Economics of Transgenic Sugarbeet Production
Paul A. Burgener, Dillon M. Feuz, and Robert G. Wilson

Sugarbeets were grown on more than 66,000 acres in Nebraska in 1999, generating in excess of $40 million in cash receipts for agricultural producers. This represents nearly 12 percent of the total cash receipts from crop production in Northwest Nebraska. Establishment of a weed-free stand is critical to sugarbeet production. Several systems have been used to achieve this goal. Hand weeding, mechanical cultivation, preplant herbicide application, and postemergence herbicide application have all been used alone or in combinations for weed control in sugarbeet production systems. Recent development of transgenic sugarbeets with Roundup Ready® or Liberty Link® technology presents another potential tool for weed control in sugarbeet production.

Transgenic sugarbeets have received government approval, but remain to be approved by sugar processors due to concerns about consumer acceptability of processed sugar from these varieties. Recent concerns from many consumers, both domestic and foreign, have influenced the acceptance of new transgenic crops. The market for transgenic crops has changed rapidly during the past two years, and continue to evolve with little information available on the expected final outcomes.

At the present rate of growth in world sugar consumption the world will need an additional 25 million tons of sugar by 2010, roughly a 20 percent increase (Duff, 1999). This increase will come from fewer acres of prime agricultural land if population continues to grow. The lower acreage in combination with increased demand for production will
require that productivity of the land will need to increase. One of the ways to meet these needs is to allow the use of new technologies, including transgenic sugarbeets.

The economic rationale for transgenic sugarbeets is also very strong. According to Duff (1999), over the past 40 years real sugar prices have fallen by between 1.5 and 2.0 percent per year (Figure 1). Production costs, on a per pound of sugar basis, have fallen at nearly the same pace allowing this industry to continue to be profitable (Figure 1). Much of the drop in production costs can be attributed to increases in productivity and changing technology. Real sugar prices are projected to continue to fall, consequently sugarbeet producers will need access to new technologies to remain competitive with other crop options available to them. The transgenic sugarbeet has the potential to give sugarbeet
producers another tool for reducing costs, creating a significant economic incentive to approve this technology.

From a farmer’s viewpoint, the success of transgenic sugarbeets will be measured by its profitability as it is with any new technology. This study will address the differences in production costs, yield response, percent sucrose in the beets, and finally the profitability of transgenic sugarbeets for producers. The present postemergence weed control technology will be compared to both Roundup Ready® and Liberty Link® technology and evaluated to determine the difference in economic returns for each strategy leading to determination of the most economical herbicide program for sugarbeet production in the Nebraska Panhandle.

Materials and Methods

Field experiments were conducted near Scottsbluff and Mitchell, Nebraska, during the 1997, 1998, and 1999 growing seasons. The sugarbeets were treated with the appropriate labeled postemergence chemical regime based on the type of seed planted in each plot (Table 1). Standard production practices were used for all field operations and furrow irrigation practices were used.

Several varieties of sugarbeets were planted each year in a randomized complete block design with six replications at each site. Individual plots were six rows wide by 30 feet long. Sugarbeets were harvested in late September to allow root samples to be analyzed in the Western Sugar tare laboratory prior to normal harvest. Transgenic (Roundup Ready® and Liberty Link®) and non-transgenic varieties were planted at each
site, and evaluated for yield, percent sucrose and sucrose loss to molasses at harvest each year.

Table 1. Herbicide treatments and corresponding costs for each treatment.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate&lt;sup&gt;a&lt;/sup&gt; (lb/acre)</th>
<th>Application Cost ($/acre)</th>
<th>Herbicide Cost ($/acre)</th>
<th>Total Cost&lt;sup&gt;d&lt;/sup&gt; ($/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Betamix + Upbeet&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.33 + 0.16</td>
<td>8.00</td>
<td>74.50</td>
<td>82.50</td>
</tr>
<tr>
<td>Roundup Ultra&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.75</td>
<td>8.00</td>
<td>20.63</td>
<td>28.63</td>
</tr>
<tr>
<td>Liberty&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.27</td>
<td>12.00</td>
<td>54.27</td>
<td>66.27</td>
</tr>
</tbody>
</table>

<sup>a</sup> Rates are for a single treatment.
<sup>b</sup> Betamix + Upbeet plots and Roundup Ultra plots were treated twice.
<sup>c</sup> Liberty plots were treated three times.
<sup>d</sup> Costs are for all treatments.

Gross returns are calculated for each plot based on the present Western Sugar grower contract payment schedule. Price per ton is determined using an average net return for sugar of $23.00 per hundredweight and the percent sucrose for each plot as determined by the tare laboratory analysis. Estimated clean root yield in tons is multiplied by the price per ton of sugarbeets to determine the gross return for each plot. Cost of production for each plot was determined using the 1999 Nebraska Crop Budgets (Selley, et. al., 1999) as the basis for production costs. In addition, cost for each herbicide treatment were calculated and included in the costs (Table 1). Custom hauling costs were also adjusted based on the gross root yield for each plot. The base costs, herbicide treatment cost, and hauling costs were combined to determine the cost of production for
each plot. The costs of production are subtracted from gross returns to determine the return to investment and management (net return) for each plot.

Evaluation of clean root yield, percent sucrose, loss to molasses, gross return and net return was completed using analysis of variance. The Proc Mixed procedure in SAS® was used to estimate means and differences for each of the factors evaluated. Varieties were combined to allow for evaluation by herbicide treatment reducing the number of treatments to three for each site and year. Estimates of treatment means and differences between treatment means were evaluated for significance and are reported.

Results

Evaluation of the results from this study require that production factors be considered in addition to economic evaluation. Results for clean root yield, percent sucrose, and loss to molasses will be discussed prior to discussion of gross returns and net returns. The production results are used to develop the economic values.

Production Values

Estimated clean root yields were calculated using the gross root yields as measured in the field at harvest minus the average percent tare for the Wester Sugar processing facility in Scottsbluff, Nebraska. The factory average tares are 7.74 percent in 1997, 7.01 percent in 1998, and 7.26 percent in 1999. Producer payments are based on the tons of sugarbeets delivered minus the percent tare determined by samples evaluated in the Western Sugar tare laboratory. The samples from this study were not evaluated for tare at the laboratory, however an adjustment for tare is important in determining the payable
yield. An adjustment for the factory average tare was determined to be the most accurate system to estimate a payable yield. Root yield results for each herbicide treatment are presented in table 2. Yield for both the Roundup Ready® and Liberty Link® beets was significantly greater than the Betamix + Upbeet control.

Table 2. Expected means for root yield, percent sucrose, and loss to molasses.

<table>
<thead>
<tr>
<th>Herbicide Treatment</th>
<th>Clean Root Yield (Tons/Acre)</th>
<th>Percent Sucrose (%)</th>
<th>Loss to Molasses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Betamix + Upbeet</td>
<td>22.74</td>
<td>14.53</td>
<td>1.29</td>
</tr>
<tr>
<td>Roundup Ready®</td>
<td>25.02*</td>
<td>14.24*</td>
<td>1.37*</td>
</tr>
<tr>
<td>Liberty Link®</td>
<td>25.92*</td>
<td>14.90*</td>
<td>1.25</td>
</tr>
</tbody>
</table>

* Result is significantly different from the Betamix + Upbeet treatment at the .05 level.

The Western Sugar grower contract determines the price per ton paid to the grower based on the percent sucrose in the sugarbeets delivered. Higher percent sucrose results in a higher price per ton paid for the crop. There are potential trade-off considerations if increases in tonnage are achieved at the expense of percent sucrose. As shown in table 2, the percent sucrose remains within 0.66 percent from highest (Liberty Link®) to the lowest (Roundup Ready®) for this study. These differences are statistically different.

In addition to the percent sucrose values, the value for sucrose loss to molasses are an important factor for both producers and processors to consider. The sugar processor under the present contract absorbs all loss to molasses, and is interested in maintaining low
losses. In the future, grower contracts may be written that move more of the responsibility of sucrose loss to molasses to the grower by paying for actual pounds of recoverable sucrose delivered. In either case, the concern with any new technology is that loss to molasses does not increase significantly. In this study, loss to molasses values remain nearly constant over all three treatments (Table 2). However, the Roundup Ready® treatment did have a statistically significant increase in sucrose loss to molasses.

Economic Returns

Any new technology must be considered profitable before producers will be willing to adopt the practice on a large scale. If the profitability of the technology can be proven over time, the technology is likely to become an industry standard. Use of transgenic sugarbeets is not accepted at the present time, however the economic value of this technology has not been documented for producer and sugar processor consideration.

The gross return values for transgenic sugarbeets are significantly higher than the non-transgenic varieties (Table 3). The increases in yield presented previously coupled with constant percent sucrose values results in gross return increases of $49.34 to $136.11 per acre for Roundup Ready® and Liberty Link® sugarbeets respectively. These return are directly related to the increase of 2.28 to 3.18 tons per acre for the transgenic varieties. This increase in root yield times the expected prices ranging from $30.00 to $45.00 per ton result in the differences in gross return.

The net return as defined in this study is return to investment in machinery and land plus the return to operator management. Net return is determined by subtracting
operating costs, depreciation, property taxes, herbicide and application costs, and custom hauling costs from the previously determined gross return values. The operating costs, depreciation, and property taxes are constant among all observations, while the herbicide and application cost varies by herbicide treatment. The hauling costs are variable for each observation, because they are charged on a per ton basis and will vary with the root yield delivered to the receiving station. For this portion of the study, sugarbeet seed cost is handled as a constant price over both transgenic and non-transgenic treatments. The net return value for transgenic treatments will need to be adjusted for the corresponding technology fee associated with the type of seed used.

Table 3. Expected means for gross return and net return for transgenic and non-transgenic sugarbeets.

<table>
<thead>
<tr>
<th>Herbicide Treatment</th>
<th>Gross Return ($/Acre)</th>
<th>Net Return ($/Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Betamix + Upbeet</td>
<td>772.12</td>
<td>248.93</td>
</tr>
<tr>
<td>Roundup Ready®</td>
<td>821.47**</td>
<td>349.48*</td>
</tr>
<tr>
<td>Liberty Link®</td>
<td>908.23*</td>
<td>395.05*</td>
</tr>
</tbody>
</table>

* Result is significantly different from the Betamix + Upbeet treatment at the .05 level.
** Result is significantly different from the Betamix + Upbeet treatment at the .10 level.

Net returns are significantly higher for the transgenic varieties than for the non-transgenic sugarbeets. This is consistent with the increase in root yield presented in table 2, in addition to the decrease in cost of herbicide treatment presented in table 1. With increase in gross return and lower costs of production, the resulting increase in net return
ranges from an increase of $100.56 per acre for Roundup Ready® to $146.12 for Liberty Link® sugarbeets over the non-transgenic varieties (Table 3).

**Allocation of Increased Net Returns**

The increased net returns from adoption of transgenic sugarbeet technology can be attributed to two factors; 1) the increased production and in at least one case, the increased percent sucrose, and 2) the herbicide cost savings associated with the use of transgenic sugarbeets. Figure 2 shows the breakdown of the increased returns. The Roundup Ready® sugarbeets show nearly equal proportion of the increased return coming from production improvement and herbicide cost savings. For the Liberty Link® crop, the increase in net return is nearly 90 percent production benefit and slightly over 10 percent herbicide cost savings.

![Figure 2](image)

**Figure 2.** Amount of increased net return attributed to yield increase and herbicide savings with transgenic sugarbeet production.
Ability to Pay Technology Fee

For the crops presently being produced using transgenic seed, a technology fee has been assessed by the seed companies to recover the cost of development. For sugarbeet seed, it is expected that the same type of fee will be instituted when seed is available to the producer. At the present time the amount to be assessed for technology fees has not been announced by the seed companies. Figure 3 shows the affect that increasing levels of technology fees will have on the expected increased net returns from transgenic sugarbeets. The Roundup Ready® grower will be able to pay as much as $50.00 per acre and continue to maintain an adequate increase in net return to consider adoption of the technology. The Liberty Link® grower will be able to pay up to $80.00 per acre before the technology is no longer cost effective.

Figure 3. Effects of technology fees on the increase in net returns from the adoption of transgenic sugarbeets.
Conclusions

The results presented suggest that root yield increases under the transgenic production systems without significant changes in percent sucrose or sucrose loss to molasses. The transgenic varieties do not experience the crop injury that is present using the traditional postemergence herbicide treatments. Without this injury, the root yield is positively influenced by the transgenic system. With the increase in yield, producers have potential gains in gross returns per acre, allowing for the potential of additional production income.

The corresponding cost of herbicide treatment is significantly lower using the herbicides available with the transgenic treatments. The lower cost of production, when combined with the increases in yield, present a significant economic benefit to producers. The difference between transgenic and non-transgenic returns are large enough to influence producers to move toward adoption of the technology when or if the technology is made available to the production system. The production of transgenic sugarbeets has the potential to increase profits to producers if the technology fee charged for the seed is not set at a level that captures all of the increased profits for the seed companies.

As with any new technology, this system should be used in conjunction with the present cropping system in place for the individual farm. Widespread adoption will be determined by the technology fee to be charged for the seed and the potential to increase returns after paying the fee. The benefits of transgenic sugarbeet varieties must be considered in relation to any increase in potential damage from other pest and disease
problems that transgenic varieties may have limited resistance to.

Acceptance of the transgenic sugarbeet varieties will be influenced by the potential of sugar processors to move the final product into the market. The majority of sugarbeet production is destined for the domestic market, reducing the effect of concerns that have recently surfaced from the European Union (Duff, 1999). For transgenic sugarbeets to be accepted in the United States, the consumer must be confident that the sugar produced is a wholesome product with no health risk. If consumers will accept the product, there will be significant interest in production of herbicide tolerant sugarbeets to reduce production costs.

References


