THE VALUE OF SOIL WATER AND WEATHER INFORMATION IN INCREASING IRRIGATION EFFICIENCY: A DISCUSSION

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The adoption of irrigation technology in the Upper Midwest as reported by Bosch and Eidman presents a challenging analytical case study of the interaction between risk, information and capital investments. The droughts of 1975-76 induced many corn and soybean producers to seriously consider the adoption of supplemental irrigation technology. The projection that by 1990 irrigation in Minnesota would represent 46% of total water consumption is surprising. Although this level falls far short of states like Arizona (75-80%), it still represents a sizable use of a limited resource, even in Minnesota. It should be pointed out that the predominant water source for irrigation is not necessarily groundwater as might be assumed by a Westerner like myself. Wilson and Eidman (1983b) point out that lakes, streams and sumps are also major sources of irrigation water in certain areas of Minnesota and represent a lower cost investment than the development of wells.

Risk, Information and Irrigation

The authors point out that supplemental irrigation traditionally has been considered as an investment which increases expected returns and reduces the variability of production. Research, especially on medium to coarse textured soils, has shown that yields can be augmented with irrigation while the distribution of irrigated production becomes more compact around the expected value. Although I would agree that irrigation reduces production or business risk, my experience suggests that supplemental irrigation or any major change in existing irrigation technology may substantially increase financial risk to the farm firm. Financial considerations take the form of principal and interest payments on the irrigation debt which must be covered by business cash flow. As risk analysts looking at new technologies in developed countries we have often overlooked the financial risk implications of new irrigation investments.

I also have difficulty concluding, as others have, that supplemental irrigation explains all the yield effect. My discussions with progressive irrigators in Minnesota and Arizona have revealed an increase in the management input on a field or fields with a new irrigation technology. Intensive management of water, fertilizer and pesticides has a synergistic yield effect which may be larger than the contribution of supplemental irrigation alone.

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Bosch and Eidman briefly review the literature on soil water and weather information and the impact improved information has on the firm's distribution of net returns. As I read this section of the paper the question of why more of this information augmenting technology is not adopted by the grower came to mind. Agricultural engineers and agronomists have invested countless person-years of time and financial resources into methods of scheduling irrigation. The checkbook method is a well-known irrigation management technique while tensionmeters, lysimeters and neutron probes are existing tools for measuring available soil water. However, most irrigators still prefer the #2 spade or shovel and visual evaluation as their irrigation management tools. Even in arid agricultural areas such as Arizona only the most progressive growers use soil probes to determine the timing of irrigations although significant amounts of money have been spent on land substitution/water conservation technologies such as laser leveling and drip irrigation (Daubert and Ayer; Wilson, Ayer and Snider).

The Conceptual Model

This paper presents a new application of generalized stochastic dominance (GSD) by using the technique to estimate the value of soil water and weather information. Traditionally, analysts have applied GSD to probability distributions of some performance indicator to obtain a dominant strategy or decision. Bosch and Eidman use the same technique but look at the value of information which stochastically equates the after-tax net returns of two alternative irrigation strategies.

Equation 5 is presented by the authors as a representation of after-tax net income. I question the appropriateness of expressing random variables without some mathematical notation indicating their variability. For example, taxes (T) are a function of previous years' and current year's income but this functional relationship is not evident in Equation 5. I would like to point out, in defense of the authors, that these functional relationships are briefly discussed later on in the paper and the reader is directed to an unpublished dissertation for more detail. I would like to see some of this detail incorporated into Equation 5 so the casual reader is not mislead regarding the complexity of the model.

The methodology for generating distributions of after-tax net income relies on historical data and a plant growth simulation model. The authors fail to discuss any validation of this model. In addition, I was not clear as to how the irrigation "triggering" decision was actually made and how this compared to actual irrigation decision making.

Risk Preference Selection and Analysis

Generalized stochastic dominance is used to compare distributions of after-tax net returns adjusted by various information cost levels. A range of Arrow-Pratt risk coefficients taken from Wilson and Eidman (1983a) is used to determine the value of soil water and weather information for individuals with different risk preferences. Bosch and Eidman express their results on a per acre basis for a corn/soybean operation. It would be interesting to compare the results from a whole-farm or enterprise perspective rather than on a per acre basis. Scale may influence the value of irrigation information for individuals with different risk preferences. In addition, the use of a risk function over several income levels rather than a single risk interval may produce greater insights into the value of information.

The authors' use of risk preference measures in their analysis of irrigation which were originally developed for swine producers raises some interesting questions. First, how do absolute risk aversion intervals for swine producers compare to those of corn/soybean producers who irrigate? Although there is some overlap in these sets of producers in the Midwest, I would hypothesize that their perceptions and responses to risk vary (Patrick). We could argue that most agricultural producers fall within a rather narrow Arrow-Pratt interval range (-.0002, .0003) so the actual interval selection is not important as long as the selected range encompasses these empirically determined values. A review of the literature lends support to this narrow range hypothesis (Wilson). Recently, our profession has not actively pursued risk preference analysis and estimation. Possibly the returns to be gained from additional research in this area are overwhelmed by the theoretical and empirical obstacles in elicitation work.

Bosch and Eidman's results generate productive grist for the discussion mill. For example, their analysis shows that the value of soil water information is substantially higher for risk averse individuals than for their risk preferring colleagues. Does this imply that irrigators are risk preferers since they do not use this management technology or are they risk averse for having adopted irrigation technology in the first place? I believe there is an interaction between scale and risk in this adoption process. The irrigation system itself is expensive insurance against crop failure while better soil water information may be regarded more as an irritant than a management tool.

Taxes reduce the value of soil water and weather information to the irrigator according to Bosch and Eidman. They argue that "When the equity position is lowered, tax obligations fall and the differences between before and after-tax values of information decline." I would encourage the authors to clarify the relationship between net worth, income and tax liability. Presently, their statements imply a causal relationship between equity and tax obligations which understates the impact of income on both of these variables. In addition, there is a negative correlation between net worth and risk aversion which would place the low-equity individual at a higher level of risk aversion. This movement would also narrow the difference between the value of information for before and after-tax net incomes.

Adoption of Technology

An important contribution of the paper by Bosch and Eidman is the evaluation of the gains from the adoption of technology which improves managerial decision making. Their results give the normative result that risk averse agents will place a higher value on soil water information than risk taking individuals. In fact, information generated by the checkbook method is worth over $2,000 on an irrigated quarter section for the mildly risk averse individual. Positive economics leads me to question whether this is actually the case in the agricultural sector. Here is where I believe more research work can be productive. Technological adoption under conditions of uncertainty has received a significant amount of attention in the development literature (Feder, Just and Zilberman) but my perception is that we have not given this topic as much emphasis in domestic agriculture. As commercial agriculture becomes more industrialized, these types of adoption decisions will become more common and the successful operations will make the best decisions. The methodology using generalized stochastic dominance presented by Bosch and Eidman may be a means for evaluating how important the information technology generated by our university research programs is to the grower.

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