Irrigation Adoption in Central North Dakota: a real options approach

Dr. Ryan Larsen
North Dakota State University
Ryan.larsen@ndsu.edu

Dr. David Ripplinger
North Dakota State University
David.ripplinger@ndsu.edu

Selected Poster prepared for presentation at the
2015 Agricultural & Applied Economics Association and Western Agricultural Economics Association
Joint Annual Meeting, San Francisco, CA, July 26-28

Irrigation Adoption in Central North Dakota: a real options approach

Dr. Ryan Larsen & Dr. David Ripplinger

North Dakota State University

Introduction

Agricultural economists have studied irrigation extensively. Irrigation research topics have ranged from the value of water to profitability and economic impacts. Droughts in certain regions of the United States and expansion of irrigated acres provide motivation to continue researching the economics of irrigation. While the general economic methods used remain relevant, changes in prices, crop rotations and yields, production practices, government programs, and the natural climate have almost certainly altered the results. In addition, developments in the measurement of risk on investment decisions can now be used to better understand potential returns to individual producers and the public. Recently researchers have begun to analyze the investment/disinvestment in irrigation using real options (Seo et al., 2008).

The focus of this research is to estimate the option value of investing in irrigation in Central North Dakota using Real Options. There are two key reasons that Central North Dakota provides an interesting area to study. First, advances in corn and soybean technology have changed the cropping patterns of the region. The traditional rotation consisted of malt barley, Durum wheat, field peas, sunflowers, and other small grains. Improvements in corn and soybean seed technology have reduced the risk of growing these crops in this region. Advances in seed technology has not been the only motivation to change crop rotation. Favorable corn and soybean prices have provided additional incentives to increase acreage. Secondly, Central North Dakota is traditionally a non-irrigated production region. The construction of the Garrison Diversion presented farmers with the option to irrigate their crops. Previous studies have addressed the issues of farm-level returns to expanded irrigation as well as regional economic impacts (Ihli et al, 2012). Knowledge of these studies helps inform decision makers. However, changes in technology, policy, and climate have changed returns to dryland and irrigated production.

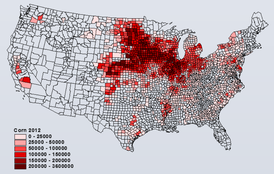
Objectives

Traditional net present value results will be compared with option values estimated via real options framework. The results will provide insight into managerial strategy and the profitability of irrigation in Central North Dakota. The comparison of results should also encourage discussion concerning the methods used to analyze capital investments and applicability of real options in other scenarios. This approach to analyzing irrigation investments should generate discussion concerning capital investment analysis and its application to future technology investments made by farmers.

Methods and Data

Capital budgeting methods are well suited for analyzing irrigation investments. Irrigations systems require a significant initial outlay followed by projected increase in future returns. The profitability of the irrigation system is then estimated by subtracting the sum of discounted future returns from the initial capital outlay. Although helpful for understanding the profitability of an investment, this type of estimation provides no managerial flexibility associated with the investment. Real options methodology provides a method to add flexibility to the traditional capital budgeting framework.

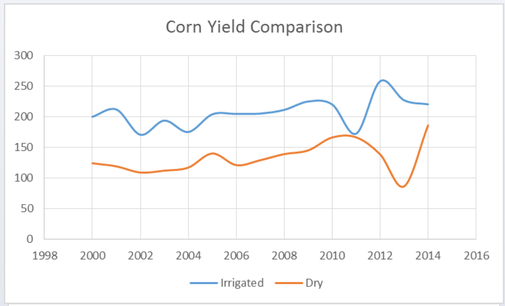
The Real Options framework establishes a correspondence between the characteristics of the project and a call option. Analyzing a project using this correspondence provides more information than capital budgeting analysis. In certain production regions irrigation is necessary to produce a crop. Irrigation in central ND provides an example of an area that is adding irrigation but is not a necessity for production. Depending on weather patterns and crop, an irrigation system's use will vary from year to year. Real Options provide a method to estimate the option value of investing in irrigation.

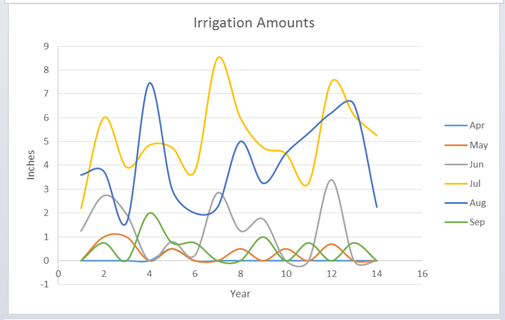


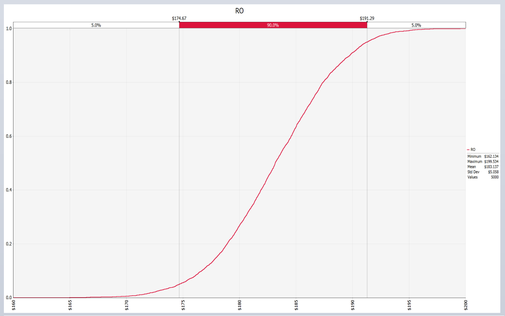
Data

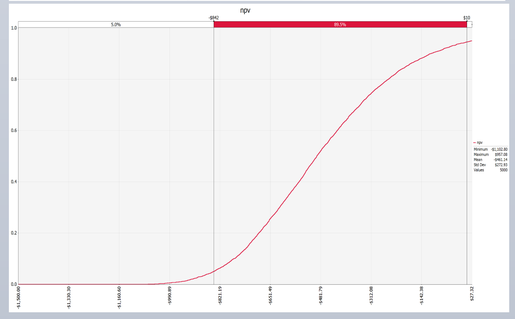
The analysis relies on expected input and crop prices, and crop yields. The USDA Farm Service Agency acres planted by crop data are used to identify representative crop rotations. The 2014 crop budgets from North Dakota State University are used when possible as they provide both the data and structure for much of the required analysis. Use of these numbers provides farmers and other decision-makers consistent values to consider. Two resources are relied on: the projected 2014 crop budgets for north central North Dakota and the projected budgets for irrigated crops for central North Dakota. Because the methods used to construct the budgets differ, prices from the North Central Crop Budget are used in the Irrigated Crop Budget to assure consistency throughout this analysis. Some values, such as fertilizer costs are rescaled based on targeted yields. Trial yields for dryland hard red spring wheat (HRS), canola, and soybean from the North Central (Minot) Research Extension Center (NCREC) and irrigated corn, dry bean and spring wheat from the Carrington Research Extension Center (CREC) were used to model variations in dryland and irrigated yields and returns. Data from the NCREC are used as it has a more arid climate than Carrington and may be more representative of the area along the McClusky Canal. Carrington irrigated corn, dry bean, and wheat data are used because no irrigated trials were conducted at Minot.

Results









Conclusions

Adoption in Central North Dakota is relatively new and little research has been done to analyze the investment of irrigation. This study analyzed investment in irrigation using the traditional NPV and a Real Options. Approach. The NPV assumes that the farmer has no flexibility. The expected NPV was estimated to be -$461/acre. This illustrates that irrigation is not a profitable investment based on NPV decision criteria. The Real Options approach estimated the option value of irrigation to be $174.55/acre. This illustrates the flexibility of the farmer to use the irrigation or abandon the irrigation project. Combining the option value with the NPV, still results in a negative NPV thus implying that the investment in irrigation is not profitable.

One key downfall is that this research only assumes that corn is irrigated. Irrigation applied to higher value crops would change the NPV estimation. Central North Dakota is beginning to plant irrigated potatoes and sugar beets. The addition of these two crops should be incorporated into future research.

References

Ihli, Hanna Julia, Syster Christin Maart, and Oliver Musshoff. "Investment and Disinvestment in Irrigation Technology–An Experimental Analysis of Farmers' Decision Behavior–." *Agricultural & Applied Economics Association's 2012 AAEA Annual Meeting*. 2012.

Seo, Sangtaek, et al. "Irrigation technology adoption and its implication for water conservation in the Texas High Plains: a real options approach." *Agricultural Economics* 38.1 (2008): 47-55.

Contact

Dr. Ryan Larsen
Ryan.Larsen@ndsu.edu

Dr. David Ripplinger
David.Ripplinger@ndsu.edu