

PAY VAC
Precision Agriculture Yield Variability Analyzer for
Cotton
(Beta Version 2)

A decision aid to use within-field yield variability to predict
potential savings from variable rate management.

*Developed by Dr. David Zilberman, University of California – Berkeley
with funding from Cotton Incorporated, Dr. Jeanne Reeves Project
Manager.*



Table of Contents

Introduction.....	2
System Requirements.....	2
Running the Program.....	3
Input Screen.....	4
Program Outputs.....	6
Interpretation of the Program's Output.....	9
Contact Information.....	12
Appendix – Changing Microsoft 2003 Excel Security Settings.....	13

Introduction

When asking the question “Will precision technologies pay on my farm?”, one of the first things to consider is the level of within-field yield variability present – if the field conditions are uniform there is no benefit from variable rate management. In order to estimate the level of yield variability needed to signal an economic benefit, a simple decision aid was developed. The decision aid requires a minimal amount of input information:

- High, low, and average yields within a given field in pounds per acre;
- Production costs in \$ per acre;
- Selling price of cotton in \$ per pound;
- Size of the field being considered in acres (or results can be reported on a per acre basis).
- Capital cost of precision technology in \$;
- Indication of in-field variability (moderate to high or extreme); and
- Indication of how a change in the price of an input effects amount of input used (slight change, moderate change, or substantial change)

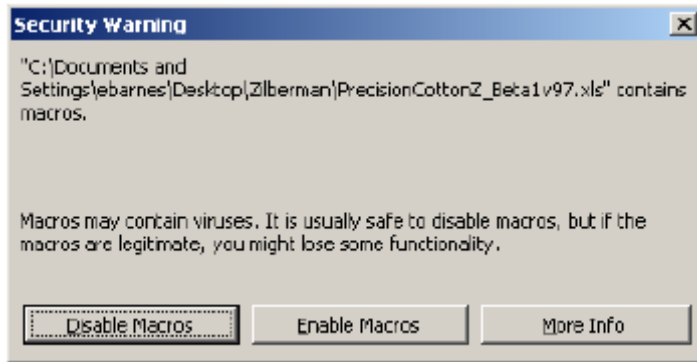
To make an estimate of potential savings from precision farming, we compute optimal land use with and without precision farming. This is done by optimizing a profit equation that takes variation in field quality into account by attributing a normal or triangular distribution to in-field variations in yield per acre. **This is a solely a decision aid; therefore, it should be one of many tools used in considering the adoption of precision technologies.**

System Requirements

This decision aid requires Microsoft Excel version 5.0 or later (includes Office 97, 2000 and 2003); or Microsoft Office 2004 for Mac. The workbook utilizes Excel macros, so the security setting for Excel will need to be set to "Medium" or "Low". If you find the macro will not run, please see the Appendix of this document to learn how to change Excel's security settings.

Running the Program

To start the program, open the file "**PrecisionCottonBeta1.XLS**" with Microsoft Excel. Depending on your security settings, you may see a message that reads:



Click the "**Enable Macros**" button to continue.

The file opens to a welcome screen (displayed below), click the "Click here to begin" button.

Input Screen

Pictured below is a representation of the worksheet where input information is entered. Cell refers to cell where information is to be inputted in actual program. The inputs shown below were used to generate the example output presented later in this guide.

User Inputs

Please enter the following information and **press enter** or return when you are done. Then click "Run Calculations".

Number of Acres:	2500
Yield per Acre (lbs)	Maximum: 1,300
	Minimum: 500
	Average: 900
Average Variable Cost per Acre:	\$450.00
Selling Price of Cotton (\$/lb):	\$0.52
Capital cost of Precision Technology:	\$100,000.00
How much variability is there in your yield?	☐ Moderate to high ☒ Extreme
If the input price increases, how much will you change input use?	☐ Slightly ☒ Moderately ☐ Substantially

Run Calculations

Number of Acres

Enter field size in acres; in the example 2500 acres is inputted into cell D5.

Yield per Acre

First, enter your estimate for the highest yielding area of the field in pounds per acre; in the example 1300 pounds per acre is inputted into cell D6. Next enter your estimate for the lowest yielding area of the field in pounds per acre in the example 500 lbs per acre is inputted into cell D7. Estimate the average yield; in the example 900 lbs per acre is inputted into cell D8.

Average Variable Cost per Acre

Enter an estimate of your average variable cost per acre; in the example \$450 is entered into cell D9. Variable costs are costs that depend on the amount of cotton grown; examples include expenses such as seed, fertilizer, pesticides and irrigation needed to produce the crop.

Selling price of cotton (\$/lb)

Enter the value you expect to receive in **dollars** per pound; in the example \$0.52 per pound is entered into cell D10.

Capital Cost of Precision Technology

Enter the estimated cost of adopting the precision technology in dollars; in the example \$100,000 is entered into cell D11

In-field variability

In-field variability refers to the variation in yield on your farm. If all of your acres produce exactly 700 pounds of cotton than there is no variability, contrarily, if some of your acres produce 1000 pounds, other produce 800 pounds, yet others produce 400 pounds, and yet others produce 200 pounds, than there is variability in your field. Estimate whether the in-field variability in your farm is moderate to high or extreme and then click on the corresponding button; in the example, extreme variability is selected.

Change in amount of input used with respect to change in input price

Click on either slightly, moderately, or substantially, to indicate how much you would change the amount of an input used if the price of that input changed. In the example moderately is selected.

Program Results

After clicking on the “Run Calculations” button a chart, similar to the following, will be displayed. Cell refers to cell in which output is displayed in actual program.

Results

	Traditional Technology	Precision Technology
Yield/acre (lbs):	900.00	943.33
Variable costs/acre	\$450.00	\$443.24
Profits/acre	\$18.00	\$47.29
	Payoff/acre	\$29.29
	Total Payoff/harvest	\$73,236.87

Cost of Precision Technology	Payback Period (years)
\$50,000.00	0.68
\$100,000.00	1.37
\$200,000.00	2.73

[See Results at Varying Prices](#)

[See Results at Varying Costs](#)

[Return to User Inputs](#)

Yield/acre (lbs)

Displays projected average yield per acre in pounds using tradition technology; in the example 900 pounds per acre is displayed in cell C5. And also displays projected average yield per acre in pounds using precision technology; in the example 943.33 pounds per acre is displayed in cell D5.

Variable costs/acre

Displays projected average variable cost per acre in dollars using traditional technology; in the example \$450.00 is displayed in cell C6. And also displays projected variable cost per acre using precision technology; in the example \$443.24 is displayed in cell D6.

Profits/acre

Displays projected average profits per acre in dollars using traditional technology; in the example \$18.00 is displayed in cell C7 and using precision technology. And also displays projected profits per acre using precision technology; in the example \$47.29 is displayed in cell D7.

Payoff/acre

Displays difference between projected profits per acre using precision technology and projected profits per acre using traditional technology; in the example \$29.29 is displayed in cell D8.

Total Payoff/harvest

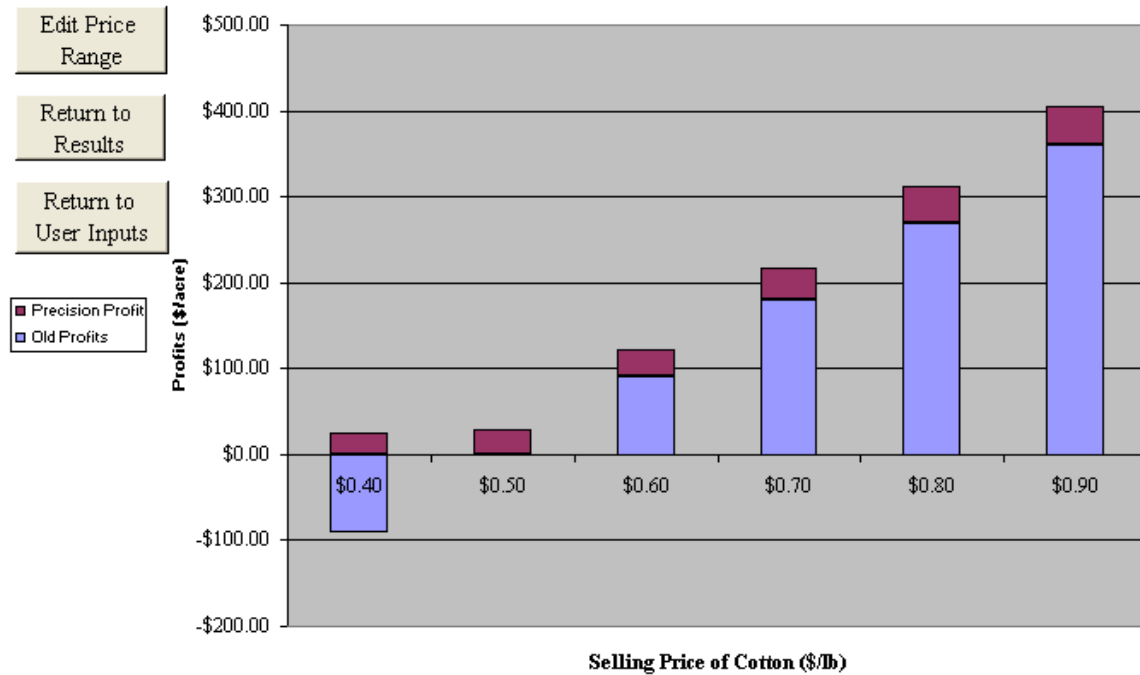
Displays difference between projected profits per harvest using precision technology and projected profits per acre using traditional technology; in the example \$73,236.87 is displayed in cell D9.

Cost of Precision Technology and Payback Period

Displays number of harvests necessary to payback the capital cost of the precision technology; in the example it shows payback period for \$50,000 in cell C12, \$100,00 in cell C13, and \$200,000 in cell C14. The payback periods in this example are respectively 0.68 years in cell D12, 1.27 in cell D13, and 1.73 in cell D14.

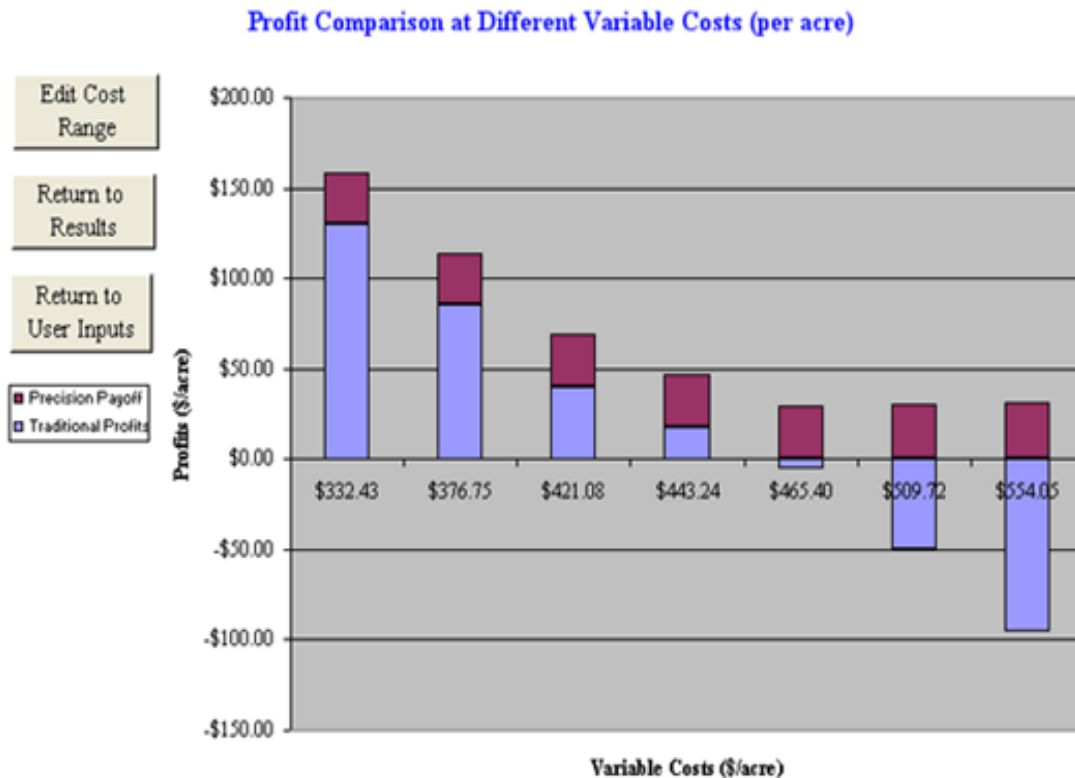
Clicking “See Results at Varying Prices” will display a graph similar to the following.

Profit Comparison at Different Sale Prices (per acre)



The vertical axis represents profits in dollars per acre and the horizontal axis represents different selling prices of cotton in dollars per pound. The blue bar represents profits at a specific selling price using traditional technology while the purple segment shows difference in profits between precision and traditional technology at a specific selling price using. In the example, at a selling price of \$0.40/lb profits per acre with traditional technology are roughly -\$100 while profits per acre with precision technology are slightly positive. At \$0.50/lb profits/acre are close to 0 with traditional technology and slightly positive with precision technology. A tabular version of this data, which allows you to look at profits at various cotton sales prices, is contained in the sheet titled “Data”. Note that in this example the difference between profits with precision technology and profits with traditional technology increases as the selling price of cotton increases.

Clicking on “Return to Results” and then “See Results at Varying Costs” will display a graph similar to the following.



Once again the vertical axis represents profits in dollars per acre. The horizontal axis represents different variable costs of producing an acre of cotton in dollars per acre. The blue bar represents profits at a specific selling price using traditional technology while the purple segment shows difference in profits at a specific selling price using precision technology. In the example, at a variable cost of 332.43 dollars/acre profits per acre are roughly \$130 dollars with traditional technology and roughly \$160 with precision technology. A tabular version of this data is contained in the sheet titled “Data”.

Interpretation of the Program's Results

Here we use a generic precision technology capable of adjusting input use to accommodate variation in crops. We compute the

In answering the question “Should I invest in Precision Technology” one must compare the payoff from the precision technology (change in profits when using precision tech) to the capital cost of purchasing the precision technology. In the example above, precision technology yields a \$73,236.87 increase in profits per harvest. Moreover one can see from the graphs that the positive change in profits will increase if the selling price of cotton increases or if the average variable cost increases. Thus, if the cost of the precision technology is a one time investment of \$100,000.00 and a massive decrease in variable cost or selling price is not expected the precision technology will yield a positive change

in total profits after 2 years and it would probably be a wise decision to invest in the technology. If the one time capital investment in precision technology is \$100,000.00 and than the investment would take more than 10 years to recoup and would thus be a riskier bet. Let's now take a different example – imagine the acreage is 800, average variable cost is \$300, maximum yield in pounds per acre is 1000, minimum yield is 800 pounds per acre, average yield is 900 pounds per acre, price of cotton remain \$0.52 per pound, capital cost stays at \$100,000, variability is moderate-high, and change in inputs used dependant on change in input price is moderate. So the input screen reads:

User Inputs

Please enter the following information and **press enter** or return when you are done. Then click "Run Calculations".

Number of Acres:		800
Yield per Acre (lbs)	Maximum:	1,000
	Minimum:	800
	Average:	900
Average Variable Cost per Acre:		\$300.00
Selling Price of Cotton (\$/lb):		\$0.52
Capital cost of Precision Technology:		\$100,000.00
How much variability is there in your yield?	☒ Moderate to high ☐ Extreme	
If the input price increases, how much will you change input use?	☐ Slightly ☒ Moderately ☐ Substantially	

Run Calculations

Click "Run Calculations" and the output screen will read:

Results

	Traditional Technology	Precision Technology
Yield/acre (lbs):	900.00	928.85
Variable costs/acre	\$300.00	\$299.88
Profits/acre	\$168.00	\$183.13
Payoff/acre		\$15.13
Total Payoff/harvest		\$12,100.15

Cost of Precision Technology	Payback Period (years)
\$50,000.00	4.13
\$100,000.00	8.26
\$200,000.00	16.53

See Results at Varying Prices

See Results at Varying Costs

Return to User Inputs

From these chart we see that the one time \$100,000.00 investment in the precision technology will take 8.26 years to recover, a rather long time, and thus the decision to

invest in \$100,000.00 of precision technology should not be taken lightly. If the technology investment is \$10,000.00 than it would take less than a year to recoup and the decision of whether to invest in precision technology would be much simpler. Let's look at one more example; imagine a farmer with 1000 acres, whose maximum yield is 1100, minimum yield is 800, and average yield is 900, the average variable cost on the farm is estimated to be \$400, imagine selling price \$0.40, capital cost will remain \$100,000.00, this farmer has moderate-high in-field variability, and change in inputs used dependant on change in input price is slight. Thus, the input screen will look like the following.

User Inputs

Please enter the following information and **press enter** or return when you are done. Then click "Run Calculations".

Number of Acres:		1000
Yield per Acre (lbs)	Maximum:	1,100
	Minimum:	800
	Average:	900
Average Variable Cost per Acre:		\$400.00
Selling Price of Cotton (\$/lb):		\$0.40
Capital cost of Precision Technology:		\$100,000.00
How much variability is there in your yield?	☒ Moderate to high ☐ Extreme	
If the input price increases, how much will you change input use?	☒ Slightly ☐ Moderately ☐ Substantially	

Run Calculations

Clicking "Run Calculations" yields the following.

Results

	Traditional Technology	Precision Technology
Yield/acre (lbs):	900.00	1018.95
Variable costs/acre	\$400.00	\$400.55
Profits/acre	-\$40.00	\$7.03
	Payoff/acre	\$47.03
	Total Payoff/harvest	\$47,027.11

Cost of Precision Technology	Payback Period (years)
\$50,000.00	1.06
\$100,000.00	2.13
\$200,000.00	4.25

[See Results at Varying Prices](#)

[See Results at Varying Costs](#)

[Return to User Inputs](#)

With these inputs there is a net loss without precision technology and a profit with precision technology, and the payoff occurs in just over two years. The reason for such a large difference in profit per acre for precision technology as compared to traditional technology in the model is the slight change of amount of inputs used when price of inputs change. If this field will be used for cotton, it is probably a wise decision to invest in the precision technology. If, however, you expect the price of cotton to fall below \$0.40 (and there is a net loss no matter what type of technology you use), or if you expect average variable cost to climb higher than \$400.00 it probably makes sense to plant something other than cotton.

Contact Information

For questions regarding the economic theory and assumptions of the model contact:

Dr. Jeanne Reeves

Agricultural Research
Cotton Incorporated
6399 Weston Parkway
Cary, NC 27513

Phone: 919-678-2370

Fax: 919-678-2233

email: jreeves@cottoninc.com

For problems using the program, at the same address, contact:

Dr. Edward M. Barnes

Phone: 919-678-2368

email: ebarnes@cottoninc.com