

Enhanced Farm Research Analyst (Paper #894)

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Enhanced Farm Research Analyst is a collection of tools that extends the capabilities of ArcView GIS to accommodate the needs of crop researchers and others involved in field scale agricultural experimentation. EFRA simplifies many of the tasks involved in setting up research plots in a GIS. EFRA helps in creating the layout of field experimental units and blocks. It also provides an easy to use interface for preparing data for statistical analysis including several descriptive statistics functions for point and surface features by experimental unit or treatment. EFRA makes possible other tasks that would be beyond the capabilities of normal research design and data analysis. Developed at the University of Illinois, EFRA is a freely available download for researchers, farmers and crop professionals.

EFRA

Enhanced Farm Research Analyst (EFRA) is an extension to ArcView GIS 3.x. It is a tool for designing, implementing, and analyzing crop research plots. Developed at the University of Illinois under the direction of Dr. Don Bullock, EFRA is a culmination of years of experience in designing on-farm research plots and analyzing the data that is generated through precision farming operations.

Designing and evaluating crops research increasingly makes use of GIS. Without GIS, crops research used small plots that had to be flagged in the field using measuring tape or measuring wheels. Hand harvesting would estimate yields for each plot. With a GIS plots can be more easily designed and implemented with in-field use of GPS equipment. Plots can also be taken to a larger, field-scale level when GIS and GPS take the place of hand-drawn maps and flags.

But even with a GIS, plot design can be a tedious process. Each plot needs to be constructed, then the treatments need to be assigned to each plot in a scientific manner. The harvest data from each plot would need to be input into the GIS. Finally, analysis of the data could be done to determine the comparison of the treatments.

EFRA was born out of the drudgery of creating plots in a GIS and analyzing the data. It was designed to streamline to processes involved in doing on-farm research. With EFRA researchers can save valuable hours in experimental design. They can quickly try several layouts and make adjustments to meet the particular conditions found in the target field. After the plots are laid out, treatments need to be applied in an unbiased manner. In a move forward from the flip-a-coin days, EFRA provides the tools needed to quickly and scientifically assign treatments to the plots.

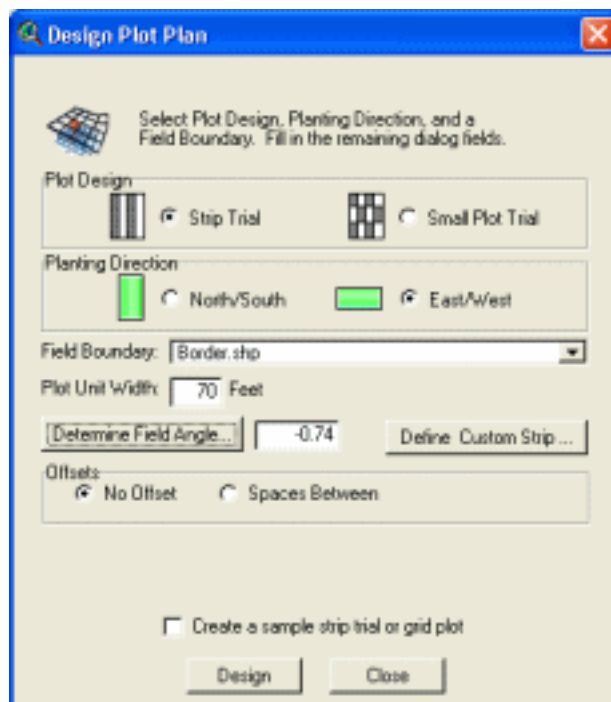
In today's research environment, many treatments are applied by commercial applicators with variable-rate equipment - particularly when the experiment is hosted by a cooperating farmer. EFRA provides the researcher a set of tools for creating treatment recommendation maps based on yield history and other parameters. These recommendation maps can be converted to application maps, used by the applicator to apply the product in the field. EFRA also makes use of yield data collected with a yield monitor. Data can be imported, filtered, enhanced with additional calculations of crop nutrient removal and adjusted for a common grain moisture, and converted to a shapefile all in one step saving much time and improving consistency of data sets.

EFRA can also greatly improve the efficiency of analyzing data. In addition to its own data analysis tools for grids and point data such as yield, it is designed to export data for use in Microsoft Excel and high-end statistical analysis packages.

This paper takes a closer look at the tools EFRA provides the crop production researcher.

Plot Design

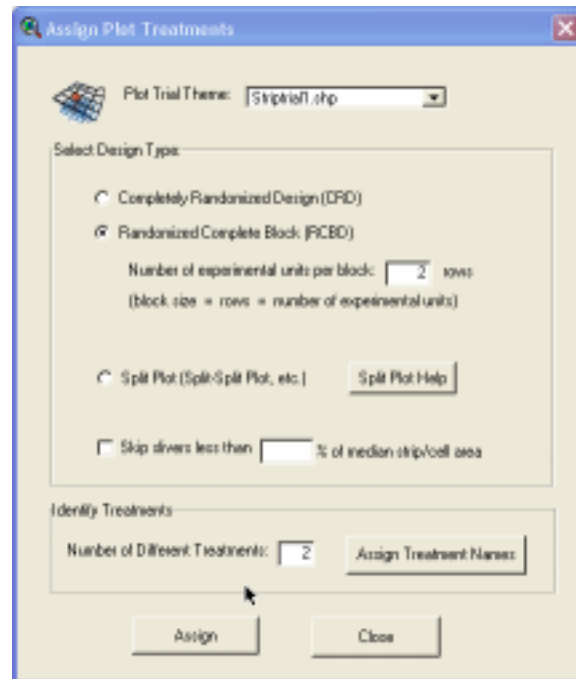
Using EFRA a researcher can design various plot layouts for a particular field location. EFRA's Design Plot Plan guides the user through choices for layout of the plot in the field. Users can choose strips or small plot designs. Plot buffers can be included to reduce the impact of edge effects. The Define Custom Strip tool allows you to create contoured strips to match the field border or terracing in a field. EFRA creates a new shapefile based on the information entered and allows the user to eliminate partial plots to generate the design appropriate for the experiment.



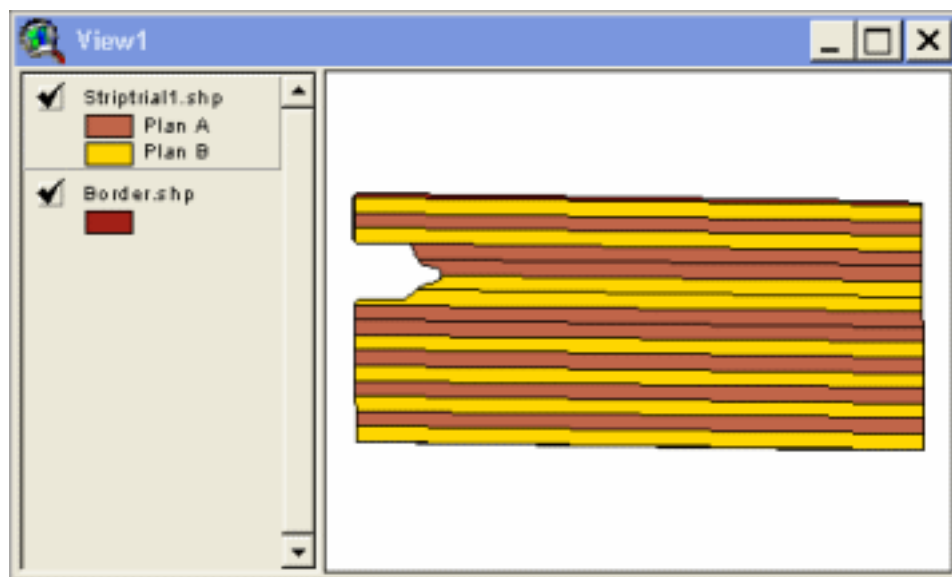
The Assign Plot Treatments dialog allows users to then assign plot treatments to the features in the plot

shapefile. Plot treatments can be assigned based on several different standard experimental designs:

- Completely Randomized Design (CRD)
- Randomized Complete Block Design (RCBD)
- Split-Plot (Split-Split-Plot, etc.)



EFRA then assigns treatments to the features based on the other parameters plugged in by the user. The changes are saved to the plot shapefile and the new plot plan with treatments is displayed in the View Window.



Data Handling and Analysis

While the plot design tools are a unique and powerful tool for researchers there are several other features of EFRA that also provide a benefit to data handling and analysis.

One of the big jobs in crop production research is managing the data that comes in from the field. That data may be sparsely populated soil test data, dense yield data sets, and other farm operations or scouting notes. EFRA provides some tools for the standard importation of yield data. Through an ODBC-connected Microsoft Access database, the user can define defaults for crops in their region that would impact the calculation of yield measurements and mapping.

For example, in Illinois corn is a major crop. An Illinois research can put in default information about the crop such as the standard dry moisture content of the grain and nutrient removal rates. When corn yield data is imported into EFRA from a text file, EFRA adjusts the yields to the standard dry moisture content and calculates the phosphorus (P) and potassium (K) removal rates. These attributes are stored in the resulting shapefile. Thus, yield monitor data can be quickly imported into EFRA for further analysis. EFRA also allows for minimum and maximum yield values. With these parameters, yield values outside an acceptable range can be filtered out of the dataset during the import process, saving additional steps to this tedious process.

The screenshot shows the 'Crops' dialog box in EFRA. It contains several input fields for crop parameters. The 'CropName' field is set to 'Corn'. The 'Units' field is set to 'bu'. The 'AveYield' field is set to '175'. The 'TestWeight' field is set to '56'. The 'LowYield' field is set to '20'. The 'DryMoisture' field is set to '15.5'. The 'HighYield' field is set to '400'. Below these fields is a section titled 'Removals' which contains a table with two columns: 'Element' and 'Removal'. The table has three rows: the first row has 'K' in the 'Element' column and '0.29' in the 'Removal' column; the second row has 'N' in the 'Element' column and '1.2' in the 'Removal' column; the third row has 'P' in the 'Element' column and '0.36' in the 'Removal' column. At the bottom of the dialog box, there are two record navigation controls. The first control shows 'Record: 1 of 3' with navigation buttons. The second control also shows 'Record: 1 of 3' with navigation buttons.

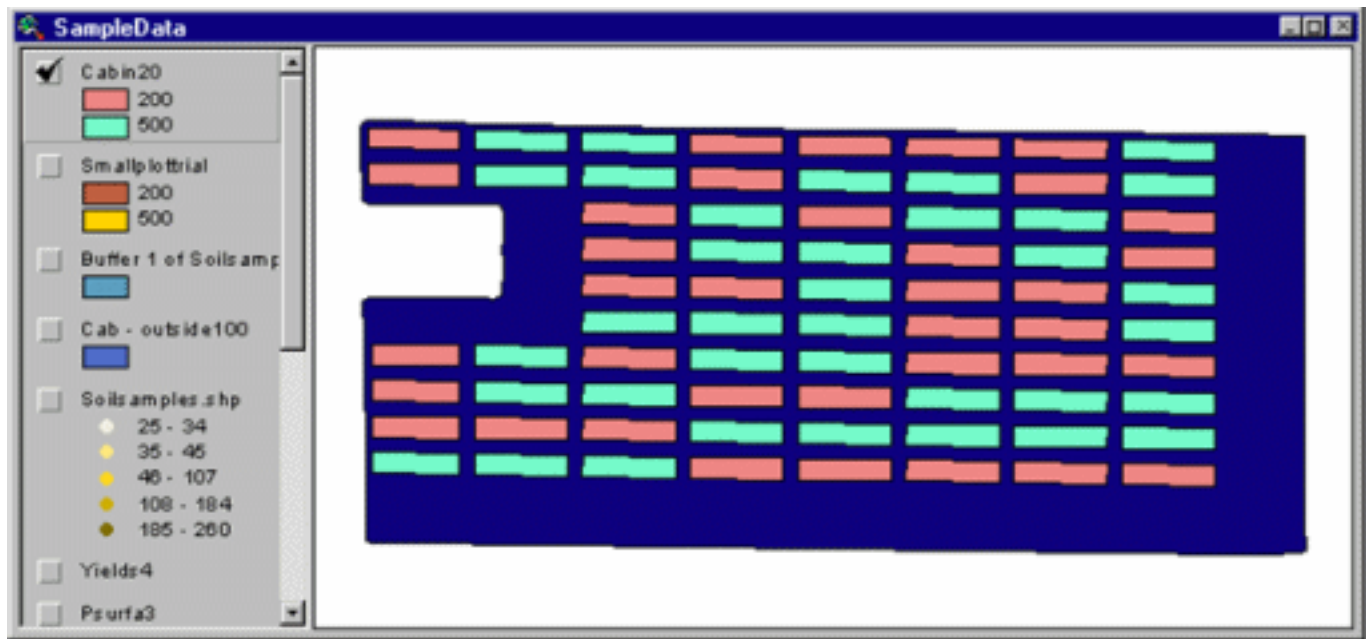
Element	Removal
K	0.29
N	1.2
P	0.36

In addition to the import features, EFRA allows for the batch creation of surfaces interpolated from a point data set. A typical example would be the creation of a soil test phosphorus map. Soil samples may be taken on a 1-acre grid, but a fertilizer recommendation map needs to cover the whole field. To determine the fertilizer need on the remaining areas of the field, the soil test values are interpolated to provide a variable map for the whole field. EFRA allows a user to create multiple surfaces from one shapefile in one step.

For example, a typical soil test shapefile will contain attributes of P, K, organic matter, and pH. EFRA

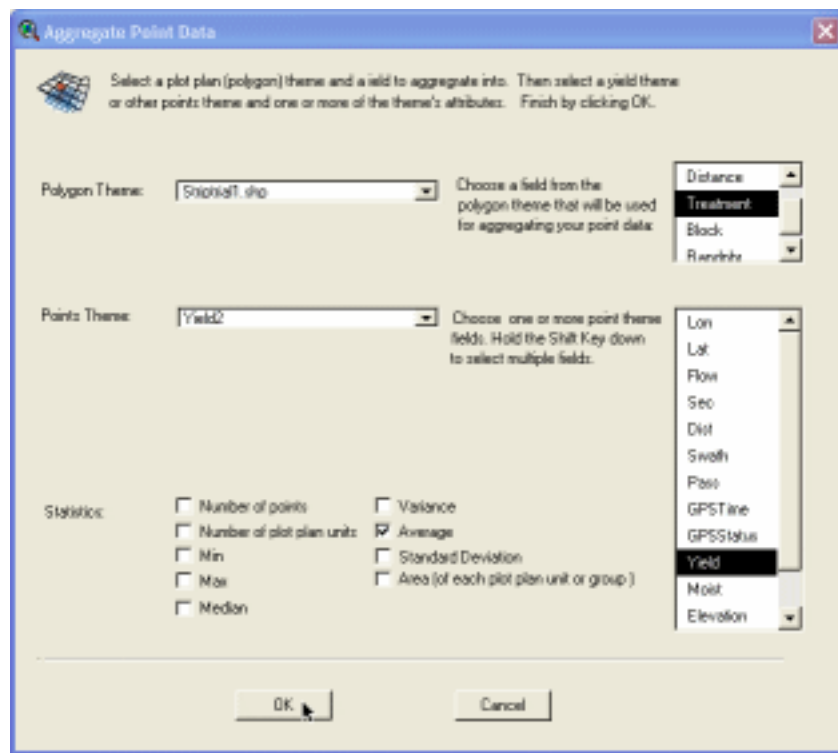
helps the user create all for maps with one step, the user just selects the attributes to interpolate. EFRA also provides access to the Kriging interpolation algorithm - not found in the standard Spatial Analyst 2.x interpolation options.

Another useful tool in EFRA is the Create Analysis Buffer. This tool creates a buffer around or inside points, lines or polygon features. The resulting shapefile reflects the desired buffer. In addition, the attributes of the buffered features are part of the new buffered shapefile.



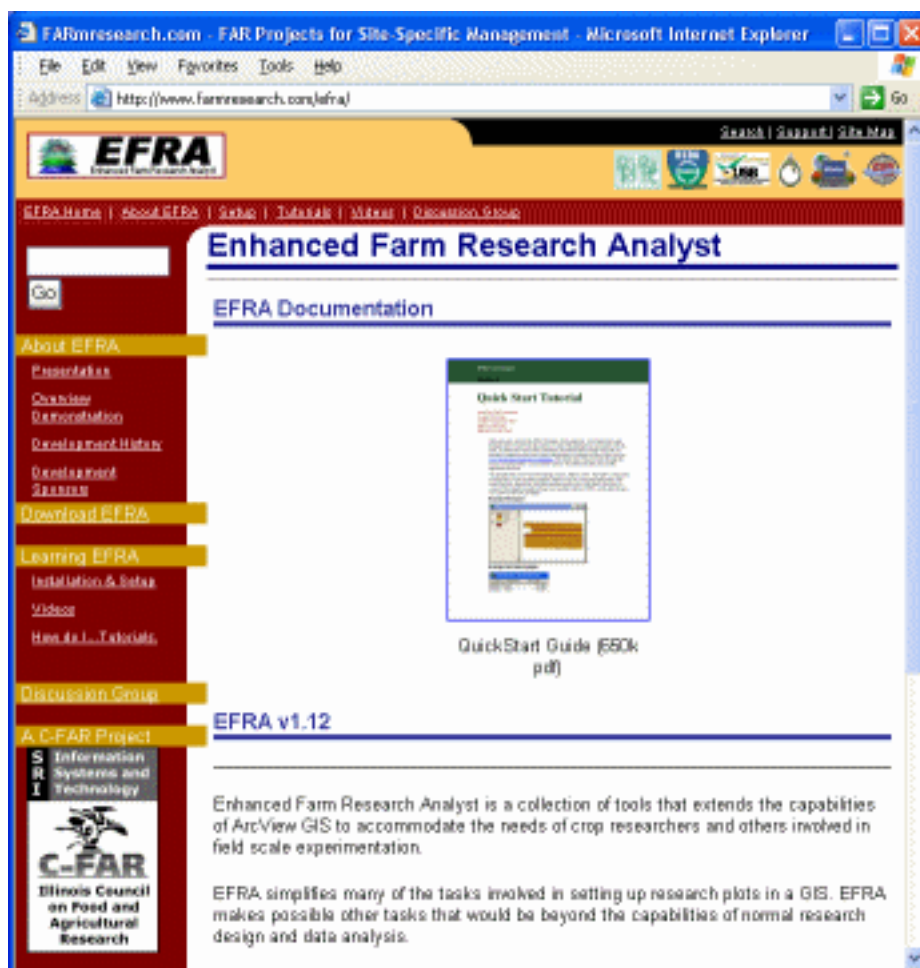
There are also two powerful analysis tools available to help researchers quickly compile the results from their experiment. The Aggregate Grid Themes tool allows a user to generate descriptive statistics for a polygon (plot) or group of polygons (treatment x) from the grid themes in the project. For example, if you had an experimental design of small plots which featured two treatments and surfaces of soil test P and soil test K, you could generate descriptive statistics for each of these surfaces by plot or by treatment by using the Aggregate Grid Themes wizard.

Similarly, the Aggregate Point Data allows you to quickly get the descriptive statistics for point data by polygon. A typical application of this tool would be to analyze yield data by treatment at the end of the experiment.



The integration of all these features into a GIS environment like ArcView provides the researcher with a powerful tool set for crop production research.

EFRA is freely available online at www.farmresearch.com/efra.



Acknowledgments

EFRA would not be possible without the tremendous contributions from those involved. Dr. Don Bullock at the University of Illinois spearheaded the development of EFRA along with the programming expertise of Ron Milby of GROWMARK during the initial stages of a crops research project sponsored by the United Soybean Board. Following that project, Dr. Bullock secured funding through the Council for Food and Agriculture Research (C-FAR). This allowed for additional refinements and enhancements to the extension. The programming for these enhancements was led by David Stigberg.

All these people and the research organizations that provided financial support deserve recognition as the foundation of EFRA, without whose support development would not have been possible.

References

More information about EFRA and its development is available at www.farmresearch.com/efra.

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