COOPERATIVE EXTENSION SERVICE
University of Kentucky – College of Agriculture

Site Specific Issues

A Precision Agriculture Newsletter

Harvest 2003 Dennis Hancock, *Extension Associate for Precision Agriculture*

Is My Operation Big Enough To Buy Precision Ag Equipment?

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Though increasing sharply, adoption of precision farming practices in Kentucky has been slowed because producers perceive or, in fact, have found the equipment to be too expensive. None-the-less, most of the research done on precision agriculture (PA) has found many aspects of it to be profitable. Certainly, a producer doesn't have to implement all aspects of precision ag for it to be successful. However, there are some PA practices that may depend on some other aspect of site-specific management. For example, variable rate application (VRA) would likely require a field map, a soil map, or some type of management zone map. Potential users of PA should consider custom hiring some PA operations as an alternative to buying the equipment or investing their time. But when is it less expensive to buy than to hire some or all of it done?

Partial budgeting serves as a means of comparing two, alternate management decisions and is useful here. It is a common tool and is a consistent method that permits one to calculate the expected profit from a proposed change in a farm's operation. From the partial budget framework, a break-even formula can be derived to compute the acreage level for which the producer is indifferent between choosing to buy the PA equipment and custom hire the service.

The cost associated with buying the equipment is set equal to the cost of custom hire:

$$TFC + TVC*acres = CH*acres \qquad (1)$$

where TFC is the total fixed cost of PA equipment ownership, TVC is the total variable costs associated with operating owned PA equipment, CH is the custom hired rate and acres is the number of acres upon which PA is used. To find the minimum acreage that you need to have that will justify buying the equipment, solve for acres to get:

$$TFC/(CH-TVC) = acres \qquad (2)$$

If the number of acres you calculate is less than what you currently crop, then it would be more advantageous for you to buy the equipment than to custom hire PA services. If you don't have enough acres to spread out fixed costs like depreciation than it is less expensive to custom hire.

As an example, let us consider implementing variable rate application (VRA) of fertilizer/lime on a farm. Consider what would be required to implement VRA on a farm: an all-terrain-vehicle (ATV), a spinner spreader truck, a VRA controller, a GPS receiver, a PCMCIA memory card, a computer, a printer and mapping/application recommendation software. Economic data are then used to compute the ownership and operating costs associated with the new equipment. The new investments involve fixed (or ownership) and variable (or operating) costs associated with PA equipment. Fixed costs include depreciation (a function of purchase price, salvage value, and useful life, interest), insurance, and property taxes. The variable costs include repair and maintenance; fuel, oil, and lubrication; and labor. These variable costs were computed only for the ATV (for field mapping and grid sampling) and the spreader (for fertilizer and lime application) on the basis of ASAE standards.

Next, consider what it is that can be done with this equipment. For the purposes of our example, the potential spectrum of uses might include four types of operations: field mapping, grid soil sampling and mapping, VRA of fertilizer, and VRA of lime. Each of these operations can be separately performed either by custom hiring or by the farmer through owned equipment.

Recent work using industry standard economic data has shown the break-even acreage for buying the PA equipment versus custom hiring is 1,060 acres to VRA one fertilizer, 882 acres to VRA one fertilizer and lime, and 511 acres to VRA two fertilizers and lime. (Note: This DOES NOT mean that VRA of one fertilizer would be profitable on farms larger than 1,060 acres. This means that if a farm was more than 1,060 acres and the farmer only planned on VRA one fertilizer, they would be better off owning the equipment than hiring it done.) See Table 1 for more results.

Table 1. Break-even Acreage Analysis Results by Operation Performed

Precision Agricultural Operation[1]	Acres
Field Mapping	44,479
Field Mapping and Grid Soil Sampling	4,981
One Fertilizer VRA	1,060
One Lime VRA	3,236
Fertilizer and Lime VRA	882
Two Fertilizers and Lime VRA	511

[1] VRA refers to variable rate application for a single input. Thus, two fertilizers and lime VRA refers to three separate machinery operations using the same equipment.

This means that the majority of commercial grain producers in Kentucky (the average commercial row crop farm size in Kentucky is 1,504 acres) would be better off buying their own set of PA equipment when deciding to perform any of these combination of PA operations. It may also be wise to custom hire one or a combination of any of these aspects to get a feel for whether or not PA is right for their situation. In our example, if one chooses to test the value of field mapping, field mapping and grid soil sampling, or only VRA lime, the choice would likely be to custom hire the operation. This would be the least cost strategy, as the break-even acreage for these three distinctive operations far exceeds the state average of 1,504 acres for commercial row crop producers.

Not everybody interested in adopting PA needs to buy the equipment. The decision to buy the equipment or custom hire will depend on the type of PA operation you want to start with and the number of acres you have. Table 1 gives a guide to follow. For example, if one farms approximately 1000 acres and decides to use PA only for VRA lime, they would probably be better off custom hiring. If one is really close to the calculated level, further analysis should be done before making a decision one way or the other.

Considerations for Harvesting Field Trials with Yield Monitors

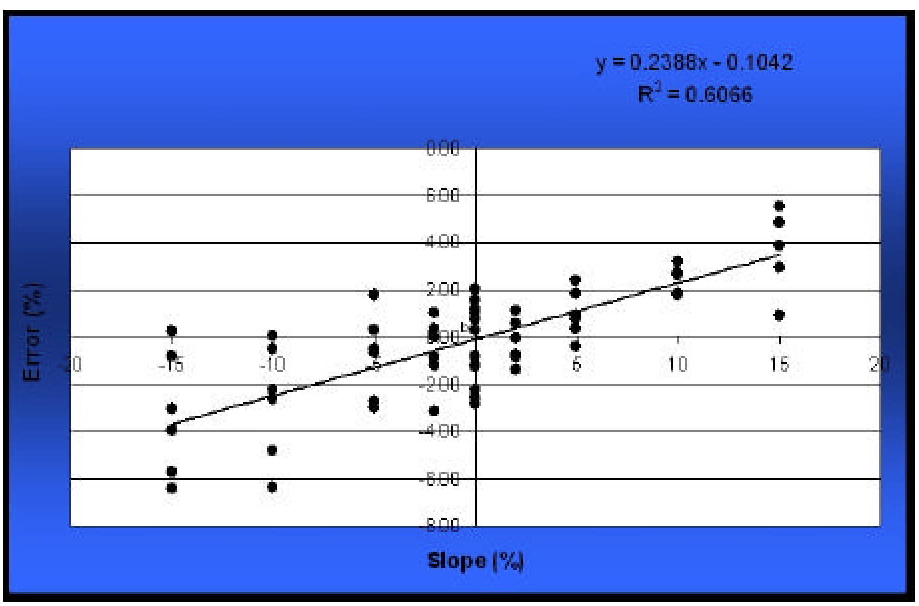
S.A. Shearer and J.P. Fulton

Increasingly, Kentucky farmers are turning to yield monitors to obtain information on crop response to cultural practices (e.g., hybrid/variety selection, plant population, nutrient levels, etc.). More importantly the field trials normally conducted by university researchers, seed companies, or chemical companies are now being conducted by farmers using yield monitors rather than the traditional weigh wagon.

While this new tool affords producers new capabilities, they are urged to remember that like most other tools the results are comparable to the user's ability to use the tool correctly. Yield monitors, like many measurement instruments, must be calibrated. The majority of the yield monitors in use today in the U.S. are "force impetus" devices. Force impetus devices rely on acceleration of the grain as it is turned 90^o at the top of the clean grain elevator. As the grain strikes the impact plate of the mass flow sensor (top of the clean grain elevator) the deflection or impact force on this plate is measured. Anything that changes the nature of this impact alters the force or displacement registered by the mass flow sensor. While every effort has been made by yield monitor manufacturers to calibrate the mass flow of grain to the magnitude of grain impact on the mass flow sensor – certain circumstances may cause this calibration to vary.

One example that might alter the relationship of mass flow rate to sensor response is operating the combine on slope. Data collected at the University of Kentucky's yield monitor test facility confirms the need for concern. A commercially available yield monitor was calibrated for a specific range of mass flows under laboratory conditions with the clean grain elevator in its normal vertical orientation. Next, data was collected by sloping the elevator forward in increments ranging from 0 to 15% (downhill) and then backwards from 0 to 15 % slope (uphill). Figure 1 summarizes these tests. Please

Figure 1. Results from sloping the clean grain elevator backwards and forward to simulate +/- 0-15% slopes.



The University of Kentucky Yield Monitor Test Facility.

note that depending on elevator inclination, the apparent mass flow rates can vary from actual by as much as 12%. Couple this with the fact that some farmers may plant field trials in strips across a field, and that they harvest in rounds – side by side hybrid trials may exhibit an apparent 12 to 15 bu./ac. difference when in reality this difference was created by harvesting different hybrids in opposite directions (uphill for Hybrid A and downhill for Hybrid B).

Does this suggest that yield monitors can not be used to assess crop response when performing research? Not in the least – providing producers put some thought into harvest practices. The simple solution is to harvest Hybrid A and B while traveling in the same direction. In keeping with this line of thought, the following suggestions are provided to stimulate thought on how best to harvest field investigations.

1. Before starting, clean the impact plate and moisture sensor. Check for material lodged behind or to either side of the impact plate. Visually inspect all sensor cables to make certain they are intact and not worn from being in contact with rotating parts.
2. Calibrate the yield monitor, or double check the most current calibration, by running the combine in a location that is similar in maturity and condition to the test plots to be harvested. If necessary, recalibrate!
3. Check combine set-up for harvest losses and make machine adjustments prior to harvesting plots.
4. Run side-by-side comparison plots in the same direction to minimize the effect of harvest errors when comparing yield results. Relative errors (the same for either plot or variety are off-setting when looking at yield differences).
5. Operate the combine under conditions that are similar to the conditions used when calibrating the yield monitor (e.g., run at the same ground speed or at nearly the same mass flow rate of grain).
6. Avoid stopping in the middle of the plots. This may be difficult when doing N application comparisons where the crop in some plots may be lodged. Plan ahead! The best solution may be to calibrate at a lower harvest rate in anticipation of harvesting lodged crops.
7. Avoid unloading the combine on-the-go while harvesting plots. This activity diverts the operator's attention from the task at hand causing mistakes and changes in harvest rates.
8. When possible, utilize a grain cart with scales or a weigh wagon for comparison of harvested weights. This should serve to increase confidence in yield monitor results, and as a back up to identify errors early on during the harvest of the investigation sites.
9. Always keep good and thorough field notes. Provide sketches and record observations such as areas with poor weed control or poor stands. This information is essential when summarizing the field data and drawing conclusions from these results.

When used correctly, the yield monitor is an excellent investigative tool that farmers can use to increase their understanding of the factors affecting the profitability of their farming operations.

The University of Kentucky's Subsurface Drip Irrigation (SDI) plots.

Initiated earlier this year, the UK-SDI plots are one of the first and largest plots to look at the potential of subsurface irrigation. With high-strength drip irrigation tape installed 18 in. deep on 5 ft. centers, researchers intend to simulate various crop rotations that include corn, soybeans, tobacco, and alfalfa. The PA team is playing a vital role in this project as this picture illustrates. Note the yellow strips in the N-trials in the corn plots, the yellowed alfalfa suffering from a potato leafhopper infection, and the spatial differences in the development of the tobacco crop.

Saving and Storing Yield Data

Dennis Hancock

As this harvest season cranks up, it is a good idea to think about how you should save and store your previous yield data and the data from this year's harvest. There are important distinctions between saving, backing up, and archiving your yield data. Just as a reminder, here are some "rules of thumb" about how and how often each of these should be done.

Saving

Data is no good if you don't have it. Thus speaks the voice of experience! Though this seems like stating the obvious, you have to save your data. It is all too easy to forget to save yield data, so I suggest saving it on a routine (preferably daily) basis. Every time you climb down out of the combine for the night, take the card with you and save it to your computer. Those extra few minutes every night will save you from pulling your hair out when you discover you've lost a whole day, whole field, or even whole farm's worth of data.

Backing Up

Once every week or two, you should backup your data. Most of the common software packages have a "BackUp" utility that saves the data in the proprietary format of that software. See Insert below. Essentially, backing up creates a copy of your data file or files, which gets saved to a floppy, CD, or other storage device. Then, this copy can be kept in a separate and safe place in case your original data is lost.

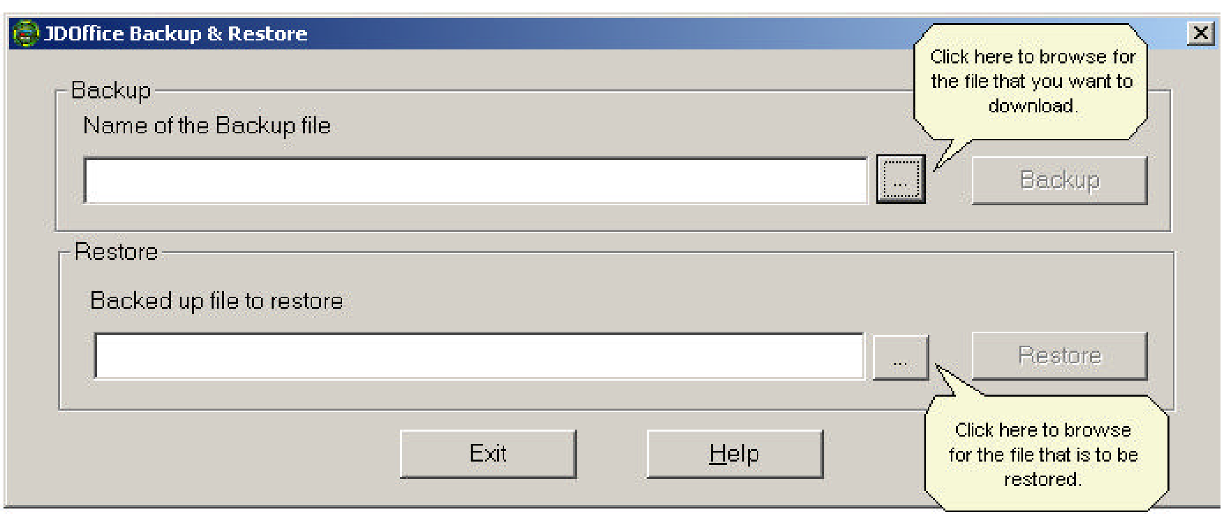
Archiving

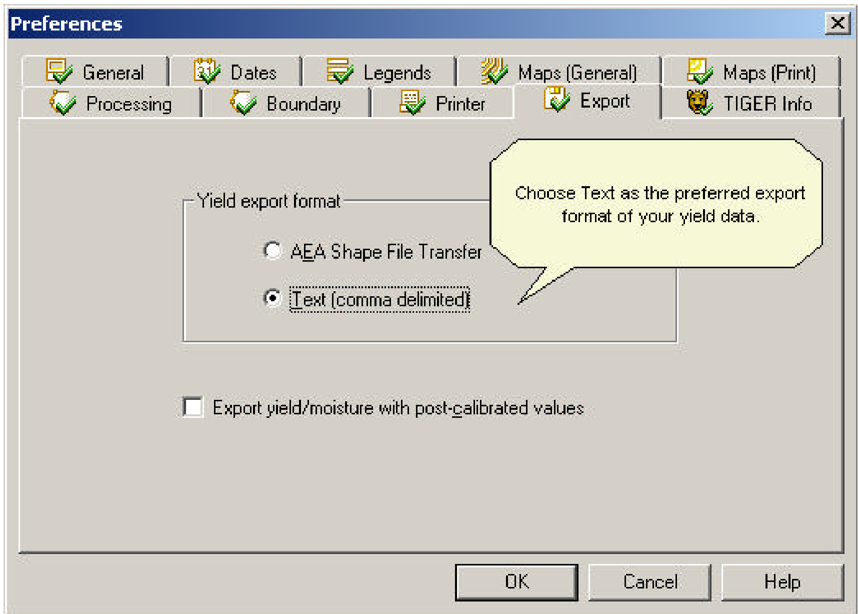
Though they are similar, backing up your data is not the same as archiving your data. As mentioned before, when data is backed up using the functionality of your software, it creates a copy that is usually only fully accessible in that computer program. In other words, you may or may not be able to use that in another software program, and even if you could import it in, you may not have all the data that you need. The absolute best way is to "Archive" this data by exporting it in a more universal data format, such as a shapefile (.shp) or as a comma delimited text file (.txt). See Insert on page 5. These formats are usually easier to import to other programs. Text files are nearly universally importable or can be manipulated into an importable form. With rapid development and changes in the software market from year to year or even week to week, it is a good idea to archive your data onto a CD or other suitable storage media at least once every few months. This will allow you to import your data into software packages that will be available years from now.

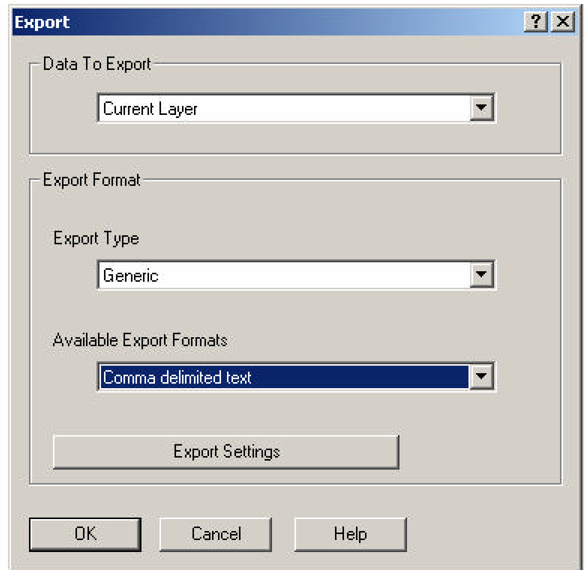
On Your Mark,... Get Set,...

Backup Functions in the Software

Here we see a screen shot that is an example of what some software programs offer as a built-in routine to backup your data. Some questions have come in as to how to browse to the file that is to be backed up or restored. Notes have been added below to show what to click.







Export Functions

Export functions in most software packages enable the archiving of data as shapefiles or text files. These files can then be imported back into that software or future software packages that you may use.

On the left is the export utility in AgLeader®'s software package SMS™ .* With an open data layer click Export under File. Then choose to export the Current Layer in a Generic Export Type as Comma delimited text. Check the Export Settings to ensure that you are exporting all of the individual data columns that you actually want and then click OK to save it.

In JDOffice™ set up the Preferences (under the File menu) so that Export will format the data as Text (comma delimited). Then click Export (under the File menu), choose the file to export, then click OK.

* These procedures are the same in CaseIH's new AFS system's software package.

Dr. John Grove, Assoc. Professor in Agronomy, presents a synopsis of his research at our recent precision agriculture project's External Review. PA practitioners from our state and researchers from other institutions were invited to attend and comment on our project's status.

Quotables: *Twain-isms*

"He was a very inferior farmer when he first began, but a prolonged and unflinching assault upon his agricultural difficulties has had its effect at last and he is now fast rising from affluence to poverty." *– in* **Mark Twain's** *Rev. Henry Ward Beecher's Farm, A Curious Dream.*

"There are two times in a man's life when he should not speculate: when he can't afford it and when he can." *in* **Mark Twain's** *Following the Equator, Pudd'nhead Wilson's New Calendar.*