2009 Kansas Wheat District Seminars

What to Consider with Cellulosic Biomass Harvest

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A Decision Making Model for Cellulosic Biomass Contracts

- Effort funded by Kansas Wheat-KAWG
  - K-State, Oklahoma State & NRCS working together
- **Purpose**: To develop a biomass contract sales decision making model for Farmers
  - To help Kansas Farmers determine whether it is profitable to sell their crop biomass on contract for cellulosic ethanol production

Key Biomass Contract Issues

- Allowable Crop Residue Removal (NRCS)
  - Prevention of Wind & Water Erosion
- Biomass Contract Income, Terms (Company)
- Farmer's Baling-Handling-Storage Costs
- Crop Nutrient Losses from Biomass Harvest
- (Potential) Soil Moisture Losses from Residue Cover Removal ⇨ Yield/$ Losses
- Other: In-Field Storage Area, Carbon Trading...

A Partial Budget Approach to Economic Decisions:

Benefits Less Costs = Profitability

Benefits	Costs
A. Revenue *Increases*	C. Revenue *Decreases*
B. Cost *Decreases*	D. Cost *Increases*
Total Benefits (A + B)	Total Costs (C + D)

Biomass Contract Specifications

Abengoa Contract Terms, January 2009

1-Time Signup bonus	$1.00 /acre
Yearly Biomass Reservation Payment	$0.50 /acre
Biomass Contract Base Payment	$2.00 /acre
Biomass Production Payment (option)	$5.00 /ton
Nutrient Removal Replacement (option)	$8.00 /ton
Residue baled & removed by Company (option)	

A. Revenue *Increases*

- Biomass Acreage Payments:
  - Signup Payment: $1.00 /acre
  - Annual Reservation Payments: $0.50 /acre
- Biomass Base Contract Payment $2.00 /acre
- Biomass Production Payment $5.00 /ton
- Compensation for Crop Nutrient Removal
  - @ Estimated Replacement Cost $8.00 /ton
- In-Field Storage Site & Carbon Credit Payments?

B. Cost *Decreases*

- In-Field Baled Biomass Storage Site (?)
  - Effect of non-producing acres used for in-field storage would be "*prorated*" over all acres from which biomass was harvested
  - Decreased crop expenses: $/acre

C. Revenue *Decreases*

- Wind & Water Erosion ⇨ Yield Effects
  - NRCS determines allowable biomass harvest
  - Impact accumulates over time $/acre
- Soil Moisture Depletion Caused by Crop Residue Removal ⇨ Crop Yield Effects
  - ⇩ Crop Income from soil moisture loss $/acre
- In-Field Storage Site Crop Losses $/acre
- Carbon Credits (undefined) $/acre

D. Cost *Increases*

- Farmer's Biomass Harvest, Baling & Handling Costs
  - Farmer vs Contractor responsibilities for biomass harvest-handling operations $/acre
- Crop Nutrient Replacement Costs
  - ⇧ Fertilizer costs to replace nutrients lost in crop stover/biomass removal $/acre
- In-Field Storage Site Preparation Cost $/acre

Biomass Production

- **Figuring Crop Stover Production**

  Crop Yield (bushels per acre)

  x Crop Weight (pounds per bushel)

  x Stover Production Efficiency (lb stover / lb grain)

  = Stover Production (pounds per acre)

- **Stover Production Efficiency**
  - Corn & Milo: 1.00 lb Stover / lb Feedgrain
  - Wheat: 1.67 lb Stover / lb Wheat
  - Soybeans: 0.75 lb Stover / lb Soybeans

Biomass Production Estimates

	Corn (Irrig)	**Wheat**	**Milo** (Irrig)
Crop Yield (bu/ac)	200 bu	45 bu	125 bu
Test Weight (lb/bu)	56 lb	60 lb	56 lb
Stover Prdn. Efficiency (lb. Stover / lb. Grain)	1.00	1.67	1.00
Pounds of Stover (lb/acre)	11,200	4,500	7,000
Tons of Stover (tons/acre)	5.6 t	2.25 t	3.5 t

Corn Stover for Biomass Harvest

200 bu Irrig., 1.00 Stover Production Efficiency

Scenario	Residue Production lbs/acre	Residue Harvested lbs/acre	Residue Harvested tons/acre	Residue Remaining %
A	11,200	1,000	0.50 ton	91 %
B	11,200	2,000	1.00 ton	82 %
C	11,200	3,000	1.50 ton	73 %
D	11,200	4,000	2.00 ton	64 %
E	11,200	5,000	2.50 ton	55 %

Wheat Straw for Biomass Harvest

45 bu, 1.67 Stover Production Efficiency

Scenario	Residue Production lbs/acre	Residue Harvested lbs/acre	Residue Harvested tons/acre	Residue Remaining %
A	4,500	500	0.25 ton	89 %
B	4,500	1,000	0.50 ton	78 %
C	4,500	1,500	0.75 ton	67 %
D	4,500	2,000	1.00 ton	56 %
E	4,500	2,500	1.25 ton	44 %

Milo Stover for Biomass Harvest

125 bu Irrig., 1.00 Stover Production Efficiency

Scenario	Residue Production lbs/acre	Residue Harvested lbs/acre	Residue Harvested tons/acre	Residue Remaining %
A	7,000	500	0.25 ton	93 %
B	7,000	1,000	0.50 ton	86 %
C	7,000	1,500	0.75 ton	79 %
D	7,000	2,000	1.00 ton	71 %
E	7,000	2,500	1.25 ton	64 %

Crop Nutrients Removed from Biomass Harvest

Crop Nutrient	Corn/Milo Lbs /ton of stover	Wheat Lbs /ton of stover	Soybean Lbs /ton of stover
Nitrogen (N)	17 lb	11 lb	17 lb
Phosphorous (P_2O_5)	4 lb	3 lb	3 lb
Potassium (K_2O)	50 lb	15 lb	13 lb
Sulfur (S)	3 lb	2 lb	2 lb

Value of Removed N & P_2O_5

82-0-0 @ $650/ton, 11-52-0 @ $510/ton

	Residue Removal Rates	
Crop	1 Lg Sq Bale 1,659 lb / acre	2 Lg Sq Bales 3,318 lb / acre
Corn & Milo $6.86 / ton of stover	$5.69 / acre	$11.38 / acre
Wheat $4.56 / ton of stover	$3.79 / acre	$7.57 / acre

Farmers' Stover Harvesting, Handling & Storage Costs

- In-Field Operations
  - Chopping Stalks ?
  - Raking Stover ?
  - Swathing Stover?
  - Baling (Large Square vs Large Round Bales) ?
  - Hauling to edge of the Field ?
  - Short-term Storage of Bales at edge of Field ?
- Custom Rates Used for Cost Estimates

Crop Yield Losses from Decreased Soil Moisture

- In Grain Producing Stages of Growth, 1 inch of available water produces…
  - 12 bu. of **Corn** per acre
  - 11 bu. of **Grain Sorghum (Milo)** per acre
  - 5 bu. of **Wheat** per acre
- $Value of 1 inch H_2O in deficit conditions
  - **Corn:** **$42 /acre** @ $3.50 /bu.
  - **Milo:** **$35 /acre** @ $3.15 /bu
  - **Wheat:** **$25 /acre** @ $5.00 /bu.

3 Irrigation Moisture-Yield Scenarios

1) **Excess Irrigation Capacity**
   - Crop residue provides no benefit to crops in suppressing soil water losses
2) **Increased Irrigation Application**
   - Crop residue saves water, reducing irrigation needs ⇨ No effect on Yields
3) **Deficit Soil Water Supplies**
   - Crop water needs exceed soil moisture plus irrigation ⇨ Lower Yields

Irrigation Moisture-Yield Impacts

$ Impact of "Increased" & "Deficit" Scenarios

2) **"Increased Irrigation" Scenario**
   - **$Impact =** Cost to applied added water

     $5.80/acre inch of water (KSU pumping cost est.)
     x Inches per acre of additional water applied
3) **"Deficit Soil Water" Scenario**
   - **$Impact =** $Value of lost crop production

     Deficit Water (inches/acre water deficit)
     x Yield response (bushels/acre/inch of water)
     x Crop Price ($/bushel)

2 Dryland Moisture-Yield Scenarios

1) **Adequate Soil Moisture**
   - Crop residue provides no benefit to crops in suppressing soil water losses

2) **Deficit Soil Moisture Supplies**
   - Crop water needs exceed soil moisture reserves plus rainfall ⇨ Lower Yields

Dryland Moisture-Yield Impacts

$ Impact of "Adequate" & "Deficit" Scenarios

1) **"Adequate Moisture" Scenario**
   - **No $Impact of Crop Residue removal**

2) **"Deficit Soil Water" Scenario**
   - **$Impact =** $Value of lost crop production

     Deficit Water (inches/acre water deficit)

     x Yield response (bushels/acre/inch of water)

     x Crop Price ($/bushel)

Irrigated Corn Stover Scenario

Assumptions

- **Center Pivot System** (125 acres of corn)
- **Yields**: 200 bushels/acre
- **Corn$**: $3.50 /bushel
- **Farmer Operation**: Raking of stover only
- "Increased Irrigation" Scenario: +1 acre inch
- **Harvested Stover** (2 Scenarios)
  - 1 Lg Sq Bale / acre (0.83 tons stover /acre)
  - 2 Lg Sq Bales / acre (1.66 tons stover /acre)

Irrigated Corn Stover Scenario #1

Preliminary results: 1 Lg Sq Bale (0.83 tons) / acre

Benefits	**Costs**
A. Revenues *Increases* Reservation Payment $2.50 /a Biomass Payment $4.15 /a Nutrient Compensation $6.64 /a	**C. Revenue *Decreases*** Crop Yield Losses (1" H_2O) $5.80 /a Storage Site Income loss $0.36 /a
B. Cost *Decreases*	**D. Cost *Increases*** Harvest, handling, etc. $4.21 /a Nutrient Replacement $5.69 /a
Total Benefits: $13.28 /a	Total Costs: $16.06 /a

Net: ($3.28) /acre

Irrigated Corn Stover Scenario #2

Preliminary results: 2 Lg Sq Bale (1.66 tons) / acre

Benefits	Costs
A. Revenues *Increases*	**C. Revenue *Decreases***
Reservation Payment $2.50 /a	Crop Yield Losses (1" H_2O) $5.80 /a
Biomass Payment $8.29 /a	Storage Site Income loss $0.36 /a
Nutrient Compensation $13.27 /a	
B. Cost *Decreases*	**D. Cost *Increases***
	Harvest, handling, etc. $4.21 /a
	Nutrient Replacement $11.38 /a
Total Benefits: $24.07 /a	Total Costs: $21.75 /a

Net: +$2.32 /acre

Dryland Wheat Straw Scenario

Assumptions

- **Nonirrigated Quarter** (160 acres of wheat)
- **Yields**: 45 bushels/acre
- **Corn$**: $5.00 /bushel
- **Farmer Operation**: Raking of straw only
- "Deficit Water" Scenario: (-1) acre inch
- **Harvested Straw** (2 Scenarios)
  - 0.5 Lg Sq Bale / acre (0.41 tons straw /ac)
  - 1.0 Lg Sq Bales / acre (0.83 tons straw /ac)

Dryland Wheat Straw Scenario #1

Preliminary results: 0.5 Lg Sq Bale (0.41 tons) / ac

Benefits	Costs
A. Revenues *Increases*	**C. Revenue *Decreases***
Reservation Payment $2.50 /a	Crop Yield Losses (1" H_2O) $25.00 /a
Biomass Payment $2.07 /a	Storage Site Income loss $0.36 /a
Nutrient Compensation $3.32 /a	
B. Cost *Decreases*	**D. Cost *Increases***
	Harvest, handling, etc. $4.21 /a
	Nutrient Replacement $1.89 /a
Total Benefits: $7.89 /a	Total Costs: $31.48 /a

Net: ($23.57) /acre

Dryland Wheat Straw Scenario #2

Preliminary results: 1.0 Lg Sq Bale (0.83 tons) / ac

Benefits	Costs
A. Revenues *Increases*	**C. Revenue *Decreases***
Reservation Payment $2.50 /a	Crop Yield Losses (1" H_2O) $25.00 /a
Biomass Payment $4.15 /a	Storage Site Income loss $0.36 /a
Nutrient Compensation $6.64 /a	
B. Cost *Decreases*	**D. Cost *Increases***
	Harvest, handling, etc. $4.21 /a
	Nutrient Replacement $3.79 /a
Total Benefits: $13.28 /a	Total Costs: $33.36 /a

Net: ($20.07) /acre

Irrigated Milo Stover Scenario
Assumptions

- **Center Pivot System** (125 acres of milo)
- **Yields**: 125 bushels/acre
- **Corn$**: $3.15 /bushel
- **Farmer Operation**: Raking of stover only
- "Increased Irrigation" Scenario: +1 acre inch
- **Harvested Stover** (2 Scenarios)
  - 0.5 Lg Sq Bale / acre (0.41 tons stover /ac)
  - 1.5 Lg Sq Bales / acre (1.24 tons stover /ac)

Irrigated Milo Stover Scenario #1
Preliminary results: 0.5 Lg Sq Bale (0.41 tons) / ac

Benefits	Costs
A. Revenues *Increases* Reservation Payment $2.50 /a Biomass Payment $2.07 /a Nutrient Compensation $3.32 /a	**C. Revenue *Decreases*** Crop Yield Losses (1" H_2O) $5.80 /a Storage Site Income loss $0.36 /a
B. Cost *Decreases*	**D. Cost *Increases*** Harvest, handling, etc. $4.21 /a Nutrient Replacement $5.69 /a
Total Benefits: $7.89 /a	Total Costs: $16.06 /a

Net: ($8.17) / acre

Irrigated Milo Stover Scenario #2
Preliminary results: 1.5 Lg Sq Bale (1.24 tons) / ac

Benefits	Costs
A. Revenues *Increases* Reservation Payment $2.50 /a Biomass Payment $6.22 /a Nutrient Compensation $9.95 /a	**C. Revenue *Decreases*** Crop Yield Losses (1" H_2O) $5.80 /a Storage Site Income loss $0.36 /a
B. Cost *Decreases*	**D. Cost *Increases*** Harvest, handling, etc. $4.21 /a Nutrient Replacement $11.38 /a
Total Benefits: $18.67 /a	Total Costs: $21.75 /a

Net: ($3.07) / acre

A Continuing Process...

- Decision Model completed by June 30, 2009
- Team Effort
  - K-State Research and Extension Staff
    - Troy Dumler – Ext. Ag Economist @ SW Kansas
    - Ron Madl – Director of BIVAP @ K-State
    - Norm Klocke – Irrigation Engineer @ SW Kansas
    - Deann Presley – Soil & Environmental Agronomist
    - Michael Langemeier – Agricultural Economist
  - Natural Resource Conservation Service (NRCS)
  - Oklahoma State University

Questions???

Comments???

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