Contracting for Biomass: Supply Chain Strategies for Renewable Energy

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Selected paper for presentation at the Southern Agricultural Economics Association Annual Meetings, Mobile, Alabama, February 3rd-6th, 2007

JEL subject areas: D21, D23, L14

Introduction

The potential for renewable energy from agriculture is greatest when the use of non-food potion of crops is considered. The development of renewable energy industries involving such products as cereal straw, corn stover and energy crops is complex. There are technical questions concerning the processing technology, seed genetics and agronomic and environmental factors; logistic questions concerning the storage and transportation of the feedstock and finally organization questions concerning the relationship between potential biomass producers and processors.

While there is much research investigating technology and logistic questions, organization and contracting decisions remains an area less represented in the current literature. Also contributing to the importance of organization is the fact that row crop waste and energy crop supply chains are less developed than other biomass based renewable energy industries. The current U.S. biopower industry is based on concentrated wood and food wastes streams where vertical integration is used in most of the industry. Further, the traditional starch to ethanol industry has well developed supply chains based on corn. Row crop waste and energy crop biomass supply channels will have significant hurdles to overcome in the shift from ad hoc supply systems involving informal contracting and barter systems to more formal systems that renewable energy processors are likely to utilize.

This paper examines the contracting aspects of the Iogen Cooperation as they attempt to develop a cellulose ethanol industry based on cereal straw in Western Canada and Northern Plain states. After the broad biomass and bioenergy literature is reviewed and a discussion of the general case of the biomass exchange, the case of Iogen is described. An example contract, retrieved from a biomass producer in Idaho, is examined in detail and compared to current biomass exchange methods. While this paper focuses on the more mirco details of one contract suggested for one biomass exchange, the broader implications for the development of biomass industries are revealed.

Biomass and Bioenegy Literature

The biomass and bioenergy literature covers many technical and non technical areas. Organizational issues are not usually a primary consideration. Some researchers do acknowledge the importance of organization in developing biomass and bioenergy industries. Klass (1998) draws attention to failed organizational recommendations in the area of storage and shipping of wood biomass. The storage and shipping methods prescribed in the literature have not occurred in industry practice (Klass 1998, p.554). van Loo and Koppejan (2003) document examples where organizational adaptations have solved technological issues— contractual arranges in the EU are used to guarantee biomass quality for a nonflexible technology. Their work underscores the importance of understanding organizational issues.

Other authors, Roos et al. (1999), Costello and Finnell (1998), Lunnan (1997), Rösch and Kaltsehmitt (1999), for example, recognize the importance of non-technical barriers, which includes potential supply chain and organizational problems. Roos et al. (1999) develops a broad based framework for considering organizational issues. Critical factors in the choice of organization include degree of integration, scale of operation, degree of competition, and national and local policy. Costello and Finnell (1998) identify four potential organizational constraints, which they argue can also be opportunities: regulatory environment, financial sources, public infrastructure availability and the perceptual beliefs of key actors. Rösch and Kaltsehmitt (1999) identify similar topics adding insurance issues and efficiency of knowledge and information flows along the supply chain. Lunnan (1997) takes an in-depth view of the institutional environment created by bioenergy policy, and especially how bioenergy policy and more general agricultural policy can be coordinated.

More recently Downing et al., (2005) describes agricultural cooperatives as examples of research, financing and exchange mechanisms in the agro-bioenergy industry. Cooperatives are a type of biomass exchange mechanism that should be considered. Cooperative cases can be compared to contracting and spot market systems that also exist in the U.S. biopower industry. However, in order to carryout such a comparison an adequate description of proposed supply chains and procurement strategies must be completed.

Overend (1993) provides a description of the main features of a general biomass industry. The author concludes: "The industry must rely on short term contracts or the spot market for fuel purchases" (Overend 1993, p.2). However, many biomass industries currently rely on captive supplies and integrated systems for fuel procurement. The underlying questions in determining the agro-biomass supply chain strategy are: when are spot markets preferable, and when do more integrated procurement systems better serve emerging renewable energy industries like cellulose ethanol? One approach to this area is to examine a technological developer nearing commercialization to determine the likely efficiency and effectiveness of their proposed procurement strategy.

The General Case

From a production cost perspective it seems that cellulose ethanol could be competitive with corn ethanol. As early as the mid 1990's scientific research on cellulose ethanol technologies revealed that cellulose ethanol could be as cheap to produce as corn ethanol (Lynd et al., 1996 and 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 cellulose ethanol industry has been slow to develop. If cellulose ethanol is competitive with corn ethanol why has no cellulose ethanol been produced commercially, while the expansion of corn ethanol is pervasive? Could supply chain problems and factors like transaction costs hold back the industry? If these non-technical barriers do exist they should be studied in more detail.

One economic theory that focuses on organization is transaction cost economics. Beyond the basic assumptions such as opportunism, incomplete contracts and bounded rationality (see Williamson 1996 for a detailed explanation of transaction cost economics) the crux of TCE is the discriminating alignment hypothesis which states that economic actors will: "Align transactions, which differ in their attributes, with alternative governance structures, which differ in cost and competence, so as to realize a transaction cost economizing result" (Williamson 1996, p.371).

Three attributes 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. In this way, asset specificity helps identify opportunity costs of assets used to support an exchange.

Asset specificity is assigned primary significance in this theory because it creates bilateral dependence between otherwise independent actors. A situation of ex ante independence is transformed into ex post bilateral dependence where trading parties are open to the potential of opportunism. In the case of low asset specificity, independent parties are less subject to opportunism on the part of their business relations since assets hold relatively high values in alternative uses. TCE holds that the relative efficiency of alternative organizational forms depends on asset specificity.

In potential biomass industries farmers and processors are indeed independent. However once they make specialized investments that support the biomass transaction they typically become bilaterally dependent on each other's actions. Hence, the choice of organizational form or biomass supply chain strategy becomes central to industry development.

For bioenergy industries the relevant assets and investments include the processing facility, the biomass harvesting equipment, storage and transportation equipment as well as the producer's time and managing effort. The degree of specificity of these assets will vary implying that a range of organizational and supply chain mechanisms will be efficient.

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 effort.

The choice facing the processor is between entering a new area where spot markets are less likely and administrative cost are higher (because longer term contracts are more likely), or entering an established biomass area where spot markets can be expected (and transaction costs lower) but the processor will have to compete with other buyers. The tradeoffs between higher biomass prices in the spot market case and higher transaction costs but lower biomass values in the contracting case become essential to compare.

There are several questions that must be answered to predict the most efficient supply chain strategy in future industries that will use row crop waste and energy crops. Will the processing technology be flexible with respect to biomass quantity and quality? Will the processor be entering an area where farmers already own the necessary equipment to serve the industry? Will special biomass husbandry techniques be expected from biomass producers?

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. 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 and manage. A multiplicity of contracts can increase the cost of enforcement as well.

The use of custom harvesters and transporters is another complication to consider. However, with the use of custom harvesters, there is another relationship/contract to manage. The processor must still negotiate and coordinate the access to the land with the producer/landowner. The second relationship to manage is that with the custom harvester to do the necessary work. With more relationships to manage more contingences need to be negotiated. What if a producer lays the biomass out to be collected and transported by a custom harvester but weather conditions make this impractical. Who owns and is responsible for the biomass in the field? This type of problem is avoided with the producer delivery system. However, with the producer delivery system the producer/land owner must be willing to invest is necessary biomass production equipment. The custom harvester option should be compared to farmer delivery systems to see which is the lower cost system including transaction costs in the analysis.

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 from such products as straw, corn stover, traditional feed crops and dedicated energy crops. Their genetically modified enzyme process, known as enzymatic hydrolysis, produces sugars, glucose and fructose, from the cellulose and hemicellulose portions of the biomass. The sugars can then be fermented with traditional yeast strains to produce ethanol. After studying the technical process for more than 30 years Iogen is nearing the full commercialization stage, investigating where to locate the first cellulose-to-ethanol plant in the world. The key question addressed in this section is what supply chain strategy have they chosen while the next section examines the details of 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 will the process work at full scale is one of many technical questions that Iogen has tried to address in their research and development program supported financially by Petro Canada, the Canadian Government and Royal Dutch Shell. In 2002, Shell's research division, Shell Globe Solutions, invested $45 million into the demonstration of Iogen's technology (Brown, 2006) which now operates the only demonstration scale processing plant in the world that produces ethanol from cellulose. More recently Goldman Sachs announced an investment of $27 million into commercializing Iogen's technology (McCoy, 2006).

Beyond the technical uncertainty, which is being addressed through scientific research, 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, cellulose ethanol faces a much more difficult challenge.

The scale that Iogen is targeting for the first processing plant would require approximately 1500 tons per day of biomass material be made available to the processing facility to produce approximately 45 million gallons of ethanol per year (Brown, 2006). This scale would require about 1000 acres per day of land resources. With this amount of biomass and land resources required, an efficient supply chain strategy is essential and is a key organizational variable to successful commercialization.

Financial requirements should also be considered. The financial resources Iogen projects are necessary for the establishment of the first cellulose to ethanol processing plant is in the range of $300 - $400 million. This compares to investments of $30 - $50 million for current corn to ethanol plants. Thus lenders and investors too will want to ensure the feedstock is available.

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 such as gift giving. Currently farmers sell there 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. It is likely Iogen and other biomass industry developers will want to have more formal relationships with their suppliers.

It is in this context that Iogen's supply chain strategy is examined. They have 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 standard production contracts signed with individual farmers. One feature of this relationship is that Iogen has a 5-6 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).

Farmers have the choice between three pricing 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 fix and variable price option. In the second pricing option the price of straw would vary from $5-$15 a ton, 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.

Iogen has also chosen to rely on custom harvest and delivery through separate contracts (Pratt, 2005). That is, storage is clearly defined within the production contract while harvest and delivery are more vaguely defined. 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. These are additional transaction costs that Iogen should take into consideration.

Of course there are many variations to this system that could also be discussed, such as, a producer harvest/bail and custom delivery option. The splitting of activities between producers and custom workers reveals many alternatives. At this point Iogen has chosen the custom harvest and delivery option over all others.

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. Thus Iogen is expecting the savings from the lower value of biomass to be higher 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 pit fall 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.

Although contracts have been signed with producers in the three proposed areas other supply mechanisms can still 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, even spot markets and futures markets for biomass could evolve if cellulose ethanol becomes more prevalent.

Contractual Analysis

The agreement analyzed in this section is an example agreement or draft of a contract offered to farmers by the Iogen Corporation (referred to as XXLLC in the contract). The contract was retrieved from the farmer on August 19th, 2006 (Grant, 2006).

The agreement is approximately 4 pages, single spaced, including 7 basic terms of the contract: Consideration, Supply Relationship, Resolving: Disputes, Assignment, Termination and Extension, Transfer of Agreement and Related Party Obligation, Acts of God and Other Interruptions and Notices, Survival, Law, and Prior Representations. The Supply Relationship term is the most complex and includes 9 sub-terms: Producer Straw Commitment, Scope of Supply, Term, and Price, Acceptable Straw, Planning and Logistical Requirements, Exercise of Option, Responsibility for Coordination, Payment Terms, Price Adjustments for Changes, Responsibilities in the Event of Problems. The following section breaks down each term and summarizes the main components of the contract.

The first term, Consideration, states the purpose and intent of XXLLC to seek an adequate supply of straw for their proposed biorefinery. Further it states that the producers agree that the development efforts of Iogen are sufficient consideration for the producer’s long term obligation under the terms of this agreement. Basically this term defines the basic intentions and obligations of the parties.

The second term, the Supply Relation term, makes up the bulk of the contract including 9 sub-terms and various tertiary terms. The Supply Relationship term breaks down the various methods to allocate the straw as well as the rights and responsibilities of the parties which represents the allocation of risk and uncertainty within this relationship. The first sub- term, 2a) Producer Straw Commitment, defines the minimum annual tons the producers will have for sale to the processor and defines that the processor has the option to purchase the straw through out the life of this contract (5-10years).

Sub-term 2b), Scope of Supply, Term, and Price defines how the straw will be valued for the purpose of this agreement and the length of the agreement. First, scope of the supply relationship includes that the producer participate in the processor's planning process, supply straw in a windrow, coordinate straw collection, stacking and storage. This must be completed with pre-approved custom operators. Further the farmer must supply storage for up to 12 months after harvest and meet standards for straw quality, storage and access (for delivery). Thus the goods and services farmers are compensated for include the good (straw), and services including participation in the planning process, coordination of logistics and storage. More specific services are listed in sub-term 2d).

In exchange for this good and these services the farmers have a choice between 3 pricing and length of contract alternatives for compensation. Choice A involves a fixed price for 5 years with the processor having the option to purchase the straw at $8/ton starting at the time the ethanol facility starts production.

Choice B is the variable price option for the processor to have 10 years right to purchase the straw. In Choice B the price of the straw is tied to the price of oil as determined by the previous 12 month average of the price of oil calculated on the 3rd Friday of April the harvest year. Prices range between $5/ton when oil is below 20/bbl, $8/ton when the price of oil is between $30-$35/ bbl and $15/ton when the price of oil is over $65/bbl. It must be noted that this example contract was written the Spring of 2005 when the price of oil was lower than 2006.

Alternative C is a hybrid pricing strategy where half the straw is price at $8/ton up to year 5 and then $9/ton for years 6-10. The other 50% of the straw is priced using the Choice B framework. In all three choices the producer grants the option to the processor to purchase the straw that must be exercised by April 15th of the harvest year for part of the Base Commitment and prior to July 15th for the full commitment, according to sub-term 2e) Exercise of Option.

Sub-term 2c), Acceptable Straw, defines 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. This term defines a broad and vague right for the processor to define quality ex post. The "preventable toxins" term could be defined more clearly within this clause of the contract.

Sub-term 2d), Planning and Logistical Requirements, formally states that the producer acknowledges that the processor faces logistical challenges and agrees to take part in the planning and procurement process. Specific items listed for producer activities include: estimate crop acres by March 15th, provide access to the Producer's Farm Service Agency (FSA) reports, provide a forecast of straw production by June 15, provide access to property and information as required by the processor, provide notice of all changes to acres farmed, crop rotation, or any other pertinent information for straw volume or yields, provide notice of address change, and a catch all item stating that the farmer must meet any requirement the processor states will reduce risk, streamline operations or administering any matter under this Agreement. This list includes inclusive specific services and general opened services that can be defined later by the processor.

Sub-term 2e), Exercise of Option, formally states the dates of April 15 and July 15th that the processor must meet to exercise their option to purchase the farmer's straw.

Sub-term 2f), Responsibility for Coordination, states that the producer is responsible for selecting and working with custom operators to collect the straw under the requirements listed in the Agreement. Further straw storage requirements are explicitly listed and include: that straw stacks must be accessible to loading and transport equipment 12 months a year, including winter months, 24 hours per day, 7 days per week; this implies snow clearing is the producers responsibility. Straw stacks must also be located in a well-drained location and acceptable distances from power lines.

Sub-term 2g), Payment Terms, specifies the processors responsibility of how the farmers are to be compensated. There are 3 payments. First one third of the order value will be paid within 30 days of the processor’s receipt of the producer’s FSA commodity report. The second payment will occur after storage at an appropriate site and a processor inspector has verified the estimated tonnage. The final payment will be made on delivery and certified measurement of the tons delivered. Stipulations are also made for over payment and multiple claims on payment.

Sub-term 2h), Price Adjustments for Changes, states that the processor has the right to develop and modify standards as it requires so long as changes apply to all producers. Further, producers can be compensated for this change in standards.

The final sub-term for Term 2, Responsibilities in the Event of Problems, states that in the event of non-delivery the rights and responsibilities of the agreement are in effect. The risk of loss remains with the Producer until delivery. Further, the failure of the processor to enforce strict compliance with strict performance does not imply a waiver of performance for other producers. Thus under this agreement farmers own and are responsible for the straw until delivery.

Term 3, Resolving disputes, identifies the American Arbitration Associate rules as an external contract resolution method.

Term 4, Assignment, Termination and Extension, identifies the transferability of the rights and responsibilities under this agreement. The processor has the right to transfer the claims for the straw and straw procurement services to another processor. The 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. The 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.

Term 5, Transfer of Agreement and Related Party Obligations, states that in the event 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. Further this term states that neither the producer nor successor operators can sell straw to competition firms without meeting the obligation of this agreement first.

Term 6, Acts of God and Other Interruptions, performance may be excused because of acts of God, to the extent that is prevented or delayed performance. Acts of God listed include weather, war, civil insurrection, fire flood, strike, failure of transportation, interruption of power, government laws, regulations, or orders, or other causes. This term protects the farmers in some cases beyond their control.

Term, 7, Notices, Survival, Law, and Prior Representations, states that the agreement is binding to the heirs of the party, will be construed by state law, and supersedes any prior agreements. A final section of the contract includes data and signatures of the producer and field representative of the processor.

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

However, 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. Informal search methods can include local ranchers or other purchasers “checking crops”. Local advertising can be used to communicate biomass for sale. Further ad hoc relationships have evolved where local suppliers and demanders use barter systems, exchanging other services such as the use of machinery for biomass. Instead of having informal relationships with many farmers from year to year, Iogen has decided to pursue the long term standard production contacts defined above. Although it will take and has taken resources to design, offer and enforce these contracts, Iogen estimates this system will be cheaper than current biomass exchange methods.

This behavior could stem from Iogen’s level of asset specificity. After more than 30 years of scientific investigation into their processing technology, and targeting their enzymes to process wheat straw in a relatively dry climate, they do not intend to rely on current informal, short term exchange mechanisms that are common in current straw and hay markets. Rather they have perused long term (5-10) year contracts on a much more formal basis that could require high negotiation, administrative and enforcement costs but matches their level of asset specificity. If they had a lower level of asset specificity they would be more likely to prefer spot markets and current ad hoc methods of exchange.

Conclusion

This paper examines, from an organizational perspective, the general biomass case 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 define rights and responsibilities. Yet this method of exchange is preferred to existing informal exchange mechanisms in current biomass markets.

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