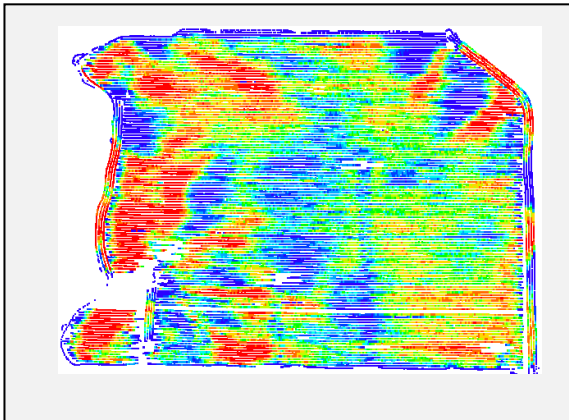


Yield Editor 2.0

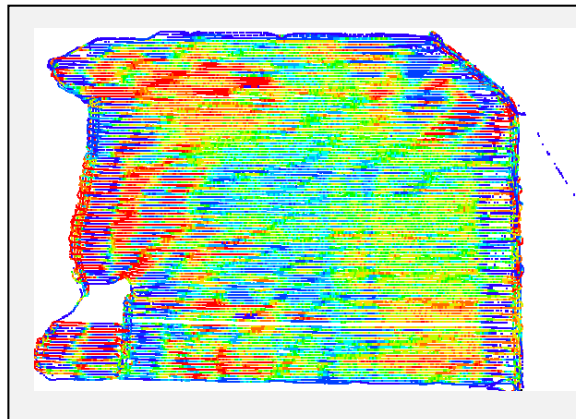
Because turning this...

```
-93.260872,39.294012,0.00,24538654,1,44,180,0.00,1,1,3260,"F1: C3S","L1: ","Corn","DK 616"  
-93.260889,39.294006,0.00,24538655,1,45,180,0.00,1,1,3260,"F1: C3S","L1: ","Corn","DK 616"  
-93.260897,39.294004,0.00,24538656,1,50,180,0.00,1,1,3260,"F1: C3S","L1: ","Corn","DK 616"  
-93.260908,39.293998,0.00,24538657,1,50,180,0.00,1,1,3260,"F1: C3S","L1: ","Corn","DK 616"  
-93.260925,39.293993,0.40,24538658,1,50,180,0.00,1,1,3260,"F1: C3S","L1: ","Corn","DK 616"  
-93.260939,39.293987,2.00,24538659,1,51,180,0.00,1,1,3260,"F1: C3S","L1: ","Corn","DK 616"  
-93.260950,39.293981,3.40,24538660,1,52,180,0.00,1,1,3260,"F1: C3S","L1: ","Corn","DK 616"  
-93.260966,39.293973,6.40,24538661,1,52,180,0.00,1,1,3260,"F1: C3S","L1: ","Corn","DK 616"  
.  
.  
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-93.260978,39.293968,7.10,24538662,1,53,180,3.50,1,1,3260,"F1: C3S","L1: ","Corn","DK 616"
```

into that...



and not THAT...



should be as easy as this. →

<click>

Introduction

Yield maps are a key component of precision agriculture, due to their usefulness in both development and evaluation of precision management strategies. The preparation of yield maps is complicated by the fact that raw yield maps contain a variety of inherent errors. The removal of these errors is critical, since they are present in a relatively large proportion of the data observations. Researchers generally report that somewhere between 10% and 50% of their data observations should be removed by filtering procedures, depending on the specific data set and filtering procedures used. Even at the 10% level, these errors – if ignored - will have a strong effect on resulting yield statistics, and may lead the end user to very different conclusions than would the raw data.

Currently, no standard method exists for cleaning yield data, though many different filtering techniques have been suggested to address specific error types. While a generally accepted standard procedure for cleaning yield data is an important long term goal, a necessary first step is a tool that allows the user to select, apply and evaluate a variety of filtering techniques during the processing of raw yield data.

Yield Editor represents our efforts to develop just such a tool. It is based upon our own experiences with yield data processing issues as well as information gleaned from discussions with other experienced practitioners and researchers. We hope that you find it both useful and easy to use. However, please realize that this is NOT a finished product, and errors, both coded and conceptual, are bound to exist. If you find such problems, please let us know. If you have suggestions for modifications or enhancements that you feel would improve the tool, we would appreciate those as well. Even just a note describing the features that you like or dislike the most will help us as we try to complete development of this software. Thank you in advance for taking the time to evaluate this tool.

The new beta version 2.01 of Yield Editor includes some of the improvements and updates that users of the software have asked me to include. I'm planning to do several updates over time – some of which will be due to trapping errors that users always seem to find – but some will be completing additional features that are currently under development, almost all of which are due to user suggestions.

While the basic engine is still intact, there are many new features that attempt to better automate the yield cleaning process. In particular, the Automated Yield Cleaning Expert (AYCE) module is able to filter a very high percentage of yield errors out of yield maps very quickly, and with little or no user input. A legend tool has been added that can assist the user in interactively determining the best setting for many of the filters. And a command line tool has been added to allow for batch mode processing of large data sets – a tool that those with thousands of acre-years of data may be happy to see. We hope you find this software useful, and please continue to provide feedback as we continue to revise and improve the software.

Contact Information

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Requirements and Installation

System Requirements:

Windows 95 (or greater, XP is currently the most thoroughly tested)
1024x768 (or greater) resolution display, 1280x800 recommended
600 MHz Processor or faster recommended

Installation:

Download and run the YieldEditor100.exe program. The program will ask you several questions about installation paths, shortcuts and quick launch options. The program installs in a standard windows fashion, and will set up the necessary uninstall files to make that process easy at a later date.

Running the software:

Use the start button to select the Yield Editor program from the Yield Editor folder. If you asked for shortcut or quick launch installations, you can also begin the program through one of these routes. The program starts, loads a default filter and configuration file, and then launches you into the *Load/Import File* tab - the first of the three tabbed pages that make up Yield Editor.

Major Changes to Yield Editor

Automated Yield Cleaning Editor (AYCE)

For folks already familiar with Yield Editor, the most important addition in version 2 is the Automated Yield Cleaning Expert (AYCE) window, shown at the bottom of Figure 1, which introduces two new filters (Overlap (OVL) and localized standard deviation (LSD)), as well as allowing automated selection of parameters for many of the previously existing yield filters. There are now options for automated selection of delay times (for grain and moisture flow) as well as automated selection of reasonable parameter ranges for many of the original Yield Editor filters described later in this document. Methodology used by AYCE for setting each of these parameters is more completely described in Sudduth et al., (2012) and provides data on the performance of these tools on a large test set of harvest data. See the section in this manual on AYCE for more details.

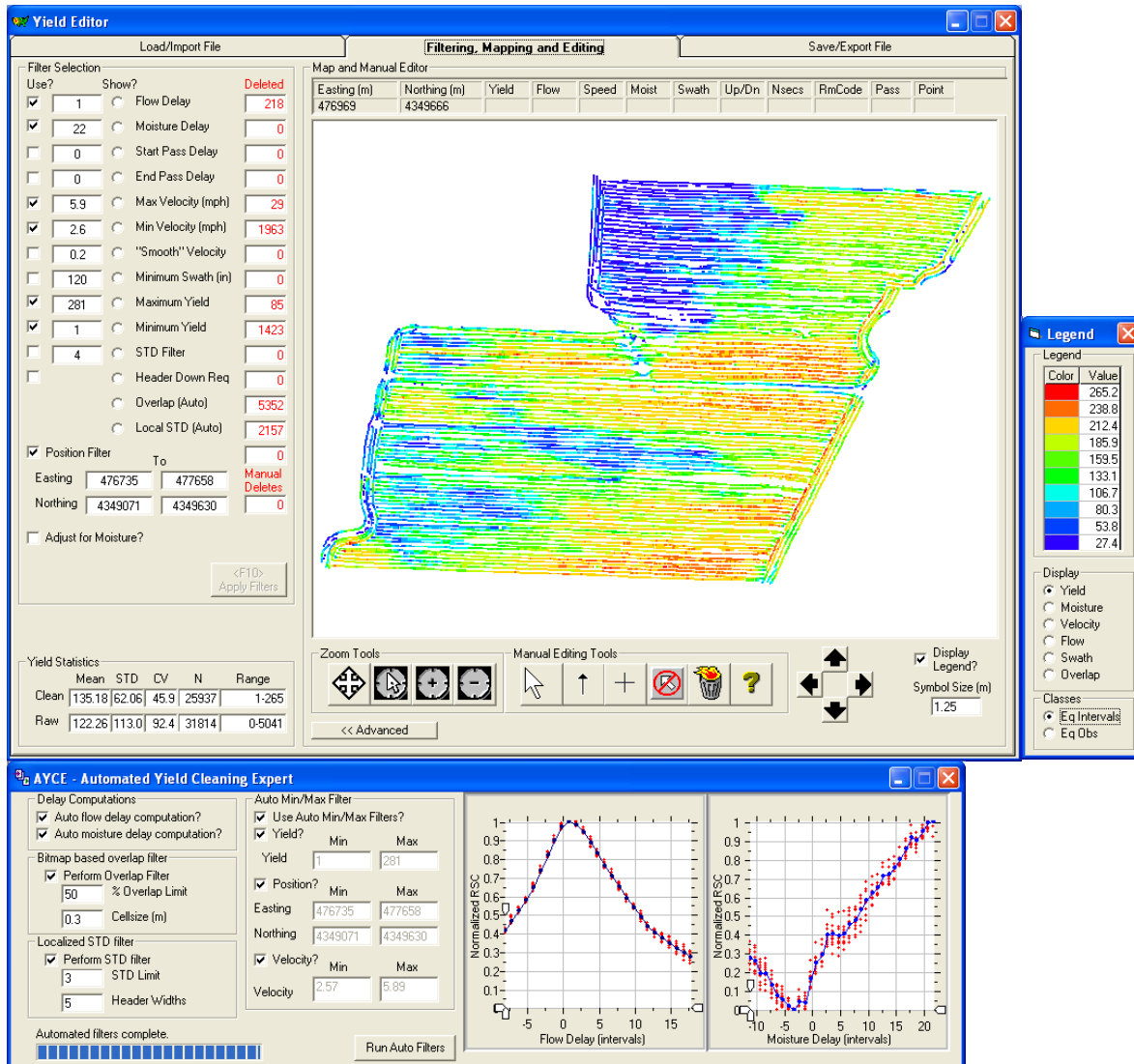


Figure 1. Layout of Yield Editor 2.01 and its two additional windows.

New Legend Feature

A legend tool was implemented in version 2 to help the user set filter parameters more accurately, as well as to make exploration of the data more informative. This feature, seen at the right of Figure 1, can be turned on or off at the bottom right of the Map and Manual Editing tab. Data which can be displayed by the legend tool include yield, moisture, velocity, grain flow, swath width and overlap ratio (if the automated bitmap method was run). This makes it much easier for the user to find “oddities” in the data, and to help diagnose possible problems within the data. There is also an option to select equal intervals for the ten color classes, which divide the data range up into 10 equal width intervals, or to select equal observations, which places 10% of the data observations within each of the ten color classes. The first method is useful to help find individual spikes and flyers, while the second is often useful for accentuating the structure of spatial trends when the yield of the field is relatively uniform. This can highlight thresher delay lags across linear and areal features, assisting in the interactive selection of delay times.

Beta Version Warning

Be aware that the current version of Yield Editor 2 (v 2.01) is currently in beta development. That means that errors can, and likely will occur during your use of the product. If you are unwilling to deal with this, you would be well served to continue using the previous version of the software, which will remain available from the website below until this version is considered stable.

<https://www.ars.usda.gov/services/software/download.htm?softwareid=20&modecode=36-20-15-00>

Form Layout and Design Descriptions

Load/Import File Tab

There are several frames on this page that provide various functions related to loading and import of various files and configuration settings. We'll take a look at several of them, one at a time.

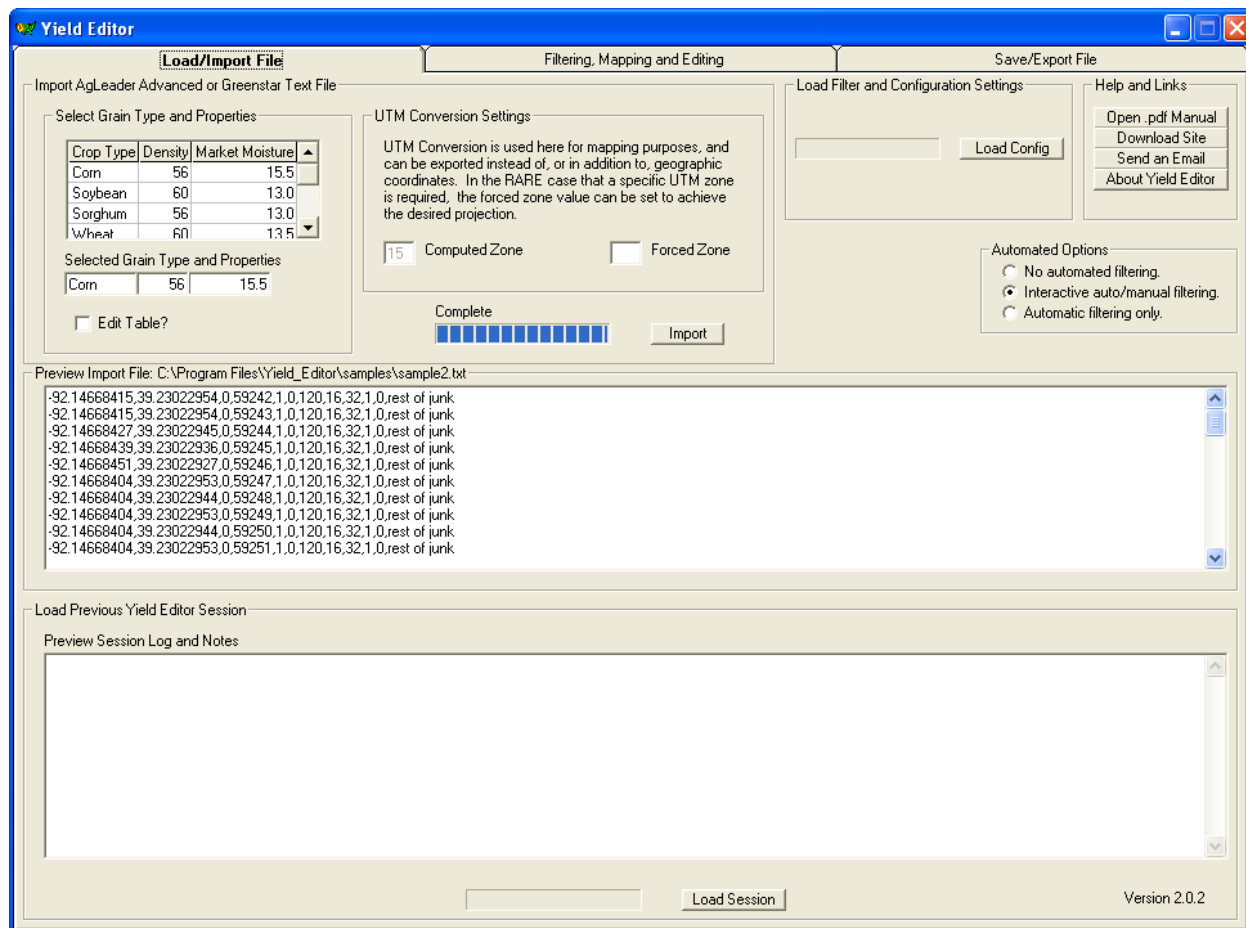


Figure 2. Layout of Load/Import File tab of Yield Editor.

Help and Links

This frame provides you with a link to this manual, in adobe acrobat format (.pdf), as well as a link to the USDA-ARS Cropping Systems and Water Quality Unit download site, where you can download the latest version of this software. Additionally, there is a direct email link that you can use to ask questions and/or provide feedback regarding this software. Finally, this frame also provides an About button, which shows the current version of the software and compilation date of that version.

Automated Options

This frame (shown in the top right on Figure 2.) allows the user to decide whether they will use the new automated features in the AYCE window, or whether they will use manual filtering and

editing features from past versions. No automated filtering does not launch the AYCE window, so the automated features are disabled. Interactive mode allows the user to use automated filters, but then to modify and/or include additional filtering and editing to the resulting map. Automatic filtering only applies the automated filters and exports the data automatically once AYCE is complete. For more information on AYCE and its operation, see that section of this manual.

Load Configuration File

This frame allows the user to load a configuration file using the *Load Config* button, which sets all of the filter and configuration settings that will be used to edit the yield data. At startup, the Yield Editor software will search for a “DEFAULT.SET” file in its program directory. If found, this file will be loaded, and those configuration and filter settings will become current. To override these settings, the user can, at any time, load a different configuration (or session) file.

You will likely want to develop several different configuration files as you become familiar with the software. For example, I have, at minimum, a different configuration file for each combine/crop combination. That way, when I am ready to import corn yield data from my R42 Gleaner, I already have a configuration file that should have filter values that are *close* to what I'll want. Due to differences in operators, yield levels, and/or combine mechanical settings, they may not be *perfect*, but they should be at least reasonable. I may develop more specific configuration files to deal with more specific issues (i.e. a configuration for the JD9600 in extremely wet corn with Matt operating, etc.)

You can load a new configuration file at any time – but realize that changes will not be reflected in the map or in any output until you apply the filters on the *Filtering, Mapping and Editing* tab. However, in general you will want to load your configuration file first - before importing your data.

One further note – the basic yield unit that is computed by Yield Editor is lb/ac. To get to another unit, your grain type density setting must be something other than one. For example, to get to bu/ac for corn, density should be set to 56. To get to hundredweights for sorghum, density must be set to 100. You can use this feature to convert output yield to any units you wish, with a little mathematical savvy.

Select Automated Options

Yield Editor 2 can be operated in three modes. The first is to use NO automated filtering, which causes it to function exactly as the original versions were designed. The user must select his filter parameters, apply them, and then save the data when he is finished.

The second method is to use interactive mode. In this mode, the user MAY choose to apply automated parameters and use some additional new filters. However, he may override the settings, modify the results, and/or manually edit the data to meet his needs.

The third method is to use automated mode. In this mode, the software is generally called from a batch file, parameters are defined both by the settings file and by the automated yield cleaning expert (AYCE) routine, and the data are processed and saved automatically to predefined locations.

Import AgLeader Advanced or Greenstar Text File

Once your configuration file is loaded, you'll next want to import some yield data. But before you do, first, make certain that your *Selected grain type* is correct, and that the crop density and market moisture levels for that grain are set properly. You can choose a different *Selected grain type* by double-clicking on the appropriate line of the table. You can use the *Edit Table* checkbox to Add, Delete or Modify entries in this table to meet your specific needs. If you don't want to have to enter these changes every time, you should save your default configuration file after your edits are complete and correct.

Next, you may want to change your geographic projection information. This software uses UTM coordinates for all mapping and calculations. As a result, the software must know what UTM zone the data should be projected into. The software computes a UTM zone based upon the first longitude and latitude found within the imported text file. As long as the data in that first line is "good" there should be no problem, and the conversion should work properly. There are times, however, where a producer might have many fields in UTM zone 15, and one field that barely falls into zone 16, and he may decide to project all his fields into zone 15 for convenience. In that case, the user can specify the *Forced Zone* value (15 in this case), and the data file he imports will then be projected to that zone.

Once your configuration, grain type and projection options have been set, you'll want to import some yield data using the *Import* button. The default file extension that the software will be searching for will be (*.txt) and should be of type AgLeader advanced or Greenstar text ONLY. Select the file for import and hit the *Open* button. The software will quickly import about 50 lines of the file for you to preview, will compute the default UTM zone from these data, and will ask you to confirm that the file, grain and projection settings are appropriate. If any of the three are incorrect, cancel this confirmation, select the correct settings, and begin the import process again. A status bar will keep you informed as to progress, and will let you know when the import is complete. If an error occurs during the import, a message will be provided. The most common cause for an error occurring at import is that the file not in either an AgLeader advanced or a Greenstar text format.

Exporting Data from Commercial Software

This software is designed to work with any data that is in AgLeader advanced or Greenstar text formats. However, in order to have the greatest control over the editing process, and to avoid the possibility of losing some useful information at the end of transects, we recommend that you select your combine export parameters from your commercial yield management software in a manner so as to minimize the number of points that will be deleted during the export, since we can easily filter any excess points, but cannot "recover" points which have not been exported. To do this, you should set a grain flow delay time that is close (± 5 s), but not necessarily identical to the correct value. In our experience, 12 seconds would be suitable on the vast majority of combine setups. Next, you should select zeroes for start and stop delays. You should probably disable minimum and maximum yield filters, and may even want to allow export of positional flyers and/or points where the header has been raised as well, if your commercial software allows you to select such options.

Import Data Using FOViewer

FOViewer provides a very simple way to download the data directly from a card into Yield Editor, without the time consuming export procedure listed above. To import data using FOViewer, you must first download and install FOViewer and any driver files that are needed for the card image type(s) that you are using. (i.e. Deere, AgLeader, CNH). The software can be downloaded from the Mapshots Inc. website, located at:
(<http://www.mapshots.com/FODM/fodd.asp>)

First hit the FODD key (bottom right) and choose the type of card you will be downloading. Next, switch to the map view, and select the fields and/or loads that you want to bring into Yield Editor. Finally, hit the Yield Editor icon  at the top of the page, and Yield Editor will be launched with the selected data already loaded and ready to process. Data can be filtered and edited, then exported and/or settings and sessions can be saved as well. *There are still some bugs I am working through with Version 2.01 and FOViewer. However, the system is quite stable using earlier versions of Yield Editor.*

Load a Previous Yield Editor Session

It is often the case that I find myself wanting to save my current editing session so that I can ask a farmer, a combine operator or consultant some questions about “oddities” that might exist in a particular map. The software allows you to save your current state (including filters and parameters, display settings, output formats, notes and more) to a file at any time. You can then load this file at a later point and continue the editing process. You can send the session file to another person so that they can get or give advice on how to proceed. You can even have them perform additional editing, make changes, add notes, and then save and return a session to you.

To load a previously saved session, hit the *Load Session* button, and choose the session you wish to load. The default file extension for a Yield Editor session is (*.yes). Select the correct filename and hit the *Open* button.

Note that Yield Editor 2.xx can read 1.xx files, and vice-versa. However, there are some advanced features of version 2.xx files that will be ignored by 1.xx versions of the software.

Note: Loading a session file loads both data and configuration information - in effect overriding your current configuration file.

Importing “other” data

The program will allow other data formats and crops, such as grapes, cotton, etc. to be processed using Yield Editor, as long as the data is placed in a format similar to AgLeader advanced export format (Table 1). The first ten columns must have at least a “placeholder” value so that parsing can be done properly, even if the value is a constant, and the columns that are **bold** are required for the software to run properly. Others, such as moisture and header status may be useful for additional filtering/adjustment purposes.

The data can be saved as a comma separated variable file (CSV), and then imported as if it were an AgLeader advanced file. Additional columns can be included after the tenth column, and they will be ignored by Yield Editor.

The pass number must exist, but it can be set to a single value, in which all data will be attributed to the same transect. This will cause some of the filters to behave erratically (e.g the start of pass and end of pass filters) and will mean that the transect selection tool will not be all that helpful to you, should manual editing be desired. Finding a way to increment pass number (e.g. when heading changes, when there is a time interval break, etc.) may be an easy way to create this pass number variable in a more useful way. Table 2 demonstrates a snippet of data in a format that will be accepted by Yield Editor.

Table 1. **Required** data fields in **bold** for emulating AgLeader advanced file format.

1) Longitude	decimal degress, negative in W hemisphere
2) Latitude	decimal degrees, negative in S hemisphere
3) Flow	pounds per second
4) GPSTime	seconds
5) Logged Interval	seconds
6) Distance	inches
7) Swath	inches
8) Moisture	percent wet basis
9) Header Status	unitless, 1 = harvesting, 0 = not harvesting
10) Pass Number	unitless, generally +1 each header up/down cycle

Table 2. A small sample of raw yield data in correct format:

-92.957970	39.878645	0	1034859103	1	36.96	342.12	11.2	0	1
-92.957974	39.878638	0	1034859104	1	34.2	342.12	11.2	0	1
-92.957976	39.878633	2.9	1034859105	1	27.6	342.12	11.2	1	1
-92.957981	39.878628	5.1	1034859106	1	25.2	342.12	11.2	1	1
-92.957984	39.878623	4.2	1034859107	1	19.68	342.12	11.4	1	1
-92.957985	39.878620	2.4	1034859108	1	15.36	342.12	11.3	1	1

Filtering, Mapping and Editing Tab

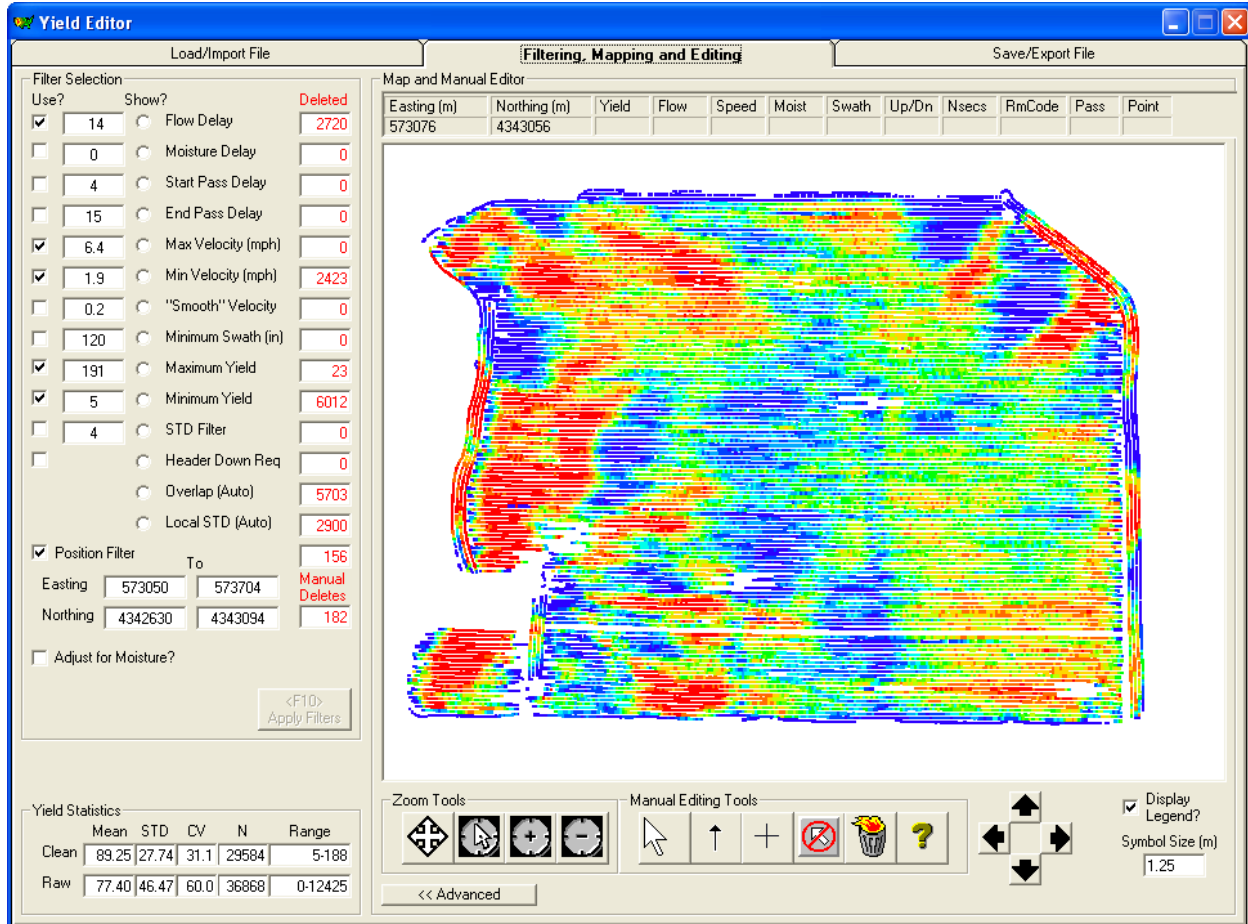


Figure 3. Layout of Filtering, Mapping and Editing tab in Yield Editor.

This is the tab where the actual work gets done. Once the data has been imported, or a session has been loaded, click on this tab to display a map of the current data. Along the left side of the form you will see a *Filter Selection* frame that deals with the selection, parameters and display of various filter types. Below that, you will see a *Yield Statistics* frame that gives basic statistics about the yield observations. The majority of the form is taken up by the *Map and Manual Editor* frame. At the bottom of this frame, there is an advanced button which, when clicked, makes available an *Advanced* frame that allows for some more powerful manual editing and masking features. Let's take a closer look at these four frames, in turn.

Filter Selection

Here you choose, modify and evaluate the performance of different filter types (shown on left side of Figure 3). To include a particular filter in the filtering process, click on the *Use?* checkbox to the left of the filter name. To modify the parameter(s) associated with the filter, change the information in the textbox next to the filter name. To "highlight" the points that have been removed by a filter, click on the *Show?* Button adjacent to the filter name. This highlights the filter name as well as the points affected by that filter on the map at the right in a magenta color. To display ONLY those removed points, double click on the *Show?* button. To turn off

this feature at any time, click on the *Filter Selection* frame, and highlighting will be turned off. To the right of each filter name are a set of textboxes that show the number of observations that have been deleted due to each of the individual filters. Note that a single point can be affected by multiple filters, so totaling these values does not give you the total number of points filtered (although that information can be found in the yield statistics frame).

Filter Types

Flow Delay (GFLO) – This parameter sets the length of time to shift the grain flow data within each transect with respect to the other data columns (position, velocity, etc.). A positive value indicates that grain flow will be moved backwards in time relative to position data, while a negative value indicates that flow will be moved forward in time. In general, the software packages used to create AgLeader advanced and Greenstar text files will have already applied a flow delay to their data. This filter is best used to slightly adjust this parameter, since Yield Editor allows you to rapidly adjust this filter and get immediate map updates. In this way, you can visually evaluate the best setting for this parameter very rapidly. A filter setting other than zero will result in some data at one end of the transect being deleted by this filter.

Moisture Delay (MFLO) – This parameter behaves in the same fashion as the flow delay filter, but with respect to the moisture data. There is no reason to believe that the delay time of grain travel to the moisture sensor should be the same as delay time to the grain flow sensor, and this filter allows you to compensate for that fact. A positive value indicates that moisture data will be moved backwards in time relative to position data. Negative values move the moisture data forwards in time.

Start Pass Delay (BEG) – This filter is used to trim observations off of the starting end of a transect. As the combine ramps into the crop, the yield estimates will be low and unreliable for some distance into the crop. This filter allows the user to chop a specific number of observations from each transect in the file at once. Note that the effect of this filter can be hidden by the flow delay filter, since a flow delay of 5 and a start pass delay of 5 will both remove the first 5 points from each transect. In general, when exporting data from your commercial yield management software to AgLeader advanced or Greenstar text files, you should set their start and end delay parameters to zero. This will make it much easier to deal with delay adjustments in Yield Editor, and will give you the most control over the editing process.

End Pass Delay (END) – This filter is used to trim observations off of the exiting end of each transect. As the combine ramps out of the crop, the yield estimates will be dropping and likely unreliable for some number of observations at the end of each transect. This filter allows the user to chop a specific number of observations from each transect in the file at once. Note that the effect of this filter can be hidden by the flow delay filter, since a flow delay of -5 and an end pass delay of 5 will both remove the last 5 points from each transect.

Max Velocity (MAXV) – This filter provides an opportunity to remove observations based upon the velocity of the combine. This is sometimes useful to remove partial swath transects that may have been harvested more rapidly, but were not properly marked in the yield monitor data. The parameter entry should be the maximum allowed velocity in mph.

Min Velocity(MINV) – This filter is one of the most critical to the yield cleaning process. As combine velocity approaches zero, while grain flow remains nearly constant, computations of point yields can become astronomical. To quickly identify and remove these points, a reasonable lower bound for combine velocity can be chosen, and points below this threshold automatically removed. The parameter entry should be the minimum allowed velocity in mph.

Smooth Velocity(SMV) – This filter can be used to help identify those regions where rapid velocity changes have taken place. The parameter here represents an allowable ratio of velocities from one point to the next point in a transect. A ratio of 0.2 means that points with velocity changes of more than 20% compared to its neighbors should be removed.

Minimum Swath (SWA) – This is another filter that can be critical, depending on your data collection procedures. If the combine operator has manually measured swath width throughout the field, and some of those swath widths near a value of zero, then swath width can have similar effects to velocity in the computation of yield. In that case, we can eliminate these problem areas by setting a minimum swath width filter. In this case, any points with swath width readings smaller than the minimum swath parameter (in inches) are deleted.

Maximum Yield (MAXY) – This filter sets a maximum threshold for reasonable yield values, in bushels per acre. If this (and the next) filters are active, the color scale used to graph the yield data is based upon the range of these two filters. The color scale is broken into ten equal size color segments, ranging through the spectrum from blue (lowest yield) to red (highest yield). If these two filters are not set, the color scale is based upon the maximum range exhibited in the yield data. This can often cause your color scheme to seem all blue, since high spikes in the yield distribution can stretch the scale out dramatically.

Minimum Yield (MINY) – This filter sets the minimum allowable yield threshold, in bushels per acre.

Standard Deviation Filter (STD) – This filter is used to remove yield data that are more than a certain number of standard deviations from the fieldwide mean of the yield data. The parameter is the number of standard deviations above or below the mean yield value that should be used for the bounds.

Header Down Req (HDR) – This filter removes any yield observations where the header down indicator was not present. Note: Depending on your settings when exporting the data from your commercial yield management software, these points may have already been filtered out of your data.

Position Filter (POS) – This filter allows you to remove positional “flyers” and/or data segments that are in your import file, but lie outside of the field of interest. The parameters are the easting and northing corners of the box that you want to REMAIN after the filter is applied. The coordinate system used here is NAD 83 UTM and the coordinates are in meters.

Adjust for Moisture (MST) – While not really a filter, since it removes no data, this section provides the user with the ability to modify yield values based upon the moisture status of the

grain. There are several things to consider here. First, if we are going to adjust grain yield back to a market moisture level, will we use the moisture sensor data to make this correction? Sometimes this is not a good idea, as the moisture sensor can have significant problems that may cause very large (and incorrect) adjustments to yield. Even if we do use the sensor, we will need a manual value to use in problem areas (the end of transects, etc.). Another approach is to use a constant manual value to make the correction across the whole field (for example, the moisture value reported at the point of sale). This approach is less prone to major sensor based errors, but may miss real variations that exist within a field. A final option that we need to consider is whether we want to expand the grain yields where the moisture falls below the market moisture level up to the yields they would have been at the market moisture level.

Yield Statistics

This frame in the Filtering, Mapping and Editing tab simply displays the mean, standard deviation, coefficient of variation, number of observations and the range of the yield values. There are two rows of data expressed. The lower row consists of the statistics on the raw data, prior to any yield editing. The upper row consists of the statistics for the remaining data at the current point in the yield editing process.

Map/Manual Editing Tools

This frame is where the yield map is displayed, and where manual editing of the yield map is carried out. At the top of this frame is a status region that has two major uses. As the mouse moves across the map area, the easting and northing values of the pointer are displayed. This provides the user a frame of reference, particularly if they are not familiar with the UTM coordinate system. Also, when a single point is selected, information about that selected point is displayed on the status bar including yield, grain flow, velocity, moisture, swath width, header indicator, time interval, a removal code (discussed later) a pass/ transect number and a point number within that pass.

The map itself consists of a number of yield observations, which are represented as colored squares. There are ten colors across the visible spectrum ranging from blue to red, and those ten classes are of equal size based upon the maximum range of the clean yield data. The symbol size of these squares can be adjusted using the textbox at the bottom right of the frame, and the units are map based, in meters. Two “special” colors may be evident on the map. A black outline around a square indicates that that observation is currently selected. A magenta outline around a point indicates that that point is currently highlighted. These two conditions will be covered in detail later.

There are three major groups of tools at the bottom of this frame: the zoom tools, the pan tools and the manual editing tools. We’ll look at each in order:

Zoom Tools



Zoom to Extents – Scale the map to the outer extents of the position data, or to the maximum extents of the position filter, if that filter is activated.



Bounding Box Zoom – Left click and hold on the map at one corner of the region you wish to display, and drag the pointer to the opposite corner of the area you wish to display and release the mouse button.



Zoom In – Performs a simple zoom in based upon the current map location.



Zoom Out – Performs the inverse operation to the zoom in tool.

Pan Tools



The pan tools consist of four directional buttons that slide the map a small increment in any of the four directions.

Manual Editing Tools



Point Select – This tool places the cursor in point select mode. The cursor that indicates that the user is in this mode is a white, angled arrow. While in point select mode, a click on the map will select the nearest point to the cursor, if that point is not already selected. If the point is already selected, the point will be unselected by that operation. The most recently selected point will have its associated data displayed on the status bar at the top of the frame.



Transect Select – This tool places the cursor in transect select mode. The cursor that indicates this mode is a vertical black arrow. While in transect select mode, a click on the map will select the nearest transect to the cursor, if that point is not already selected. If the transect is already selected, the transect will be unselected.



Bounding Box Select – This tool places the cursor in bounding box select mode. The cursor that indicates this mode is a black cross. While in this mode, a left click and drag followed by a release will select all of the points bounded by the coordinates of the drag operation. If the <Ctrl> key is held down in conjunction with this operation, the points inside the region will be unselected instead.



Unselect All – This button will cause all of the selected points to become unselected.



Delete Selection – This button will cause all of the selected points to become manually deleted. Pressing the key will also have this effect.



Query Selection – This button will open an analysis tool that will display several histograms based upon all currently selected data points. Data types analyzed include yield, grain flow, velocity, moisture and swath width. The user can page between any of these five histograms, and can increase or decrease the number of bars used to display the histogram, as well as rescaling either the X or Y axes. This tool can help the user diagnose possible problems in the data, and may assist them with the selection of reasonable values for many of the filters

Advanced Editing Tools

The final section of this tab which we need to consider is the advanced manual editing section. This section becomes available by hitting the <Advanced> button. These tools provide a very powerful way of dealing with problems that can come up during the editing process. However, these tools are a bit difficult to understand, and can confuse the user who is not familiar with them. In any case, these features should generally be used ONLY after all of the automated filters have been applied, as reapplying the automated filters MAY undo any masking (described below) that has been done.

The first option that you will see in this frame is the ability to select point types other than “Clean”. *Clean* is the default option, and will cause only those points remaining in the map to be selected by a select operation. However, there are times when a user may delete a selection and then realize that they want those points back. Choosing the *Deleted* option causes the selection tools to perform their operation ONLY on deleted points. Similarly, selecting the *All* option allows the user to select all points, clean or deleted,.

The usefulness of this feature is that we can then mask the effects of any of the filters, over any subset of points in the map. For example, suppose that we wanted to use a start pass delay of 7 seconds and an end pass delay of 12 seconds on a particular field. However, there were several areas in the field where the combine header was raised momentarily, say to cross a 1m wide ditch in the field. This would have the effect of causing a “break” in the transect, and the two areas on opposite sides of the break would be in different transects. Therefore, 7 seconds would come off of the “starting” end and 12 seconds would come off of the “ending” end – leaving a gap of about 19 seconds removed over that instantaneous break. We really do want to remove issues related to velocity, min a max yield, and all the other filters, but we would like to remove the effects of the start and end pass delays on these small areas only.

To accomplish this, we would choose the *Deleted* points option, use our selection tools to select the regions where we wanted to remove the effects of these filters, and then choose the filters we want to mask from the listbox. You can use the <Shift> and <Ctrl> keys to select multiple filter types from this listbox. As you select filters, the *RmCode* textbox will update with the specific masking value that will remove the effect of the selected filters. This *RmCode* is, in effect, a decimal representation of the series of binary filter flags that apply to individual data points. The individual bit flag values associated with each filter type are:

Flow Delay	= 1	= 2 ⁰
Moisture Delay	= 2	= 2 ¹
Start Pass Delay	= 4	= 2 ²
End Pass Delay	= 8	etc.
Max Velocity	= 16	
Min Velocity	= 32	
Smooth Velocity	= 64	
Minimum Swath	= 128	
Max Yield	= 256	
Min Yield	= 512	
STD Filter	= 1024	
Header Down	= 2048	
Position	= 4096	
Manual Deletion	= 8192	
Overlap	= 16384	
Localized STD	= 32768	

The *RmCode* for several filters can be manually added together and entered by hand into the textbox above the *Mask* button (though it is generally easier to select them from the listbox). Of more use is the fact that the *RmCode* can be exported (see Save/Export File section) and can be used on a point by point basis to determine the reason(s) for the removal of individual points.

Once you have your points selected and your filters to mask selected, hit the *Mask* button and the selected points that had been removed by those specific filters will be returned to *Clean* status and restored to the map. But points that were removed due to even one other filter than those selected will not be restored. Manual deletions, can be undone with the use of the last option in the filters to mask listbox – *Manual*.

Note: These masks are temporary in nature – meaning that if you reapply the automated filters by hitting the *Apply Filters* button, the areas that you restored will once again be removed. For this reason, you will want to make sure that you have finished ALL of your automated filtering before you begin the masking process.

Save/Export File Tab

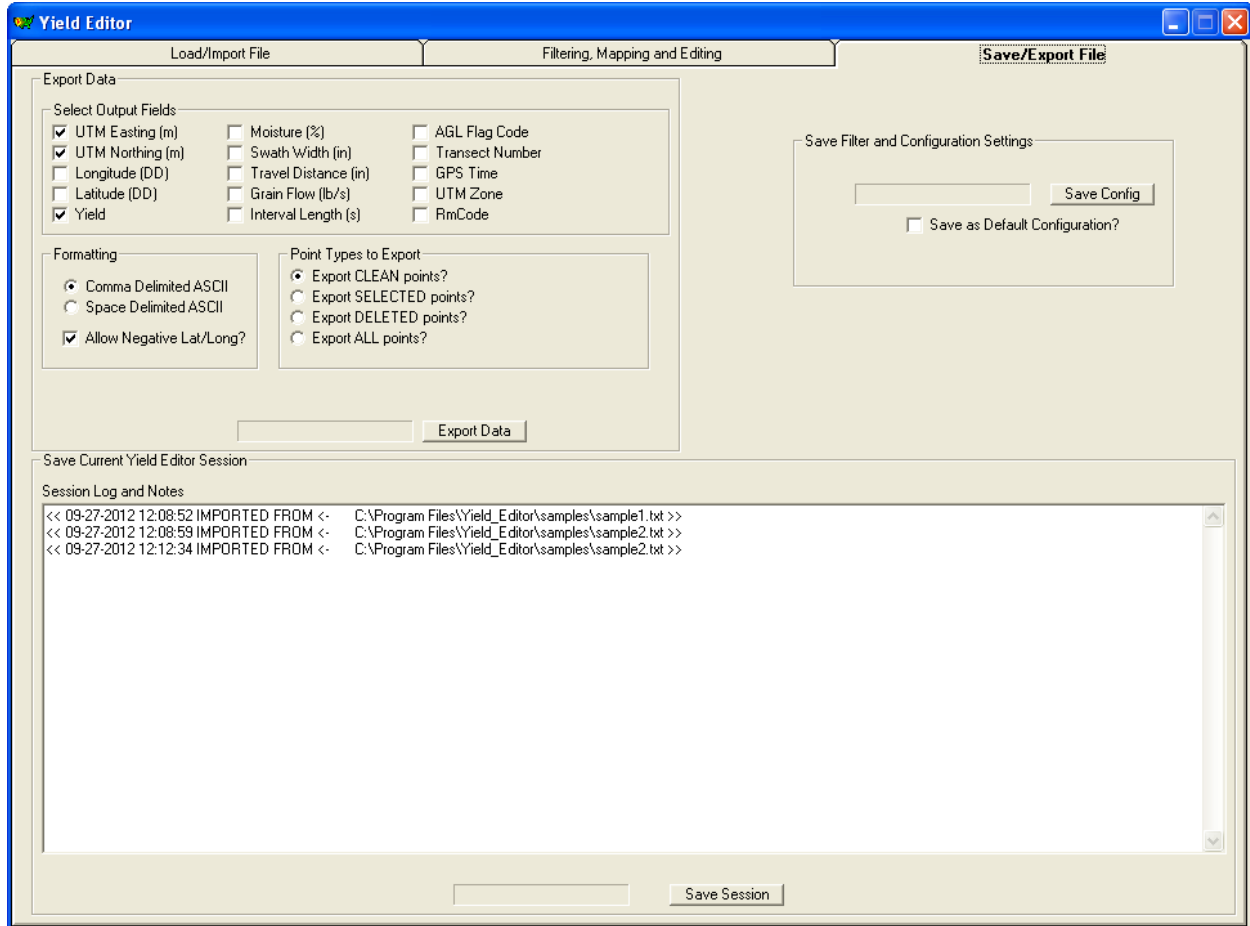


Figure 4. Layout of Save/Export File tab in Yield Editor.

This is the tab where our work gets saved. There are three frames on this page that deal with this process: *Export Data*, *Save Filter and Configuration Settings*, and *Save Current Yield Editor Session*. We'll take a look at each of these frames in turn.

Export Data

This is how we get our final product, clean yield data, out of our software (see upper left frame in Figure 4). The user can select which fields they want to output by selecting the check boxes next to each name. The data will be exported in the order listed, though only the selected columns will be output. Of these, the ones that are not self explanatory are AGL Flag Code, and RmCode. The AGL Flag Code is the value in the AgLeader advanced format that includes, but is not limited to the header indicator. For example, if you use their marking system in the field, the values of those marks will show up in this field. The RmCode is the removal code generated by the Yield Editor software. It is a code that tells the user which filter or filters have caused the deletion of that point from the data. Obviously, if we export only the clean data, this RmCode will be zero in every case.

There are a couple of formatting options that may be selected. First, the user can select comma or space delimited ASCII. Either of these can be very easily imported into almost any GIS, analysis or graphics software. The other option is how to handle negative latitude and longitudes. Some packages prefer that these values remain positive, even when in the southern or western hemispheres. This gives the user the ability to export lat/lon either with (where appropriate) or without the negative sign.

The last selection that must be made is to choose what subset of data we wish to export. Usually, we will want to export only the clean points. However, there are times that we might want to export only a selected region for some reason. Also, to do more analysis of why certain points were removed, we may want to export only the deleted points, or possibly all of the points, along with the RmCode to assist in recognizing the good from the bad.

Save Filter and Configuration Settings

This is the place where individual configuration files can be created. As mentioned previously, it may be a good idea to have several configuration files, at least one per every combine/crop combination that you use, so that you will have a good point from which to start. Also notice that you can save the current configuration to be the default configuration – making it the configuration that will come up when Yield Editor is started each time.

Save Current Yield Editor Session

This is the place where we can save our current session, and be able to resume it at a later time. The session log seen in this frame is saved along with the session, and will include important operations that occurred (i.e. file imports and exports, etc.). It can also be manually edited in case you want to add notes, questions or comments before archiving or possibly transferring the file on to some other user. Even if you have exported the cleaned data, it is a good idea to save the session, as it will provide you a great deal of information about filter and configuration settings, as well as allowing you to make further modifications at some later date, should the need arise.

AYCE – Automated Yield Cleaning Expert

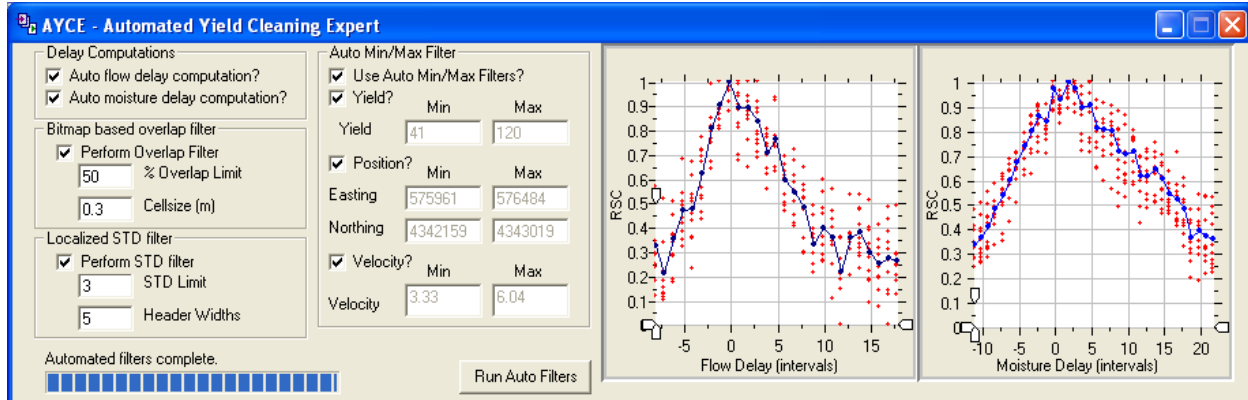


Figure 5. Layout of AYCE window in Yield Editor.

Auto Min/Max Filters

This frame (shown center left in Figure 5) allows the user to let AYCE pick automated ranges for position data, velocity data and yield data. If the checkboxes adjacent to each of these filters are selected, the software will determine reasonable parameters for the POS, MINV, MAXV, MINY and MAXY filters and will set them as selected. Once these filters have been applied, the map will be updated, and the execution of AYCE will continue.

Delay Computations

AYCE uses a method based upon a technique from image processing known as phase correlation. Lee et al. (2012) give a complete description of the method. The method is based upon a random noise image, so each run through the method can provide a “different” answer. As a result, we call this method ten times each for grain flow delay and moisture flow delay estimations. The two graphs on the right of the screen show the results of these runs for one sample file. The Y axis is the relative spatial consistency of the image at each flow delay time computed. The red dots indicate the best solution for each of the individual runs. The blue lines indicate a “normalized” average value over all ten runs combined. In both of these cases, the individual runs vary by a few seconds, but the range of these estimates is quite consistent. If the values were more inconsistent, the outline of each graph might be colored yellow or red. A yellow border is a warning that the estimate may not be very reliable – in other words, the user should beware. A red border indicates that the method is not finding any kind of convergence in the estimates, and as a result the automated method will NOT select a delay time, and the default in your settings file will be used instead.

Bitmap Based Overlap Filter

The overlap filter (OVL), which is used to remove observations where the combine was travelling over a previously harvested area, was based on the bitmap method suggested by Han et al. (1997). The method produces a bitmap with a cellsize that can be user selected, with each cell in the bitmap initialized to a value of “unharvested”. While the user can select this value, we found a cellsize of 30 cm to be generically suitable, and this is the current default setting in version 2.01. Figure 6 illustrates the basic idea behind the bitmap method. During a given time interval, the combine header moves forward a discrete distance, creating a “harvested” polygon P. Each of the grid cell centers that falls inside P is checked to see whether it is already marked

(e.g. harvested) or unmarked. The ratio of marked cells to total cells inside P, termed the overlap ratio, is computed, and then all of the cells inside P are flagged as marked. If a polygon has an overlap ratio above a user-defined threshold parameter, indicating that a significant portion of the area has already been harvested, then the yield data point associated with that polygon is flagged for removal by the bitmap filter. We found this method to be extremely effective at removing overlapped data on fields harvested with a single combine, assuming reasonably good GPS data and that the harvest data were properly sorted in chronological order. Data from fields harvested with multiple combines would need to be chronologically sorted across all combines before the overlap filter could be applied. Poor GPS accuracy will limit overlap filter utility. The user may modify both the overlap limit percentage for retaining points, and the cell size of the bitmap. Smaller bitmaps may use drastically larger memory space, and take much longer to complete.

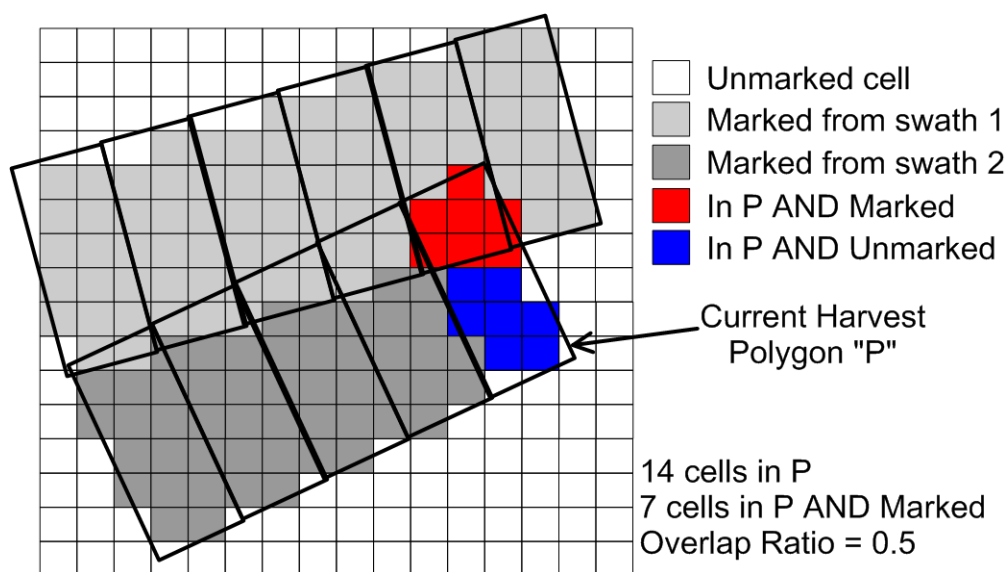


Figure 6. Illustration of the bitmap method by Han et al. (1997) for removal of overlapped areas.

Localized STD filter

The localized STD filter (LSD) helps to catch spikes and fliers that are obviously out of place compared to their neighbors. This filter operates by producing a square grid of resolution equal to a user-defined integer multiple of combine header widths after implementing the POS filter which defines the field extent. Within each grid cell, the mean and standard deviation of the yield are computed. Observations outside of the range of plus or minus a user-defined number of standard deviations are removed by this filter. The LSD filter is effective at catching fliers missed by the SMV, MINV, MAXV, MINY, and MAXY filters, as well as reducing the effect of ramping at the border between end rows and the interior field passes. The user may modify parameters of both the number of standard deviations from the mean for retention, and the size of the grid, in header widths.

Using AYCE in Interactive Mode

The interactive mode behaves exactly like the previous version of Yield Editor, with one caveat. When the Map and Manual Editing tab is activated, the AYCE window will also be loaded. Filter parameters for both the new and old filter types can be set, choices of which filters will be

implemented can be made, and then IF the user wants, he may hit the “Run Auto Filters” button on the AYCE screen. If so, the AYCE module will take a short while, usually less than a minute, to determine suitable settings for each automated procedure, and will update the map as each filter setting is complete. A message “Automated Filters Complete” will display above the progress bar on the AYCE window when all automated filters have been applied.

The user may then change filter settings manually, re-run AYCE with new parameters and/or do additional manual editing to the data. When complete, the user may save and/or export the data manually, and if the program was run from batch mode, additional saves and exports may occur on exit, per the instructions from the batch call.

Using AYCE in Automated Mode

The automated mode was created strictly for batch processing of harvest files. The batch call is generally made in visible mode, so the user can see the yield cleaning process as it is being completed. However, there is also a hidden mode option, so that the processing is done without loading and viewing the windows.

Batch Mode Language Details

Calling Yield Editor 2 is as simple as opening a batch file or a dos prompt and entering one or more lines of the following form.

Path\yieldeditor /option1 /option2 ... /optionN

Where:

Path = installed path of Yield Editor (usually c:\Program Files\Yield_Editor)

And options include:

/fin = “f”	‘ f = the settings file (.set) to read in before execution.
/fout = “f”	‘ f = the settings file (.set) to export after execution.
/csvin = “f”	‘ f = the harvest data file (.csv) AgLeader advanced format to import.
/csvout = “f”	‘ f = the cleaned data file (.csv) where export data will be saved.
/yesin = “f”	‘ f = the Yield Editor Session (.yes) file to load on startup.
/yesout = “f”	‘ f = the Yield Editor Session (.yes) file to save on exit.
/hide=“y”	‘ indicates batch cleaning will be invisible to the operator.
/auto = “y”	‘for fully implemented AYCE processing
/auto=“p”	‘for interactive processing which MAY include AYCE options
/auto=“s”	‘for non-interactive processing of simple YE1 filters based upon settings file

Examples:

C:\Program Files\Yield_Editor\yieldeditor /fin="SB_CP_02.set" /csvin="sample1.txt" /auto="p" /yesout="Sample1.yes"

This line calls yield editor with the SB_CP_02.set settings file loaded, imports Agleader advanced text or comma delimited data from “sample1.txt”, launches the AYCE module in interactive (p=prompt) form, so the user can select and approve of parameters, and then saves the yield editor session file to “Sample1.yes” on exit from Yield Editor.

```
C:\Program Files\Yield_Editor\yieldeditor /fin="CN94.set" /csvin="sample2.txt" /auto="y"  
/csvout="Sample2C.csv"
```

This line calls yield editor with the CN94.set settings file loaded, imports the Agleader advanced “Sample2.txt” file, performs the automated filters automatically, and then automatically exports the data columns indicated in CN94.set to the output file “Sample2C.csv” and exits.

```
C:\Program Files\Yield_Editor\yieldeditor /fin="CN2.set" /csvin="sample3.txt" /auto="y"  
/yesout="Sample3.yes" /hide  
C:\Program Files\Yield_Editor\yieldeditor /fin="CN1.set" /csvin="sample4.txt" /auto="y"  
/yesout="Sample4.yes" /hide
```

These two lines of a batch file will do the automated filtering and saving of session files indicated, but will do it in the background, so that the user doesn’t see the forms and dialogs.

Though I haven’t done so in these examples to minimize space, it is probably wise to indicate full paths to all filenames for both input and output. Errors and or searches for “lost” files will likely result otherwise.

Recommended Procedures

Figure 7 shows the basic flow of operation for Yield Editor 2. The automated filters, if selected, can provide a high level of rapid, hands-free error removal. Additionally, the user can explore interactive filtering as described previously. If both automated and manual filtering methods are to be used, we recommend first using the automated AYCE methods and then following that with any interactive filtering and manual editing that might be desired/required.

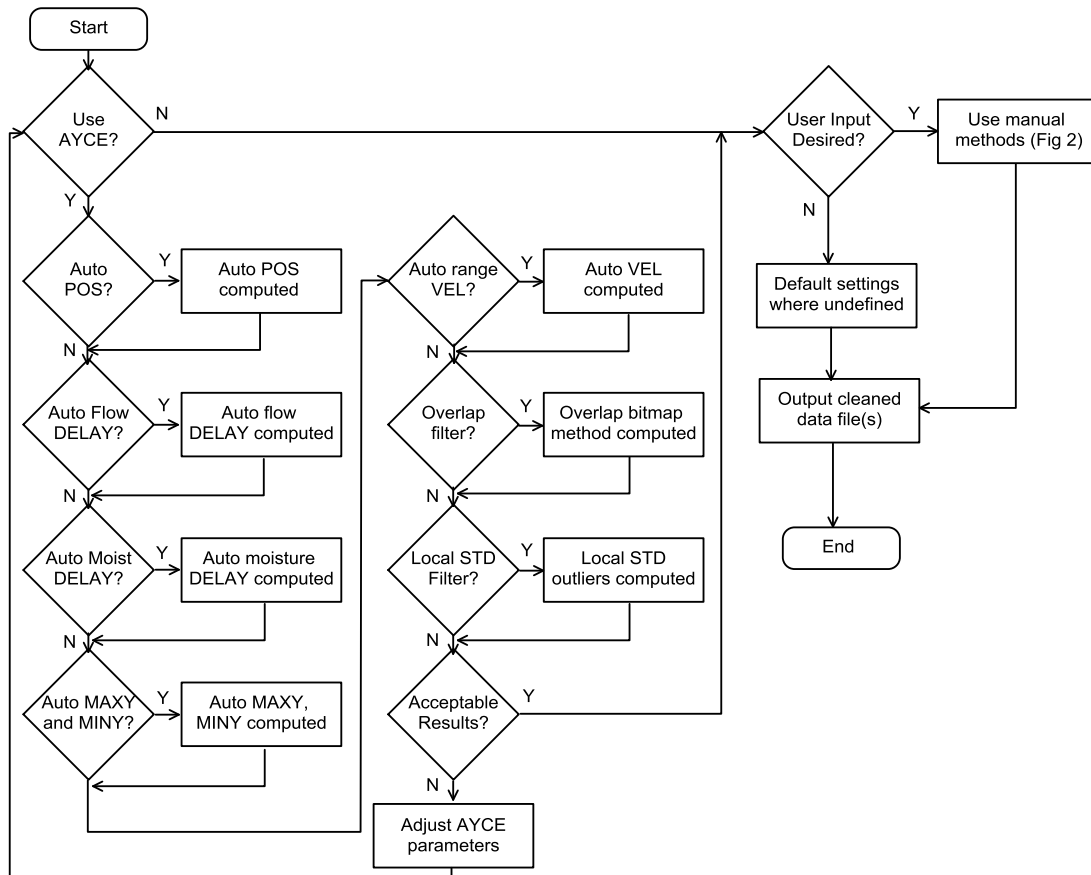


Figure 7. Sequence for applying Yield Editor 2.0 automated and interactive filtering methods.

Yield Mapping – Some Useful References

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Simple Tutorial using AYCE

The following tutorial with a very simple yield map should help get you started with this software. Follow the steps below, and you should be able to understand most of the features in just a few minutes time.

- 1) Start the Yield Editor software
- 2) From **Load/Import File** tab, hit the *Load Config* button, and choose the default.set file from the \Program Files\Yield Editor\Samples directory.
- 3) Hit the *Import* button, and select the sample2.txt file. Notice that several lines of data will fill the preview pane, and that the crop type matches our selected crop type. Also, notice that the computed UTM zone is 15 – which is correct for this field. Hit *OK* to continue with the import.
- 4) Flip to the **Filtering, Mapping and Editing** tab and you should see the map displayed, with all the automated filters having been applied. Notice the AYCE form which has also been loaded. Hit the <Run Auto Filters> button. It will take a minute or so for AYCE to complete all operations.
- 5) There are still a few transects that appear to be overlapped, or narrow swaths. Under the manual editing tools frame, select the vertical black arrow which is used for transect selection. Move the cursor onto the map and click on a specific suspect transect. You can see that it has been selected when a black outline appears over each of the observations. Click on the same transect again. The transect will now become unselected, and the black outlines will disappear. You can select as many transects as you like for removal, then hit the delete (flaming trashcan) button. These transects have been removed.
- 6) Before using the point selection tool, zoom in on the map a bit. Choose the bounding box zoom tool (crosshairs with a pointer inside) and then do a drag and drop on a smaller area of the field that you want to investigate more closely. If you haven't zoomed in quite right, you can use the zoom to extents, zoom in or zoom out tools to help you get to the right level of zoom. You can also use the four pan arrows to slide the image up, down, left or right.
- 7) Now choose the point selection tool (white arrow pointing to the left a bit). Your cursor should switch to this white arrow as well. Now go in and select individual points with your mouse. Notice that as you select points in this mode, the status report area at the top of this frame shows a large amount on information about that specific point. Also notice that if you select the same point again, the point is unselected. If you have points you want removed, select them and delete as described in step 5. To clear a selection use the *Unselect All* tool. This removes all points from the current selection (but does not delete them!).
- 8) When you are happy with any edits you have made, switch to the Save/Export File tab to save your work.
- 9) At the bottom of the page, you'll see a session log and notes section. It contains information about the configuration and import files that were used during this session. You can also click on this textbox and add additional notes or questions.
- 10) Hit the *Save Session* button to save the current state of the yield editor system, including filter selection, parameters and configuration settings, notes, etc.

- 11) If you wish to do so, you can export the data, and/or the configuration settings as well – these sections are fairly self explanatory.

Tutorial using advanced manual techniques

This tutorial should show you how to use the non-automated tools to clean your yield maps more aggressively and with more control than with the automated methods.

- 1) Start the Yield Editor software
- 2) From **Load/Import File** tab, hit the *Load Config* button, and choose the CP_Beans.set file from the \Program Files\Yield Editor\Samples directory.
- 3) Hit the *Import* button, and select the sample1.txt file. Notice that several lines of data will fill the preview pane, and that the crop type matches our selected crop type. Also, notice that the computed UTM zone is 15 – which is correct for this field. Hit *OK* to continue with the import.
- 4) Flip to the **Filtering, Mapping and Editing** tab and you should see the map displayed, with all the automated filters having been applied. Adjust the value of the flow delay filter from 2 to 3 and hit the *Apply Filters* button (or <F10>). Now try several more values. Notice how the map quickly adjusts to the new delay time. After trying several different values, settle in on one that appears to align the features on the map most clearly (2 appeared best to me).
- 5) Next, turn off the checkboxes next to the flow delay, start pass delay and end pass delay filters and hit the *Apply Filters* button. You will notice that a significant number of low yielding (blue colored) points will become visible on the map, especially at the end of passes, and in the northernmost block of transects. Most of these were removed by the start and end pass delay flags. Turn these filters back on again and hit the *Apply Filters* button again to see the difference.
- 6) Making sure that the filter has been turned on and applied, you can see which points were removed by the start pass delay, by clicking on the show option next to the start pass delay label. These points will be displayed in magenta. To see those points more clearly, double click on the show option next to the start pass delay label. You can try this feature with any of the applied filters.
- 7) Next, let's try out the selection tools. Under the manual editing tools frame, select the vertical black arrow which is used for transect selection. Move the cursor onto the map and click on a specific transect. You can see that it has been selected when a black outline appears over each of the observations. Click on the same transect again. The transect will now become unselected, and the black outlines will disappear. You can select and/or deselect as many transects as you like.
- 8) Now let's try the bounding box select tool. Choose the black cross button and move your cursor over the map. You should have a black cross cursor at this point. Click and hold the cross over one corner of a region you want to select, and then drag the mouse to the other corner and release. All of the points inside this region should be selected. You can do this over as many regions as you like. To unselect some or all of these, hold down on the <Ctrl> key while operating the mouse as described above, and any points inside the region should be unselected.

- 9) Before using the point selection tool, zoom in on the map a bit. Choose the bounding box zoom tool (crosshairs with a pointer inside) and then do a drag and drop on a smaller area of the field that you want to investigate more closely. If you haven't zoomed in quite right, you can use the zoom to extents, zoom in or zoom out tools to help you get to the right level of zoom. You can also use the four pan arrows to slide the image up, down, left or right.
- 10) Now choose the point selection tool (white arrow pointing to the left a bit). Your cursor should switch to this white arrow as well. Now go in and select individual points with your mouse. Notice that as you select points in this mode, the status report area at the top of this frame shows a large amount of information about that specific point. Also notice that if you select the same point again, the point is unselected.
- 11) Now clear your current selection. The fastest way to do this is to choose the *Unselect All* tool. This removes all points from the current selection (but does not delete them!).
- 12) Now zoom out to extents and choose your bounding box selection tool. Select a fairly large chunk of data – say several hundred points. Then hit the *Query* tool (a large yellow question mark). This will launch a second form, which displays a histogram of the yield data in your current selection. You can select several different data layers (grain flow, velocity, etc.) and can change the appearance of the graph as well in several ways. You can also return to the map page and continue modifying your selection. Your query results will be updated each time you add to your selection, to represent the new data that have been added (or deleted). If your selection should become empty then the query results form will automatically close. If at any time you wish to bring the Query form to the foreground, just hit the *Query* button again. Go ahead and hit the *Unselect All* button and accept the prompt which closes down the Query Results form.
- 13) Hit the *Advanced* button at the bottom of the page. An advanced frame will appear at the bottom left of the form. We are going to use this section to replace those points at the top of the map that were removed by the start delay and end delay filters.
- 14) On the advanced frame, choose the option to select points of the *Deleted* type.
- 15) On the eight transects at the top of the map there are several sections where the header was lifted for a very short period of time, causing the start and end delay filters to remove significant areas of good data from the map. Using the bounding box select tool, select those regions NOT NEAR THE END ROWS where this occurred.
- 16) In the *Filter(s) to Mask* listbox, select the Start Delay filter, then hold down on the **<Ctrl>** key and select the End Delay filter as well. Once both of these are highlighted, hit the *Mask* button. The selected points that had been removed only due to the start and delay filters, have now been restored to the map. Notice that some selected points were not restored. This is due to the fact that some of the points had other filters that had caused their removal. You can click and double-click the show buttons in the filter frame to investigate this further.
- 17) Switch to the Save/Export File tab to save your work.