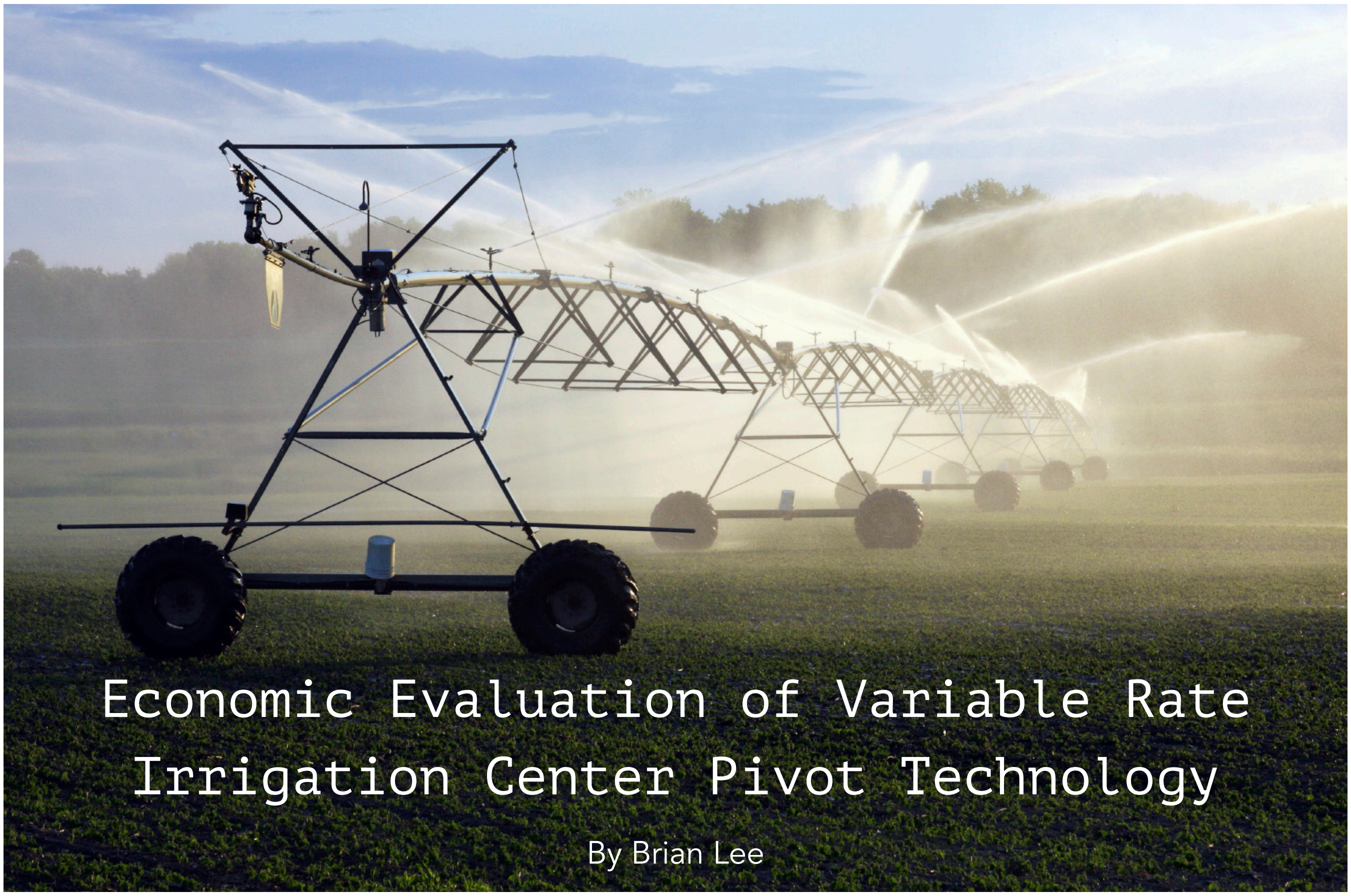

Economic Evaluation of Variable Rate Irrigation Center Pivot Technology

By Brian Lee

Variable Rate Irrigation (VRI) is a relatively new technology in agriculture that has the potential to become an integral part of precision farming systems. VRI systems are attached to center pivot irrigation sprinklers, and allow producers to save resources, time, and money. The systems allow for the more accurate application of irrigation water within an agricultural field. The system uses an electrical conductivity (EC) map to determine maximum water holding capability of areas within the field. As the center pivot covers the field, water application varies each section of the field. This technology allows for variable, and more efficient, irrigation similar to already established types of precision agriculture such as fertilizer application.

The motivation behind VRI is the desire of agriculture producers to raise crops more efficiently. There are numerous benefits to a VRI system. The first is the ability to apply water to a field more accurately, ultimately producing a crop with less water waste. Some benefits associated with VRI, but beyond simply efficiently applying water, are that less nitrogen will leach out of the soil and erosion will be minimized due to less run-off. Another positive outcome is the economic benefit of cost savings from using less energy to apply the water to the field. This outcome is due to the need to pump less water. A VRI system theoretically should allow a producer to realize both of these benefits.

For the purpose of this research; however, only energy savings from pumping fewer gallons of water will be taken into consideration. No readily available onsite data exists to consider biological or soil benefits that may result from this technology. The Sustainable Agriculture Research and Extension Center (SAREC) in Lingle, Wyoming, installed a VRI system on a 67-acre half-circle pivot in May of 2014. The 67-acre area was previously under gravity irrigation that contains a very steep grade on about half of the field. This field was selected for the VRI system because of its water run off potential and steep grade. The pivot runs off of its own well that is roughly 40 feet deep.

No irrigation systems in the area were accessible to be used for comparison. Therefore, breakeven energy savings and returns needed over a range of kilowatt hour values and useful life values will be calculated. The bid cost to retrofit a 7 tower 67-acre pivot is $29,513 dollars. (Valley Irrigation, 2014). A VRI system is assumed to have a useful life of approximately 15 years (Lu et al., 2003) with periodic maintenance.

RESULTS

A system costing $29,513 dollars for a 67-acre pivot, considering a $100 maintenance cost every five years with a 15-year useful life will have to have a return of $2,167.60 per year compared to an average pivot. Again, remember this return can be in the form of energy savings, additional yield, and runoff control. Numbers listed below in Example 1 show a range of returns required given the useful life of the VRI system is five years less or five years more than 15. The values in Example 1 do not consider a maintenance cost.

EXAMPLE 1. RETURN NEEDED FOR RANGE OF USEFUL LIFE.

If a VRI system useful life is 10 years, the annual return required to pay for the system would be $2,951. If the useful life is 15 years, the associated annual return required would be $1,967.60. Lastly, if the useful life is determined to be 20 years, the associated annual return required would be $1,475.65.

Few studies have been conducted that actually return a dollar amount that is associated with cost savings of a VRI system over irrigating when one part of a field needs it. One such study out of New Zealand suggests that producers could save NZ$51 to NZ$151 per hectare, per year with a VRI system. (Hedley et al., 2010). This equates to $13.76 to $40.47 US dollars per acre. This information will be used as a base to evaluate such a system in Wyoming. The New Zealand study was conducted from 2004 to 2008, it also concluded that water savings ranged from eight percent to 21 percent over their test sites.

For a 67-acre pivot in Wyoming, the cost savings according to Hedley et al., could range anywhere from $921.92 to $2,711.49 per year. This range is partially within our dollars of annual return needed over the useful life of the system. So what would the NPV of such a system be, assuming the associated returns? The median of that range is $1,816.71, so let's start there. With this average yearly return for a 67-acre pivot, the payback would be 16.25 years. The associated discounted Net annual savings for the average cost over the life of the VRI system is $29,703.12. This is assuming a two percent discount rate and a 20-year useful life of the VRI system. This means if the VRI system averaged a savings of $27.12/acre over the next 20 years, the investment is worth $29,703 dollars to us today. The initial cost of the system we figured to be $29,513, so, $29,703.12-$29,513.00= NPV $190. Again, remember this was assuming we had an average return per acre. A positive net present value means this would be a good investment all things considered.

Price for kWh can vary greatly year to year which will play a large part in determining cost savings for irrigation. Also, as mentioned before, there are many other positive biological benefits to the systems that can be hard to quantify. More information and research is needed to determine more accurately all of the savings involved with this technology. As mentioned before, there are benefits derived from reducing erosion and also nutrient leaching from applying the correct amount of water. Also, intuition would suggest that agricultural producers could produce a healthier crop from not over or under watering in parts of the field. These benefits are hard to quantify and therefore need some more research.