

## Abstract

Field studies were conducted on a farm in northwest Wyoming to compare variable-rate fertilization (VRF) with uniform-rate fertilization (URF) of sugar beets. Results from this study failed to show an economic advantage from VRF compared to URF, implying producers should be very cautious to adopt VRF technology, unless field fertility needs are highly variable.

## Precision Fertilization of Wyoming Sugar Beets: A Case Study

By Sully Taulealea, Larry J. Held, Bart Stevens, and Edward Bradley

### Introduction

It should be recognized that this analysis of variable rate fertility is simply a case study concerning one crop (sugar beets) grown in one region of the country (northwest Wyoming). This research may be useful for not only analyzing Variable-Rate Fertilization of Wyoming sugar beets, but could also offer insight for producers of other high-value cash crops in general.



**Sully R. Taulealea** is a former graduate research assistant at the University of Wyoming. He received his B.S. in Agriculture from the University of the South Pacific in Western Samoa (1997); a M.S. in Agricultural Economics from the University Wyoming (2004); and a second M.S. in International Studies from the University Wyoming (2005).

**Larry J. Held** is professor of Agricultural and Applied Economics at the University of Wyoming. He received his B.S. degree (1971) and M.S. degree (1973) in Agricultural Economics from North Dakota State University; and his Ph.D. degree in Agricultural Economics from the University of Nebraska (1977).

**Bart Stevens** is a Research Agronomist with the U.S.D.A. Agricultural Research Service at Sidney, Montana; and formerly was a soil scientist at the University of Wyoming Powell Research & Extension Center with research focused on variable rate technology. He received his B.S. degree in Crop Science (1991) and M.S. degree in Plant Nutrition from Brigham Young University (1993); and his Ph.D. degree in Soil Fertility from the University of Illinois (1997).

**Edward Bradley** is associate professor of Agricultural and Applied Economics at the University of Wyoming. He received his B.S. degree in Agricultural Economics (1971) from the University of Wisconsin and his Ph.D. in Agricultural Economics (1978) from the Pennsylvania State University.

In a review of studies examining the profitability of VRF of various crops, Swinton and Loowenberg-DeBoer (p. 442) report that “VR fertilization of wheat and barley was not profitable, the results for corn were mixed, and VR fertilization of sugar beets was profitable.” Furthermore they suggest that “Anecdotal evidence indicates that VR technology is also likely to be profitable on other higher-value field crops (e.g., potatoes, popcorn, and hybrid seed-corn.” Therefore results of this study may be applicable to a range of other “high value” field-crops besides sugar beets. Sugar beets are grown in 11 states nationwide.<sup>1</sup> Sugar beets are a “high-value” cash crop.<sup>2</sup>

### Objective

The purpose of this article is to compare the profitability of VRF with uniform-rate fertilization (URF) in producing sugar beets.

### Data and Methods

Field studies were conducted in 2001 and 2002 on a cooperator’s farm in northwest Wyoming at three different sites. Site #1 (4.9 acres) was evaluated in 2001; Site #2 (5.4 acres) and Site # 3 (6.7 acres) were evaluated in 2002. Soils, climatic conditions, and farming practices varied little among the sites. They were part of the same farm, in the same soil series (Garland clay loam), and sugar beets were irrigated in the same way. Sugar beets at each site were planted, irrigated, and harvested at the same times of year and in an identical manner. Climatic conditions in 2001 vs. 2002 were very similar. Any observed differences between VRF and URF should not be attributed to differences in soil types, production practices, or different climatic conditions between 2001 and 2002.

Treatments at each site included VRF at a recommended rate of N application vs. URF at a recommended rate of N. URF applications were based on a field-average soil test results. In contrast, VRF applications were calculated at separate grid points using precision farming technology.

A net return value per acre was computed for each treatment by subtracting a selected set of variable costs (SVC) from a per acre gross return value. SVC includes only those costs which are different between VRF and URF treatments including: (1) sampling and mapping at \$27 per acre; (2) application and material costs; and (3) custom harvesting cost at a rate of (\$5

per ton) for sugar beets (Hewlett, 2000). Custom harvesting will be higher for higher yielding treatments, and lower for lower yielding treatments.<sup>3</sup>

Gross return for VRF and URF treatments represents the product of sugar beet yield (tons/acre) and price (\$/ton). Sugar beet price is based on percent sugar content and wholesale sugar price, as specified in a current Western Sugar Company contract (Taulealea, 2003).

### Results

Table 1 shows that performance of VRF was very inconsistent compared to URF in terms of sugar beet yields, prices, and net returns.

Specifically, VRF sugar beet yields were slightly higher at all three sites, by only very narrow margins (less than one ton per acre). Although VRF sugar beet prices were slightly higher than URF prices at one site, the converse was actually true at two other sites.

Because of the inconsistent price and yield advantages between VRF and URF treatments, a consistent net return advantage between VRF and URF treatments was not observed. Specifically, only a narrow net return advantage from VRF vs. URF was found at two of the three sites. At another site (#2), the net return margin from the VRF treatment was actually worse (-\$4/acre) than the corresponding URF treatment.

Table 1 also shows the amount of N applied (lbs./ acre) was very similar between VRF and URF treatments at all sites, perhaps indicating that there was not a great amount of variation in terms of N fertility needs within these fields.

### Discussion

Swinton and Loowenberg-DeBoer (p.442) noted that “VR fertilization of sugar beets was profitable.” However, results from this study do not present a strong case for implementing VRF for sugar beets.

Why did VRF in this case fail to show consistent net return advantage over URF? Swinton and Loowenberg-DeBoer note that, “In theory, [site specific farming] SSF should have a greater benefit in areas where soil variability is greater” (p.

444). Because soils were very similar within the three study sites, it is very possible that N fertility needs were not different enough within these study sites to warrant the extra cost of implementing VRF. It should be noted that applications of N were nearly the same between VRF and UFR at each of the study sites.

By way of comparison, an earlier study reported in the *Journal*, concerning precision application of nematicide for sugar beet nematodes proved to be profitable for Wyoming sugar beets, compared to uniform blanket applications of nematicide (Held, et al., 2003). There are two fundamental differences between the variable rate fertility study considered here, and the former variable rate nematicide study. First, compared to the cost of N, nematicide is a relatively expensive input (costing up to \$150 per acre), and second, perhaps even more important is the high degree of field variability needing nematicide treatments compared to within field variability of N. The success of employing variable rate nematicide was largely due to the fact that nematode populations are rarely distributed evenly over a field, but are highly variable, and located in scattered clusters across a field. N fertility needs at the three study sites, appeared to be evenly distributed.

Results based on only three data points limit the basis for drawing more definite conclusions. Yet, if limited N variability is a primary cause for marginal VRF performance in this case, these results may have broader implications concerning other crops (besides sugar beets grown in Wyoming). More research would be desirable to determine if small variations in N fertility are typical for better than average farmland used for producing high value crops. In spite of limited data points, these results imply that VRF benefits could be very marginal or ineffective for a wide range of crops when limited N variability is the case.

A major implication from this study is that crop producers should consider adoption of VRF with a great deal of caution, especially if they would rather err on the side of not adopting an unproven and unprofitable practice as opposed to implementing a losing practice. The reason for this caution could generally apply not only to sugar beets production, but also for other crops as well. Unless there is good reason for a farmer to believe that N fertility needs are extremely variable within his fields, VRF will not be worth the extra cost, to improve profitability.

## End Notes

<sup>1</sup> Sugar beets are an important crop, nationally. They are grown in 11 states (U.S.D.A., NASS, 2006), including: California = 44,000 acres, Colorado = 364,000 acres, Idaho = 160,000 acres, Michigan = 154,000 acres, Minnesota = 491,000 acres, Montana = 539,000 acres, Nebraska = 484,000 acres, North Dakota = 255,000 acres, Oregon = 10,000 acres, Washington = 8,000 acres, and Wyoming = 362,000 acres.

<sup>2</sup> Hewlett, et al., (1995) reveals sugar beets have the potential to generate gross incomes above \$900 per acre, but are also expensive to grow. Variable production inputs such as planting, harvesting, fertilizer, herbicide, and other pesticides can exceed \$500 per acre.

<sup>3</sup> For example if one treatment generates a higher sugar beet yield, than another treatment, e.g., 20 ton/acre vs. 10 ton /acre. Then it follows: (20 ton/ acre yield x \$5/ ton custom rate) = \$100/ acre harvest cost, vs. (10 ton/ acre yield x \$5/ ton custom rate) = \$50/ acre harvest cost).

## References

- Held, L.J., T.J. Opp, D.W. Koch, F.A. Gray, and J.W. Flake, 2003. "Profitability of variable rate nematicide for Sugar beets". *Journal of the American Society of Farm Managers and Rural Appraisers*: 74-93.
- Hewlett, J.P., J. Jenkins, and P. Burgener, 1995, "Crop Enterprise Budget, Sugar beets". University of Wyoming Bulletin M.P. 723.
- Hewlett, J.P. 2000. "Custom rates for Wyoming farm and ranch operations". University of Wyoming Ext. Bulletin 1084.
- Swinton, S.M., and J. Lowenberg –DeBoer. 1998. "Evaluating the profitability of site specific farming." *Journal of Production Agriculture*", 11,W :439-46.
- Taulealea, S.L. 2003. "Economics of variable rate vs. uniform rate fertilization with Wyoming sugar beet." M.S. Thesis, University of Wyoming.
- United States Department of Agriculture, 2006. National Agricultural Statistics Service. "Quick Stats (Sugar Beets)." December.

Table 1. Sugar beet yields, prices, N applied and net return: VRF treatment vs. URF treatment at three study sites

Study Sites <sup>a/</sup>	Yields ton/ac	Prices \$/ton	N applied lbs./ac	Net Return <sup>b</sup> \$/ac
Site #1(URF)	17.5 t	\$43.54	190#	\$618
Site #1(VRF)	17.8 t	\$43.45	180#	\$641
<b>VRF advantage #1</b>	<b>+0.3 t</b>	<b>-\$0.09</b>	<b>-10#</b>	<b>+\$23</b>
Site#2(URF)	21.9 t	\$43.31	253#	\$772
Site#2(VRF)	22.8 t	\$41.92	251#	\$768
<b>VRF advantage #2</b>	<b>+0.9 t</b>	<b>-\$1.39</b>	<b>-2#</b>	<b>-\$4</b>
Site #3(URF)	19.9 t	\$41.66	239#	\$661
Site #3(VRF)	20.6 t	\$43.75	239#	\$726
<b>VRF advantage #3</b>	<b>+0.7 t</b>	<b>+\$2.09</b>	<b>0#</b>	<b>+\$65</b>

<sup>a/</sup>Field trials were conducted on a farm in Northwest Wyoming, during the 2001 and 2002 growing seasons: Site #1 (4.9 acre field in 2001), Site #2 (5.4 acre field in 2002), and Site #3 (6.7 acre field in 2002).

<sup>b</sup> Net Return in this study represents return over specified variable costs, or only those costs which are different between VRF and URF treatments. Therefore, Net Return as used here is not a true measure of the profitability of growing sugar beets, and as shown here Net Return would overstate the true profitability of growing sugar beets.