A COMPUTER DECISION AID FOR THE VRT INVESTMENT DECISION IN COTTON PRODUCTION

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Abstract

This article introduces the Variable Rate Technology (VRT) module for the Computer Precision Agriculture Investment Decision Aid (CPAIDA). CPAIDA is a stand alone, computerized decision tool for analyzing investments in precision agriculture technologies. This module was developed to meet the need for better educational information about the returns required to pay for investments in VRT systems for agricultural sprayers. The components of the decision aid are described, and use of the decision aid is illustrated with a case study for cotton production in West Tennessee.

Introduction

Cotton producers face a multitude of pre- and post-emergence input application decisions, involving herbicides, insecticides, plant growth regulators and harvest aids. Most of these inputs are applied on a repetitive basis, resulting in increased chemical and application costs. For example, the USDA reported an average chemical input cost of $107/acre for cotton production in the Mississippi portal region of the United States between 2003 and 2007 (USDA-ERS, 2007). VRT for self-propelled, boom-type agricultural sprayers may reduce these chemical and application costs. VRT helps producers identify input needs within a field, prescribe site-specific input application rates, and then apply those inputs as needed (Roberts, English, and Larson, 2006). In contrast, uniform rate technology (URT) is designed to maintain a constant application rate across the entire field. Results from a 2005 cotton precision farming survey conducted in 11 southern states indicated that 48% of respondents had adopted some form of precision farming technology (Roberts et al., 2006). Further increases in precision technology adoption by cotton producers are constrained by a lack of information about the returns required to pay for the ownership and information costs associated with VRT systems (English et al., 2006).

Objective

The objective of this research was to develop an interactive, computerized decision tool to aid cotton growers in evaluating the VRT investment decision. The decision tool is part of the Computer Precision Agriculture Investment Decision Aid (CPAIDA), a stand alone web-based tool for analyzing investments in precision agriculture technologies. The CPAIDA program was developed to meet the need for better educational information about the returns required to pay for investments in precision agriculture technologies.

The VRT Investment Decision Aid

The decision aid guides users through a systematic analysis of the VRT investment decision via a set of clickable tabs and expandable menu options:

Equipment Information. The equipment information tab allows the user to select VRT equipment components and enter purchase price. Required equipment includes the self-propelled sprayer, a variable rate controller-monitor, a global positioning system (GPS), and a personal computer with geographic information system (GIS) software. Optional equipment includes automatic boom control, automated guidance, and real-time kinematic (RTK) upgrades. Users can click on cells to change equipment manufacturers or modify prices.

Farm Data. The farm data screen lets users personalize information used in calculating equipment ownership costs and net returns. General farm information includes cotton and other crop area, lint yield and price, input prices, and the number annual passes across the field. Information-gathering costs include annual fees for subscription to a GPS signal provider and GIS software maintenance, and attending workshops or training on how to manage and analyze spatial VRT data. VRT payback parameters include input cost savings, lint yield gain, and reduced application costs through increased field speed or reduced boom overlap. Cost calculation factors include equipment lifetime, interest rate, salvage value, and the percent of equipment cost allocated to sprayer operations.

Profitability Summary. The profitability summary tab displays results in the form of enterprise budgets. The first column provides cost and return estimates for the URT scenario. The second column presents cost and return estimates for the identical sprayer equipped with VRT capabilities. The final column indicates which costs vary with the VRT investment decision and summarizes the expected profitability from switching from URT to VRT.

Sensitivity Analysis. The sensitivity analysis sheet displays results graphically. The main figure summarizes the profitability of the proposed VRT investment and provides an estimate of the payback period in years. Users can also perform sensitivity analysis on key parameters, such as farm size or input savings, to evaluate how small changes in values influence VRT profitability and time to payback.

Case Study: Cotton Production in Tennessee

We demonstrate how to use the decision tool by presenting an example analysis based on no-till cotton production in West Tennessee. The assumptions used in the case study were as follows:

- Farm area is based on a representative, medium-sized cotton farm in West Tennessee with 900 cotton acres and 1000 other crop acres (Tiller and Brown, 2002).
- Lint yield of 850 lbs/acre and price of $0.65/lb were from the University of Tennessee no-till cotton production budget with Bollgard II Roundup Ready Flex seed technology (Gerloff, 2008).
- VRT equipment components selected included a variable rate controller-monitor, GPS receiver and antenna, personal computer with GIS software, and custom installation.
- VRT equipment costs were from a price list published by Raven Technologies (Raven Industries, 2007).
- Equipment and information costs were allocated at 80% to sprayer operations.
- Information costs were $9/acre for aerial imaging services, $1/acre for custom mapping services, $800/year for subscription to a GPS signal network, $350/year for software maintenance, $700/year for training in spatial data analysis, and 10 hours of on-farm labor for data analysis and interpretation.
- Baseline annual URT input costs were $62.46/acre for herbicides, $29.00/acre for insecticides, $5.10/acre for growth regulators, and $6.60/acre for defoliants (Gerloff, 2008).
- Baseline values for the VRT payback variables were set at a 7% reduction in chemical input costs and no change in field speed or boom overlap. No increase in field speed or decrease in boom overlap was assumed.

Results

The net return to VRT equipment for the specified scenario was $2.68/acre (Fig. 1). Net return was positive because input savings ($9.16/acre) were sufficient to offset the increase in annualized equipment ownership costs ($0.88/acre), information collection costs ($3.89/acre), and other annual costs ($1.71) associated with retrofitting the sprayer with variable rate application and mapping capabilities (Fig. 1).

The VRT investment became profitable relative to URT after a period of 3.5 years (Fig. 2). This breakeven period in years was determined by the point where the present value of cost savings (solid black line) surpassed the present value of VRT investment and annual information costs (solid red line) (Fig. 2). Assuming a 900 acre cotton area and 9 annual passes across the field, the breakeven cotton area sprayed was 28,350 acres and the rate of return was 38% across the 10-year equipment lifetime. These results suggest that investments in VRT by producers with similar farm characteristics would be profitable given an average level of input savings of 7% or greater across the lifetime of the investment.

Per Acre Estimates	Unit	Uniform Rate (URT)	Variable Rate (VRT)	Change (URT to VRT)
1. Gross Revenue	$/Acre	552.50	552.50	0.00
2. Input Costs	$/Acre	130.85	121.69	-9.16
Herbicides	$/Acre	73.79	68.62	-5.17
Insecticides	$/Acre	40.00	37.20	-2.80
Growth Regulators	$/Acre	5.10	4.74	-0.36
Harvest Aides	$/Acre	11.96	11.12	-0.84
3. Sprayer Operating Costs	$/Acre	15.92	15.92	0.00
Repair and Maintenance	$/Acre	10.58	10.58	0.00
Fuel and Lubricants	$/Acre	4.19	4.19	0.00
Labor	$/Acre	1.16	1.16	0.00
4. Sprayer Ownership Costs	$/Acre	8.98	8.98	0.00
Depreciation and Interest	$/Acre	5.26	5.26	0.00
Taxes, Insurance, and Housing	$/Acre	3.72	3.72	0.00
5. VRT Equipment Ownership Costs	$/Acre	0.00	0.88	0.88
Control Console	$/Acre	0.00	0.74	0.74
GPS Receiver_Antenna	$/Acre	0.00	0.11	0.11
Guidance	$/Acre	0.00	0.00	0.00
Autoboom	$/Acre	0.00	0.00	0.00
Personal Computer	$/Acre	0.00	0.03	0.03
6. Information Collection Costs	$/Acre	2.00	5.89	3.89
Field Scouting	$/Acre	2.00	2.00	0.00
Aerial/Satellite Imaging	$/Acre	0.00	3.62	3.62
Prescription Mapping	$/Acre	0.00	0.20	0.20
Labor	$/Acre	0.00	0.06	0.06
7. Annual Costs	$/Acre	0.00	1.96	1.71
Foam Markers	$/Acre	0.02	0.00	-0.02
GPS Signal Subscription	$/Acre	0.00	1.12	1.12
Software Maintenance Fee	$/Acre	0.22	0.22	0.00
Data Analysis and Management Training	$/Acre	0.00	0.62	0.62
8. Net Return	$/Acre	394.75	397.18	2.68

Fig. 1. Screen showing the profitability summary for the VRT module in CPAIDA

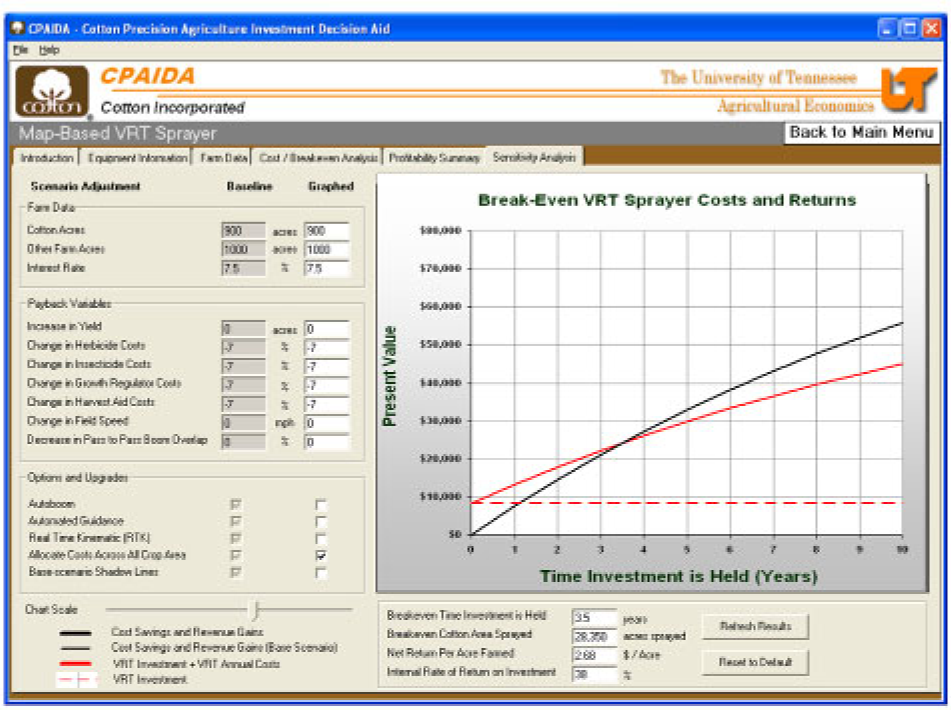

Fig. 2. Screen showing the sensitivity analysis tab for the VRT module of CPAIDA

Summary

This article describes an interactive computerized decision tool for evaluating investments in VRT for agricultural sprayers. The decision tool was designed to provide educational information about ownership costs and required returns to pay for map- and sensor-based VRT systems. An example investment analysis was presented for a medium-sized cotton farm in West Tennessee to demonstrate how the decision tool works and how results are interpreted. Examples of other potential investments that can be evaluated include VRT systems combined with automatic boom control, precision guidance, or real-time kinematic technology. With care in specifying values, users can evaluate a variety of "what if" scenarios based on their own unique farm characteristics.

Acknowledgement

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Disclaimer

Mention of a manufacturer, trademark, or vendor does not imply approval or recommendation of the product by the authors to the exclusion of others that may be suitable.

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