Making yield maps

Accurate yield maps can provide data for improved farm management decisions now and in the future. Examples of their use include estimating nutrient removal, gross margin and water use efficiency, as well as for the delineation of management zones.

The following information has been written primarily for grain growers but is of relevance to all crop types.

The production and storage of accurate yield maps follows five steps:

1. collecting accurate yield data;
2. data storage;
3. data cleaning - removal of erroneous data points;
4. changing the GPS projection to easting and northing; and
5. interpolating (producing a smooth map surface) data.

At the completion of these steps the yield map should be an accurate representation of the paddock's production and is ready for use.

Software supplied with yield monitors is gradually becoming more sophisticated, with many packages able to produce yield maps from yield data at the touch of a button. However, the supplied software generally uses less exacting statistical methods to interpolate the data; that is, to turn the yield data collected at points into a smooth continuous map surface. Software that uses 'kriging' rather than inverse distance weighting (IDW) is recommended for producing more robust maps.

If using the yield mapping software supplied with your yield monitor, you will only need to complete the first three steps, referring to your instruction manual for information on how to clean yield data. However, if you want to produce representative yield maps that you can integrate with other sources of mapped data, such as EM38 or elevation, follow all five steps. In general, the map derived from yield monitor software is regarded as a quick overview but for applications other than a quick look, production of a more robust, representative map is strongly recommended.

Step 1 – Collecting accurate yield data
See page 6.

Step 2 – Data storage
Before starting the mapping process make sure all previously collected yield data has been transferred from your data card to your computer. Make a back-up copy of all the raw data files onto a CD.

On completing each of the steps three, four and five, data will need to be saved. Following a common naming theme will help when relocating files in the future.

File names should contain paddock name, crop type (eg. wheat, canola), year collected and data type (eg. raw, trimmed, interpolated).

Examples: a raw yield file containing wheat data from House Paddock harvested in 2007 would be named

House_wheat_07_raw.txt

If the data was trimmed (abbreviated to tr) and converted into MGA coordinates (easting and northing) then the new file may be named
House_wheat_07_MGA_tr.txt

If the data had been interpolated by kriging (abbreviated to kr) then the new file may be named
House_wheat_07_MGA_kr.txt

A hierarchal filing system (Figure 1) is suggested to assist in the rapid retrieval of the correct data.

With this system many paddocks can be stored under 'Farm', and multiple years under 'Paddock' and several data types (yield, soil, crop biomass, etc.) under each 'Year'. It is recommended that raw data is stored in a 'Raw' data folder, and any subsequent files that have been altered are saved in the 'Manipulated' data folder.
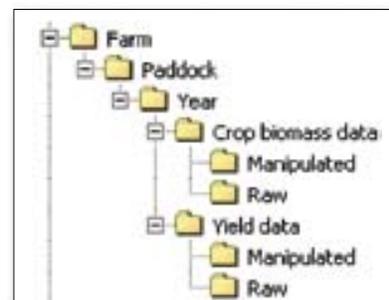

Figure 1. *An illustration of a logical yield data file structure that allows easy retrieval of saved data.*

Further detailed discussion on this issue is available in the GRDC PA Manual and Precision Ag News Vol 2 Issue 3 – Summer 2004.

Figure 2. *Australian Universal Transverse Mercator – source www.environment.gov.au/erin/ tools/mga2geo-gda.html*

Step 3 – Data cleaning

Not every data point is appropriate for mapping; some may be misplaced due to GPS signal error, others are low or even zero readings at the start and end of rows when the comb is not at full capacity or abnormally high when the harvester slows, or when there is a blockage in the system. All of these erroneous data points need to be removed.

Firstly, yield monitor calibration accuracy should be checked. This can be done by comparing total deliveries (do not forget stored or grain kept for seed) with the total yield recorded on the yield monitor. This is best done for each grain type. Yield adjustment can be made in the yield mapping software to correct for any discrepancies at any point denoted by (i) in the equation below.

If the calibration is not accurate, yield maps still identify areas of higher and lower yield but this will not be sufficiently accurate for making nutrient removal, gross margin or water use efficiency maps.

If data is to be cleaned with the yield mapping software then refer to the yield mapping software manual or help guide. If alternative software is used the data will need to be exported as "comma separated values" (.csv) or "text" (.txt).

Incorrect data can be removed in a spreadsheet such as Excel. Specific recommendations for cleaning grain yield data are described in Precision Ag News Volume 1 Issue 2 October 2002.

Alternatively, for grain growers a software program like Yield Editor can be used; this is free to download from www.ars.usda. gov/services/software/download. htm?softwareid=20. Yield Editor allows incorrect data to be removed using a number of filters. For grain data, use 'filters' for maximum and minimum yield, standard deviation, start and end pass delay (ie. when pulling in and out of the crop),

maximum and minimum speed, and changes in speed (ie. to remove points where the harvester has stopped or started rapidly). Manual deletion of points is also possible.

Yield Editor will only import data saved in an AgLeader Advanced txt file format. With FOViewer (a free program www.mapshots.co/FODM/ fodd.asp) data from most yield monitors can be read.

For grape yield mapping, Dr Rob Bramley, CSIRO recommends the removal of any data recorded when the GPS was not receiving a differential signal. This would also be a wise strategy for grain growers.

Irrespective of the crop being grown, Dr Bramley also recommends the trimming of the top and bottom 1% of yield values from the dataset. Guidance on how to do this is available at www. cse.csiro.au/client_serv/resources/ protocol_supp1.pdf.

Step 4 – Changing the GPS projection to easting and northing

GPS data is generally gathered based on longitude and latitude on decimal degrees using the WGS84 American standard. However, mapping software requires it to be in eastings and northings with units of metres. To make this change the software will require your Universal Transverse Mercator (UTM) zone; Australia is covered by UTM zones 49 to 56 (Figure 2). Geod is a free program able to convert Australian coordinates available at www.lands. nsw.gov.au/survey_maps/geodesy/ gda/geod_software

Yield Editor can convert the GPS projection to eastings and northings, which bypasses Step 4. However, it is important to note that, as Yield Editor is American software it locates data on the standard datum (WGS84) rather than the Australian datum (GDA94). There is approximately a 70cm difference between the two
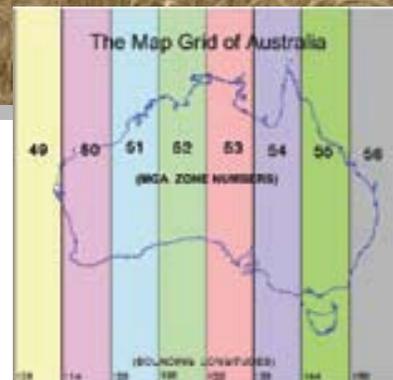
but as most broadacre equipment takes several meters for rates to change this is not of major concern. Ideally the datum should be converted as recommended in Step 4.

Step 5 – Interpolating data

To turn all the data points and spaces between them into a yield surface the data needs to be interpolated. VESPER is a shareware program ($55 from www.usyd.edu.au/su/agric/acpa/ pag.htm) that kriges the data and places it on a standard grid. Kriging produces a smoothed map surface and allows yield data to be layered with data from other sources, eg. EM38, which has been placed on the same grid. Creation of a grid is a key step. For each paddock, always use the same grid (same size and location). Ideally, the grid will be derived from a differential GPS survey of the paddock boundary.

For grain crops a 5 to 10 metre grid is appropriate. For block kriging grain a 25 to 30 metre block is recommended.

After yield map interpolation, the results need to be displayed. Ideally, this is done using GIS software eg. ArcGIS, AGIS, PAM and SMS Advanced among others. They vary in price, functionality and user friendliness, so seek advice before purchasing. However, some yield monitor software will allow the processed data to be imported back in for map display. The yield map should now be an accurate display of the actual yield variation observed in the paddock.

More information on yield mapping is found in back issues of Precision Ag News available at **www.spaa.com.au**

Adjusted yield (i) = $\dfrac{\text{measured yield from the yield monitor (i) x total tonnes delivered}}{\text{total tonnes harvested by the yield monitor}}$