UPOV

International Union for the Protection of New Varieties of Plants

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Enlarged Editorial Committee	**TC-EDC/Mar18/15**

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DATA PROCESSING FOR THE ASSESSMENT OF DISTINCTNESS AND FOR PRODUCING VARIETY DESCRIPTIONS

Document prepared by the Office of the Union

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EXECUTIVE SUMMARY

1.   The purpose of this document is to present developments concerning the possible development of new guidance for document TGP/8 on "Data Processing for the Assessment of Distinctness and for Producing Variety Descriptions" describing different methods used by UPOV members for measured quantitative characteristics.

2.   The TC-EDC is invited to note:

        (a)   the developments at the TWC, at its thirty-fifth session; and

        (b)   that a document compiling the descriptions of methods to transform measurements into notes, will be presented to the TWC at its thirty-sixth session, using the same format and clarifying the differences between the methods.

3.   The structure of this document is as follows:

ANNEX I   "Different forms that variety descriptions could take and the relevance of scale levels", document prepared by an expert from Germany

ANNEX II   "Comparison of methods used for producing variety descriptions: results of the practical exercise", document prepared by an expert from France

ANNEX III   "Short explanation on the French methods for producing varieties descriptions for measured characteristics", document prepared by an expert from France

ANNEX IV   "Short explanation on measured, quantitative characteristics for United Kingdom veg & herbage", document prepared by an expert from the United Kingdom

ANNEX V   "Reasons and situations when certain approaches would/would not be appropriate for transforming observations into notes", document prepared by an expert from the United Kingdom

ANNEX VI   "Short explanation on the Japanese methods for assessment table for producing variety descriptions", document prepared by an expert from Japan

ANNEX VII   "Characteristics, genotype by environment interaction (GEI) and DUS trials", document prepared by experts from Finland and Italy

4.   The following abbreviations are used in this document:

        CAJ: Administrative and Legal Committee
        TC: Technical Committee
        TC-EDC: Enlarged Editorial Committee
        TWA: Technical Working Party for Agricultural Crops
        TWC: Technical Working Party on Automation and Computer Programs
        TWF: Technical Working Party for Fruit Crops
        TWO: Technical Working Party for Ornamental Plants and Forest Trees
        TWPs: Technical Working Parties
        TWV: Technical Working Party for Vegetables

BACKGROUND

5.   The Technical Committee (TC), at its forty-eighth session, held in Geneva from March 26 to 28, 2012, considered Annex III: "TGP/8 PART I: DUS Trial Design and data analysis, New Section 6 – Data processing for the assessment of distinctness and for producing variety Descriptions" in conjunction with Annex VIII: "TGP/8 PART II: Techniques used in DUS Examination, New Section 13 - Methods for data processing for the assessment of distinctness and for producing variety descriptions" of document TC/48/19 Rev. It agreed that the information provided in Annex VIII of document TC/48/19 Rev. and at the UPOV DUS Seminar, held in Geneva in March 2010, together with the method provided by Japan and the method used in France for producing variety descriptions for herbage crops, as presented at the TWC at its twenty-sixth session (see documents TWC/26/15, TWC/26/15 Add. and TWC/26/24), provided a very important first step in developing common guidance on data processing for the assessment of distinctness and for producing variety descriptions, but concluded that the information as presented in Annex VIII of document TC/48/19 Rev. would not be appropriate for inclusion in document TGP/8. It agreed that the Office of the Union should summarize the different approaches set out in Annex VIII of document TC/48/19 Rev. with regard to aspects in common and aspects where there was divergence. As a next step, on the basis of that summary, consideration could be given to developing general guidance. The TC agreed that the section should include examples to cover the range of variation of characteristics. It further agreed that the detailed information on the methods should be made available via the UPOV website, with references in document TGP/8 (see document TC/48/22 "Report on the Conclusions" paragraph 52).

6.   At their sessions in 2012, the TWPs received a presentation prepared by the Office of the Union on "Summary of different approaches of transformation of measurements into notes for Variety Description", as reproduced in the Annex I of document TC/50/25 "Revision of document TGP/8: Part II: Selected Techniques Used in DUS Examination, New Section: Data Processing for the Assessment of Distinctness and for Producing Variety Descriptions".

7.   The TWC, at its thirtieth session, held in Chisinau, Republic of Moldova, from June 26 to 29, 2012, agreed that the experts from Finland, Italy and the United Kingdom would support the Office of the Union to summarize the different approaches for further developing common guidance on data processing for the assessment of distinctness and for producing variety descriptions (see document TWC/30/41 "Report", paragraph 42). It also agreed that experts from the United Kingdom in cooperation with experts from France and Germany should conduct a practical exercise. The exercise would be to process a common data set to produce variety descriptions in order to determine the aspects in common and where there was divergence among the methods (see document TWC/30/41 "Report", paragraph 43)

8.   The TC, at its fifty-second session, held in Geneva from March 14 to 16, 2016, agreed with the TWC and the TWA that the guidance on "Different forms that variety descriptions could take and the relevance of scale levels", as reproduced in Annex I to this document, should be used as an introduction to future guidance to be developed on data processing for the assessment of distinctness and for producing variety descriptions.

9.   Further developments concerning a possible new section for document TGP/8 "Data Processing for the Assessment of Distinctness and for Producing Variety Descriptions" prior to the Technical Working Party sessions in 2017 are reported in document TWP/1/15 "Data Processing for the Assessment of Distinctness and for Producing Variety Descriptions".

DEVELOPMENTS IN 2017

Consideration by the Technical Committee

10.   The TC, at its fifty-third session, held in Geneva from April 3 to 5, 2017, noted the developments reported in document TC/53/18 "Data Processing for the Assessment of Distinctness and for Producing Variety Descriptions" (see document TC/53/31 "Report", paragraphs 117 to 119).

11.   The TC considered the analysis made by the expert from France in Annex II of this document and agreed to invite the expert from France to check the highlighted values in the table in paragraph 6 for possible data inconsistency. The expert from France informed the UPOV Office about the plans to provide further information to the TWC, at its thirty-fifth session.

12.   The TC agreed that participants in the practical exercise should be invited to provide a short description of their methods to transform measurements into notes and provide examples when these methods might be used, such as for particular characteristics, types of propagation or different situations, on the basis of the short descriptions provided by France and the United Kingdom. The TC agreed to invite the TWC to review the explanations to be provided by the participants in the practical exercise to be considered as a possible basis for guidance for revision of document TGP/8. The experts participating in the practical exercise informed the UPOV Office that they intended to provide a short description of their methods and provide examples to the TWC, at its thirty-fifth session.

Comments by the Technical Working Parties

13.   The TWA, the TWV, the TWO, the TWF and the TWC considered document TWP/1/15 "Data processing for the assessment of distinctness and for producing variety descriptions" (see documents TWA/46/10 "Report", paragraphs 25 to 27; TWV/51/16, paragraphs 35 to 38; TWO/50/14 "Report", paragraphs 33 to 36; TWF/48/13 "Report", paragraphs 39 to 42; and TWC/35/21 "Report", paragraphs 52 to 62).

14.   The TWA, TWV, TWO, TWF and TWC noted that the TC had agreed to invite the experts from France to check the highlighted values in the table in document TWP/1/15, Annex II "Comparison of methods used for producing variety descriptions: results of the practical exercise", paragraph 6, for possible data inconsistency. The TWA noted that the expert from France planned to provide further information to the TWC, at its thirty-fifth session.

15.   The TWA, TWV, TWO, TWF and TWC noted that the TC had agreed to invite participants in the practical exercise to provide a short description of their methods to transform measurements into notes and provide examples when these methods might be used, such as for particular characteristics, types of propagation or different situations, on the basis of the short descriptions provided by France and the United Kingdom, as set out in document TWP/1/15, Annexes III to V.

Technical Working Party on Automation and Computer Programs

Practical exercise: table of notes attributed to candidate varieties using different methods

16.   The TWC considered document TWC/35/9 "Comparison of methods used for producing variety descriptions: results of the practical exercise" and the revised information provided by an expert from France in relation to the comparison of methods used for producing variety descriptions. The TWC agreed that the document provided a useful comparison of methods for the future guidance on converting observations into notes. The TWC agreed that the table of notes attributed to candidate varieties using the different methods as provided in document TWC/35/9 should replace that of document TWP/1/15, Annex II.

Short descriptions methods to transform measurements into notes

17.   The TWC considered documents TWC/35/10 "Guidance for development of variety descriptions: the Italian experience", TWC/35/12 "Short explanation on the Japanese methods for assessment table for producing variety descriptions", TWC/35/14 "Reasons and situations when the approaches described in the United Kingdom practical exercise (TWC/30/32) would/would not be appropriate for transforming observations into notes on measured, quantitative characteristics", and TWC/35/15 "Short explanation on some United Kingdom methods for data processing for the assessment of distinctness and for producing

variety descriptions for quantitative characteristics" and reviewed the explanations provided by the participants in the practical exercise to be considered as a possible basis for guidance for revision of document TGP/8.

18.   The TWC noted the explanation by the expert from Italy that the method described in document TWC/35/10 was still under development and agreed that it should be included in the draft guidance at a future stage.

19.   The TWC agreed to invite Germany to provide a short description of their method to transform measurements into notes and provide examples when these methods might be used, such as for particular characteristics, types of propagation or different situations.

20.   The TWC agreed that the explanation provided by the expert from the United Kingdom in document TWC/35/14, paragraph 5 should be amended to read as follows:

> "Equal-spaced states would be used if:
> […]
> - ~~where~~ the range of values is continuous"

21.   The TWC noted that explanations provided by the participants in the practical exercise presented information in different ways. The TWC agreed to request the expert from the United Kingdom to prepare a document for the thirty-sixth session of the TWC compiling all explanations received using the same format and clarifying the differences.

22.   The TWC considered document TWC/35/5 "Characteristics, genotype by environment interaction (GEI) and DUS trials" which was a summary of the presentation in document TWC/34/17 "Genotype by environment interaction (GEI) - DUS Test and data transformation into notes", made by experts from Finland and Italy. The TWC agreed that document TWC/35/5 provided relevant information for future guidance on transformation of observations into notes and agreed to request the expert from the United Kingdom to take that information into consideration when preparing the document compiling the explanations of methods received and clarifying the differences.

23.   The TWC considered the report on the work done by Germany on "Variability of assessment data over years in apple", on the basis of the presentation reproduced in document TWP/1/15, Annex VI. The TWC noted that the variety descriptions were produced on the basis of assessing the same trees in different years. The TWC agreed that the growing trial needed appropriate management in order for the replications over years to be considered as independent growing cycles and to produce consistent descriptions.

24.   The TC-EDC is invited to note:

(a)   the developments at the TWC, at its thirty-fifth session; and

(b)   that a document compiling the descriptions of methods to transform measurements into notes, will be presented to the TWC at its thirty-sixth session, using the same format and clarifying the differences between the methods.

[Annexes follow]

ANNEX I

DIFFERENT FORMS THAT VARIETY DESCRIPTIONS COULD TAKE
AND THE RELEVANCE OF SCALE LEVELS

Document prepared by an expert from Germany

Variety descriptions can be based on different data depending on the purpose of the description. Different variety descriptions may be used for the assessment of distinctness or in the official document which forms the basis for granting protection. When variety descriptions are used for the assessment of distinctness it is important to take into account on which data the descriptions for different varieties are based. Special attention has to be given to the potential influence of years and locations.

The different forms of variety descriptions and their relevance for the assessment of distinctness can be classified according to the different process levels to look at a characteristic. The process levels are defined in document TGP/8: Part I: DUS trial design and data analysis. Section 2 (New): Data to be recorded (see TC/50/5, Annex II) as follows:

Table 5: Definition of different process levels to consider characteristics

Process level	Description of the process level
1	characteristics as expressed in trial
2	data for evaluation of characteristics
3	variety description

The process levels relevant for the assessment of distinctness are level 2 and 3. Any comparison between varieties in the same trial (same year(s), same location) is carried out on the actual data recorded in the trial. This approach relates to process level 2. If varieties are not grown in the same trial, they have to be compared on the basis of variety descriptions which relates to process level 3. In general, the identification of similar varieties to be included in the growing trial ("Management of variety collection") relates to process level 3, whereas data evaluation within the growing trial relates to process level 2.

Process level	Measurements (QN)	Visual assessment (QN/QL/PQ)	Remark
2	Values	Notes	Basis for comparison within the same trial
3	Transformation into notes ↓ Notes	Same Notes as in Process level 1 ↓ Notes	Notes resulting from one year and location
	"**Mean variety description**" If varieties are assessed in several trials/years/locations mean descriptions can be established.		Basis for management of variety collection

In general, quantitative characteristics are influenced by the environment. An efficient way to reduce the environmental influence is the transformation of actual measurements into notes. The notes represent a standardized description of varieties in relation to example varieties (see TGP/7). In addition, the comparability of variety descriptions for varieties not tested in the same trial can be improved by calculating a mean description over several growing cycles. In particular, the mean description over several growing cycles at the same location can provide a representative description related to the location. The calculation

of a mean description over different locations should only be considered if the effects of the locations are very well known and variety x location interactions can be excluded for all characteristics. The calculation of mean descriptions over locations should be restricted to the cases where these conditions are fulfilled.

If variety descriptions from different growing trials are used for the assessment of distinctness - that means for the management of variety collections - it is important to take into account the origin of the different variety descriptions of the candidate variety and the varieties of common knowledge. The comparability of variety descriptions is influenced by many factors, for example:

- Description based on a single year or a mean over several years?
- Description based on the same location or different locations?
- Are the effects of the different location known?
- Varieties described in relation to the same variety collection or a variety collection which might cover a different range of variation?

The potential bias of variety descriptions due to environmental effects between candidate varieties and varieties in the variety collection have to be taken into account in the process of distinctness testing, and in particular, for the identification of varieties of common knowledge to be included in the growing trial.

<div align="right">[Annex II follows]</div>

COMPARISON OF METHODS USED FOR PRODUCING VARIETY DESCRIPTIONS: RESULTS
OF THE PRACTICAL EXERCISE

Document prepared by an expert from France

Notes to the revised version

The table in paragraph 6 has been modified from the previous version presented to the TC and the TWPS at their sessions in 2017.

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1.   The main purpose of this practical exercise is to help developing a common guidance by clarifying and comparing the different methods used by UPOV members to transform quantitative characteristics into notes.

Dataset: Description

2.   A common dataset on Flax varieties was produced by experts from France for this practical exercise. The dataset is based on observations made on UPOV characteristic 21 ("Stem: length from cotyledon scar to top boll", see document TG/57/7, Test Guidelines for Linseed, Flax). It's a restriction of a larger dataset, which finally has been restricted to observations on the first 20 plants of the varieties and years where 20 or more plants of the variety were observed in the year. This reduced common data set consists of 936 variety-by-year combinations for 153 reference varieties and 30 candidates in 10 years from 2002 to 2012, for which the variety-by-year means were calculated on the original scale of the characteristics.

Methods used by the UPOV members

3.   The different methods used by UPOV members in order to assign notes to the candidate varieties are briefly summarized in the table below.

COUNTRY		Method : description	Example varieties	Crop expert judgment	Equal-spaced state
France	**Method 1**	Combined use of example varieties and reference collection	x	x	
	Method 2	Adjusted means from COY program + linear regression method calibrated with example varieties	x	x	
Italy		Average range of historical means + median used as "reference point" + partitioning into equal spaced states + calibration with crop expert judgment and example varieties	x	x	x
Germany		Adjusted mean from COY program + partitioning based on example varieties and crop expert judgment	x	x	
Japan		Adjusted Full Assessment Table (FAT) : states determined with historical data of example varieties	x		x
United Kingdom	**Method 1**	Range of expression of the over-year means for the reference collection varieties (for the past 10 years) divided into equal spaced states			x
	Method 2	Crop experts define delineating varieties whose over-year means are used to delineate each state	x	x	

4.   We can first notice that all the UPOV members who performed the exercise use example varieties in their process to assign notes. In particular, the method used by Japan and the number 2 French method 2 rely directly on UPOV example varieties (or any other own example varieties), whereas UPOV example varieties are used by crop expert for final calibration in the German and the Italian methods.

5.   Italy, Japan and United Kingdom (method 1) divide the total range of expression of the characteristic for the reference varieties into equal-spaced states in order to set a note and Italy and Japan also adjust each state according to crop expert judgment or example varieties.

Results by method

6.   The table below shows the notes attributed to the 30 candidate varieties with each method.

Variety	2011 mean	2012 mean	Over-year mean	Note France method 1	Note France method 2	Note Italy	Note Germany 2012	Note Japan 2012	Note United Kingdom method 1	Note United Kingdom method 2	Average note by variety
Variety 262	207	316	262	1	1	1	1	2	1	1	*1.1*
Variety 287	-	351	-	1	-	1	2	3	1	1	*1.5*
Variety 263	226	382	304	1	2	1	2	3	1	1	*1.6*
Variety 284	-	360	-	2	-	1	2	3	2	2	*2.0*
Variety 283	-	369	-	2	-	2	2	4	2	2	*2.3*
Variety 288	-	436	-	4	4	2	3	4	3	3	*3.3*
Variety 290	-	454	-	5	-	3	4	4	3	3	*3.7*
Variety 289	-	455	-	5	-	3	4	4	3	3	*3.7*
Variety 303	-	451	-	5	-	3	4	4	3	3	*3.7*
Variety 277	381	481	431	5	5	3	4	5	4	4	*4.3*
Variety 297	-	463	-	5	-	3	4	5	3	4	*4.0*
Variety 269	329	462	396	5	4	2	4	5	3	4	*3.9*
Variety 302	-	462	-	5	-	3	4	5	4	4	*4.2*
Variety 275	329	474	401	5	4	2	4	5	3	3	*3.7*
Variety 274	406	488	447	5	5	3	4	5	4	4	*4.3*
Variety 270	546	606	576	7	7	5	6	7	7	6	*6.4*
Variety 228	466	594	530	6	6	5	6	7	6	5	*5.9*
Variety 267	525	652	589	8	8	5	7	7	7	7	*7.0*
Variety 293	-	630	-	7	-	6	7	7	7	7	*6.8*
Variety 295	-	658	-	8	-	6	7	8	7	7	*7.2*
Variety 292	-	670	-	8	-	6	8	8	7	8	*7.5*
Variety 300	-	655	-	8	-	7	7	8	8	8	*7.7*
Variety 291	-	649	-	8	-	7	7	8	8	8	*7.7*
Variety 294	-	681	-	8	-	7	8	8	8	8	*7.8*
Variety 299	-	674	-	8	-	7	7	8	8	8	*7.7*
Variety 273	540	691	615	8	8	6	8	8	7	7	*7.4*
Variety 272	552	673	612	9	8	6	7	8	8	8	*7.7*
Variety 298	-	727	-	9	-	7	8	9	9	9	*8.5*
Variety 296	-	765	-	9	-	8	9	9	9	9	*8.8*
Variety 301	-	744	-	9	-	8	9	9	9	9	*8.8*
Mean by method				5.9	5.2	4.3	5.3	6.0	5.2	5.2	
Standard deviation				2.6	2.3	2.3	2.4	2.1	2.7	2.7	

7.   Only 13 out of the 30 candidate varieties have been noted with the French method 2 because this method requires having data of two years for the candidate varieties in order to calculate an adjusted mean with the COY program and then to assign the corresponding note.

8.   The presence of both linseed and flax varieties in the complete dataset is responsible for a non-normal distribution with a peak of small varieties with low notes (linseed) and a peak of tall varieties with high notes (flax). Consequently, the probability for a candidate variety to obtain a medium note (between the two peaks) is low. That's why, for several methods, one of the medium note has never been attributed to a candidate variety. For example, with the Italian method, each note but the note 4 has been assigned to at least one candidate variety.

9.   Some methods try to take into account the annual effect using COY adjusted means (French method 2, German method, United Kingdom method) or by calibrating their model with data of the year, as in the Japanese method with the FAT sliding adjustment or in the French method 1.

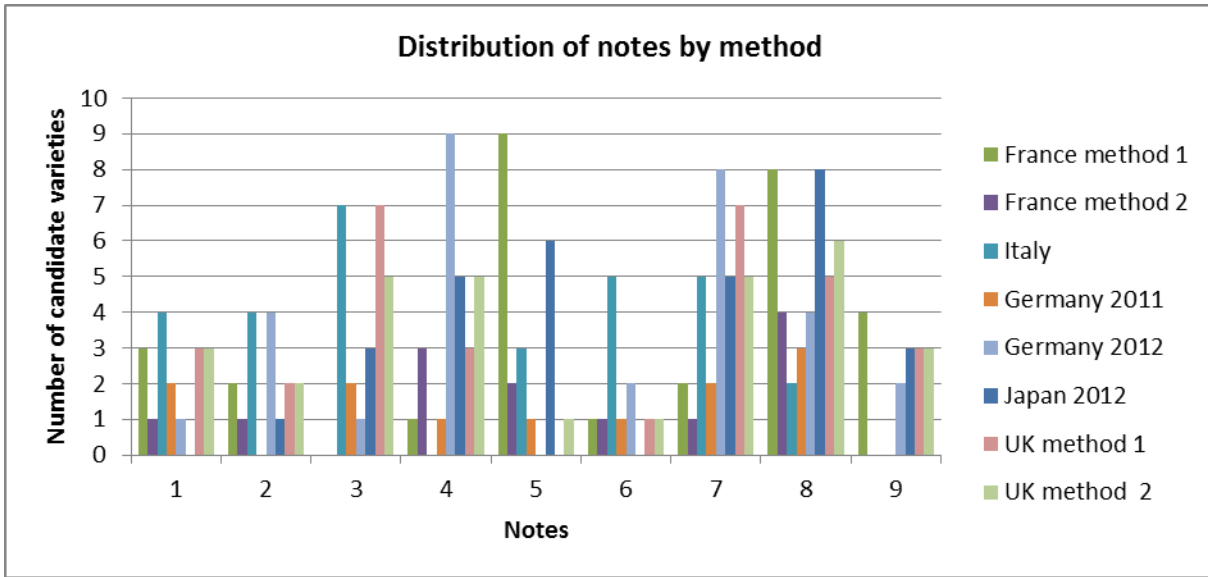Comparison of the results (New graph)

Figure 1 : Distribution of notes by method.

10.   The graph above shows that the distribution of notes is not normally distributed in the tested methods. But in most of the cases, distributions reveal two distinct peaks, which correspond to the two kinds of varieties: the first one corresponds to linseed varieties (smaller varieties with low notes) and the second one to flax varieties (taller varieties with higher notes).
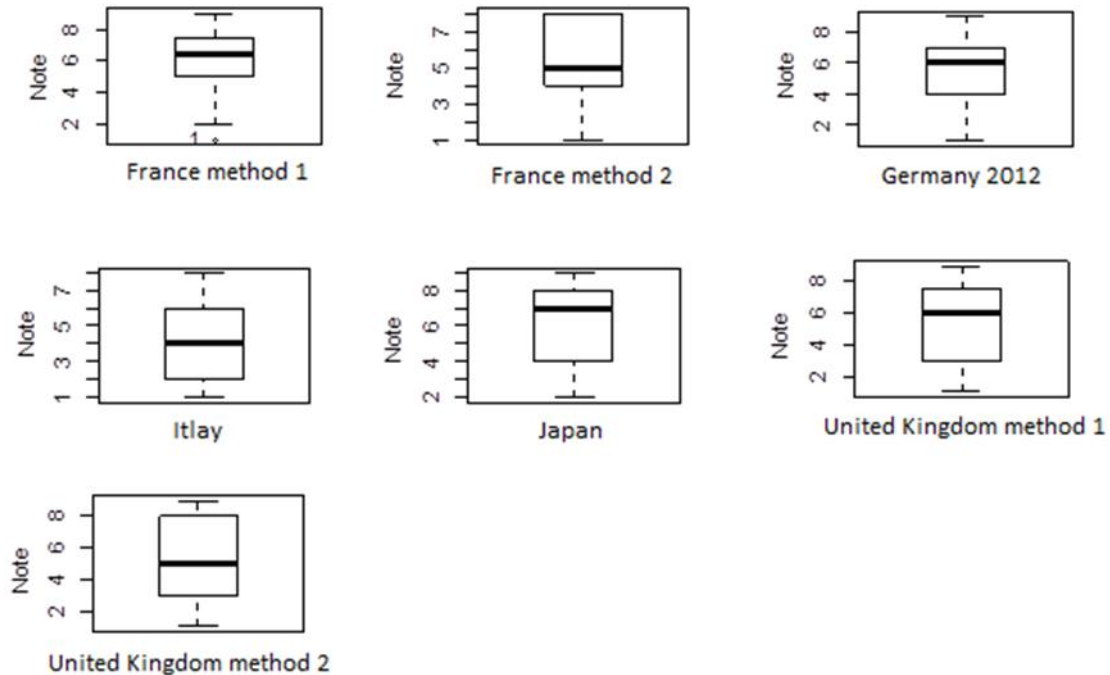

Figure 2 : Boxplot of notes for candidate varieties by method.

11.   The boxplots show that the median of notes is higher with the Japanese method than the median of the French method 2 or the Italian method. 50% of the candidates' notes are concentrated between 2 and 6 with the Italian method.

12.   The percentage of common notes between each pair of methods has been calculated (number of varieties with identical notes divided by number of varieties notated with both methods) and summarized in the following table.

Method	Note France method 2*	Note Italy	Note Germany 2012	Note Japan 2012	Note United Kingdom method 1	Note United Kingdom method 2
Note France method 1	84,6%	18,5%	57,1%	53,6%	39,3%	39,3%
Note France method 2*		8,3%	46,2%	46,2%	30,8%	23,1%
Note Italy			16,7%	0,0%	26,7%	26,7%
Note Germany 2012				35,5%	48,4%	58,1%
Note Japan 2012					38,7%	38,7%
Note United Kingdom method 1						83,9%

Table 1: Percentage of candidate varieties with identical notes.
*: total number of candidate varieties notated inferior to 30 (13 for the French method 2)

13.   The two French methods are the closest ones because 85% of the candidate varieties obtain the same note with these two methods. The Japanese method also shares nearly 50% of common notes with these two methods. These three methods seem to assign close descriptions.

14.   The two United Kingdom methods give very similar results (84% of identical notes) and the German method is also close to both United Kingdom methods. This can define a second group of close methods.

15.   The Italian method doesn't share many common notes with the other methods. In particular, the Japanese and the Italian methods appear to be quite distinct because they never produce identical notes for a candidate variety. A candidate variety obtains always a higher note with the Japanese method than with the Italian method. The average note for a candidate variety varies from 4,3 with the Italian method to 6,0 with the Japanese method. Moreover, the range of notes varies from 1 to 8 with the Italian method and from 2 to 9 in the case of the Japanese one.

16.   All the methods have then been compared with a non-parametric test, namely the Wilcoxon signed rank test for paired samples, because the distributions are not normally distributed. According to that test, the notes obtained with these methods are significantly different from one method to another, except for the two French methods, each French method with the Japanese method, the two United Kingdom methods and each United Kingdom method with the German method. Therefore, we can consider three different groups: a first one composed by the two French methods and the Japanese method, a second composed by the two United Kingdom methods and the German method. The third group contains only the Italian method which seems to be significantly distinct from every other method. This confirms the groups previously defined on the percentage of common notes.

17.   We can't distinguish a special common point between the methods used in each group.

Conclusion

18.   The methods used by UPOV members to assign a note to the candidate varieties rely on a combination of division into equal-spaced states, use of the results of examples varieties and crop expert judgment.

19.   The non-normal distribution of notes in most of the methods is explained by the composition of the dataset, which includes two different types of linseed and flax varieties among the candidate varieties.

20.   Despite the diversity between the UPOV member methods, the notes set for the candidate varieties are finally close. Nevertheless, we can distinguish 3 groups of methods which are significantly different based on the Wilcoxon signed rank test for paired samples:

-   the two French methods and the Japan method;

-   the two United Kingdom methods and the German method; and

-   the Italian method. On average, a note assigned by the Italian method is lower than with the others methods.

[Annex III follows]

ANNEX III

SHORT EXPLANATION ON THE FRENCH METHODS FOR PRODUCING VARIETIES DESCRIPTIONS
FOR MEASURED CHARACTERISTICS

Document prepared by an expert from France

In France, two main methods have been developed to produce varieties descriptions from measurements. The first one is used mainly on agricultural and vegetable crops and the second one mainly on herbage and some other agricultural crops. A third method can be used only on very stable characteristics observed under controlled conditions: variety description produced according to a fixed scale.

Method 1

Method 1 is based on experience on reference collection varieties and on example varieties. It can only be used for species with a living reference collection.
The first step is to determine the range of notes of the year. To do that, for example for note 5, we calculate the mean of year n of all the reference varieties which were noted 5 the year n-1. This mean becomes the middle of note 5 for year n. Then we determine the limits of notes by this simple formula:
Max (Note 5) = Middle note 5 + [Middle note 6 – Middle note 5] / 2
The main interest of this method is the fact that more reference varieties than only example varieties are taken into account. It increases the power of the transformation of measures into notes. It also takes into account the environmental effect of the considered year. This method is used in France on several species such as maize, oilseed rape or flax.

Method 2

Method 2 is based on a regression calculation from a set of example varieties to determine the notes of candidate varieties.
Means of example varieties are used to set the following regression model:
$Y = a + bX$
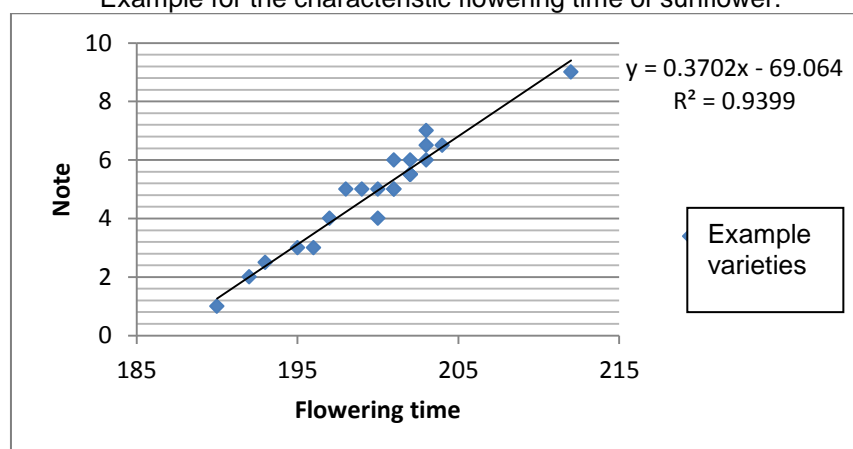Y is the note of the example variety
X is the mean of the measurement for this example variety (depending on the specie, the mean can be the arithmetic mean or the adjusted mean using COY analysis).

An equation is then obtained for each measured characteristic, which allows to calculate the notes of each candidate variety.

The choice of example varieties is crucial in this method and it can be difficult to find good example varieties for all the notes. However it is a reliable method which shows a good stability of descriptions and notes and takes into account the environmental conditions of the year.

This method is used in France mainly on herbage and sunflower.

Example for the characteristic flowering time of sunflower:

$y = 0.3702x - 69.064$
$R^2 = 0.9399$

Example varieties

In any methods, the crop expert judgment is fundamental to validate the transformation each year and he/she can perform adjustments if needed.

[Annex IV follows]

ANNEX IV

SHORT EXPLANATION ON MEASURED, QUANTITATIVE CHARACTERISTICS
FOR UNITED KINGDOM VEG & HERBAGE

Document prepared by an expert from the United Kingdom

These two methods are only for characteristics which are measured and quantitative.

(a) The delineating varieties method using herbage as an example:

Over-year variety means are calculated from the yearly trial means. Trial means from the past 10 years' trials are used for herbage crops. The over-year means are calculated using a fitted constants analysis; this allows for varieties not being present in every year. Finally, the over-year means are converted to notes. For herbage crops this is done by use of delineating varieties chosen by crop expert judgement and are based on the notes for example varieties. Delineating varieties differ from example varieties. A delineating variety defines each upper (or lower) intervening limit of the states within the range of expression. By contrast, an example variety usually represents the typical or mid-interval expression of each state within the range of expression.

(b) The equal spaced notes method using field peas as an example:

Over-year variety means are calculated from the yearly trial means. Trial means from all years where the reference collection varieties have been tested are used for peas. The over-year means are calculated using a fitted constants analysis; this allows for varieties not being present in every year. Finally, the over-year means are converted to notes. For peas this is done so that the states are equally spaced.

Both methods use over-year means to minimise any observed variation in varieties due to differences in years. In effect, reference varieties (including example varieties) remain the same note year on year.

For greater detail of these two methods and worked examples, see document TWC/30/32 "Handling Measured, Quantitative Characteristics for Vegetable and Herbage Crops Tested in the United Kingdom". Please note that the worked examples are based on an artificial data set in order to illustrate the method.

[Annex V follows]

ANNEX V

REASONS AND SITUATIONS WHEN CERTAIN APPROACHES WOULD/WOULD NOT BE APPROPRIATE
FOR TRANSFORMING OBSERVATIONS INTO NOTES

Document prepared by an expert from the United Kingdom

Cases when use of delineating varieties chosen by crop expert judgement would or would not be appropriate
for transforming observations into notes

Crop expert chosen delineating varieties* would **not be used if**

- the delineating variety did not express the same state as in previous years, e.g. if the delineating
  varieties "drifted", or

- new varieties regularly arose that showed more extreme expression.

- available datasets too small for COYD analysis.

Crop expert chosen delineating varieties would **be used if**

- the delineating varieties do not drift, such as with herbage crops where there are annual changes
  according to field and climate conditions, but then all the varieties tend to be affected in the same way
  by these. It is also used for cereals and winter oilseed rape crops.

*   Delineating varieties differ from example varieties in that in the former, a delineating variety defines
each upper (or lower) intervening limit of the states within the range of expression. By contrast, with
example varieties an example variety represents the typical or mid-interval expression of each state within
the range of expression.

Cases when use of equal-spaced states would/would not be appropriate for transforming observations into
notes

Equal-spaced states would **not be used if**

- reference varieties with more 'extreme' states are not included in the growing trial

- where the range of values is not continuous, e.g. in pod width characteristic in peas (and to a certain
  extent also the length characteristic). In peas there are two types of pod; the "normal" and the
  "balloon". Below are pictures and a histogram of the over-years mean pod width. This shows that
  there is a mixture of two distributions for the pod width, corresponding to the two types: a normal
  distribution for the "normal" type but a scattering of "balloon" types at the top end. If you use the
  "Equal-spaced method" in this case the individual notes get stretched. There are really two discrete
  scales here which reflect the two different pod-types.

- available datasets too small for COYD analysis.

Equal-spaced states would **be used if**

- reference varieties represent the full states of expressions.

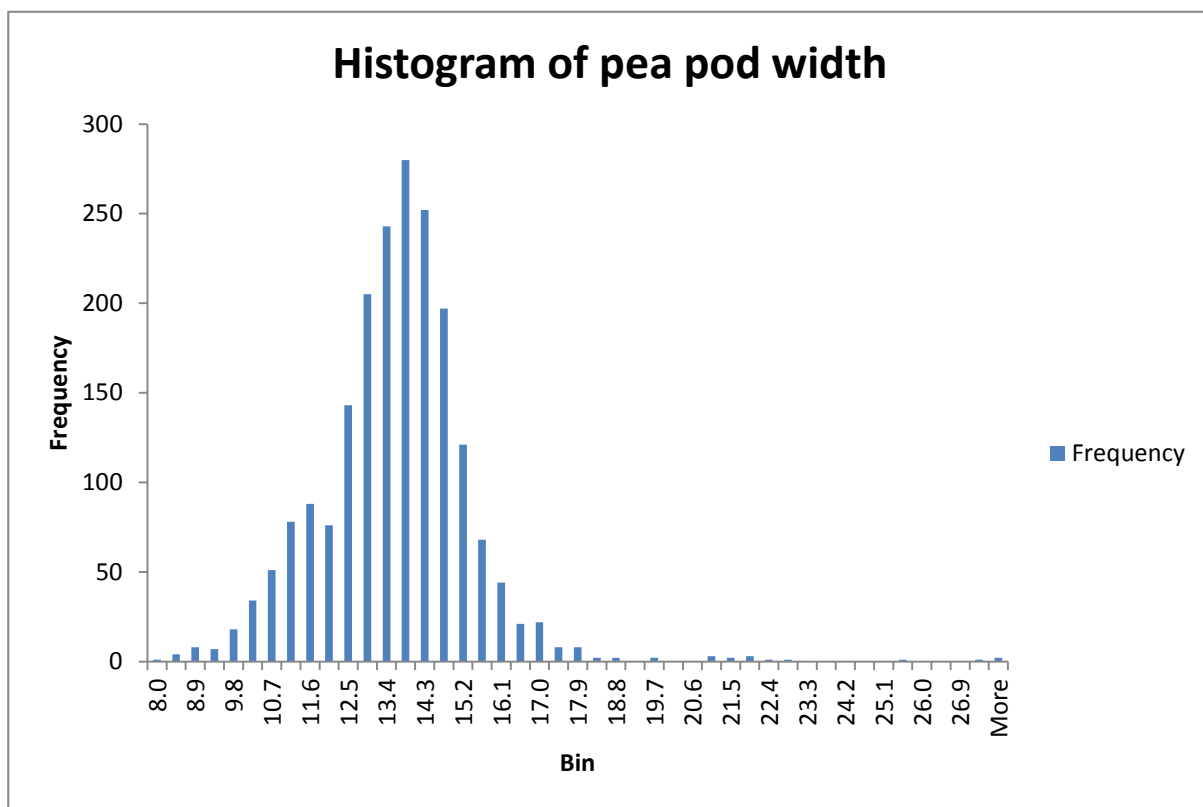- the range of values is continuous

Balloon pods

Normal pods

Histogram of pea pod width characteristic

TC-EDC/Mar18/15

ANNEX VI

SHORT EXPLANATION ON THE JAPANESE METHODS FOR ASSESSMENT TABLE FOR PRODUCING VARIETY DESCRIPTIONS

Document prepared by an expert from Japan

The measured data for QN characteristics in DUS growing trial are transformed to numerical notes based on the assessment table. The assessment table are developed by the measurement data of respective example variety which are allocated in the specific notes, are precisely defined each range of notes. In case of major crops as we have accumulated measured data from long standing DUS growing trials which have been carried out under the same places, similar circumstances and same condition for the crops growing.

Under these circumstances, the fundamental assessment table (FAT) are developed by these accumulated measured data of the example variety. The FAT is corrected by the growing degree calculated by the comparison with current years measured data of example variety.

Introduction to using fundamental assessment table (FAT) system for Quantitative Characteristics in Japan

1. Assessment Table

Assessment Table had been working to transform measured data into numerical note in DUS test. Each note was allocated "Range" by their measured data of example varieties.

Table 1: Example of Assessment Table for characteristic 'Length of leaf blade'

Characteristic	Note	1	2	3	4	5	6	7	8	9
Length of leaf blade	Range	~34	35~44	45~54	55~64	65~74	75~84	85~94	95~104	105~
mm	Example			Example Variety A				Example Variety B		

As growing of these example varieties have been affected by the yearly climatic situation or other environmental elements, their actual measured data for QN characteristics have tendency of fluctuation in some extent. Usually registered varieties have been used as similar varieties for DUS growing trials, in the case of registered variety as note 3, registered variety doesn't always keep their original states when the variety registered by applying above Assessment Table because of fluctuating for the distance of measured data between example variety A and B.

To keep the evaluation unchangeably, the assessment table had been improved based on the accumulated measured data of example varieties.

2. The fundamental assessment table (FAT) system

2.1   Fundamental assessment table (FAT)

FAT is developed by more than 10 years' average as "Trial Mean" of data of example varieties which are allocated "Median" of the Range of Note.

Following table is set by 10 years' average of example varieties.

Table 2: Example FAT for characteristic 'Length of leaf blade'

Characteristic	Note	1	2	3	4	5	6	7	8	9
Length of leaf blade	Range	~ 39	40 ~ 49	50 ~ 59	60 ~ 69	70 ~ 79	80 ~ 89	90 ~ 99	100 ~ 109	110 ~
	Distance		10	10	10	10	10	10	10	
	Median		45	55	65	75	85	95	105	
mm	Example Variety: Trial Mean of 10 years			Example Variety A: 55mm				Example Variety B: 95mm		

FAT is the assessment table which involved 10 years' error as principle table, usually FAT is converted by current year's data of example varieties before the evaluation of the note for QN characteristics.

Current trial data should always be assessed by transforming fundamental assessment table (FAT) to current assessment table (CAT).

2.2 Transforming current assessment table (CAT)

To transform from FAT to CAT, it is used "Growth Score" as followings.

2.2.1 Growth Score

Example

10 years' average as "Trial Mean" of leaf length is 55mm with example variety A.
"Current years' Mean" of leaf length is 52mm with example variety A.
Current Mean of 52mm / Trial Mean of 55mm = 0.95 ="Growth Score"

2.2.2 Multiplying "Growth Score"

CAT is developed by multiplying "Growth Score" to FAT for adjustment to the current growth level.

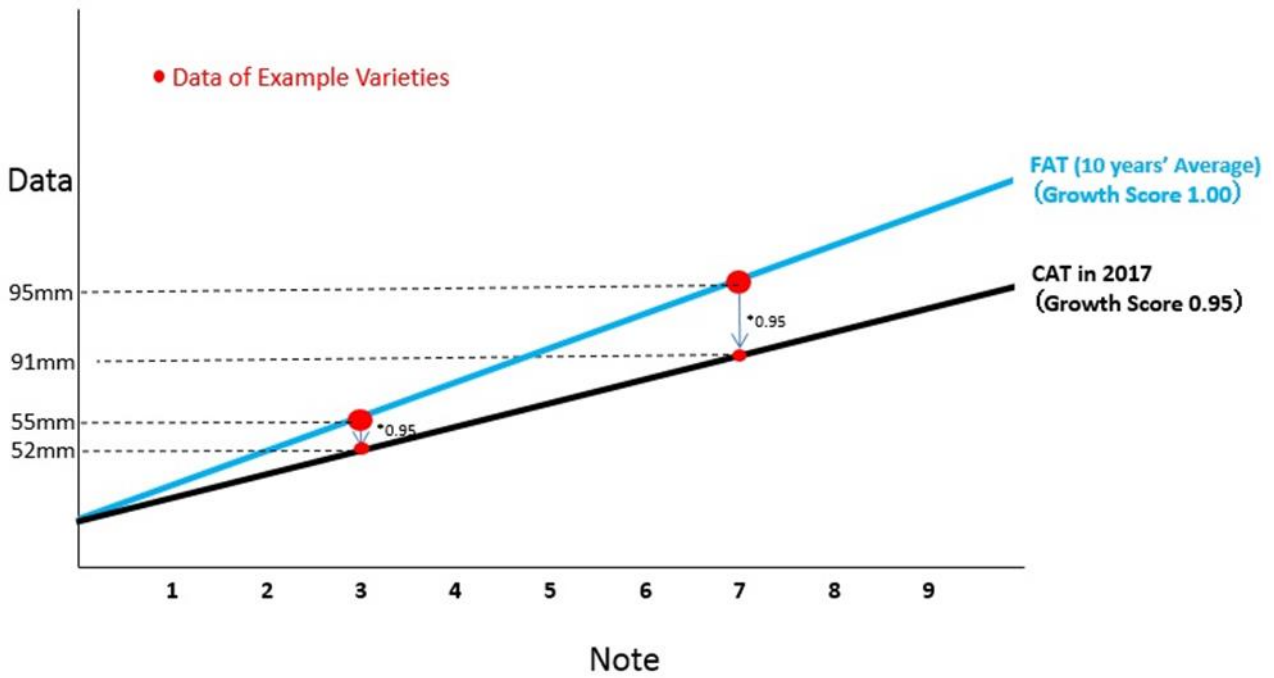| Characteristic	Note	1	2	3	4	5	6	7	8	9
Length of leaf blade	Range	~ 39	40 ~ 49	50 ~ 59	60 ~ 69	70 ~ 79	80 ~ 89	90 ~ 99	100 ~ 109	110 ~
	Distance		10	10	10	10	10	10	10	
	Median		45	55	65	75	85	95	105	
mm	Example Variety: Trial Mean of 10 years			Example Variety A: 55mm				Example Variety B: 95mm		

FAT is multiplied Growth Score 0.95

Characteristic	Note	1	2	3	4	5	6	7	8	9
Length of leaf blade	Range	~ 38	39 ~ 47	48 ~ 56	57 ~ 66	67 ~ 75	76 ~ 85	86 ~ 95	96 ~ 105	106 ~
	Distance		9.5	9.5	9.5	9.5	9.5	9.5	9.5	
	Median		43	52	61	71	81	91	101	
mm	Example Variety: Trial Mean of 10 years			Example Variety A: 52mm				Example Variety B: 91mm		

CAT is produced with reflected growth level of the trial (0.95)

2.3   Relevance of FAT and CAT

Following graph explains relation between FAT and CAT. FAT is always retained 1.00 Growth Score. Current trial Growth Score to be scored year by year.

[Annex VII follows]

ANNEX VII

CHARACTERISTICS, GENOTYPE BY ENVIRONMENT INTERACTION (GEI) AND DUS TRIALS

Document prepared by experts from Finland and Italy

Genotype by environment interaction takes place when different genotypes respond in a different way to different environments and it produces a phenotype variation (e.g. year and location). Many studies have shown that plant species may produce a broad range of phenotypes in response to the variation of the environment. See Figure 1. The ability of a single genotype to produce multiple phenotypes in response to the environment is called «phenotypic plasticity». When instead a genotype tends to maintain constant characteristics through environments its ability is called «phenotypic stability». The characteristics that are most influenced by the environment are QN and PQ.
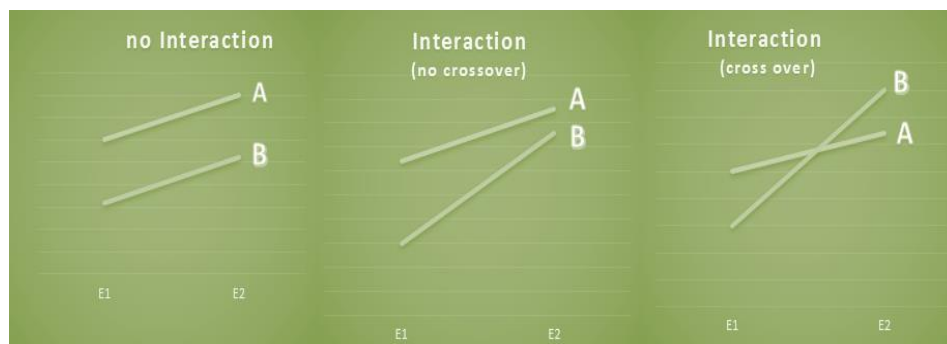

Figure 1 Graphic view of main GEI cases (Environments E1 and E2)

Observations and trials data are based on phenotypes and may change over years because of GEI. To limit the environmental influence and, consequently, the number of the possible phenotypes, the use of one permanent location for DUS trials as «reference location» is recommended.

EXAMPLE VARIETIES AND DELINEATING REFERENCE VARIETIES

Example varieties and *Delineating reference varieties* are state references that are used as comparisons of varietal descriptions. Their use must be appropriate and carefully evaluated because changes of rank over years are possible when characteristics are influenced by the environment. Example varieties and Delineating reference varieties should be as stable as possible. An estimator of varietal stability over years for QN characteristics is the coefficient of variation (CV). It is defined as the ratio of the standard deviation to the mean and it can also be expressed as a percentage:
$$CV = (SD / Mean) * 100$$

USE OF REGIONAL SETS OF EXAMPLE VARIETIES

Databases can be increased by adding new data from candidate and reference varieties. Databases should include data of varieties grown and/or tested in a reference location where DUS test takes place. The use of regional sets of Example varieties is preferable because it enables to compare characteristics of all varieties included in a database, as well as to test how stable a variety is in a specific region.

Where large regions are present in the same country because of very different agro-climatic conditions, more than one reference location is conceivable. In this case we could have more than one description for a single variety due to different phenotypes. Only one description should be the official one.

If more than one location is used for DUS trials and more than one description is produced, criteria to choose the official one are needed. Possible criteria for choosing the 'official Location/description' are:
- *Location in the area with the largest adaptation/cultivation of the species* (choice based on the most common phenotype in that area)
- *Location where CV range of varieties is the lowest* (choice based on stability over years)

STABLE AVERAGES VS COMBINING NOTES

Reference and candidate varieties produce different values over years. The frequency and level of interaction (GEI) of a given variety is unpredictable because they depend on its genetics and on the relative effect of the environment on the set of tested varieties. For each characteristic a stable average of historical means is reached only after several years. *Average over years* can be considered a good estimation of characteristic measure (even though the 'median' could be more logical where historical averages have strong skewed distribution). This method is largely used to transform observations into notes.

Immediate transformation of each year mean into a note and then combining notes of trial years is possible as well. In this case, a loss of information may be possible, because a note can summarize many averages.

[End of Annex VII and of document]