Guidelines for Estimating
Wheat Straw Biomass Production Costs

2016

Average Crop Residue Zone in Manitoba
Guidelines for Estimating
Wheat Straw Biomass Production Costs
Average Crop Residue Zone

Date: January, 2016

The following budgets are estimates of the cost of producing wheat straw biomass in Manitoba. General Manitoba Agriculture, Food and Rural Development (MAFRD) recommendations are assumed in using fertilizers and chemical inputs. These figures provide an economic evaluation of wheat straw biomass and estimated prices required to cover all costs. Costs include labour, investment and depreciation, but do not include management costs, nor do they necessarily represent the average cost of production in Manitoba.

These budgets may be adjusted by putting in your own figures. As a producer you are encouraged to calculate your own costs of production for various crops. On each farm, costs and yields differ due to soil type, climate and agronomic practices.

This tool is available as an Excel worksheet at: www.manitoba.ca/agriculture or at your local MAFRD GO The Farm Machinery Custom and Rental Rate Guide is also available to help determine machinery costs.

*Average Crop Residue generally refers to areas of Manitoba outside of the Red River Valley where farmers manage crop residue with minimum tillage practices. Producers should use the publication that best corresponds to their farming practices and soil type.

Note: This budget is only a guide and is not intended as an in-depth study of the cost of production of this industry. Interpretation and use of this information is the responsibility of the user. If you need help with a budget, contact your local MAFRD GO Office.
### Wheat Straw Biomass Cost of Production Summary - January, 2016

**Based on 600 Acres - 45 bu grain yield and 1.13 tons straw per acre**

<table>
<thead>
<tr>
<th>A. Operating Costs</th>
<th>$/acre</th>
<th>$/ton</th>
<th>Your Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.01 Estimated Net Nutrient Value</td>
<td>$17.27</td>
<td>$15.28</td>
<td></td>
</tr>
<tr>
<td>1.02 Custom Baling</td>
<td>$23.91</td>
<td>$21.16</td>
<td></td>
</tr>
<tr>
<td>1.03 Custom Field Moving</td>
<td>$7.53</td>
<td>$6.66</td>
<td></td>
</tr>
<tr>
<td>1.04 Custom Hauling</td>
<td>$2.03</td>
<td>$1.80</td>
<td></td>
</tr>
<tr>
<td>1.05 Repairs &amp; Maintenance</td>
<td>$0.30</td>
<td>$0.27</td>
<td></td>
</tr>
<tr>
<td>1.06 Miscellaneous</td>
<td>$2.50</td>
<td>$2.21</td>
<td></td>
</tr>
<tr>
<td><strong>Sub-total Operating Cost</strong></td>
<td><strong>$53.54</strong></td>
<td><strong>$47.38</strong></td>
<td></td>
</tr>
<tr>
<td>1.07 Interest on Operating</td>
<td>$1.47</td>
<td>$1.30</td>
<td></td>
</tr>
<tr>
<td><strong>Total Operating Costs</strong></td>
<td><strong>$55.01</strong></td>
<td><strong>$48.68</strong></td>
<td></td>
</tr>
</tbody>
</table>

**B. Fixed Costs**

<table>
<thead>
<tr>
<th>2.0 Depreciation</th>
<th>$/</th>
<th>$/</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.01 Storage</td>
<td>$5.00</td>
<td>$4.42</td>
</tr>
</tbody>
</table>

**Total Fixed Costs**

<table>
<thead>
<tr>
<th>3.0 Investment</th>
<th>$/</th>
<th>$/</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.01 Storage</td>
<td>$0.30</td>
<td>$0.27</td>
</tr>
<tr>
<td><strong>Total Fixed Costs</strong></td>
<td><strong>$5.30</strong></td>
<td><strong>$4.69</strong></td>
</tr>
</tbody>
</table>

**Total Cost of Production**

| $60.31 | $53.37 |

**Energy Cost Comparison**

<table>
<thead>
<tr>
<th>Per Million Btu</th>
<th>Per kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat Straw @ $61.37/ton</td>
<td>$6.88</td>
</tr>
<tr>
<td>Wheat Straw cubes @ $101.37/ton</td>
<td>$11.36</td>
</tr>
<tr>
<td>Coal-lignite @ $120/ton</td>
<td>$15.20</td>
</tr>
<tr>
<td>Wood Pellets @ $225/ton</td>
<td>$22.22</td>
</tr>
<tr>
<td>Oats - grain @ $3.10/bu</td>
<td>$19.45</td>
</tr>
<tr>
<td>Electricity @ $0.07672/kWh</td>
<td>$22.48</td>
</tr>
<tr>
<td>Natural gas high E @ $0.4370/cu.meter</td>
<td>$14.46</td>
</tr>
<tr>
<td>Natural gas low E @ $0.4370/cu.meter</td>
<td>$17.74</td>
</tr>
</tbody>
</table>

**Breakeven Biomass Value**

<table>
<thead>
<tr>
<th>Wheat Straw per Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal-lignite @ $120/ton</td>
</tr>
<tr>
<td>Wood Pellets @ $225/ton</td>
</tr>
<tr>
<td>Oats - grain @ $3.10/bu</td>
</tr>
<tr>
<td>Electricity @ $0.07672/kWh</td>
</tr>
<tr>
<td>Natural gas high E @ $0.4370/cu.meter</td>
</tr>
<tr>
<td>Natural gas low E @ $0.4370/cu.meter</td>
</tr>
</tbody>
</table>

Breakeven wheat straw $/ton = $ per million Btu x 8.9239 million Btu per ton wheat straw.

1. Est. Nutrient Value is based on 12.5lb.N@$0.53/lb, 4.1lb.P@$0.57/lb, 14lb.K@$0.38/lb, 2.5lb.S@$0.40/lb. per ton of straw minus $0.00 estimated residue management cost per acre.
2. The cost of custom baling is based on $9.52 per bale.
3. The cost of custom field moving of bales is based on $3.00 per bale.
4. The cost of custom hauling is based on $5.50/mile for 5 miles.
5. Total straw Cost of Production (COP) + 15% producer markup (risk, management and profit margin).
6. Total straw COP + 15% producer markup + $40.00/ton straw cube production cost.

**Disclaimer:** This budget is only a guide and is not intended as an in depth study of the cost of production of this industry. Interpretation and utilization of this information is the responsibility of the user.

Manitoba Agriculture, Food and Rural Development
## Wheat Straw Biomass Cost of Production Input Assumptions

### Land
| Total Acres | 600 acres |

### Producer Markup
(Risk, management, and profit margin)  
15%

### Nutrient Value (Fertilizer cost)

<table>
<thead>
<tr>
<th>Nutrient Value</th>
<th>Wheat</th>
<th>Straw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrient Value</td>
<td>$/lb</td>
<td>lbs/ton</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.528</td>
<td>12.5</td>
</tr>
<tr>
<td>Phosphate</td>
<td>0.568</td>
<td>4.1</td>
</tr>
<tr>
<td>Potassium</td>
<td>0.383</td>
<td>28.0</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.397</td>
<td>2.5</td>
</tr>
</tbody>
</table>

### Grain Production

| Wheat yield       | 45.0  |
| Straw to Grain Ratio | 1.30 S:G |
| Baled/Harvested Straw | 65% |

### Custom Rates

- Heavy harrow - custom rate ($/acre): $4.20 $/acre
- Average harrow passes per acre: 0 passes
- Deep tillage - custom rate ($/acre): $0.00 $/acre
- Baling - custom rate ($/bale): $9.52 $/bale
- Pickup, load, unload and stack - ($/bale): $3.00 $/bale
  - Average round bale weight (lbs): 900 lbs
  - Average bale moisture content: 11%
- Hauling - custom rate per loaded mile: $5.50 $/mile
- Hauling - average miles per load: 5 miles
- Hauling - average bales per load: 34 bales

### Repairs & Maintenance

- % rate of investment: 2%

### Miscellaneous

- Miscellaneous Costs: $2.50 $/acre
- Straw chopper - diesel fuel: $0.00 $/acre
- Wheat straw cube production: $40.00 $/ton
- Average coal moisture content: 12%
- Wood pellet moisture content: 5%
- Oat grain moisture content: 12.5%

### Interest

- Interest on Operating: 5.50%
- Investment interest rate: 2.50%

### Energy Cost Comparisons

<table>
<thead>
<tr>
<th>Energy Cost</th>
<th>Cost per unit</th>
<th>Btu per unit</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat straw - dry basis</td>
<td>$53.37</td>
<td>ton</td>
<td>7,713 lb.</td>
</tr>
<tr>
<td>Electricity residential rate</td>
<td>$0.07672</td>
<td>kWhr</td>
<td>3,413 kWh</td>
</tr>
<tr>
<td>Coal - lignite</td>
<td>$120</td>
<td>ton</td>
<td>6,900 lb.</td>
</tr>
<tr>
<td>Wood pellets</td>
<td>$225</td>
<td>ton</td>
<td>8,200 lb.</td>
</tr>
<tr>
<td>Oats (grain - 34 lb. bushel)</td>
<td>$3.10</td>
<td>bushel</td>
<td>8,242 lb.</td>
</tr>
<tr>
<td>Natural gas - high efficiency</td>
<td>$0.437</td>
<td>m³</td>
<td>32,844 m³</td>
</tr>
<tr>
<td>Natural gas - low efficiency</td>
<td>$0.437</td>
<td>m³</td>
<td>32,844 m³</td>
</tr>
</tbody>
</table>

### Capital Costs

<table>
<thead>
<tr>
<th>Capital Costs</th>
<th>Biomass</th>
<th>Useful</th>
<th>Salvage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Investment</td>
<td>$15</td>
<td>3</td>
<td>0%</td>
</tr>
<tr>
<td>Market Value</td>
<td>$9,000</td>
<td>100%</td>
<td>$9,000</td>
</tr>
<tr>
<td>Allocated to Biomass</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Capital Investment</td>
<td>$9,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Manitoba Agriculture, Food and Rural Development
### Assumptions

1. Assumed a total of 600 acres of wheat straw biomass.
2. Assumed an average yield of 1.13 tons per acre.
3. Assumed a 15% producer markup per ton of straw.
4. Straw value is based on net nutrient value per acre.
5. Machinery and equipment costs for the wheat straw biomass enterprise are based on custom rates. Storage facilities were valued at $9,000 in total.
6. The budget is based on a round bale production system with outside storage.

### Wheat Straw Biomass Cost of Production Worksheet

<table>
<thead>
<tr>
<th>A. Operating Costs</th>
<th>Your Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.01 Estimated Net Nutrient Value</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Nitrogen</strong></td>
<td></td>
</tr>
<tr>
<td>12.5 lbs/ton straw</td>
<td></td>
</tr>
<tr>
<td>1.00 straw nutrient value</td>
<td></td>
</tr>
<tr>
<td>$0.53 cost/lb</td>
<td></td>
</tr>
<tr>
<td>$6.60 $/ton</td>
<td></td>
</tr>
<tr>
<td><strong>P₂O₅</strong></td>
<td></td>
</tr>
<tr>
<td>4.1 lbs/ton straw</td>
<td></td>
</tr>
<tr>
<td>1.00 straw nutrient value</td>
<td></td>
</tr>
<tr>
<td>$0.57 cost/lb</td>
<td></td>
</tr>
<tr>
<td>$2.33 $/ton</td>
<td></td>
</tr>
<tr>
<td><strong>K₂O</strong></td>
<td></td>
</tr>
<tr>
<td>28 lbs/ton straw</td>
<td></td>
</tr>
<tr>
<td>0.50 straw nutrient value</td>
<td></td>
</tr>
<tr>
<td>$0.383 cost/lb</td>
<td></td>
</tr>
<tr>
<td>$5.36 $/ton</td>
<td></td>
</tr>
<tr>
<td><strong>Sulfur</strong></td>
<td></td>
</tr>
<tr>
<td>3 lbs/ton straw</td>
<td></td>
</tr>
<tr>
<td>1.00 straw nutrient value</td>
<td></td>
</tr>
<tr>
<td>$0.40 cost/lb</td>
<td></td>
</tr>
<tr>
<td>$0.99 $/ton</td>
<td></td>
</tr>
</tbody>
</table>

**Subtotal** = $15.28 $/ton estimated nutrient value

**Estimated straw nutrient value per acre** = $17.27

- $4.20 heavy harrow per acre
- 0.0 passes per acre
- $0.00 deep tillage per acre
+ $0.00 straw chopper - diesel fuel per acre

**Estimated residue management per acre** = $0.00

**Total** = $17.27 Estimated Net Nutrient Value per Acre

**Wheat Yield**

- 45.0 bu/acre
- 36.744 bu/tonne

**Estimated straw nutrient value per acre** = 1.22 tonnes per acre

**Straw Yield**

- 1.30 straw to grain ratio

Manitoba Agriculture, Food and Rural Development
0.65 baled/harvested straw
\times 1.34 \text{ tons grain per acre} = 1.13 \text{ tons straw per acre}
\times 600 \text{ acres} = 678 \text{ tons of straw produced}

1.02 Custom Baling Costs
1.1 \text{ tons straw per acre} \times 2000 \text{ lbs/ton} \div 900 \text{ bale weight (lbs)} \times \$9.52 /\text{bale} = \$23.91 /\text{acre}

1.03 Custom Field Moving Costs
Pick up, load, unload & stack
1.1 \text{ tons straw per acre} \times 2000 \text{ lbs/ton} \div 900 \text{ bale weight (lbs)} \times \$3.00 /\text{bale} = \$7.53 /\text{acre}

1.04 Custom Hauling Costs
5 miles per load
\$5.50 /\text{mile} \times 34 \text{ bales/load} \times 900 \text{ bale weight (lbs)} \times 1.1 \text{ tons/acre} \times \$1.80 /\text{ton} = \$2.03 /\text{acre}

1.05 Repairs & Maintenance
2.0% percentage rate \times \$15 \text{ investment/acre} = \$0.30 /\text{acre}

1.06 Miscellaneous
\$2.50 /\text{acre}

1.07 Interest on operating costs
\$53.54 \text{ subtotal operating} \div 2 \text{ average} \times 5.5\% \text{ interest rate} = \$1.47 /\text{acre}

\begin{tabular}{|c|c|c|}
\hline
\textbf{Capital Costs} & \textbf{Market Value} & \textbf{% Allocated to Biomass} & \textbf{Allocated Biomass} \\
\hline
Storage & \$9,000 & 100\% & \$9,000 \\
\hline
Total Capital Investment & \$9,000 & & \$9,000 \\
\hline
\end{tabular}

*Investment in straw biomass includes storage.
B. Fixed Costs
   2. Depreciation
      2.01 Storage
         $9,000 storage investment
         - $0 salvage value
         ÷ 3 years useful life
         ÷ 600 acres
         = $5.00 $/acre

3. Investment
   3.01 Storage
      $9,000 storage investment
      + $0 salvage value
      ÷ 2 average
      ÷ 600 acres
      x 4.0% investment rate
      = $0.30 $/acre

C. Energy Cost Comparison
   4.01 Wheat Straw
      7,713 Btu per pound
      x 0.89 dry matter content
      = 6,864.57 Btu per pound (as received)
      x 2,000 Pounds per ton
      = 13,729,140 Total Btu per ton
      x 65% Heat Efficiency
      = 8,923,941 Net Btu per ton
      $53.37 Cost of Production per ton
      x 15% Producer Margin
      = $61.37 Cost per ton
      ÷ 8,923,941 Million Btu per ton
      = $0.0235 per kWh

   4.02 Wheat Straw Cubes
      7,713 Btu per pound
      x 0.89 dry matter content
      = 6,864.57 Btu per pound (as received)
      x 2,000 Pounds per ton
      = 13,729,140 Total Btu per ton
      x 65% Heat Efficiency
      = 8,923,941 Net Btu per ton
      $53.37 Cost of Production per ton
      x 15% Producer Margin
      + $40.00 Wheat Straw cube production per ton
      = $101.37 Cost per ton
      ÷ 8,923,941 Million Btu per ton
      = $11.36 per Million Btu

      8,923,941 Net Btu per ton
Guidelines: Wheat Straw Biomass Production Costs

\[
\begin{align*}
\text{4.03 Coal - Lignite} & \quad 6,900 \text{ Btu per pound} \\
& \times 0.88 \text{ dry matter content} \\
& = 6,072.00 \text{ Btu per pound (as received)} \\
& \times 2,000 \text{ Pounds per ton} \\
& = 12,144,000 \text{ Total Btu per ton} \\
& \times 65\% \text{ Heat Efficiency} \\
& = 7,893,600 \text{ Net Btu per ton} \\
& \div 7.8936 \text{ Million Btu per ton} \\
& = 15.20 \text{ per Million Btu} \\
\text{4.04 Wood Pellets} & \quad 8,200 \text{ Btu per pound} \\
& \times 0.95 \text{ dry matter content} \\
& = 7,790.00 \text{ Btu per pound (as received)} \\
& \times 2,000 \text{ Pounds per ton} \\
& = 15,580,000 \text{ Total Btu per ton} \\
& \times 65\% \text{ Heat Efficiency} \\
& = 10,127,000 \text{ Net Btu per ton} \\
& \div 10.1270 \text{ Million Btu per ton} \\
& = 22.22 \text{ per Million Btu} \\
\text{4.05 Oats - grain} & \quad 8,242 \text{ Btu per pound} \\
& \times 0.88 \text{ dry matter content} \\
& = 7,211.75 \text{ Btu per pound (as received)} \\
& \times 2,000 \text{ Pounds per ton} \\
& = 14,423,500 \text{ Total Btu per ton} \\
& \times 65\% \text{ Heat Efficiency} \\
& = 9,375,275 \text{ Net Btu per ton} \\
& \div 9.3753 \text{ Million Btu per ton} \\
& = 225.00 \text{ Cost per ton} \\
& \div 3.413 \text{ Btu per kWh} \\
& = 66.80 \text{ kWh per ton} \\
& \div 2,614.69 \text{ kWh per ton} \\
& = 0.0388 \text{ per kWh} \\
\end{align*}
\]
$19.45 \text{ per Million Btu}

\[
\begin{align*}
9,375,275 \text{ Net Btu per ton} & \div 3,413 \text{ Btu per kWh} \\
= & 2,746.93 \text{ kWh per ton} \\
\end{align*}
\]

\[
\begin{align*}
\$182.35 \text{ Cost per ton} & \div 2,746.93 \text{ kWh per ton} \\
= & \$0.0664 \text{ per kWh} \\
\end{align*}
\]

$0.0767 \text{ per kWh}

\[
\begin{align*}
4.06 \text{ Electricity} & \times 1.00 \text{ Million Btu} \\
\end{align*}
\]

$22.48 \text{ per Million Btu}

$0.0494 \text{ per kWh}

\[
\begin{align*}
32,844 \text{ Btu per cubic meter} & \times 92\% \text{ Heat Efficiency} \\
= & 30,216 \text{ Net Btu per cubic meter} \\
\end{align*}
\]

$0.437 \text{ Cost per cubic meter}

\[
\begin{align*}
4.07 \text{ Natural Gas -High Efficiency} & \times 1.00 \text{ Million Btu} \\
\end{align*}
\]

$14.46 \text{ per Million Btu}

$0.0605 \text{ per kWh}

\[
\begin{align*}
32,844 \text{ Btu per cubic meter} & \times 75\% \text{ Heat Efficiency} \\
= & 24,633 \text{ Net Btu per cubic meter} \\
\end{align*}
\]

$0.437 \text{ Cost per cubic meter}

\[
\begin{align*}
4.08 \text{ Natural Gas -Low Efficiency} & \times 1.00 \text{ Million Btu} \\
\end{align*}
\]

$17.74 \text{ per Million Btu}

$0.0605 \text{ per kWh}
For more information

- Contact your local Manitoba Agriculture, Food and Rural Development (MAFRD) Growing Opportunities (GO) Office.
- Visit us at manitoba.ca/agriculture.