

Guidance & Section Control Profit Calculator - User's Tutorial

Guidance & Section Control Profit Calculator

Welcome | Instructions | Whole Farm Data | Sprayer | Planter | Fertilizer | Other | Whole Farm Results

To Get Started,
Click the Instructions Tab

welcome to the
Guidance & Section Control Profit Calculator

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Sprayer-Specific Data

Sprayer Information

1 Swaths (passes) to cover headlands (count)
90 Width of machine (feet)
75% Turnaround speed percent of field speed (percent)
7 Boom sections to be controlled (count)
15 Reaction distance (overlap) on manual shutoff (feet)
\$5.00 Custom rate of machine operations, \$/application acre
\$15.00 Cost of herbicide, \$/application acre
\$0.00 Lost yield revenue for doubling up, \$/doubled-up acre
7.00% Current overlap to consider
1.50% Expected overlap to consider

Expected technology investment

9,000 Total acres of use annually
\$15,000 Autoguidance
\$10,000 Boom/section control

Results of Precision Ag Technologies Analysis

Payback vs. Applied Acres

ROI and Net Benefits vs. Planted Acres

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This tool has been developed with the support of the
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GUIDANCE & SECTION CONTROL PROFIT CALCULATOR – USER’S TUTORIAL

This tutorial explains how to use the **Guidance & Section Control Profit Calculator**. Note that there are two versions of the calculator – a Web Dashboard online version and an Excel Spreadsheet version. The two versions are very similar, but there are some minor differences in how data are entered. This tutorial focuses primarily on the Web Dashboard version. At the end of this tutorial, there is a brief section which provides additional notes for the Excel Spreadsheet version.

In order to open and operate the Web Dashboard calculator, you may need to download and install the latest version of Adobe Flash Player on your computer. This is available via a free download at <http://get.adobe.com/flashplayer/>.

Welcome

Once you have Adobe Flash Player installed, go to www.agmanager.info/farmmgt/machinery/#3 and click on the appropriate link for the **Guidance & Section Control Profit Calculator**. After a few seconds (or minutes depending on your connection speed), the Web Dashboard Calculator should become visible and the Welcome tab should appear on your computer screen.

The purpose of this tab is to simply serve as an introduction to the Calculator and to identify the developers of this tool. This tool was developed with the support of the PrecisionAg Institute (www.precisionag.com) by Kevin Dhuyvetter, Craig Smith, Terry Kastens, and Dietrich Kastens. The contact information for each contributor is listed and questions regarding this tool can be sent to any one of those listed. For more information related to precision agricultural technologies, you are encouraged to visit websites of both the PrecisionAg Institute and K-State AgManager (www.agmanager.info).

To navigate within this tool click on the respective tabs, of which there are eight located near the top of the screen. The information displayed in each tab was designed so that the user can easily view it without having to scroll up and down or side to side. But depending on your computer and monitor settings, it may be necessary to adjust your zoom level. This is accomplished by clicking on the dropdown button located at the bottom-right corner of your web browser. Try adjusting the zoom settings to make the information more easily readable. Note, it may be necessary to enter a “custom” zoom level. When you are ready to proceed, click on the Instructions tab.

Instructions

This tab briefly explains how the calculator works and gives general instructions for completing an analysis. The details of this tab are self-explanatory and will not be covered in the tutorial, but be sure you read and understand the information in this tab before proceeding. Also, before proceeding, let us briefly cover the limitations of this tool:

The **Guidance & Section Control Profit Calculator** allows its user to approximate the benefits to GPS-based guidance and boom and section control for farm machinery. To accomplish that, certain numerical features of a typical or representative farm field are used. But, these numerical measures

never describe perfectly and completely that field and how farm machines are used in that field. So, there always will be error in the analysis. And, in certain situations, especially involving large machinery being used on extremely small fields, the error in analysis could be quite large, making the tool inappropriate for such situations. An example would be using a 100-foot sprayer to spray an odd-shaped 5-acre field. Yet, the tool should be sufficiently accurate for the typical farm to make profitable technology investment decisions. So, it should be considered in that light.

Aside on overlap and headlands geometry

Before entering data into the calculator, it is necessary to understand the real tangible effects of having GPS guidance and section control technologies. Using Figure 1, first consider an operator who is running a sprayer and opens the field by making two passes around the perimeter of the field. Without autoguidance technologies, there will be some amount of overlap between the two passes as shown in Figure 1. This results in a reduction of machine operation efficiency as well as doubles up inputs on the overlapped portion of ground. Thus, the economic effects of overlap are two-fold: a waste of costly inputs and a loss of machine efficiency. Additionally, there could be lost crop yield due to overlap of chemicals. Autoguidance has the potential to reduce this amount of overlap in the headlands as well as in the pass-to-pass trips throughout the rest of the field.

Now consider the sprayer as it approaches the headlands at some angle less than 90 degrees, as in Figure 1 (which will be the case in a non-square field). Without section control capabilities, the operator will not turn off the applicator until the very last nozzle on the far right of the boom reaches the headlands. This results in a doubling-up of inputs across area A. Further, assuming the operator does not have perfect reaction time, there also will be doubling up on area Q. Section and boom controls have the potential to eliminate some if not all of this doubling-up of inputs. As one can see from the diagram, the angle of approach plays a key role in determining the amount of doubling-up that can be avoided with precision agricultural technologies. The data you enter into the calculator determine the areas and distances shown in Figure 1, which play a major role in the ensuing economic analyses.

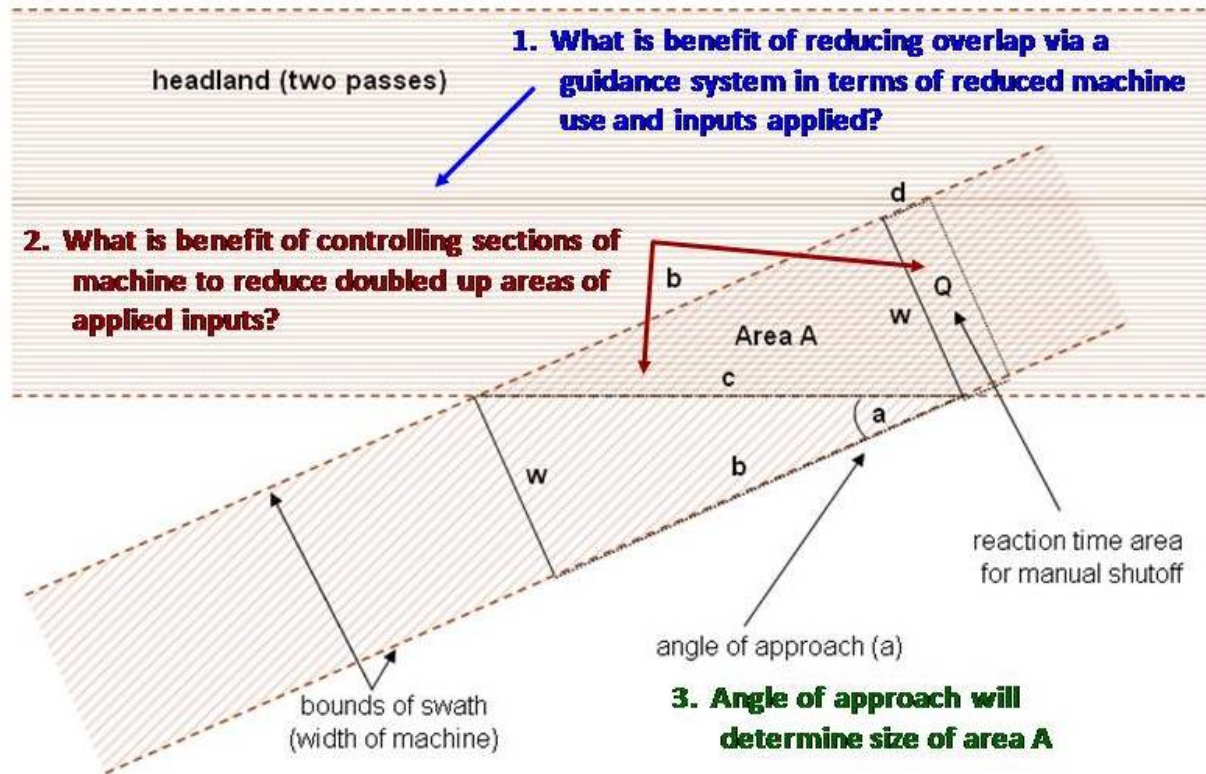


Figure 1 Diagram of overlap and doubling-up of inputs

We are now ready to move on to the Whole Farm Data tab.

Whole Farm Data

The first three inputs on this tab are related to describing a “typical,” thus representative, field. A user of this tool should have in hand a visual map of a field considered representative of the fields involved in the farming operation. Representativeness should involve primarily size and shape. FSA maps are readily available and suitable for this purpose, with distances of interest easily measured with a ruler after knowing the scale. With non-square fields, it may be useful to use a piece of string to measure the perimeter. Users who find it difficult to settle on a single map they would call representative should work with several maps, computing the items of interest on each, and then averaging the results. Moreover, using this tool for specific fields of interest will provide other worthwhile information, for example, how field size and shape affect the economics of the precision agricultural technologies.

1. **Size of typical field:** Enter the size in acres of a typical field on your farm.
2. **Maximum width of field, perpendicular to direction of swaths (feet):** This value determines the number of swaths given machine width. The value for this cell can be determined by GPS or with a ruler on a scaled map (see Figure 2). Note that in Figure 2 the field is worked back and forth from southeast to northwest.

- 3. Running distance of headlands to cover for field (feet):** One of the numerical inputs required of the tool is the running distance of the field's headland. This measure mostly affects the economics of boom and section control, having almost no impact on the economics of guidance. A bit of explanation here will help users decide which value to use for the representative field in question.

The advent of ever more GPS-based guidance has changed the way we farm. First, most of the land once operated in round-and-round fashion is now operated in a back-and-forth mode. Consequently, this tool analyzes only such back-and-forth farming methods. We make no allowance for round-and-round. Admittedly, even more sophisticated GPS-based systems now allow for following curves. But, such techniques are used more for the second round of a headland operation rather than in the body of a field. The second "change" wrought by GPS-based operations is the realization that few fields actually have truly straight lines. That is, even when a field edge borders a straight-running county road, it still tends to deviate from a straight line. So, once farmers farm in straight lines, there is a tendency for all field edges to involve areas of overlap, even when such edges do not seem like true turn around areas. Once again, as a side note, headlands typically are worked prior to the body of the field today, since that is how the in-cab computer and software knows where to turn on and off machinery sections. However, it should be pointed out that our tool's analysis does not depend upon knowing the order in which headland operations are performed.

So, what does all of this mean for running distance of headlands? Given our understanding of traditional and modern farming practices, our simplest recommendation would be to merely include the entire perimeter of a field as the headland distance that should be applied in the tool (as shown in Figure 2). The one exception would be a representative field that was essentially square. But, even in that case we would not recommend using a distance equal to only half the perimeter, i.e., only two of the four sides. Rather, we would suggest using at least three fourths of the perimeter distance. Why? Because no field is ever perfectly square. And, because even square fields typically involve a partial swath as the last swath.

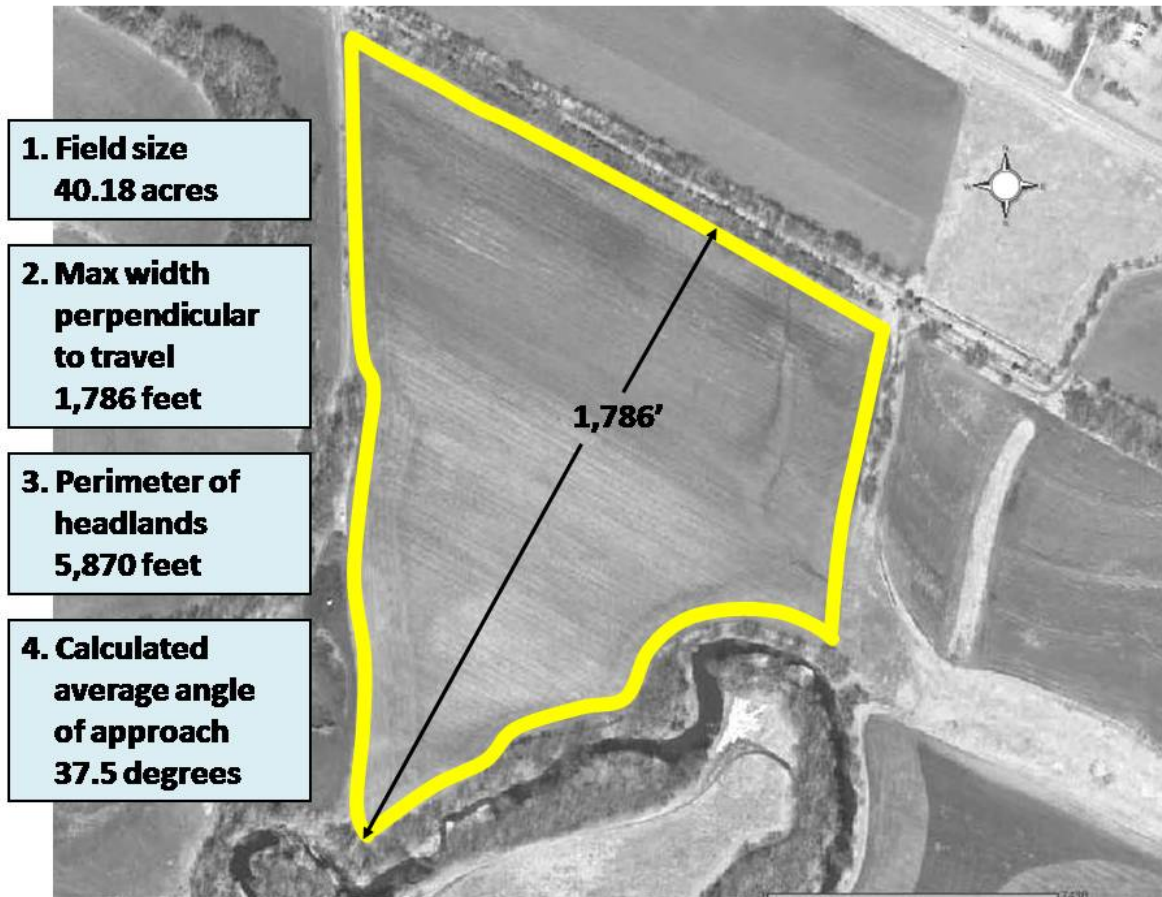


Figure 2 Representative field measurements

4. **Calculated angle of approach:** Given user-entered information for field size, perimeter of headlands, and the maximum distance perpendicular to travel, the tool calculates an average angle of approach for the field.
5. **Interest rate for investment analysis (percentage):** Typical bank interest rate for borrowing money. This is used in the net present value and amortization calculations.
6. **Number of years for amortization (years):** Number of years over which an investment is amortized. Analysis assumes no salvage value. If salvage value exists, either enter a longer time horizon (i.e., increase years of amortization) or decrease initial technology investment costs (on equipment specific tabs – covered next).
7. **Annual non-ownership costs for current technology (\$/farm):** Enter non-ownership costs associated with the current technology. This represents any “hassle” factors that you think you incur. If no precision agriculture technology is currently used, this value should be \$0. Note, this cost is allocated across auto-guidance and boom/section control relative to the investment costs of each.

8. **Annual non-ownership costs for new technology (\$/farm):** Enter non-ownership costs associated with the precision agricultural technology you are considering investing in. If unmeasured benefits (i.e., reduced operator fatigue/stress) are greater than hassle factor costs, a negative value for non-ownership cost can be entered. Note, this cost is allocated across auto-guidance and boom/section control relative to the investment costs of each.
9. **Include in Whole-Farm Analysis:** Enter a 1 in each column to include a particular implement in the Farm Total column, or enter 0 to exclude a particular implement/operation from the Farm Total. This affects which implements are included in the results you will see on the Whole Farm Results tab. Note, if a 0 is entered here none of the annual non-ownership costs will be allocated to that particular implement (i.e., results reported in implement-specific tabs for implements excluded here will not include a portion of the non-ownership costs).

We are now ready to enter equipment-specific information. You have the option of entering information for up to four different types of equipment, including: Sprayer, Planter, Fertilizer, and Other. The same type of information is entered for each implement. For brevity, this tutorial will only discuss data entry for a Sprayer.

Proceed by clicking on the Sprayer tab.

Sprayer

This tab requires the user to enter equipment-specific information. Here we enter data for a crop sprayer.

1. **Swaths (passes) to cover headlands (count):** This is the number of passes you complete on headland before operating back-and-forth in field, or the number of swaths it takes to "clean up" headlands when you are done with the field if you cover headlands last.
2. **Width of machine (feet):** Enter the width of the implement in feet.
3. **Turnaround speed percent of field speed (percent):** Enter an estimate for the speed the machine travels in the headlands as a percent of field speed. For example, if the headland speed is 75% of the in-field speed, enter 75%. By entering a value less than 100% (i.e., machine is slowed down), "effective" acres covered will increase slightly. This speed adjustment applies to the turnaround area, which is assumed to be the same area encompassed by the headlands.
4. **Boom sections to be controlled (count):** This value impacts the economics of section controllers reported in the results. If you wish to analyze controlling 5 boom sections of a sprayer use 5. If you want to consider individual row control of a 16 row planter enter 16. If you do not want to consider section controllers enter 1.
5. **Reaction distance (overlap) on manual shutoff (feet):** In manually shutting off a sprayer or planter, for example, for the headland, this is the distance you travel after you think you've covered all uncovered land just to be sure you leave no windows (area Q in Figure 1). Calculations

assume the same distance applies for turning sprayer or planter on "too quickly" before getting into uncovered land. Generally, it may help to think about a perfectly square field when you answer this question.

6. **Custom rate of machine operations, \$/application acre:** Enter the typical custom rate for the machine operation you are analyzing.
7. **Cost of herbicide, \$/application acre:** Enter the value (\$/acre) of the crop input (e.g., seed, chemical, fertilizer) you are using. If spraying, be sure to insert the value for a typical application (i.e., the average herbicide cost across multiple applications on the same acre). For example, if annual herbicide cost/acre for corn is \$30/acre, but that was in three applications, \$10/ac ($\$30/3$) should be entered. If you don't want to examine an input (e.g., a tillage operation), just set to \$0.
8. **Lost yield revenue for doubling up, \$/doubled-up acre:** If you believe, for example, that where you double-up on an input in the headlands you have 10 bu/acre lower yields and that yield is valued at \$3.00/bu, then enter \$30 here. If you don't have such headland doubling-up yield losses just set to \$0. Remember, that this is loss associated with each application. So, if the yield revenue loss just noted was associated with three herbicide applications annually, you would want to divide the total by 3 (i.e., you would enter \$10 rather than \$30). Note that this applies to the doubled up area in only the headlands. Also, note that we assume excess crop inputs associated with pass-to-pass doubling up, but no associated yield loss for that area.
9. **Current overlap to consider:** Enter an estimate of the overlap of your current (baseline) situation as a percentage (e.g., if a 40 foot implement is overlapped 2 feet, this would be 5%). For crop spraying and tillage work, some consider 8% as appropriate for foam markers, 4% for lightbars, and 0-1% for autoguidance. For planting with markers, this probably should be 2-3%.
10. **Expected overlap to consider:** Enter an estimate of the overlap of investing in the guidance system being considered as a percentage (e.g., if a 40 foot implement is overlapped 6 inches, this would be 1.25%).

We are now ready to enter the expected technology investment costs. It is important to note that if a given technology is used on multiple implements, the total cost should be allocated over each of the implements.

Expected technology investment

1. **Total acres of use annually:** Enter the total number of acres the precision agricultural technology (guidance system or section controllers) is used on annually. For example, if you expect to spray 3,000 acres three times each year, then enter 9,000 acres.
2. **Autoguidance:** Enter the total investment required for the guidance system consistent with the percent reduction in overlap values entered above. To reiterate, if a guidance system is used on multiple implements, allocate the total over different implements.

3. **Boom/section control:** Enter the total investment required for boom/section controllers consistent with the number of sections to control entered above.

We are now finished entering data for our crop sprayer. At this point, you can view the results of the sprayer analysis via the two line graphs on the right hand side of the screen. These graphs give you an idea of how Payback, Return on Investment, and Net Benefits are impacted by variations in acreage sprayed. Note that you can place your mouse pointer over a marker on the graph to view the exact point estimate values. If you are interested in printing any of the reports, we recommend going to “File”, “Page Setup”, and select “Landscape” orientation before printing. We will go into more detail about how to interpret the results in the next section.

If you wish to analyze precision agricultural technologies on other types of equipment for inclusion in your whole farm analysis, click on the appropriate equipment tab and enter data in a similar manner to the sprayer example.

When you are finished entering all of your data, proceed to view the comprehensive results by clicking on the Whole Farm Results tab.

Whole Farm Results

The Whole Farm Results tab displays an analysis of precision agricultural technologies for the whole farm including only those implements identified earlier on the Whole Farm Data tab. On this tab, we will see both graphical results and numerical results. Everything displayed in the graphs is also reported in the table, so we will just focus on the interpretation of the data in the table.

First, you will notice that all of the results are evaluated against a percentage of acres applied annually. The 100% column is representative of the data you entered. Since we know this is only an estimate of actual acreage covered, we have included a sensitivity analysis giving the user an idea of how the results might change if more or less acres are actually applied. Let’s first look at the results of Guidance System:

Guidance system

1. **Sum of net annual benefits, \$/applied acre:** Calculated value of the annual net benefits per applied acre from investing in a guidance system (excludes depreciation and interest on investment).
2. **Payback for given investment, years:** Number of years for the investment in the guidance system to pay back given the interest rate entered in inputs section and the expected net annual benefits (assumes no salvage value).
3. **Sum of annual net benefits including cost of investment, \$/applied acre:** Calculated value of the annual net benefits per applied acre from investing in a guidance system (includes depreciation and interest on investment).

4. **ROI given benefits, years, and investment, %:** Return on investment on a guidance system given the interest rate and years for amortization entered in the inputs section.

Section control

1. **Sum of net annual benefits, \$/applied acre:** Calculated value of the annual net benefits per applied acre from investing in section controllers (excludes depreciation and interest on investment).
2. **Payback for given investment, years:** Number of years for the investment in section controls to pay back given the interest rate entered in inputs section and the expected net annual benefits (assumes no salvage value).
3. **Sum of annual net benefits including cost of investment, \$/applied acre:** Calculated value of the annual net benefits per applied acre from investing in section controllers (includes depreciation and interest on investment).
4. **ROI given benefits, years, and investment, %:** Return on investment on section controls given the interest rate and years for amortization entered in the inputs section.

Guidance system and Section control ROI, %: Return on investment for total investment in both guidance system and section controllers.

Conclusion

To conclude, machinery technology that reduces machinery costs and input use due to overlap (i.e., guidance systems) is one form of precision agriculture that a producer can choose to invest in. Another machinery technology that has great promise is automation that allows individual rows or sections of large equipment to be managed separately. Whether a producer will find it economical to invest in these precision agricultural technologies will depend on farm-specific factors (e.g., farm and field size, field shape, investment required). This decision tool allows you to evaluate the economics of these technologies and will be helpful in making wise investment decisions.

If you desire more customization and flexibility in your analysis, we would recommend the Excel Spreadsheet version of the **Guidance & Section Control Profit Calculator** available online at www.agmanager.info . The last section offers some additional notes for the use of this version.

Additional notes for the Excel Spreadsheet version

The Excel Spreadsheet version allows for a slightly more rigorous economic analysis of guidance systems and section controllers. The spreadsheet operates very similar to the Web Dashboard version and has been designed with many cell comments to aid the user. For that reason, this section only will focus on key differences and other notable points. Users are encouraged to watch the video tutorial for the spreadsheet version available online at: www.agmanager.info/farmmgmt/machinery/#Decision-Making_Tools.

Macros are necessary for the calculator to operate effectively. The first tab, "FYI", provides information on how to enable macros depending on the version of MS Excel that you are using. Once macros have been enabled, you are ready to proceed to the "Welcome" tab and then to the "Instructions" tab. When you are finished reading the information on this tab, please click on the "Inputs" tab.

Many of the inputs are the same as in the Web Dashboard version. All inputs include cell comments that provide descriptions of the type of data that should be entered. Data should be entered in only the blue cells.

One feature of the spreadsheet is that a user can "calculate" what a representative or typical field on their farm may look like based on a weighted average of their individual fields. This can be seen by clicking on the "Fields" tab. Here, dimensions (size, maximum width, and running distance of headlands) for up to 100 individual farm fields can be entered and acre-weighted averages are calculated. These resulting values (in red font) can then be transferred to the corresponding cells in the "Inputs" sheet (cells G5, G6, and G7).

The spreadsheet allows for the analysis of up to five farming implements/operations. The user can type in a unique name for each implement/operation in cells D21-H21. Note, that you can specify which implements/operations to include or not include in the whole farm analysis by entering a 1 or 0 in cells D22-H22.

When you are finished entering data on the "Inputs" sheet, click on the "View Results" command button. A user form should appear asking you to select the economic analysis report you wish to view from a list of six options, which correspond to the (up to) five implements/operations you previously entered plus the whole farm report. Click on the appropriate report and you will be taken to the "Results" sheet with the correct report in view. The results will be in both tabular and graphical form, with two graphs located below one table for each individual report. You have the option of printing the individual report or viewing other reports by clicking on the suitable command button located either above the table or below the second graph.

The final two tabs of the spreadsheet provide additional information related to the data and calculations. The "Notes" tab describes the geometrical calculations while the "Amortization" tab describes the net present value calculations that are necessary for accurately characterizing costs and benefits over time.