Kansas Farmers' Interest and Preferences for Growing Cellulosic Bioenergy Crops

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ABSTRACT

A survey was administered to determine Kansas farmers' willingness to grow crops for biofuel. The primary purpose of the survey was to assess farmers' willingness to produce biomass for cellulosic bioenergy in the forms of a value added crop, an annual energy crop, and a perennial energy crop under a favorable contractual arrangement, as well as to determine reasons they would or would not grow a bioenergy crop under a contract. Results show that net returns and contract length were the most important characteristics influencing farmers' willingness to produce cellulosic bioenergy crops.

Introduction

The Energy and Independence Security Act of 2007 mandates that renewable fuel use increase to 36 billion gallons by the year 2022 (U.S. Environmental Protection Agency, 2010). This mandated increase in ethanol usage will require using other biofuel feedstocks because production of traditional, first-generation (i.e., grain-based ethanol) fuels is capped at 15 billion gallons under the act. Second-generation biofuels such as "advanced" or lignocellulosic biofuel will need to be used to fill the gap. To qualify as lignocellulosic ethanol, greenhouse gas (GHG), emissions must be 60 percent below the baseline GHG emissions. The baseline GHG emissions are those produced from regular gasoline in 2005 (U.S. Environmental Protection Agency, 2010). This contrasts with corn-based ethanol that only reduces GHG emissions about 20 percent from baseline levels (U.S. Environmental Protection Agency, 2010). Agricultural sources of lignocellulosic ethanol feedstock include corn stover, wheat straw, sweet or forage sorghum, switchgrass, and miscanthus, to name a few.




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Several research studies have assessed the technical feasibility of producing biomass for bioenergy in North America (de la Torre Ugarta, English, and Jensen, 2007; Gallagher et al., 2003; Graham et al., 2007; Graham ,1994; Heid, 1984; Nelson et al., 2010; Perlack et al.; 2005). While farmers' technical ability to produce significant quantities of biomass for bioenergy is unquestionable, their willingness to do so under different contractual, pricing, storage, and transportation contexts is unknown, especially with respect to perennial and annual biomass crops such as switchgrass, miscanthus, and energy sorghum. The lack of an established market adds a great deal of uncertainty for farmers during development of this nascent industry. Farmers' willingness to grow biomass will depend on a number of factors including costs, profit potential, machinery requirements, markets, contracting arrangements, risks, and government policy (Paine et al., 1996; Mapemba & Epplin 2004). This study examines some of these and other factors including the characteristics of Kansas farms and farm mangers who are willing to supply and not willing to supply biofuel crops based on an enumerated survey of 290 farm operators. This information will be useful for both farm operators and bioenergy producers interested in establishing contractual arrangements and policy makers designing incentives to encourage biofuel feedstock production.

Review of Bioenergy Crop Production Issues

To provide some perspective on the questions asked in the survey and results reported in this study, it is useful to have an understanding of some of the issues related to bioenergy crop production.

Changes in agricultural land use for bioenergy crop production may be significant as biofuel use increases. Gallagher et al. (2003) estimate the Great Plains can supply one-fourth of crop residue biomass, with the Corn Belt supplying about two-thirds of crop residue biomass. Traditional crop acreage and livestock production will decline as more land produces energy crops, if prices are high enough (Gallagher et al., 2003; de la Torre Ugarta, English, and Jensen, 2007; U.S. Department of Energy 2011). However, the production of dedicated energy crops combined with decreases in traditional crop, forage, and livestock production will cause prices for these commodities to increase in the long term and competition among dedicated energy crops will increase (Dicks et al., 2009; Walsh et al., 2003).

Reductions in conservation program acres such as CRP may occur as crop acreage shifts to bioenergy crops (Walsh et al., 2003). Other environmental concerns may arise, such as declines in soil quality due to the removal of crop residues, affecting government program requirements for erosion control (Gallagher et al., 2003). On the other hand, some environmental improvements may result with adoption of perennial bioenergy crops, including improvements in soil organic carbon levels (McLaughlin & Walsh, 1998) and wildlife habitat and water quality (Paine et al., 1996).

The mix of crop residue and dedicated bioenergy crops supplied will depend largely on farmers' willingness to produce these crops. Biomass prices which will be very uncertain as the market develops will influence this decision. Contracting between farm mangers and bioenergy producers can help alleviate some of the price risk farmers face by

guaranteeing the price received is higher than costs to produce a crop. However, experience with contracts for biomass production is very limited.

Farmers may require additional equipment to produce and harvest a dedicated bioenergy crop, particularly perennials. As a result, they may require assistance with start-up costs. Farmers will be faced with alternative cropping systems and production constraints such as time, weather, and topography which will affect their ability to change farming practices, as well as their willingness to venture into new enterprises (Larson et al., 2005). This further creates a need for contracts between the processor and farm manager. Lajili et al. (1997) found that a relatively short-term (two-year) contract with low investment sharing and moderate production cost-sharing is preferred when asset specificity and uncertainty are mixed in other combinations.

Jensen et al. (2007) found that younger farmers, smaller farmers, farmers who plant soybeans, more highly educated farmers, and farmers who practice conservation methods such as no-till are more willing to adopt crops for bioenergy production than their neighbors. In addition, farmers who own or have ready access to haying equipment are more willing to plant switchgrass, indicating they have the means to cut, bale, and handle switchgrass without additional capital investment. An exception was livestock operators who were less likely to be willing to adopt switchgrass. Farmers indicated they would grow switchgrass if they could receive government payments, establish long-term contracts, acquire technical assistance, have access to markets, and cut CRP acres more than one out of three years.

While much of the previous work focused on production costs and potential returns for farmers growing bioenergy crops, few have asked farmers whether they are willing to grow bioenergy crops or under what conditions farmers may be willing to plant bioenergy crops. This study seeks to build upon past research by examining farm characteristics, bioenergy production issues, and contractual issues that may influence farmers' decisions regarding bioenergy crop adoption.

Data and Methods

To determine Kansas farmers' willingness to grow crops for biofuel, a survey was administered in three areas of Kansas - west, central, and northeast - by Kansas State University and the USDA, National Agricultural Statistics Service (NASS) from November 2010 to February 2011. These areas of Kansas were selected based on the number of farms growing corn and/or sorghum and the mix of irrigated and dryland production. The primary purpose of the survey was twofold: 1) to assess farmers' willingness to produce biomass for cellulosic bioenergy in the forms of a value added crop such as corn stover, wheat straw, or other crop residue; an annual energy crop such as forage or sweet sorghum; and a perennial crop such as switchgrass or miscanthus under a favorable contractual arrangement; and 2) to determine reasons they would or would not grow a bioenergy crop under a contract. The survey presented respondents with potential net returns, contract lengths, and other possible situations that may be important for large-scale bioenergy crop production. Farmers also responded to statements regarding bioenergy crop production, contracting,

and pricing by asking them to rank their agreement or disagreement with the statements on a scale ranging from 1 (strongly disagree) to 6 (strongly agree). Finally, the survey asked farmers about their crop rotation patterns, conservation practices, risk preferences, and demographics.

A random sample of 485 farms over 260 acres in size and $50,000 in gross farm sales were selected from the USDA-NASS farmer list for the three areas of the state (northeast, central and west). The sample includes only commercial farms that will be more likely to grow biofuel crops and supply the necessary quantities of biomass to maintain a cellulosic biofuel industry. Farmers already participating in USDA-NASS enumerated surveys (e.g., ARMS) were removed from the sample and replaced with another randomly drawn name. Prior to the survey entering the field, it was field-tested with focus groups at an annual extension conference hosted by the Department of Agricultural Economics at Kansas State University and then tested using face-to-face interviews with farmers in the targeted study areas.

Western, central, and northeastern Kansas regions were chosen as the survey areas for several reasons. First, they are selected based on proximity to current grain-based or future cellulosic-based biorefineries. Secondly, we wanted to survey farmers with a mix of irrigated and dryland production as well as farms growing corn and/or sorghum. We also wanted to include geographical and climate differences throughout the state. Western Kansas has the most irrigated land of the three regions. Central Kansas is the largest producer of sorghum in the state and uses less irrigation than farmers in western Kansas. Northeastern Kansas borders the western Corn Belt and produces mainly corn and soybeans.

Potential participants received a four-page flier via mail asking for their participation in the survey and providing information about cellulosic biofuel feedstock production one week prior to being contacted by USDA-NASS enumerators. USDA-NASS enumerators then scheduled one-hour interviews with the farmers to complete the survey. Interviews, on average took 57 minutes to complete. Upon completion of the survey and receipt at the USDA-NASS office in Topeka, KS, farmers were compensated for their time with a $15 gift card. Of the 485 farmers contacted, 290 completed the survey, 38 were out of business, did not farm, or could not be located, making the survey response rate (290/(485-38)) = 0.65 or 65 percent.

Table 1 provides a comparison of survey respondent characteristics to the 2007 Census of Agriculture (National Agricultural Statistics Service, 2009) statistics. Respondents were, on average, slightly younger and operated more acres than the statewide averages reported by NASS. However, smaller farms and hobby farms were intentionally not included in the survey, therefore it is reasonable that acreage is larger in the survey than the general farm population. The average size of the operations in the survey was 2,124 acres with 898 acres owned and 1,387 acres rented. The category for average market value of sales chosen in the survey most often was $200,000 to $399,000. This range reflects the average market value of agricultural products sold, $219,944, according to the 2007 NASS Census of Agriculture (2009).

Results

Willingness to Adopt

Table 2 shows the number of farmers willing to produce versus not produce each type of bioenergy feedstock with the use of a contract with a biorefinery in each region of Kansas. The perennial crop is the only crop with less than an overall 50 percent willingness to adopt rate (41.9%). The value-added crop (crop residue) has a 53.1 percent willingness to adopt rate and the annual crop has a 60 percent willingness to adopt rate. Crop residue is valued lower than the actual crops grown, which may reflect the lower rate of willingness to adopt for this crop. In addition, many farmers graze residue, practice no-till, or other conservation tillage practices to conserve soil moisture and reduce erosion, so they may not be willing to remove residue if they already have a use for it or are concerned about conservation. These results are not unexpected due to farmers' familiarity with growing annual crops and, conversely, their unfamiliarity with a perennial like switchgrass. In addition, an annual crop rotates well with other crops while a perennial ties up land for a long period, making it difficult to switch to a potentially more profitable crop and usually has higher establishment costs. The value added crop removes residue from the soil surface which has soil tilth, nutrient, and soil moisture benefits if it is not removed.

For all three crops, farmers in the central part of the state are most willing to adopt. The willingness to adopt rate for the annual crop is 75 percent, the value-added crop is 68.5 percent, and the perennial is 58.2 percent. The central part of the state is the only region where perennial crop willingness to adopt is greater than 50 percent. This area also has more CRP acres than the other areas of the state.

Western Kansas has the lowest percentage of operators interested in providing crop residue (value-added) to a biorefinery. This is likely due to the drier climate in this region. With respect to a perennial crop, since more land is irrigated in this part of the state and it is unlikely farmers will irrigate perennial bioenergy crops; the willingness to adopt rate is only about 35 percent. The annual crop willingness to adopt rate is lower in the western part of the state than the central or northeast, where about half of respondents indicated they would adopt this crop. This is likely due to more irrigated corn production; expected profits associated with irrigated corn outweigh those potentially earned from annual bioenergy crops such as energy sorghum.

In the northeastern region of Kansas, 51.6 percent of farmers indicated they would be willing to adopt a value-added bioenergy enterprise, 57.4 percent indicated they would be willing to adopt an annual bioenergy crop, and only 33.7 percent were willing to adopt a perennial. The northeastern corner of Kansas is a corn and soybean production region and perennial bioenergy crop production is currently not likely to be perceived as competitive with higher profits from these row crops.

Willingness to Adopt Factors

Farmers were also asked to select the three most important bioenergy crop characteristics that would influence their willingness to adopt. Table

3 contains results from respondents' answers regarding these important characteristics. Expected net returns was the most often chosen response for each bioenergy crop and was chosen over three-fourths of the time for willing to adopt and over half of the time for not willing to adopt. The second most important reason influencing their decision to adopt or not was contract length. Over half of those willing to adopt picked this reason for each crop. Those unwilling to adopt crop residue harvest, annual, and perennial production, also thought contract length was important; 36 percent, 44 percent, and 58 percent, respectively. Planting a perennial crop is a long-term investment, so it is likely that contract length influences their decision to produce a perennial more. In contrast, farmers may see these long-term contracts as a deterrent to adopting, given they may be unable to reduce residue harvest to conserve soil moisture or plant an alternative crop should a more profitable cropping enterprise become available.

Another important reason that farmers chose to be willing to adopt or not is uncertainty. About one-fourth of those willing to adopt and one-third of those unwilling to adopt indicate uncertainty is an important concern for residue harvest (value-added) and annual and perennial crops. A nutrient replacement option, where a biorefinery will compensate a farmer for lost nutrients due to residue removal, was an important contract feature for those willing to adopt and those unwilling to adopt the value added crop, with 50.3 percent of those willing to adopt and 39.3 percent of those unwilling to adopt choosing it. Approximately 36 percent of those unwilling to adopt a value added crop indicated increased soil erosion is a concern.

For those unwilling to adopt the annual and perennial crops, the risk of starting a new enterprise is an important consideration. The results show that 26.3 percent of those unwilling to adopt an annual crop and 30.9 percent of those unwilling to adopt a perennial crop believe the enterprise is too risky, while only 14.8 percent of those unwilling to adopt a value-added crop thought the enterprise was too risky. The government incentive and establishment cost-share features for the annual and perennial crops, respectively, were important considerations for those willing to adopt these enterprises with 21.1 percent and 24.4 percent, respectively, choosing these options. Additionally, 50.3 percent of those willing to adopt a value-added option thought a nutrient replacement option paid for by the biofuel producer was an important factor.

Characteristics of Those Willing to Adopt and Unwilling to Adopt

Table 4 provides farms and farm operators' characteristics based on whether they are willing to harvest a value added crop (i.e., corn stover, wheat straw, etc.). Table 5 and Table 6 provide the same information based on whether farm operators are willing to grow or not willing to grow a dedicated annual or perennial bioenergy crop, respectively. Standard errors were included with the means to show the variation in the data. The smaller the standard error is, the less variance in the responses from farmers.

Farm and farm manager attributes based on willingness to harvest crop residue are reported in Table 4. In all three regions, farmers who, on average, are willing to harvest their crop residue have more acres enrolled in CRP, a greater percentage of land leased, and larger total farm sales than farmers who are not willing to harvest residue. Farm operators who are slightly younger as well as farmers with slightly less experience are willing to harvest crop residue. In western and central Kansas, farmers who are willing to harvest crop residue farm more total acres, but in northeastern Kansas, more farms with smaller total acreage indicated they are willing to harvest than larger acreage farms.

Farmers who are willing to grow a dedicated annual bioenergy crop have more total acres, more total CRP acres, higher percentage of leased acres, and higher total sales on average in western and central Kansas than farmers who are not (Table 5). Farmers who are slightly younger and farmers with slightly less experience are willing to grow a dedicated annual bioenergy crop. In northeastern Kansas, farmers with fewer total acres and fewer acres enrolled in CRP are willing to grow a dedicated annual crop compared to farmers with more acres. Farmers with more land leased as well as farmers with greater total sales, on average, are willing to grow a dedicated annual bioenergy crop in northeastern Kansas.

Table 6 shows that in all three areas of Kansas, younger farmers, those with less experience and those who have a higher percentage of land leased, are willing to grow a dedicated perennial bioenergy crop. In western Kansas, on average, farmers with fewer total acres, fewer acres enrolled in CRP, and lower total sales, are willing to grow a dedicated perennial bioenergy crop. In central and northeastern Kansas, farmers with more total acres and higher average sales are willing to grow a dedicated perennial energy crop. However, in central Kansas, those willing to grow have, on average, more CRP acres; while in the northeast part of the state, farmers with fewer CRP acres are more willing to grow perennial bioenergy crops.

Farm operators in central Kansas who used a baler are more likely to supply any of the three bioenergy crops than those that did not use a baler. This was not as an important factor in the other regions.

Farmer Preferences

Survey participants were asked to respond to several preference statements using a scale from 1 to 6 where 1 was "strongly disagree" and 6 was "strongly agree" with the statement. Tables 7, 8, and 9 summarize these results for those willing to and those not willing to harvest crop residue, grow a dedicated annual bioenergy crop, and grow a dedicated perennial bioenergy crop. The numbers reported are the most common response on the scale of 1 to 6 for the two groups. In several cases, no single response has the highest frequency[1], so all responses with the same frequency are listed. The mean response is reported in parentheses.

The results for crop residue, a value added crop, are reported in Table 7. For several statements, the most common response of farmers from all regions of Kansas, regardless of whether they are willing to harvest their crop residue or not, is strongly agree

(5 or 6). These statements are: "I would not grow a bioenergy crop until it has an established market;" "I would prefer a contract that ties (indexes) the biomass sale price to the price of major inputs such as fertilizer, fuel, or some other energy price index;" and "I would prefer a contract that provides a minimum price guarantee for the biomass delivered to the biorefinery or processor." Average responses for these statements are all over 4.0, indicating at least some agreement with the statements. In addition, there are several statements where the most frequent response was slightly agree (4) or strongly agree (5 or 6). These statements include "I would prefer a contract that ties (indexes) the biomass sale price to the biorefinery's output;" "I would prefer a contract that provides quality premiums and discounts for the biomass I sell to a biorefinery or processor;" and "Removing biomass (crop residue) will increase soil erosion." Again, the average responses are very close to 4.0 indicating that, in general, operators agreed with the statements. There is less consensus among farmers in the remaining statements. The most common response among all categories of farmers is strongly disagree (1 or 2) to the statement, "I would be willing to invest in a biomass refining facility," except for those willing to harvest their crop residue in western Kansas, where the most frequent response was slightly agree (4) with the statement. For the remaining statements, "I would prefer a contract that requires a minimum biomass tonnage requirement be delivered to the biorefinery or processor," "I am willing to store biomass bales on my farm for longer than six months under contract," and "I would prefer to enter into a contract where payment is made when the biomass is delivered to the refinery rather than being paid immediately after harvest," no consistent response frequencies exist across those willing to harvest or not, or across regions. Average responses for these statements are between 1.6 and 3.5, indicating that farm operators, in general, disagree to somewhat disagree with these statements across each region of Kansas regardless of whether they are willing to supply crop residue as a bioenergy crop.

Table 8 summarizes the results for a dedicated annual bioenergy crop. The results are similar to those in Table 7. Regardless of which region they are from or if they were willing to grow a dedicated annual bioenergy crop, farmers' most frequent response to "I would not grow a bioenergy crop until it has an established market;" "I would prefer a contract that ties (indexes) the biomass sale price to the price of major inputs such as fertilizer, fuel, or some other energy price index;" and "I would prefer a contract that provides minimum price guarantee for the biomass delivered to the biorefinery or processor" was strongly agree (5 or 6). The average response for most of these statements is close to 5.0, indicating agreement across regions and preferences for growing dedicated annual energy crops. Farmers in Central Kansas exhibit a little less agreement with these statements, as indicated by average responses ranging from 4.4 to 4.8. The most frequent response regardless of regions, or willingness to grow for the statements "I would prefer a contract that ties (indexes) the biomass sale price to the biorefinery's output" and "I would prefer a contract that provides quality premiums and discounts for the biomass I sell to a biorefinery or processor" are all either slightly agree (4)

or strongly agree (5 or 6). Average responses range from 3.7 to 4.6 indicating that, on average, farmers agree with these statements. The most frequent response across farmers in all regions of the state, regardless of whether they are willing to grow a dedicated annual bioenergy crop or not is strongly disagree (1 or 2) with the statement "I would prefer a contract that requires a minimum biomass tonnage requirement be delivered to the biorefinery or processor." The average responses range from 2.4 to 2.9. The most frequent response for farmers in western Kansas who are willing to grow a dedicated annual bioenergy crop is slightly agree (4) with the statement "I would be willing to invest in a biomass refining facility," but on average, farmers disagree with this statement as indicated by average values less than 3.0. The most common response to this question for all other categories of farmers is strongly disagree (1 or 2). There is little consistency for the most frequent response across regions of Kansas or based on if farmers are willing to grow a dedicated annual bioenergy crop for the statements "I am willing to store biomass bales on my farm for longer than 6 months under contract" and "I would prefer to enter into a contract where payment is made when the biomass is delivered to the refinery rather than being paid immediately after harvest." Average responses range between 2.7 and 3.7 across all regions. These indicate that, in general, respondents somewhat disagree with these statements.

The results of the preference questions for a dedicated perennial bioenergy crop are reported in Table 9. There are several statements whose most frequent response is strongly agree (5 or 6) in all regions of Kansas, regardless of whether farmers are willing to grow a dedicated perennial bioenergy crop. These statements are: "I would not grow bioenergy crops until it has an established market;" "I would prefer a contract that ties (indexes) the biomass sale price to the price of major inputs such as fertilizer, fuel, or some other energy price index;" and "I would prefer a contract that provides a minimum price guarantee for the biomass delivered to the biorefinery or processor." Average responses for these statements are greater than 4.5 except for operators in Western Kansas willing to grow a perennial bioenergy crop. For these farmers, the average response to the statement, "I would prefer a contract that ties (indexes) the biomass sale price to the price of major inputs such as fertilizer, fuel, or some other energy price index," was only 4.4. The most frequent response for the statement, "I would prefer a contract that ties (indexes) the biomass sale price to the price of the biorefinery's output" was either slightly agree (4) or strongly agree (5) and the average was between 3.5 and 4.5, indicating farm operators may only somewhat agree, on average.

The statement, "I would prefer a contract that provides quality premiums and discounts for the biomass I sell to a biorefinery or processor," had most frequent responses of either slightly agree (4) or strongly agree (5 or 6) and average responses between 4.1 and 4.6. The most frequent response across all categories of respondents except those who are not willing to grow a dedicated perennial bioenergy crop in central Kansas is strongly disagree (1 or 2) to the statement "I would prefer a contract that requires a minimum biomass tonnage

requirement be delivered to the biorefinery or processor." The average responses range from 2.3 to 3.0 indicating some disagreement with the statement. Farm operators in western Kansas who are willing to grow a dedicated perennial crop most frequently responded slightly agree (4) with the statement, "I would be willing to invest in a biomass refining facility" while all other categories of farmers' most frequent responses were strongly disagree (1 or 2). For all regions, average responses to this question are less than 3.0, indicating a general disagreement with the statement. The most frequent responses to the statements, "I am willing to store biomass bales on my farm for longer than six months under contract" and "I would prefer to enter into a contract where payment is made when the biomass is delivered to the refinery rather than being paid immediately after harvest" is not consistent across respondents, but average responses from 2.8 to 3.5 indicate, on average, farm operators somewhat disagree with these statements.

Regional Applicability of Results

Although this study was conducted in three regions of Kansas, some of the results should be applicable to other regions in the U.S. It is likely that farm operators in other regions will agree with farm operators in this study and will harvest crop residues or grow an annual bioenergy crop before they would make a large upfront investment in a perennial crop. Preferences for growing a perennial bioenergy crop versus harvesting crop residue is likely to be influenced by the amount of livestock and crop residue consumed by livestock in the region. It will also depend on the role crop residue serves in conserving soil moisture and reducing soil erosion. Farm operators in drier climates may be less willing to harvest crop residue.

Expected net returns, contract length, an option for nutrient replacement, and the impact of biomass production and harvest on soil erosion will likely affect operators' decisions in all regions of the U.S., because these factors are common concerns of traditional commodity production and not just bioenergy crop production.

It is likely that farm operators in other regions of the country will agree with farm operators in this study on a number of other issues. They may have similar marketing preferences including a desire not to grow a bioenergy crop until it has an established market, a preference for a minimum price guarantee, quality and premium discounts, and not having to agree to a minimum biomass tonnage requirement for delivery. These marketing factors would generally not be influenced by region. Most operators have a stronger preference indexing biomass prices to major production input costs as compared to ethanol but generally support one of these types of indexing options in contracts. This result points to the possibility that biofuel producers may have to offer alternative contracting arrangements with farm operators within a given region. These contracting arrangements will likely be different for each feedstock type procured by a biomass refining facility, as well.

Alternatively, farm characteristics including acres enrolled in CRP, land tenure arrangements, farm size, crop and livestock enterprise mix, and the type

of bioenergy crop that can be produced in the region will vary considerably by region and will influence operators' willingness to adopt these crops. For instance, it is unlikely a perennial bioenergy crop will become popular in row crop production regions such as the Corn Belt but a value-added crop could be viable. The Great Plains states and areas with more marginal land for row crop production may have land that is economically suitable for any of the three types of biofuel crops.

Conclusions

This paper summarized responses to a survey about farm characteristics and farmer interest and preferences for growing bioenergy crops to produce cellulosic ethanol in three regions of Kansas. Specific types of crops studied were a value-added enterprise such as corn stover, an annual bioenergy crop such as sweet sorghum, and a perennial bioenergy crop such as switchgrass. The region of Kansas in which farms operate influences their decision. A lower percentage of farm operators in western Kansas are willing to grow bioenergy crops compared to farmers in central or northeastern Kansas. This is likely due to the desire to use crop residue to conserve soil moisture and reduce wind erosion as well as produce relatively highly profitable irrigated crops in western Kansas. A higher percentage of central Kansas farmers are willing to grow any of the three types of bioenergy crops than farmers in other regions. This is the only area where at least half of the respondents were willing to grow a perennial crop. In western and northeastern Kansas, only about one-third of farmers were willing to adopt a perennial bioenergy crop.

The most important characteristics of bioenergy crop production and contracting that determine whether farmers are willing to adopt any of the bioenergy crops were net returns and contract length. Contracts will be an important part of starting and maintaining a cellulosic bioenergy industry due to uncertainty and farmers' unfamiliarity with producing biomass for biofuels. For those unwilling to adopt a perennial bioenergy crop, 58 percent indicated contract length was an important consideration in their decision not to be willing to adopt. A high percentage of non-adopting producers indicated important characteristics of bioenergy crop production include uncertainty and risk, especially for perennial crops. About half of adopting farmers indicated nutrient replacement is an important contract feature for a value added crop residue enterprise. About one-fourth of adopting producers indicated government incentives and establishment cost share influence their willingness to adopt annual or perennial crops, respectively.

Farms with slightly higher total acres are, on average, more willing to harvest their crop residue or grow a dedicated annual bioenergy crop; whereas farmers with slightly more total acres are, on average, less likely to grow a dedicated perennial crop. In addition, slightly younger farmers as well as slightly less experienced farmers indicated their willingness to grow bioenergy crops over older or more experienced farmers. In central Kansas, farmers with livestock are more willing to grow bioenergy crops than in western or northeastern Kansas, but this may be due to their higher willingness to grow biofuel feedstocks in general.

Most farmers prefer that an established market

exists before entering into a bioenergy contract. In addition, they generally prefer that biomass prices are indexed either to output (e.g., ethanol) prices or input prices such as fertilizer, etc. Regardless of whether they are willing to adopt a dedicated bioenergy crop, they do not prefer contracts with minimum tonnage requirements. In general, farmers would prefer to be paid immediately after harvest rather than waiting for the biomass to be delivered to the biorefinery and are only somewhat willing to store biomass on their farm for more than six months. Both those willing to adopt and those unwilling to adopt a bioenergy crop prefer a minimum price guarantee contract.

Endnote

[1] Percentage distributions are available upon request from the authors.

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Table 1. Summary of Survey Respondents' Farm Characteristics and Comparison of Kansas Farmer Demographics to the 2007 Census of Agriculture

	2007 Census of Agriculture[a]	Survey
Age	57.7 years	55.9 years
Percent male principal operators	87.9%	95.9%
Average size of farm (total acres operated)	707 acres	2,124 acres
Average owned land in farm	381 acres	898 acres
Average rented land in farm	863 acres	1,387 acres
Average corn acres[b]	328 acres	494 acres (N = 258)
Average sorghum acres[b]	231 acres	331 acres (N = 133)
Average soybean acres[b]	196 acres	433 acres (N = 194)
Average wheat acres[b]	377 acres	613 acres (N = 239)
Average market value of agricultural products	$219,944	$200,000 to $399,999

[a] (National Agricultural Statistics Service, 2009)
[b] NASS acres are for grain only. The survey only asks acres of each crop and does not specify whether the acres are for grain, forage, or both.

Table 2. Number and Percentage of Respondents Adopting or Not Adopting a Contract for a Cellulosic Bioenergy Crop

	Value-added (*N* = 288)		Annual Crop (*N* = 285)		Perennial Crop (*N* = 284)	
Region	Willing to Adopt	Not Willing to Adopt	Willing to Adopt	Not Willing to Adopt	Willing to Adopt	Not Willing to Adopt
West	41	60	48	51	34	64
Central	63	29	69	23	53	38
Northeast	49	46	54	40	32	63
Total	153	135	171	114	119	165
West[a]	40.6%	59.4%	48.5%	51.5%	34.7%	65.3%
Central	68.5%	31.5%	75.0%	25.0%	58.2%	41.8%
Northeast	51.6%	48.4%	57.4%	42.6%	33.7%	66.3%
Total	53.1%	46.9%	60.0%	40.0%	41.9%	58.1%

[a] Regional percentages are calculated as number Willing to Adopt in that region divided by total for each crop in that region (e.g., "Adopt Value-added in West" is calculated as: [41/(41+60)]*100 = 40.6%). Total is calculated as the number Willing to Adopt or Not Willing to Adopt divided by the total number (*N*) for all three regions for each crop (e.g., "Adopt Value-added for Total" is calculated as [153/(153+135)]*100 = 53.1%).

Table 3. Reasons Farmers Chose or Chose Not to be Willing to Adopt a Contract Scenario[a]. Values are Percentage of Times the Reason was Selected

	Value-added (*N = 288*)		Annual Crop (*N = 285*)		Perennial Crop (*N = 284*)	
	Willing to Adopt (*n = 153*)	Not Willing to Adopt (*n = 135*)	Willing to Adopt (*n = 171*)	Not Willing to Adopt (*n = 114*)	Willing to Adopt (*n = 119*)	Not Willing to Adopt (*n = 165*)
Net Returns	76.5	51.9	80.7	56.1	79.0	52.7
Contract Length	53.6	36.3	60.2	43.9	62.2	58.2
Harvest Flexibility/Timing	11.8	4.4	11.7	7.0	10.9	7.3
Lack of a Spot Market	2.0	3.0	2.9	4.4	5.0	6.7
Uncertainty	26.1	30.4	23.4	45.6	26.1	40.0
I'm a First Adopter	1.3	0.7	1.2	0.9	0.0	1.8
Lack of Machinery	15.7	14.8	18.7	16.7	13.4	24.2
Environmental Stewardship	6.5	9.6	—	—	5.9	10.9
Water Conservation	4.6	11.9	—	—	—	—
Enterprise Too Risky	5.2	14.8	9.4	26.3	9.2	30.9
Increased Soil Erosion	11.8	35.6	8.8	10.5	—	—
More Income Streams	9.2	0.7	—	—	—	—
Lower Risk	2.6	1.5	4.7	1.8	11.8	0.6
Nutrient Replacement Option	50.3	39.3	—	—	—	—
It's a Value-added Enterprise	7.8	1.5	—	—	—	—
Labor Availability	9.2	8.9	8.2	8.8	3.4	12.1
Higher Income	—	—	15.8	11.4	16.8	4.8
Govt. Incentive Payments	—	—	21.1	8.8	—	—
Can be part of Crop Rotation	—	—	14.0	8.8	—	—
Production Costs	—	—	11.1	7.0	—	—
No Irrigation	—	—	2.3	4.4	—	—
Establishment Cost-Share	—	—	—	—	24.4	6.7
Seed Provision	—	—	—	—	16.0	4.8
Low Yields	—	—	—	—	4.2	3.0
Decreased Soil Erosion	—	—	—	—	5.9	6.1

[a]Percentages are the number of responses divided by the number of those Willing to Adopt or Not Willing to Adopt each crop. (To find the number of times "net returns" was chosen for value-added adopters, calculate: (76.5*153)/100 = 117, etc.) Respondents were asked to pick the top three reasons for choosing or not choosing a contract.

Table 4. Farm and Farmer Characteristics of Those Willing to Harvest and Not Willing to Harvest a Value Added Bioenergy Crop

	West		Central		Northeast		Total	
	WTH[a]	Not WTH	WTH	Not WTH	WTH	Not WTH	WTH	Not WTH
Total Acres	2430.2 (1820.5)[b]	1841.4 (1610.5)	1557.8 (1291.7)	1008.3 (522.5)	1082.5 (763.5)	1147.3 (868.8)	1603.7 (1411.7)	1520.7 (1356.2)
Total CRP Acres	220.7 (294.7)	151.8 (137.9)	109.6 (117.0)	60.0 (0.0)	64.9 (49.8)	28.7 (25.8)	120.2 (183.3)	122.9 (129.4)
Percent of Acres Leased	63% (34%)	54% (33%)	61% (30%)	60% (30%)	53% (30%)	47% (33%)	59% (31%)	54% (33%)
Percent Raise Livestock[c]	45% (--)	51% (--)	66% (--)	50% (--)	75% (--)	88% (--)	62% (--)	59% (--)
Total Farm Sales	$456,132 ($318,723)	$392,733 ($283,699)	$411,000 ($290,532)	$288,542 ($177,215)	$390,426 ($269,626)	$389,844 ($278,059)	$412,012 ($290,566)	$374,472 ($267,056)
Years Experience	34.0 (13.9)	34.5 (15.1)	34.6 (10.7)	35.8 (11.1)	34.6 (12.8)	38.7 (15.8)	34.2 (12.3)	35.6 (14.5)
Age	56.0 (12.1)	58.3 (15.1)	55.7 (10.2)	57.0 (7.3)	54.5 (11.5)	59.8 (15.0)	55.0 (11.2)	58.4 (13.8)
Percent Use Bailer[c]	30% (--)	31% (--)	71% (--)	43% (--)	76% (--)	81% (--)	62% (--)	44% (--)

[a] WTH is willing to harvest.
[b] Standard errors are in parenthesis.
[c] Yes/no response. Standard errors are not relevant for responses using yes or no.

Table 5. Farm and Farmer Characteristics of Those Willing to Grow and Not Willing to Grow a Dedicated Annual Bioenergy Crop

	West		Central		Northeast		Total	
	WTG[a]	Not WTG	WTG	Not WTG	WTG	Not WTG	WTG	Not WTG
Total Acres	2395.0 (1893.1)[b]	1834.7 (1449.3)	1496.1 (1097.7)	1428.6 (1479.4)	1082.5 (757.5)	1117.8 (879.7)	1656.8 (1441.7)	1466.2 (1310.3)
Total CRP Acres	209.5 (288.5)	164.8 (144.2)	118.7 (125.3)	77.5 (81.1)	64.9 (44.1)	91.8 (132.1)	132.0 (201.8)	114.5 (129.2)
Percent of Leased Acres	65% (32%)	50% (34%)	64% (28%)	54% (35%)	53% (29%)	51% (33%)	62% (30%)	51% (34%)
Percent Raise Livestock[c]	48% (--)	46% (--)	73% (--)	41% (--)	75% (--)	81% (--)	64% (--)	57% (--)
Total Farm Sales	$461,864 ($305,706)	$373,311 ($296,246)	$422,708 ($291,779)	$330,556 ($245,398)	$390,426 ($285,019)	$359,122 ($260,985)	$431,960 ($293,512)	$356,683 ($268,442)
Years Experience	31.9 (13.6)	37.8 (14.9)	32.9 (10.4)	38.8 (10.4)	34.6 (13.6)	36.6 (12.7)	32.7 (12.5)	37.7 (12.9)
Age	54.4 (12.8)	61.1 (13.6)	54.1 (8.8)	59.9 (10.7)	54.5 (11.3)	56.8 (13.4)	53.9 (11.0)	59.2 (12.8)
Percent Use Bailer[c]	30% (--)	32% (--)	77% (--)	43% (--)	76% (--)	69% (--)	62% (--)	48% (--)

[a] WTG is willing to grow.
[b] Standard errors are in parenthesis.
[c] Yes/no response. Standard errors are not relevant for responses using yes or no.

Table 6. Farm and Farmer Characteristics of Those Willing to Grow and Not Willing to Grow a Dedicated Perennial Bioenergy Crop

	West		Central		Northeast		Total	
	WTG[a]	Not WTG	WTG	Not WTG	WTG	Not WTG	WTG	Not WTG
Total Acres	2088.4 (1749.2)[b]	2236.1 (1763.8)	1539.6 (1089.5)	1419.0 (1379.4)	1082.5 (756.9)	1052.9 (845.1)	1555.8 (1276.7)	1621.4 (1494.3)
Total CRP Acres	146.8 (159.6)	239.5 (304.6)	112.5 (120.5)	87.2 (97.3)	64.9 (48.8)	92.0 (159.4)	102.4 (121.1)	167.4 (246.5)
Percent of Leased Acres	65% (32%)	56% (35%)	64% (29%)	56% (32%)	53% (28%)	52% (33%)	61% (29%)	55% (33%)
Percent Raise Livestock[c]	53% (--)	44% (--)	74% (--)	50% (--)	75% (--)	77% (--)	67% (--)	57% (--)
Total Farm Sales	$400,000 ($272,751)	$444,375 ($321,810)	$400,833 ($278,623)	$384,146 ($287,826)	$390,426 ($261,668)	$375,481 ($287,920)	$403,354 ($269,011)	$404,820 ($301,399)
Years Experience	31.1 (14.2)	36.0 (14.2)	32.4 (9.5)	37.6 (11.5)	34.6 (9.4)	34.2 (15.9)	32.9 (11.0)	35.9 (14.1)
Age	52.9 (13.7)	59.3 (12.9)	53.1 (8.5)	59.6 (10.1)	54.5 (9.6)	54.1 (14.1)	53.7 (10.5)	57.6 (12.8)
Percent Use Bailer[c]	42% (--)	24% (--)	78% (--)	52% (--)	76% (--)	72% (--)	69% (--)	47% (--)

[a] WTG is willing to grow.
[b] Standard errors are in parenthesis.
[c] Yes/no response. Standard errors are not relevant for responses using yes or no.

Table 7. Summary of Farmers' Most Frequent and Average Response to Preference Questions for Those Willing to Harvest and Those Not Willing to Harvest a Value Added Crop[a]

	West		Central		Northeast		Total	
	WTH[b]	Not WTH	WTH	Not WTH	WTH	Not WTH	WTH	Not WTH
I would not grow bioenergy crops until it has an established market.	6 (5.5)	6 (5.3)	6 (4.7)	6 (4.3)	6 (5.2)	6 (5.4)	6 (5.1)	6 (5.1)
I would prefer a contract that ties (indexes) the biomass sale price to the price of the biorefinery's output (e.g., ethanol, biodiesel, etc.).	5 (4.2)	5 (4.3)	5 (3.9)	4 (4.0)	4 (3.7)	4; 5 (4.0)	5 (3.9)	5 (4.2)
I would prefer a contract that ties (indexes) the biomass sale price to the price of major inputs such as fertilizer, fuel, or some other energy price index.	5 (4.9)	6 (4.9)	5 (4.8)	5 (4.2)	5 (5.0)	6 (5.1)	5 (4.9)	6 (4.8)
I would prefer a contract that provides quality premiums and discounts for the biomass I sell to a biorefinery or processor.	5 (4.4)	4; 6 (4.6)	4 (4.3)	5 (3.8)	5 (4.4)	4 (4.4)	5 (4.4)	4 (4.4)
I would prefer a contract that provides a minimum price guarantee for the biomass delivered to the bio-refinery or processor.	6 (4.9)	6 (5.1)	5 (4.8)	5 (4.2)	5 (5.0)	5 (4.5)	5 (4.9)	5; 6 (4.8)
I would prefer a contract that requires a minimum biomass tonnage requirement be delivered to the biorefinery or processor.	1 (2.5)	1 (2.7)	3 (2.8)	1; 2; 4 (2.6)	2 (2.4)	4 (3.1)	2 (2.6)	2 (2.8)
I am willing to store biomass bales on my farm for longer than 6 months under contract.	4 (3.4)	2 (2.8)	5 (3.3)	4 (3.3)	2 (3.0)	1 (2.5)	5 (3.2)	1 (2.8)
I would be willing to invest in a biomass refining facility.	4 (2.9)	1 (2.2)	1 (2.4)	1; 2 (2.2)	2 (2.4)	1 (1.6)	2 (2.6)	1 (2.1)
I would prefer to enter into a contract where payment is made when the biomass is delivered to the refinery rather than being paid immediately after harvest.	2 (3.3)	1 (3.3)	4 (3.5)	1; 5 (3.4)	4 (3.0)	1 (2.7)	4 (3.2)	1 (3.2)
Removing biomass (crop residue) will increase soil erosion.	6 (5.1)	6 (5.5)	4 (4.3)	6 (4.8)	5 (4.7)	6 (5.2)	6 (4.7)	6 (5.3)

[a] One (1) equals strongly disagree and six (6) equals strongly agree. In some cases, more than one answer was chosen most often. Therefore all relevant answers are reported. The average of the responses is reported in parentheses.
[b] WTH is willing to harvest.

Table 8. Summary of Farmers' Most Frequent and Average Response to Preference Questions for Those Willing to Grow and Those Not Willing to Grow a Dedicated Annual Bioenergy Crop[a]

	West		Central		Northeast		Total	
	WTG[b]	Not WTG	WTG	Not WTG	WTG	Not WTG	WTG	Not WTG
I would not grow bioenergy crops until it has an established market.	6 (5.4)	6 (5.5)	6 (4.6)	6 (4.8)	6 (5.3)	6 (5.0)	6 (5.1)	6 (5.1)
I would prefer a contract that ties (indexes) the biomass sale price to the price of the biorefinery's output (e.g., ethanol, biodiesel, etc.).	5 (4.1)	5 (4.6)	5 (3.9)	4 (4.0)	4 (3.8)	4 (3.7)	5 (3.9)	4 (4.1)
I would prefer a contract that ties (indexes) the biomass sale price to the price of major inputs such as fertilizer, fuel, or some other energy price index.	5 ; 6 (4.9)	5 ; 6 (4.9)	5 (4.8)	5 (4.4)	5 (5.0)	5 (5.0)	5 (4.9)	5 (4.8)
I would prefer a contract that provides quality premiums and discounts for the biomass I sell to a biorefinery or processor.	5 (4.5)	4 ; 6 (4.6)	4 (4.3)	5 (4.0)	5 (4.5)	4 (4.3)	5 (4.4)	4 ; 5 (4.3)
I would prefer a contract that provides a minimum price guarantee for the biomass delivered to the bio-refinery or processor.	6 (5.0)	6 (5.0)	5 (4.8)	5 ; 6 (4.5)	5 (5.0)	5 (4.8)	5 (4.9)	5 (4.8)
I would prefer a contract that requires a minimum biomass tonnage requirement be delivered to the biorefinery or processor.	1 (2.4)	1 (2.8)	2 (2.9)	1 (2.6)	2 (2.5)	2 (2.6)	2 (2.6)	1 (2.7)
I am willing to store biomass bales on my farm for longer than 6 months under contract.	4 (3.4)	1 ; 2 (2.7)	2, 5 (3.4)	4 (3.2)	2 ; 5 (3.1)	1 (2.7)	2 (3.3)	1 (2.8)
I would be willing to invest in a biomass refining facility.	4 (2.8)	1 (2.3)	1 (2.6)	2 (2.1)	2 (2.4)	2 (2.0)	1 (2.6)	1 (2.1)
I would prefer to enter into a contract where payment is made when the biomass is delivered to the refinery rather than being paid immediately after harvest.	2 (3.1)	5 (3.6)	4 (3.7)	2 (3.1)	4 (3.0)	2 ; 4 (2.8)	4 (3.3)	1 ; 2 (3.2)

[a] One (1) equals strongly disagree and six (6) equals strongly agree. In some cases, more than one answer was chosen most often. Therefore all relevant answers are reported. The average of the responses is reported in parentheses.
[b] WTG is willing to grow.

Table 9. Summary of Farmers' Most Frequent and Average Response to Preference Questions for Those Willing to Grow and Those Not Willing to Grow a Dedicated Perennial Bioenergy Crop[a]

	West		Central		Northeast		Total	
	WTG[b]	Not WTG	WTG	Not WTG	WTG	Not WTG	WTG	Not WTG
I would not grow bioenergy crops until it has an established market.	6 (5.2)	6 (5.6)	5 (4.6)	6 (4.8)	6 (5.4)	6 (5.1)	6 (5.0)	6 (5.2)
I would prefer a contract that ties (indexes) the biomass sale price to the price of the biorefinery's output (e.g., ethanol, biodiesel, etc.).	5 (3.9)	5 (4.5)	4 (3.7)	5 (4.2)	4 (3.5)	4 (3.9)	5 (3.7)	4 ; 5 (4.2)
I would prefer a contract that ties (indexes) the biomass sale price to the price of major inputs such as fertilizer, fuel, or some other energy price index.	5 (4.4)	5 (5.2)	5 (4.9)	5 (4.5)	5 (5.1)	5 (4.9)	5 (4.8)	5 (4.9)
I would prefer a contract that provides quality premiums and discounts for the biomass I sell to a biorefinery or processor.	5 (4.4)	4 ; 6 (4.6)	4 (4.1)	5 (4.4)	5 (4.6)	5 (4.3)	5 (4.3)	5 (4.4)
I would prefer a contract that provides a minimum price guarantee for the biomass delivered to the bio-refinery or processor.	6 (5.1)	6 (4.9)	5 (4.9)	6 (4.6)	5 (5.0)	5 (4.9)	5 (5.0)	6 (4.8)
I would prefer a contract that requires a minimum biomass tonnage requirement be delivered to the biorefinery or processor.	1 (2.3)	1 (2.8)	2 (2.6)	4 (3.0)	2 (2.3)	2 (2.8)	2 (2.4)	2 (2.8)
I am willing to store biomass bales on my farm for longer than 6 months under contract.	4 (3.4)	2 (3.0)	2 (3.3)	4 (3.4)	2 (3.0)	1 (2.9)	2 (3.2)	4 (3.1)
I would be willing to invest in a biomass refining facility.	4 (2.8)	2 (2.5)	1 (2.8)	1 (2.0)	2 (2.4)	1 (2.1)	1 (2.7)	1 (2.2)
I would prefer to enter into a contract where payment is made when the biomass is delivered to the refinery rather than being paid immediately after harvest.	2 ; 4 (3.1)	5 (3.4)	4 (3.5)	4 (3.5)	2 (3.0)	4 (2.8)	4 (3.2)	4 (3.2)

[a] One (1) equals strongly disagree and six (6) equals strongly agree. In some cases, more than one answer was chosen most often. Therefore all relevant answers are reported. The average of the responses is reported in parentheses.
[b] WTG is willing to grow.