracts they have signed in the area of the plant and let the other contracts expire (Pratt, 2005). Iogen has also chosen to rely on custom harvest and delivery through separate contracts (Pratt, 2005). Storage is clearly defined within the production contract while harvest and delivery are more vaguely defined. Producers must supply enough storage space and access to Iogen that they can have delivery occur as needed 12 months a year, 24 hours per day, 7 days per week. Rather than negotiate a delivered price and let the producer organize harvest and delivery, Iogen has determined that a custom harvest and delivery system would be cheaper. They have yet to organize this relationship but will have to coordinate in some fashion, access to the land for the custom harvester to bale and collect the straw, storage of the bales until the plant is ready for delivery, and long distance transport from the field edge or farm to the processing plant.

The strategy of custom harvest and delivery is combined with the entry into areas where in general producers do not typically collect straw for livestock industries. Iogen is expecting the savings from the lower value of biomass to be greater than the

transaction costs of managing and enforcing contracts which would not be necessary if they entered more established biomass area and could utilize spot markets. The pitfall of having two separate contracting systems, one for the biomass and another for harvest and transportation, is the potential administrative costs of the system. The benefit of their strategy is entry into areas where the existing price and presumably other alternative uses of the straw is low.

Farmers have choices in terms of Pricing and Payment options. They have the choice between a fixed price option of $8/ton, a variable price option that ties the price of straw received to the price of oil, and a mixture of fixed and variable price options. In the second pricing option the price of straw would vary from $5-15/ton, priced as laid in the field, depending on the price of oil that year (Grant, 2006). This allows the farmer to manage input cost risk of their fossil fuel-based inputs such as fertilizer and diesel. Thus the goods and services farmers are compensated for include the goods (straw) and services including participation in the planning process, coordination of logistics, and storage.

The biomass Quality is well defined in terms of moisture content. However, Iogen does reserve the right to alter straw type (e.g., barley or wheat) and the allowable toxins from year to year. Iogen also reserves the right to other Change in Terms as long as the changes apply to all producers who will be compensated when appropriate. As expected, the contract contains a number of contingencies for Assignment, Termination, Transfer, and Extension. Generally, the processor retains exclusive rights to the feedstock supply and the producer must make an effort to transfer supply obligations if crop ground is sold or no longer leased.

Farm managers will want to closely examine supply contracts as they develop in this industry. Not only must the producer consider their willingness to supply the feedstock versus the value in alternative uses (such as building soil structure), but they must also carefully consider the management burden. For instance, in Iogen's contract it is the farmer's job to coordinate with the custom harvester and to provide access. These issues may impact other elements of the farm operation, such as the ability to double-crop fields that are still awaiting the custom harvester. Likewise, additional equipment traffic on certain soils may result in compaction, reducing crop yields in subsequent years. Undoubtedly, the learning curve with these biomass contracts will be steep, and the producer needs to consider the primary components of the contracts (Table 1) along with any secondary effects on their operation.

Discussion and Conclusions

This paper takes an organizational perspective to examine the general case of biomass, and the specific case of the Iogen Corporation as an example of new bioenergy industries with a focus on the type of exchange mechanism. An example contract is examined and is demonstrated to have various vaguely defined rights and responsibilities, yet this method of exchange is preferred to existing informal exchange mechanisms in current biomass markets.

The important elements of the contract include: the pricing elements that give producers the ability to reduce input cost risk; and several terms that offer Iogen control rights *ex post* while leaving responsibilities of the producer vaguely defined. Like most contracts, the production contract is specific on some rights and responsibilities while vague on others; thus, contract imperfections and enforcement costs are inevitable.

This formal contracting effort represents the desire to improve on current biomass exchange mechanisms and to lower yearly search costs. In current hay and straw markets, the biomass is sold on a much more informal basis, such as classified advertising. Possibly due to their high level of asset specificity, Iogen has decided to pursue the long term standard production contracts presented here. While the cost to design, offer, and enforce these contracts is substantial, Iogen apparently estimates this system will be more economical than current biomass exchange methods. Plus, these contracts are appealing to farmers in areas that have few alternatives for their biomass, which allows Iogen to enter areas with lower cost feedstock.

Producers will want to carefully consider the primary aspects of the proposed contracts, such as pricing, supply commitments, quality, and transferability. In particular, the relationship between raw feedstock supply, harvest, storage, and delivery activities must be well understood. The producer may be obligated to manage relationships among service providers. Also, the producer will want to consider secondary impacts on

their management time and resources under these supply contracts, such as the provision for year-round access to stored feedstock.

The contracts examined in this paper have been signed with producers but alternative supply mechanisms will surely evolve. Another possibility includes the use of a biomass marketing cooperative to lower contracting costs. Further, producers could integrate into the ethanol processing stage as either a processing cooperative or regular corporation and Iogen could license their technology and supply enzymes to the processing company. Finally, in some cases, active spot markets for biomass could evolve if cellulosic ethanol becomes more prevalent. Producers will want to closely examine their own structure (asset specificity) and that of the processor to understand how these markets may develop in their area.

References

Altman, I.J., Sanders, D. R., & Boessen, C. R. (2007). Applying Transaction Cost Economics: A Note on Biomass Supply Chains. *Journal of Agribusiness*, 107-114.

Brown, R. (2003). *Biorenewable resources: Engineering new products from agriculture*. Ames, Iowa: Blackwell Publishing.

Brown, S.F. (2006, February 6). Biorefinery breakthrough. *Fortune,* 88.

Downing, M., Volk, T., & Schmidt, D. (2005) Development of New Generation Cooperatives in Agriculture for Renewable Energy Research, Development, and Demonstration Projects. *Biomass and Bioenergy. 28, 4*, 25-34.

Klass, D. (1998) *Biomass for renewable energy, fuels, and chemicals*. San Diego, California: Academic Press.

Lynd, L. (1996) Overview and Evaluation of Fuel Ethanol from Cellulosic Biomass: Technology, Economics, the Environment, and Policy. *Annual Review of Energy and the Environment, 21*, 403-465

Overend R. (1993) *Biomass power industry: Assessment of key players and approaches for DOE and industry interaction*. Golden, CO: National Renewable Energy Laboratory.

Pratt, S. (2005, March 24) Shopping for straw. *Western Producer,* p.110.

van Loo, S. & Koppejan, J. (2003) *Handbook on biomass combustion and cofiring*. Enschede, Netherlands: Twente University Press.

Williamson, O.E. (1979). Transaction-Cost Economics: The Governance of Contractual Relations. *Journal of Law and Economics*. *22*, 233-261.

Williamson, O.E. (1996). *The mechanisms of governance*. New York: Oxford University Press.

Wyman, C. (1994). Ethanol from Lignocellulosic Biomass: Technology, Economics, and Opportunities. *Bioresource Technology, 50,* 3-16

Table 1. Biomass supply contract summary

Sections	Key Points
Supply, Storage, and Coordination	1. Defines the minimum annual tons 2. Grants processor option to purchase straw for life of the contract (5-10 years) 3. Farmer must supply storage for up to 12 months after harvest and meet standards for straw quality, storage and access (for delivery) 4. Farmer must estimate crop acres by March 15, provide a forecast of straw production by June 15, and provide notice of all changes to acres farmed, crop rotation, or any other pertinent information for straw volume or yields. 5. Processor must exercise option to purchase straw by April 15 and July 15. 6. Farmer is responsible for selecting and working with custom operators. 7. Straw stacks must be accessible to loading and transport equipment 12 months a year, 24 hours per day, 7 days per week. 8. Performance may be excused because of acts of God. 9. The risk of crop loss remains with the producer until delivery
Pricing and Payment	1. Pricing option include 3 choices: a. Fixed price, 5 years at $8/ton b. Variable price based on crude oil prices, 10 years at approximately $5-$15/ton c. A combination of (a.) and (b.) 2. Payments are made in three installments a. One-third order value will be paid within 30 days of the processor's receipt of the producer's Farm Service Agency report verifying acreage b. A second payment will occur after storage at an appropriate site and a processor inspector has verified the estimated tonnage c. Final payment will be made on delivery and certified measurement of the tons delivered
Quality	1. Acceptable straw quality to be harvested golden without rot or weathering, maximum of 18% moisture content, segregated as the type of straw as agreed, and free of any preventable toxins as identified by the processor in advance of harvest
Change in Terms	1. Processor has the right to develop and modify standards as it requires so long as changes apply to all producers 2. Producers can be compensated for this change in standards
Assignment, Termination, Transfer, and Extension	1. Processor has the right to transfer the claims for the straw and straw procurement services to another processor 2. Producer has the right to terminate the agreement if the commencement of construction of a facility has not occurred within 4 years of the date of this option. 3. Processor has the right to offer to extent the agreement 2-4 years, if the producer does not reject the extension within 60 days the extension will be deemed accepted. 4. If the producer sells his land or does not renew leased land, the producer shall make their best effort to transfer the obligations under this agreement. 5. Neither the producer nor successor operators can sell straw to competition firms without meeting the obligation of this agreement first.