The PV-PLUS system for NVT analysis and reporting.

Aanandini Ganesalingam, The UWA Institute of Agriculture, The University of Western Australia
Alison Smith, National Institute for Applied Statistics Research Australia, University of Wollongong and
Brian Cullis, National Institute for Applied Statistics Research Australia, University of Wollongong

Key messages

- *The Production Value - PLUS (PV-PLUS) system is a new methodology for the NVT multi-environment trial (MET) analysis and reporting of results*
- *The analysis provides a unique production value (PV) for each variety in each environment (NVT year and site combination)*
- *PVs are reported with environment information to help select the best varieties for particular growing environments*

Aims

The Grains Research and Development Corporation (GRDC) National Variety Trials (NVT) program is the largest independent varietal evaluation program in the world. The aim of this program is to provide growers with the best information for the selection of varieties for their particular growing environment. Currently the NVT is the primary source of variety performance information for eleven of the winter crop species for Australian farmers and their advisors.

To achieve this aim of providing the best information to growers and their advisors, the GRDC Statistics for the Australian Grains Industry (SAGI) project has developed the Production Value-PLUS system (PV-PLUS). PV-PLUS comprises a state-of-the-art mixed model analysis of NVT MET data. The analysis provides Production Values (PVs), which quantify variety yield performance (t/ha) in individual environments. Environments are defined using the trial site name and year, and they represent all the environmental influences experienced during the conduct of the trial.

The aim of this paper is to explain the PV-PLUS system methodology for the presentation of the NVT results.

Method

The PVs in this paper were based on a multi-environment trial (MET) data-set comprising NVT wheat trials grown in WA for the 5-year period 2009-2013. This consisted of 172 varieties grown across 215 trials for the 5 growing seasons. The PVs are best linear unbiased predictions of variety effects from the statistical analysis of the MET data (see Smith et al., 2014 for full details).

PVs for each variety in each environment are expressed in tonnes per hectare (t/ha). They are shown as positive or negative differences relative to a baseline , which reflects the expected average yield of all the varieties in the current NVT data set (172), if grown in that particular environment. Thus, varieties may be viewed as having expected yields that are equal to the baseline (PV=0) or above (PV>0) or below (PV<0) the baseline for a particular environment.

Results

For each environment, we choose to present PV's in tables as well as a graphical form developed by Smith et al. (2014). We briefly illustrate the interpretation of Fig.1, which is the wheat PV graph for a selection of APW varieties for the location of Mingenew. . The variety Mace had a PV of +0.45 t/ha in 2011. This is an indication that it is expected to yield 0.45 t/ha higher than the expected average in this type of environment. We note that selection decisions are based on the comparative performance of varieties; hence it is the difference between PVs that is critical. For example at Mingenew, Magenta with a PV of 0.6 t/ha in 2011 would be expected to yield 0.15 t/ha more than Mace (PV = 0.45t/ha) when the varieties are grown under these conditions.

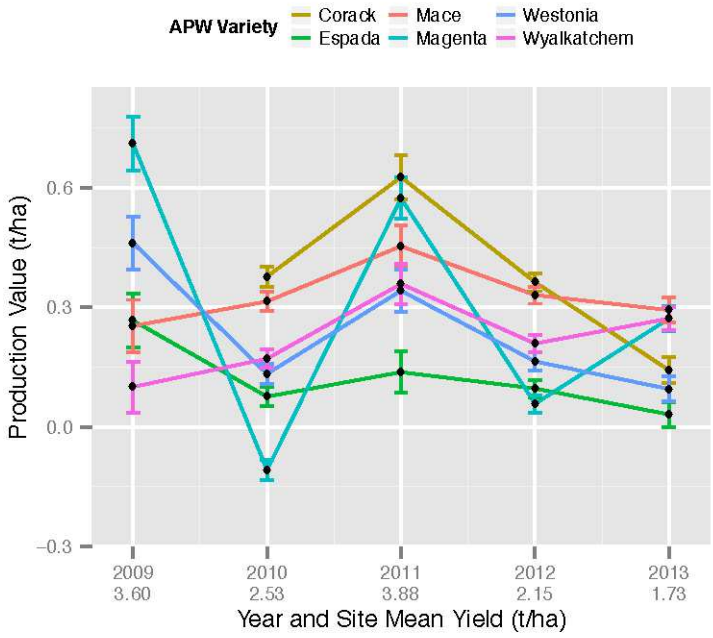

Figure 1. PVs of APW varieties at Mingenew

Besides quantifying variety performance across locations and years, PV-PLUS also enables an examination of the stability of variety performance. Considering the Mingenew example, Mace appears to have had stable expected yields – always above the expected environment average yield. Magenta on the other hand had expected yields that ranged from 0.7 t/ha above the average in 2009 to 0.10 t/ha below the average in 2010. This indicates a greater environment influence on Magenta than Mace. The site mean yields displayed on the x-axis of PV graphs provide a reference of the type of growing season experienced at this trial location and in the corresponding year. The bars attached to individual points are standard error bars (see Smith et al, 2014). PVs are only shown for varieties that were grown in the associated trial, so for example Fig 1. shows that Corack was not grown in the Mingenew trial in 2009.

Environmental drivers & PV-PLUS

In order to identify the type of environment encountered at a site and year we include a list of common environmental drivers such as trial sowing date, growing season rainfall, previous crop history and soil pH. Also included is the "site average correlation" is a relativity measure that is included in the reporting. It indicates how the variety ranking of the trial resembles neighbouring trial result rankings within the current agzone and year.

Site	Mingenew	Mingenew	Mingenew	Mingenew	Mingenew
Year	2009	2010	2011	2012	2013
Sowing Date	29-May	17-May	18-May	13-Jun	14-May
GS Rain (May to Oct)	148	218	475	247	283
pH ($CaCl_2$) at 10cm	5.5	4.6	5.1	5.3	5.4
pH ($CaCl_2$) at 60cm	4.7	4.8	4.2	4.6	4.5
Previous Crop		Lupin	Lupin	Lupin	Lupin
Site av. Correlation	0.77	0.72	0.72	0.67	0.55

Conclusion

Previously, the information reported to growers comprised long-term regional (Agzone) means. These were obtained from a statistically valid MET analysis, as described in Smith et al. (2001), but were not ideal as they often failed to identify important local variety by environment interaction. Growers and advisers therefore resorted to the practice of using results from the analyses of individual trials to make varietal selection decisions. Such results are merely a snap-shot of what occurred on a specific area of land in a specific time-frame and are based on a very small amount of data. If used for variety comparisons, the risk of errors can be unacceptably high. SAGI acknowledged both the need for the provision of variety information at this local rather than regional level and the potential for using a more up-to-date and superior statistical approach for the analysis of MET data. PV-PLUS was developed on the basis of these fundamental principles. PV-PLUS therefore delivers more accurate variety information at an individual environment level. This information is not the same as the individual trial results and is more reliable since it is based on more data and an appropriate statistical model for variety by environment interaction.

Key words

NVT, variety selection, variety performance, VxE

Acknowledgments

The authors gratefully acknowledge financial support from the GRDC. We also thank GRDC and ACAS for the use of the NVT data.

GRDC Project Number: UOW00005

Paper reviewed by: Chris Lisle

References

Smith A, Cullis, B, and Gilmour, A (2001) “The analysis of crop variety evaluation data in Australia”. Australian and New Zealand Journal of Statistics 43(2):129-145

Smith AB, Ganesalingam A, Kuchel, H, and Cullis BR (2014) Factor analytic mixed models for the provision of grower information from national crop variety testing programs. Theoretical and Applied Genetics DOI 10.1007/s00122-014-2412-x, 1-18.