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INTERNATIONAL UNION FOR THE PROTECTION OF NEW VARIETIES OF PLANTS

Geneva

OECD/UPOV/ISTA JOINT WORKSHOP ON MOLECULAR TECHNIQUES

Seoul, Republic of Korea, November 12, 2014

INTRODUCTION TO UPOV AND THE SITUATION WITH REGARD TO MOLECULAR TECHNIQUES

Document prepared by the Office of the Union

Disclaimer: this document does not represent UPOV policies or guidance

The Annex to this document contains a copy of a presentation "Introduction to UPOV and the situation with regard to molecular techniques" made at the OECD/UPOV/ISTA Joint Workshop on Molecular Techniques.

[Annex follows]

ANNEX

OECD/UPOV/ISTA JOINT WORKSHOP ON MOLECULAR TECHNIQUES

Introduction to UPOV and the situation with regard to molecular techniques

Seoul, Republic of Korea, November 12, 2014

1. INTRODUCTION TO UPOV

UPOV: INDEPENDENT INTERGOVERNMENTAL ORGANIZATION

The International **Convention** for the
Protection of New Varieties of Plants

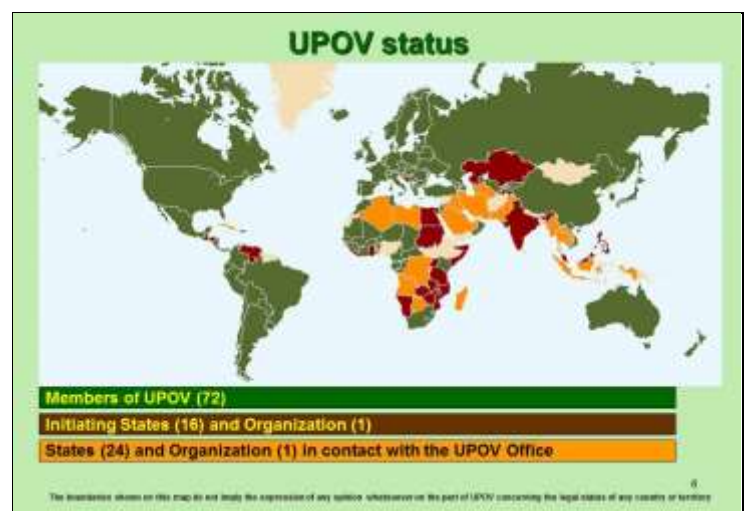
established in 1961

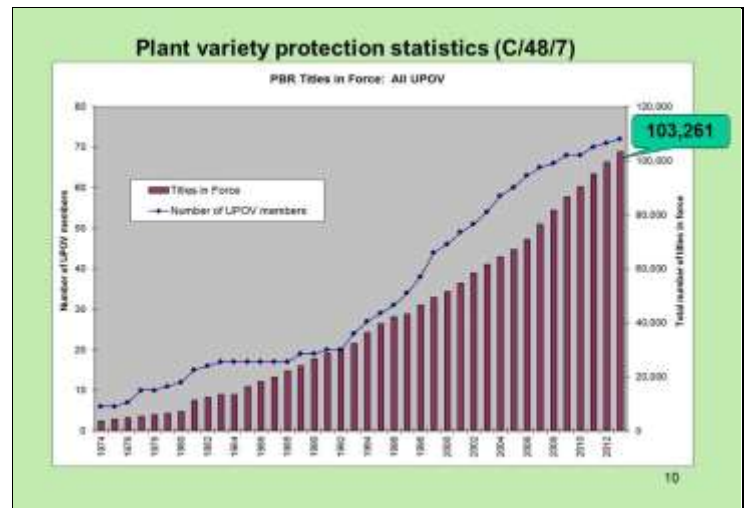
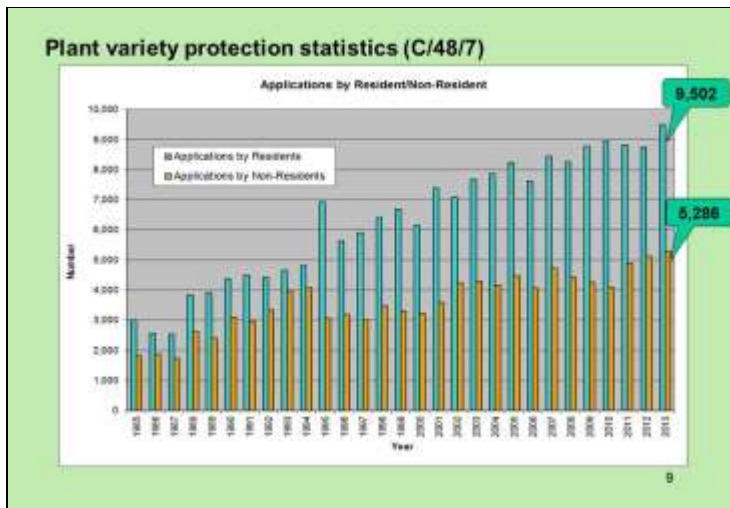
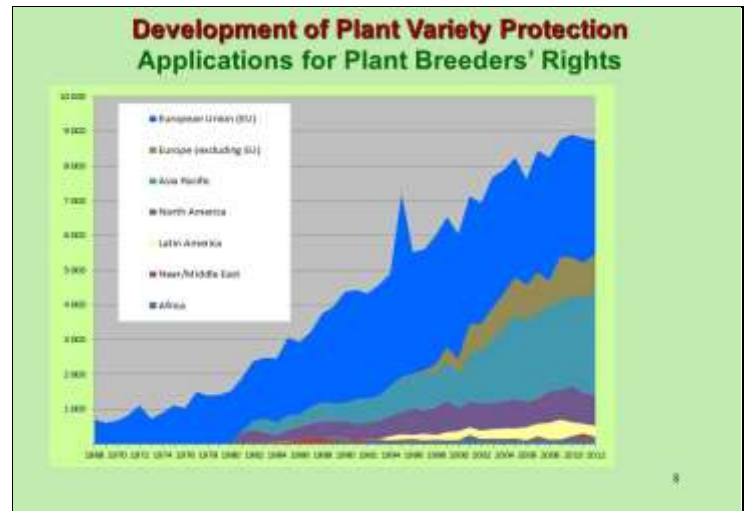
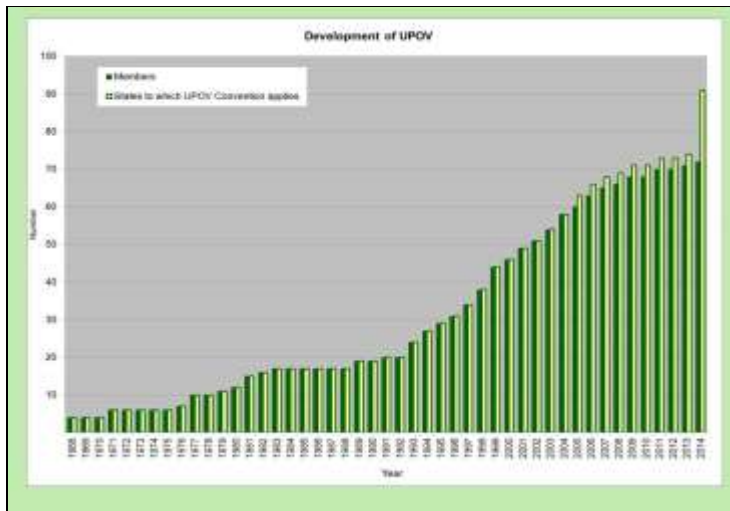
The International **Union** for the Protection of
New Varieties of Plants

Union internationale pour la
protection des **ob**tentions **v**égétales

Mission Statement

To provide and promote an effective
system of plant variety protection, with
the aim of encouraging the development
of new varieties of plants, for the benefit
of society.





2. Overview of DUS Examination

- a: Conditions for granting a breeder's right
- b: Guidance for DUS Examination
- c: Characteristics

THE CONDITIONS FOR GRANTING A BREEDER'S RIGHT

Criteria to be satisfied

- NOVELTY
- DISTINCTNESS
- UNIFORMITY
- STABILITY



"DUS"

THE CONDITIONS FOR GRANTING A BREEDER'S RIGHT

Other conditions

- VARIETY DENOMINATION
- FORMALITIES
- PAYMENT OF FEES

NO OTHER CONDITIONS!

2. Overview of DUS Examination

- a: Conditions for granting a breeder's right
- b: Guidance for DUS Examination**
- c: Characteristics

Guidance for DUS Examination

facilitates:

BEST PRACTICE (based on experience)

- => good decisions
- => good definition of the object of protection (strong protection)
- => efficiency in method of examination (learn from the best)

HARMONIZATION

- => efficiency
 - mutual acceptance of DUS reports (minimize cost of examination for individual authorities)
 - mutual recognition of variety descriptions (all parties speak the same "language")
 - simple and cheap system for applicants (minimize cost for breeders)

Importance of Harmonized Approach within UPOV

- ⇒ To facilitate cooperation in DUS testing
e.g. purchase of DUS reports
- ⇒ To establish internationally recognized variety descriptions (effective protection)

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UPOV provides guidance by:

- The "General Introduction" (TG/1/3)
 - General technical principles
 - Organization of DUS Testing
 - Associated "TGP" Documents (e.g. statistical methods)

– version 3

TG/1/3 General Introduction

"Associated" TGP Documents

Ref.	Title
TG/06	List of TGP Documents and Latest Issue Dates
TGP/1	General Introduction With Explanations
TGP/2	List of Test Guidelines Adopted by UPOV
TGP/3	Varieties of Common Knowledge
TGP/4	Conditions and Maintenance of Variety Collections
TGP/5	Experience and Cooperation in DUS Testing
TGP/6	Arrangements for DUS Testing
TGP/7	Development of Test Guidelines
TGP/8	Test Design and Techniques Used in the Examination of DUS
TGP/9	Examining Distinctness
TGP/10	Examining Uniformity
TGP/11	Examining Stability
TGP/12	Special Characteristics
TGP/13	Guidelines for New Types and Species
TGP/14	Glossary of Technical, Botanical and Statistical Terms Used in UPOV Documents
TGP/15	Guidance on the Use of Biochemical and Molecular Markers in the Examination of Distinctness, Uniformity and Stability (DUS)



2. Overview of DUS Examination

- a: Conditions for granting a breeder's right
- b: Guidance for DUS Examination
- c: **Characteristics**

"CHARACTERISTICS"

- may have direct commercial relevance
 - Flower color (ornamental)
 - Fruit color
- but **commercial relevance NOT required**
 - Leaf shape

Selection of Characteristics

The basic requirements that a characteristic should fulfill before it is used for DUS testing or producing a variety description are that its expression (TG/1/3: Section 4.2.1) :

- (a) **results from a given genotype** or combination of genotypes;
- (b) is sufficiently **consistent and repeatable** in a **particular environment**;
- (c) exhibits sufficient **variation between varieties** to be able to establish distinctness;
- (d) is capable of **precise definition and recognition**;
- (e) allows **uniformity requirements** to be fulfilled;
- (f) allows **stability requirements** to be fulfilled, meaning that it produces consistent and repeatable results after repeated propagation or, where appropriate, at the end of each cycle of propagation.

Selection of Characteristics

- **Yield ???**
- **Straw strength ???**
- Etc.

Selection of Characteristics

Criteria	Fruit: color	Leaf: shape	Yield
(a) results from a given genotype or combination of genotypes	Yes	Yes	
(b) sufficiently consistent and repeatable in a particular environment	Yes	Yes	
(c) exhibits sufficient variation between varieties to be able to establish distinctness	Yes	Yes	
(d) is capable of precise definition and recognition	Yes	Yes	
(e) allows uniformity requirements to be fulfilled	Yes	Yes	
(f) allows stability requirements to be fulfilled	Yes	Yes	
Commercial value	Yes	No	
ACCEPTABILITY	Yes	Yes	

Selection of Characteristics

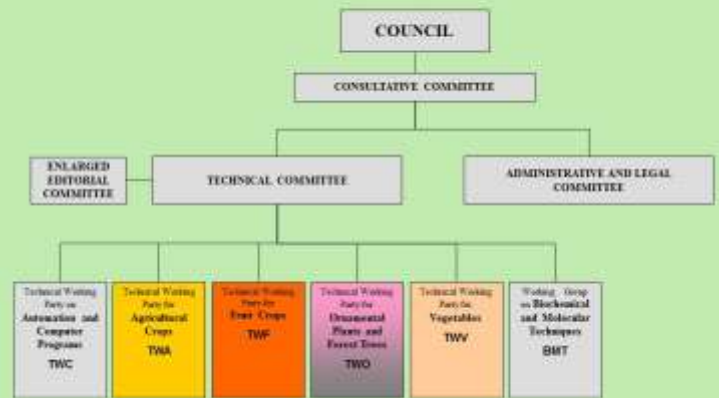
Criteria	Fruit: color	Leaf: shape	Yield
(a) results from a given genotype or combination of genotypes	Yes	Yes	Yes
(b) sufficiently consistent and repeatable in a particular environment	Yes	Yes	(No)
(c) exhibits sufficient variation between varieties to be able to establish distinctness	Yes	Yes	???
(d) is capable of precise definition and recognition	Yes	Yes	(No)
(e) allows uniformity requirements to be fulfilled	Yes	Yes	???
(f) allows stability requirements to be fulfilled	Yes	Yes	???
Commercial value	Yes	No	Yes
ACCEPTABILITY	Yes	Yes	No

Special Characteristics: Disease Resistance

Criteria	Disease Resistance
(a) results from a given genotype or combination of genotypes	*Knowledge of nature of genetic control of resistance is important
(b) sufficiently consistent and repeatable in a particular environment	*Standardize conditions (greenhouse / laboratory) & methodology *Standardize inoculum *Ring-test
(c) exhibits sufficient variation between varieties to be able to establish distinctness	*Susceptible / Resistant OR varying degrees of resistance?
(d) is capable of precise definition and recognition	*Define and recognize races and strains
(e) allows uniformity requirements to be fulfilled	see above
(f) allows stability requirements to be fulfilled	see above
Difficult and expensive	

3. The Role of BMT within UPOV

UPOV Structure



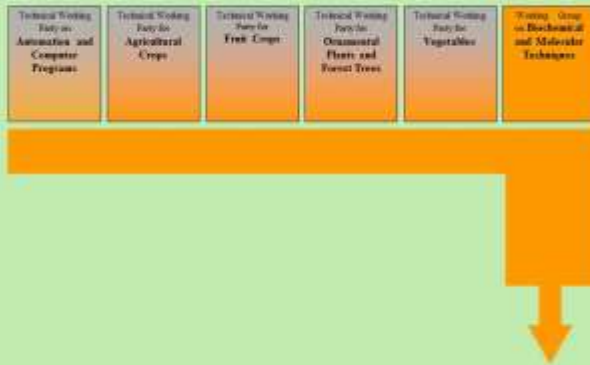
UPOV Structure



UPOV Structure



UPOV Structure



Role of the BMT

The BMT is a group open to DUS experts, biochemical and molecular specialists and plant breeders, whose role is to:

- (i) Review general developments in biochemical and molecular techniques;
- (ii) Maintain an awareness of relevant applications of biochemical and molecular techniques in plant breeding;
- (iii) Consider the possible application of biochemical and molecular techniques in DUS testing and report its considerations to the TC;
- (iv) If appropriate, establish guidelines for biochemical and molecular methodologies and their harmonization [...];
- (v) Consider initiatives from TWPs, for the establishment of crop specific subgroups [...];
- (vi) Develop guidelines regarding the management and harmonization of databases of biochemical and molecular information, in conjunction with the TWC;
- (vii) Receive reports from Crop Subgroups and the BMT Review Group;
- (viii) Provide a forum for discussion on the use of biochemical and molecular techniques in the consideration of essential derivation and variety identification.

Role of the BMT

Consider the possible application of biochemical and molecular techniques in DUS testing

(see document BMT/12/2: Annex, page 2)

The BMT is a group open to DUS experts, biochemical and molecular specialists and plant breeders, whose role is to: [...]

- (iii) Consider the possible application of biochemical and molecular techniques in DUS testing and report its considerations to the TC;
- (v) Consider initiatives from TWPs, for the establishment of crop specific subgroups [...];
- ((vii) Receive reports from Crop Subgroups and the BMT Review Group.)

- ⇒ UPOV/INF/18 "Possible Use of Molecular Markers in the Examination of Distinctness, Uniformity and Stability (DUS)" (2011)
- ⇒ TGP/15 "Guidance on the Use of Biochemical and Molecular Markers in the Examination of Distinctness, Uniformity and Stability (DUS)" (2013)
- ⇒ BMT/14 agenda item 5 "Report of work on molecular techniques in relation to DUS examination", 9 "The use of molecular techniques in examining essential derivation", and 10 "The use of molecular techniques in variety identification"

Role of the BMT

Guidance and harmonization for a range of applications

(see document BMT/12/2: Annex, page 2)

The BMT is a group open to DUS experts, biochemical and molecular specialists and plant breeders, whose role is to: [...]

- (iv) If appropriate, establish guidelines for biochemical and molecular methodologies and their harmonization [...];
- (vi) Develop guidelines regarding the management and harmonization of databases of biochemical and molecular information, in conjunction with the TWC;

- ⇒ UPOV/INF/17 "Guidelines for DNA-Profiling: Molecular Marker Selection and Database Construction ("BMT Guidelines")" (2010)
- ⇒ BMT/14 agenda item 6 "International guidelines on molecular methodologies", item 7 "Variety description databases"

Role of the BMT

Raise awareness of general developments:

(see document BMT/12/2: Annex, page 2)

The BMT is a group open to DUS experts, biochemical and molecular specialists and plant breeders, whose role is to:

- (i) Review general developments in biochemical and molecular techniques;
- (ii) Maintain an awareness of relevant applications of biochemical and molecular techniques in plant breeding;

- ⇒ BMT/14 agenda item 4 "Short presentations on new developments in biochemical and molecular techniques by DUS experts," and item 8 "Methods for analysis of molecular data"

Role of the BMT

(see document BMT/12/2: Annex, page 2)

The BMT is a group open to DUS experts, biochemical and molecular specialists and plant breeders, whose role is to: [...]

- (viii) Provide a **forum for discussion** on the use of biochemical and molecular techniques in the consideration of **essential derivation** and **variety identification**.

- ⇒ BMT/14 agenda items 9 "The use of molecular techniques in examining essential derivation" and 10 "The use of molecular techniques in variety identification"

4. Situation in UPOV concerning the Possible Use of Molecular Techniques in the DUS Examination

- Use of biochemical and molecular markers in the examination of Distinctness, Uniformity and Stability (DUS)
- Frequently Asked Questions in molecular techniques (FAQ)

STATUS OF UPOV DOCUMENTS CONCERNING MOLECULAR TECHNIQUES

1. ADOPTED in OCT. 2010 (UPOV/INF/17) and OCT. 2011 (UPOV/INF/18)

Document reference	Title
UPOV/INF/17/1	Guidelines for DNA Profiling: Molecular Marker Selection and Database Construction ("BMT Guidelines")
UPOV/INF/18/1	Possible Use of Molecular Markers in the Examination of Distinctness, Uniformity and Stability

2. ADOPTED in OCT. 2013

Document reference	Title
TGP/15	Guidance on the Use of Biochemical and Molecular Markers in the Examination of Distinctness, Uniformity and Stability (DUS)

UPOV/INF/17/1 (INFORMATION document)

"Guidelines for DNA Profiling: Molecular Marker Selection and Database Construction ("BMT Guidelines")"

The purpose of this document (BMT Guidelines) is to provide guidance for developing harmonized methodologies with the aim of generating high quality molecular data for a range of applications. The BMT Guidelines are also intended to address the construction of databases containing molecular profiles of plant varieties [...]

UPOV/INF/18/1 (INFORMATION document)

"Possible Use of Molecular Markers in the Examination of Distinctness, Uniformity and Stability"

The purpose of this document is to provide guidance on the possible use of biochemical and molecular markers in the examination of Distinctness, Uniformity and Stability (DUS). [...]

→ Both documents have been **adopted and published on UPOV website.**

UPOV/INF/18 POSSIBLE APPLICATION MODELS

MODELS WITH A POSITIVE ASSESSMENT

- Characteristic-specific molecular markers
- Combining phenotypic and molecular distances in the management of variety collections
- Calibrated molecular distances in the management of variety collections



MODELS WITHOUT A POSITIVE ASSESSMENT

- Use of molecular marker characteristics

TGP/15/1 (TECHNICAL GUIDELINES PROTOCOL)

"Guidance on the Use of Biochemical and Molecular Markers in the Examination of Distinctness, Uniformity and Stability (DUS)"

The purpose of this document is to provide guidance on the use of biochemical and molecular markers in the examination of Distinctness, Uniformity and Stability (DUS) on the basis of the models in document UPOV/INF/18 that have received a positive assessment and for which accepted examples have been provided.

→ Adopted by the Council of UPOV in October, 2013.

APPLICATION MODELS in TGP/15 (brown part)

MODELS WITH A POSITIVE ASSESSMENT

- Characteristic-specific molecular markers
- Combining phenotypic and molecular distances in the management of variety collections
- Calibrated molecular distances in the management of variety collections

MODELS WITHOUT A POSITIVE ASSESSMENT

- Use of molecular marker characteristics



APPLICATION MODEL:

Characteristic-specific molecular markers

Molecular markers can be used as a method of examining DUS characteristics that satisfy the criteria for characteristics set out in the General Introduction (TGP/1), Chapter 4, section 4.2, on the following basis:

- (a) the test for the marker is conducted on the same number of individual plants, with the same criteria for DUS as for the examination of the characteristic by a bioassay;
- (b) there is verification of the reliability of the link between the marker and the characteristic;



APPLICATION MODEL:

Characteristic-specific molecular markers (Cont.)

- (c) different markers for the same characteristic are different methods for examining the same characteristic;
- (d) markers linked to different genes conferring expression of the same characteristic are different methods for examining the same characteristic; and
- (e) markers linked to different regulatory elements for the same gene conferring expression of the same characteristic are different methods for examining the same characteristic

(see TGP/15, Section 2.1)



APPLICATION MODEL:

Combining phenotypic and molecular distances in the management of variety collections

A key feature of the process of eliminating varieties of common knowledge prior to the DUS growing trial is that the threshold is set with a suitable margin of safety. This threshold is termed the "Distinctness plus" threshold, which means that the distances between a candidate variety and "Distinct plus" varieties are robust enough to take a decision without direct comparison in the growing trial.



APPLICATION MODEL:

Combining phenotypic and molecular distances in the management of variety collections (Cont.)

A combination of phenotypic differences and molecular distances can be used to identify within the variety collection, those varieties which need to be compared with candidate varieties in order to improve the selection of "Distinct plus" varieties, on the following basis:



APPLICATION MODEL:

Combining phenotypic and molecular distances in the management of variety collections (Cont.)

- (a) there is reliable information that the molecular distances are sufficiently related to phenotypic differences, such that
- (b) the method selects varieties in the variety collection which are similar to the candidate varieties; and
- (c) the method does not create an increased risk of not selecting a variety in the variety collection which needs to be compared to the candidate varieties in the field.

(see TGP/15 Section 2.2)

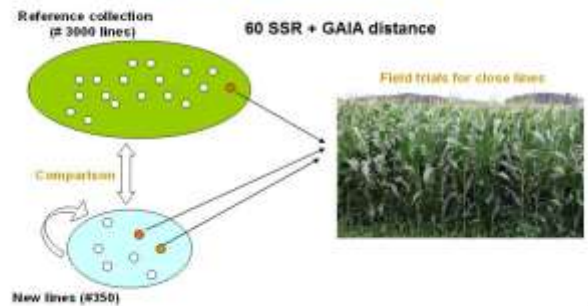
TGP/15 Annex II: Example of Parent Lines in Maize

The objective of this example is to develop an efficient tool, based on a combination of phenotypic and molecular distances, to identify within the variety collection, those varieties which need to be compared with candidate varieties in order to improve the selection of "distinct plus" varieties and so to limit the workload without decreasing the quality of the test. The challenge is to develop a secure system that:

- (a) only selects varieties which are similar to the candidate varieties; and
- (b) limits the risk of not selecting a variety in the variety collection which needs to be compared in the field, especially when there is a large or expensive variety collection.

MANAGEMENT OF THE REFERENCE COLLECTION

DISTINCTNESS PROCEDURE



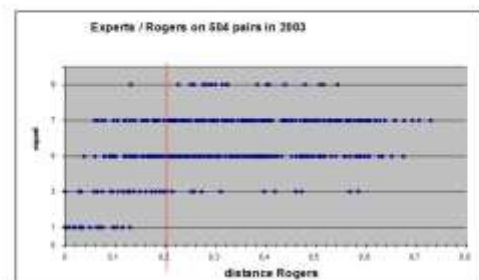
Visual assessment by maize crop experts:

Scale of similarity:

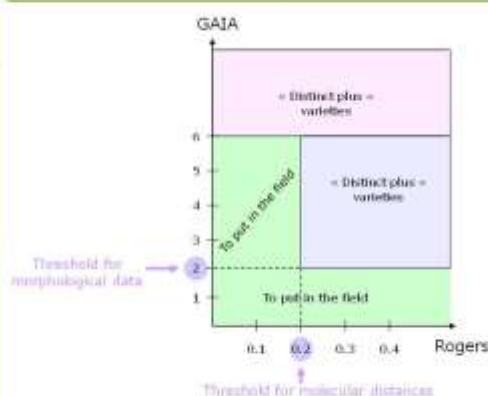
1. the two varieties are similar or very close
3. the two varieties are distinct but close
5. the comparison was useful, but the varieties are clearly distinct
7. the comparison should have been avoided because the varieties are very different
9. the comparison should have been avoided because the varieties are totally different

(*even* notes are not used in the scale)

EVALUATION OF THE LEVEL OF CORRELATION BETWEEN MOLECULAR AND MORPHOLOGICAL DATA



Each data point corresponds to the lowest note determined by the panel of experts and the Rogers distance, for a given pair.



4. Situation in UPOV concerning the Possible Use of Molecular Techniques in the DUS Examination

- Use of biochemical and molecular markers in the examination of Distinctness, Uniformity and Stability (DUS)
- Frequently Asked Questions in molecular techniques (FAQ)

Question: Does UPOV allow molecular techniques (DNA profiles) in the DUS examination?

- It is important to note that, in some cases, varieties may have a different DNA profile but be phenotypically identical, whilst, in other cases, varieties which have a large phenotypic difference may have the same DNA profile for a particular set of molecular markers (e.g. some mutations).
- In relation to the use of molecular markers that are not related to phenotypic differences, the concern is that it might be possible to use a limitless number of markers to find differences between varieties at the genetic level that are not reflected in phenotypic characteristics.

On the above basis, UPOV has agreed the following uses in relation to DUS examination:

Question: Does UPOV allow molecular techniques (DNA profiles) in the DUS examination?(Cont.)

- (a) Molecular markers can be used as a method of examining DUS characteristics that satisfy the criteria for characteristics set out in the General Introduction if there is a reliable link between the marker and the characteristic.
- (b) A combination of phenotypic differences and molecular distances can be used to improve the selection of varieties to be compared in the growing trial if the molecular distances are sufficiently related to phenotypic differences and the method does not create an increased risk of not selecting a variety in the variety collection which should be compared to candidate varieties in the DUS growing trial.

Question: Does UPOV allow molecular techniques (DNA profiles) in the DUS examination?(Cont.)

The situation in UPOV is explained in documents TGP/15 'Guidance on the Use of Biochemical and Molecular Markers in the Examination of Distinctness, Uniformity and Stability (DUS)' and UPOV/INF/18 'Possible use of Molecular Markers in the Examination of Distinctness, Uniformity and Stability (DUS)'.



THANK YOU