UNITED KINGDOM NATIONAL LIST TRIALS: TRIAL DESIGN AND DATA HANDLING PROCEDURES
FOR OFFICIAL EXAMINATION OF VALUE FOR CULTIVATION AND USE (VCU)

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SECTION A – GENERAL INFORMATION

A.1. PURPOSE

A.1.1 This document sets out the approved procedures to be followed in the design of, and the recording, analysis and reporting of data, from variety trials conducted for UK National List (NL) Value for Cultivation and Use (VCU) purposes.

A.2. SCOPE

A.2.1 These procedures, where applicable, should be used for National List VCU trials for all crops.

A.3. RESPONSIBILITIES

A.3.1 National List and Seeds Committee (NLSC)

These procedures are authorised by the National List and Seeds Committee. They cannot be amended without their approval. Requests and suggestions for amendment of the procedures should be put in writing to the Plant Variety Rights Office and Seeds Division either directly or via the appropriate TrialsOrganiser or the Chairman of the Inter-Departmental Statisticians Group (IDSG).

A.3.2 Administration

The procedures are administered by:

Plant Varieties and Seeds (PVS)
The Food and Environment Research Agency (Fera)
Eastbrook, Shaftesbury Road
Cambridge
CB2 8DR
Tel. No. 03000 600497
Fax. No. 03000 602115
Email: pvs.helpdesk@fera.gsi.gov.uk

A.3.3 Maintenance

The Inter-Departmental Statisticians Group is responsible for keeping these procedures under review and for advising on any appropriate amendments to them.

A.3.4 Implementation

The Trials Organiser for each crop is responsible for ensuring that these procedures are implemented.

A.3.5 Trial Design and Data Handling

Trial designs are supplied by the Trial Design and Data Handling Operator. For potatoes the TrialsOrganiser designs the trials, with input from the Trial Design and Data Handling Operator.

A list of approved Operators and Organisations for Trial Design and Data Handling are shown in Appendix 1.
SECTION B - TRIAL DESIGN AND DATA ANALYSES

B.1. DESIGN OF GROWING TRIALS

B.1.1 Trials series

B.1.1.1 Candidate varieties are sown in a series of growing trials (VCU trials) along with control varieties.

B.1.1.2 In order to sample a range of growing conditions, trials are generally planted in each of two years at locations representative of those in which commercial crops will be grown.

B.1.2 Control varieties

B.1.2.1 The role of control varieties is to provide a trial baseline that links the performance of candidate varieties in the current trials with that of varieties on the National List, which have been tested in earlier years.

B.1.2.2 The number of control varieties sown in trials influences the reliability and accuracy with which a candidate variety’s performance is ranked relative to that of National List varieties. Trials should include a minimum of one control in each VCU crop category, e.g. maturity, ploidy. Control varieties should express a range of yield, quality, agronomic and disease characters. In potatoes, different characters are assessed in each trial and so different sets of Controls may be chosen.

B.1.2.3 It is also important that a stand-alone analysis of each trial provides reliable estimates of error for hypothesis testing. This may involve increasing the number of controls and/or increasing the number of replicates. Trials with less than 12 plots are not recommended.

B.1.3 Maximising Precision

B.1.3.1 Introduction: Within each trial, varieties are allocated to plots in a controlled way. The main aim in allocating varieties to plots in the field is to maximise precision and to minimise bias.

B.1.3.2 Effective blocking: To limit the effects of extraneous variation, plots of the control and candidate varieties are located as close together as possible in the field and each replicate is managed, as far as possible, as a single unit, e.g. when spraying.

B.1.3.3 Randomised complete block designs: RCB arrangements are normally used where the number of varieties is 14 or less.

B.1.3.4 Alpha-lattice designs: If the number of varieties is 15 or more then alpha-lattice incomplete block designs are recommended. The appropriate alpha-lattice design is chosen so that:

- The shape of the sub block is such that the soil and environmental variation between plots within the sub block is minimised.
- The average efficiency of pair wise comparisons is as large as possible given the number of varieties in the trial, the replication and the block size.

B.1.3.5 Replication: At least two plots of each variety are sown in a trial for all crops where yield is a major character in VCU assessment.

B.1.4 Minimising bias

B.1.4.1 Randomising varieties: To avoid bias in the allocation of varieties to plots, the following procedures are applied independently for each trial when generating a plan:
• for randomised blocks each variety, starting with the control varieties, is assigned a code number ranging from 1 through to the number of varieties in the experiment.

• for alpha-lattice designs, the control varieties are randomised to the first code numbers in the plan in order to ensure that controls are distributed across the trial area; this property arises from the method of design construction.

• code numbers for the candidate varieties are then randomised to subsequent codes.

• the code numbers are randomised within the plan in stages - in RCB designs, by plots within replicate blocks; for alpha lattice designs by incomplete blocks within replicate blocks, followed by plots within (incomplete) blocks.

B.1.4.2 Restricted randomisation: In certain circumstances, interference can occur between plots of neighbouring varieties, e.g. taller varieties may dominate shorter neighbours. Where it is possible to obtain prior information on the factors associated with interference, e.g. plant height, then neighbour-restricted alpha-lattice designs may be introduced so that varieties that interfere significantly with each other, e.g. extremely tall and extremely short varieties, do not appear in neighbouring plots.

B.1.4.3 Restricted randomisation: for oilseed rape and oats, varieties may be grouped according to type. For oilseed rape, these are conventional, hybrid and semi-dwarf and for oats, conventional and semi-dwarf. In these cases, it is beneficial to keep varieties from the same group together within each replicate in the trial, facilitating management and reducing interference. Separate designs and randomisations are produced for each group and the position of the groups within the replicates is randomised.

B.1.5 Communicating the design

The information supplied to the Growing Trial Operator includes:

• the trial identifier and management, a list of varieties and the code letters or numbers used to identify them in the plan.

• design type and the plan; i.e. the randomised arrangement with plots numbered in sequence, the replicates and small blocks indicated and the code letters of the varieties and treatments.

B.1.6 Plan validation and storage

B.1.6.1 The Growing Trial Operator must return layout details to the Trial Design and Data Handling Operator, once the trial is sown. A copy of the plan should be returned with:

• the name of the Growing Trial Operator;

• the date of sowing;

• any changes between generated and sown plan marked;

• a sketch map of the trial as laid out in the field with the plot numbers and variety codes, which occur at the beginning and end of each bank. The direction of north is indicated along with the position of the main entrance to the field. (For some crops the sketch map is returned with the first site data information.)

B.1.6.2 The Trial Design and Data Handling Operator must check the actual layout against the computer plan. The sketch map provided by the trials officer is checked against the computer-held plan to ensure, in particular, that the plot numbering sequence in which the observations are to be recorded agrees with that given in the computer-plan. If changes have been made, the Trial Design and Data Handling Operator must consider statistical validity of the new plan, especially with regard to the blocking applied. If the changes are
such that the validity of the plan is materially reduced, the Trial Design and Data Handling Operator and the Trials Organiser should agree an appropriate action.

B.1.6.3 A copy of the validated plan is stored in a computer file by the Trial Design and Data Handling Operator and this file is used for subsequent processing of data.

B.1.6.4 The date on which the plan was checked and the name of the person validating the plan is recorded.

B.1.6.5 Checked and stored plans must be sent as soon as possible via e-mail to the Trials Inspection and Technical Validation Operator.

B.2. DATA ANALYSIS

B.2.1 Introduction

B.2.1.1 All routine statistical analyses of individual trials are carried out by the Trial Design and Data Handling Operator using established and agreed statistical procedures. Any changes in statistical methods have to be discussed and agreed by the IDSG before implementation.

B.2.1.2 Analysis of VCU trial data is done in two stages:

- within trial: plot data from each trial are summarised to give variety means and estimates of individual trial precision.
- over trials: trial variety means from a trial are assembled in a summary table classified by varieties, trials and years. Analysis of this table provides the variety means and estimates of between-trials precision, which are the basis of VCU decisions. Details of these procedures can be found in the Data Review, Standard Setting and Decision-Making document.

B.2.1.3 Arrangements for detecting unusual observations and trial results and methods for summarising variety trial data in order to reach a decision on varieties are described in the Data Review, Standard Setting and Decision-Making Procedures.

B.2.1.4 The Trial Design and Data Handling Operator carries out within trial analyses. The Data Review and Standard Setting Organisation carries out over trials analyses.

B.2.2 Within trial analysis

B.2.2.1 Methods of analysis: for characters of major importance and where they are available, plot data are subject to analysis of variance. For incomplete block-designed trials, variety means are adjusted for block differences. This may be done by specific procedures, such as those found in VTAB, or by using REML. For secondary VCU characters, simple variety means are generally calculated.

B.2.2.2 Presentation of results: For some characters of major importance, the mean of the control varieties and the candidate variety means are usually presented with the standard error of differences, LSD’s, F ratio or F probability significance.

For other characters, means only are presented.

B.2.2.3 Transformations: the Procedures Development Group, who will take the advice of the IDSG, will consider the use of transformations. It will be applied on a long-term basis.
B.2.2.4 Data loss: In the case of yield characters, if observations on a variety are lost for all but one replicate, then the results for that variety are normally treated as missing for the trial, with the following provisos:

- if a component of the DM yield assessment is lost, and the component can be reliably estimated from the remaining observation(s), then its value is replaced by an estimated value, e.g. the mean of the other assessments.
- in the case of herbage cut yields where a single plot value is missing for a cut then missing values are estimated using standard statistical missing value estimation procedures.
- if 50% or more of the plot is lost the plot values should be removed. In all cases of loss of part of the plot, the residuals should be scrutinised carefully before making a decision to accept the plot values.
- if more than 1/3rd of the plots in a replicate are missing then the residuals should be scrutinised before accepting data from the remaining plots.
- if more than ½ of the plots in a sub-block of an incomplete block design are missing then the residuals should be scrutinised before accepting the data from the rest of the sub-block.

For other characters, an observation from just one replicate is normally treated as sufficient to complete the records for the trial.

Where plots are partially damaged, e.g. rabbit damage, and an assessment of the damage to each plot is available, then an analysis of data may be done which adjusts yield data for the effects of damage.

B.2.3 Within-trial monitoring

This section applies to yield data. Variates other than yield are subject to levels of checking commensurate with their importance in the decision making process and with the nature of the data. Yield analyses must be sent to the Trials Inspection and Technical Validation Operator for validation

B.2.3.1 Range checks:

Average yields from a trial should be within the range expected from the crop in agricultural practice. If they are out of range, then the DM yield calculations and the harvested plot dimensions should be checked.

B.2.3.2 Coefficient of Variation:

The coefficient of variation (CV) should be within the limit set for the crop by the Data Review and Standard Setting Organisation. The CV may be high because yields are low, and would be within limits if based on average yields from other trials. If not then careful technical scrutiny of the trial data should be conducted by the Trial Design and Data Handling Operator. The Trial Design and Data Handling Operator should send CVs to the Data Review and Standard Setting Organisation.

B.2.3.3 Variety yield F-ratio:

The ratio of the variety yield mean square to the residual mean square in the analysis of variance should usually be statistically significant at the 5% level or lower. Check that the field plan is correct and that the plot data have been entered correctly. Sometimes, trials with small numbers of varieties may not reach statistical significance. The Trial Design and Data Handling Operator should send information on F-ratio significance levels to the Data Review and Standard Setting Organisation.
B.2.3.4 Residuals:

The Trial Design and Data Handling Operator must check the individual plot values for yield by examining standardised residuals. A residual is the plot yield less the value predicted by the model used for analysis and is standardised by dividing by the root mean square of all residuals. The standardised residual is distributed as "Students t" with (no of varieties-1) x (no of replicates-1) degrees of freedom, to a high level of approximation. Assuming that there are 20 df or more for error estimation, 95% of such residuals should lie in the range +2.1 to –2.1, 99% should fall in the range +2.8 to -2.8, and 99.8% in the range +3.6 to -3.6.

Where plot yields have residuals greater than 2.8 or less than –2.8 the Data Handling organisation must check with the Growing Trial Operator whether the results appear to have been correctly recorded and handled. Information on residuals must be sent to the Trials Organiser and the Trials Inspection and Technical Validation Operator. The Trials Inspection and Technical Validation Operator, with advice from the Data Handling Organisation, will then decide whether there is valid justification for excluding data.

B.2.3.5 Data loss:

For all routinely recorded characters where a loss of trial data occurs, the loss is highlighted in inspection reports by the Trials Inspection and Technical Validation Operator.

B.2.4 Rounding of numbers

B.2.4.1 Whilst all calculations are carried out to the maximum accuracy permitted by the computational algorithms involved, the results are presented in rounded form, usually to an accuracy of three significant digits for the smallest number.
## APPROVED OPERATORS AND ORGANISATIONS

### Approved Trial Design and Data Handling Operators:

<table>
<thead>
<tr>
<th>Operator</th>
<th>Address</th>
<th>Crop</th>
</tr>
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<tbody>
<tr>
<td><strong>AFBI</strong></td>
<td>Agri-Food and Biosciences Institute Plant Testing Station 50 Houston Road Crossnacreevy Belfast BT6 9SH</td>
<td>Herbage (Northern Ireland)</td>
</tr>
<tr>
<td><strong>BioSS</strong></td>
<td>JCM, Kings Buildings, Edinburgh. EH93JZ</td>
<td>Wheat Barley Oats Field Peas Field Beans Potatoes Herbage (Scotland)</td>
</tr>
<tr>
<td><strong>NIAB</strong></td>
<td>Huntingdon Road, Cambridge. CB3 0LE</td>
<td>Winter Oilseed Rape Soya bean Spelt Wheat Lupins Herbage (England and Wales) Maize Swede Minor Fodder Sugar Beet</td>
</tr>
<tr>
<td><strong>HGCA</strong></td>
<td>HGCA, Agriculture and Horticulture Development Board, Stoneleigh Park, Kenilworth, Warwickshire CV8 2TL</td>
<td>Spring Oilseed Rape Spring Linseed Triticale Rye</td>
</tr>
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