Variety Registration, Field Inspection and Seed Certification

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Outline

• **Introduction:** Concepts, terms & definitions

• Variety development, testing and registration

• Maintaining seed and varietal quality

• Field Inspection and certification procedures

• Variety registration and certification practices from some Asian countries
What is a variety?

**VARIETY (= Cultivar):** is an assemblage of plants that (a) has been selected for a particular character or combination of characters, and (b) remains distinct, uniform, and stable in these characters when propagated by appropriate means (ICNCP, 2016)
Why we need new varieties?

- High yield and good product
- Resistance to biotic stress
- Resistance to abiotic stress
- Response to modern inputs
- Efficient use of inputs
- Suitability for mechanization
New Variety
Old Technology
2.69 t/ha

Old Variety
Old Technology
2.62 t/ha

New Variety
New Technology
3.62 t/ha

Old Variety
New Technology
3.05 t/ha

New Variety
Old Technology
0.07 t

Old Variety
Old Technology
0.36 t

New Variety
New Technology
0.93 t

Old Variety
New Technology
0.43 t

New Variety
Old Technology
1 t

Old Variety
Old Technology
0.59 t

Source: Z. Bishaw, ICARDA
What is variety release?

• Identification and submission of promising lines with acceptable characters from breeding lines for further evaluation

• Testing of new variety for registration and performance by competent authority

• Approval of new variety for commercial use

• Inscription of varieties in national catalogue

• Making available breeder seed of new variety for multiplication
Stages of Variety Testing

- Breeder's observation plots in an experimental station (many experimental lines)

- Wider scale testing in many locations outside an experimental station

- Large-scale testing for adaptability in large number of locations under wide range of environments (agroecology, fertility, etc)
Stages of variety testing  (Example from Ethiopia)

• **Observation nursery**- screening of new crosses/introductions in 1-2 observation rows in comparison with check (one location).

• **Preliminary Yield Trials**: about 100 entries advanced from observation nursery are evaluated (>1 location) in replications.

• **Pre-National Yield Trials**: a quarter of varieties from preliminary yield trials are compared (> 4 locations).

• **National Yield Trials**: 50-70% of varieties are tested with similar procedures as Pre-NYT, but with more replications, test locations and years (3).

• **On-Farm Verification Trials**: promising lines evaluated for one year in un-replicated 100m² plots on station (1) and on farm verification trials on farmers’ fields (2 sites).
Organization & Management of Variety Release

• The agency responsible for final evaluation varies from country to country
  – Governmental organization
  – Private agencies (breeders/associations)

BUT
  – Should be independent and impartial
Types of Variety Tests

- **Distinctness, Uniformity and Stability (DUS) tests:** Botanical (=variety) description

- **Value for Cultivation and Use (VCU) tests:** description (= performance)
DUS TESTS

Why DUS tests?

- Establishing varietal identity
- Seed production (variety maintenance, roguing)
- Seed certification (field inspection)
- National variety lists (registration)
- Plant variety protection (PBRs)
- Consumer protection

Considerations in description

- Variety should not be segregating
- Descriptions made in representative area
- Morphological traits described in full detail
- Descriptions stored for data retrieval
- New variety should be distinct
  - Qualitative characters
    - show discontinuous variation
    - controlled by one or two major genes
    - not or little affected by environment
    - measured visually (e.g. flower color)
    - scored as consecutive

- Quantitative characters
  - show continuous variation
  - controlled by many genes (polygenic)
  - influenced by environment (G,E, GE)
  - measured numerically (or metrically)
  - usually or are often scored on a 1-9 scale

- Pseudo qualitative characters
  - The range of expression is partly continuous, but varies in more than one dimension (seed shape)

- Results- variety description
DUS TESTS (cont..)

**Uniformity**
- Uniformity between plants and within population
- Mode of crop reproduction

**Stability**
- Stability over years
- Mode of reproduction
VCU TRIALS

- Value for cultivation and use
- Different agro-ecological zones
- Identify wide/specific adaptation
- Different management practices
- Comparison with existing varieties
VCU TRIALS (cont....)

- Different designs will be used
- Randomization of experiments
- Agronomic packages (farmers’)
- Two to three subsequent years
- Inclusion of standard check
Variety Release

- Variety release committees
  
  **objective review**
  
- Representation from stakeholders
  
  **public sector**
  
- Review results & recommends
  
  – Voluntary system-breeder
  
  – Compulsory system-Agency
  
  – Variety catalogues
    
    - Restrictive
    
    - Informative
  
- Updated/published yearly
  
  - Remove old/enter new varieties
Naming of Variety

- Numerals and symbols should be avoided

- Names should not exaggerate the merits

- Names should not consist more than two words

- Names should be simple, short, easy, etc

- Names should not be used once variety is withdrawn
UPOV: International Union for the Protection of New Varieties of Plants

- It is an intergovernmental organization headquartered in Geneva (Switzerland).
- Provides guidance on DUS
  - General technical principles
  - DUS Testing methods
  - Other associated documents (e.g. DUS records, statistical methods, guidelines)

- UPOV aims at providing and promoting an effective system of plant variety protection systems
- Aim to encourage development of new varieties of plants, for the benefit of society
- Ensure that the breeders get at least a fair reward for their varieties
DUS Evaluation for maize

- Minimum of one season required, sometimes two seasons to determine stability, but for hybrids that are true-breeding, one season is sufficient.
- Growing conditions ideal for “normal” growth (minimise GxE).
- For hybrids and OPVs a minimum of 60 plants is required; For Inbred lines 40 plants are required.
- Generally, DUS is comparative and subjective, scores rather than measurements used.
- UPOV has 34 characteristics for maize.
- Standard or reference samples are useful.
- Useful to group varieties according to maturity, height, silk colour and grain colour.
First leaf: anthocyanin coloration of sheath

Kiboko (960 masl): 7 days after planting
Kitale (1900 masl): 10 days after planting

Absent or very weak
Weak
Medium

SCALE
1 = absent or very weak
3 = weak
5 = Medium
7 = Strong
9 = very strong
First leaf: shape of tip

Kiboko (960 masl): 7 days after planting
Kitale (1900 masl): 10 days after planting

Pointed  Round  Spatulate

SCALE
1 pointed
4 round or spatulate
2 pointed or round
5 spatulate
3 round
Leaf: angle between blade and stem

3. Small
5. Medium
7. Large

SCALE

1  very small
7  large
3  small
9  very large
5  medium

Recorded for leaf just above upper ear at flowering
Leaf undulation

Recorded from the leaf just above upper ear at flowering

Absent/slight

Intermediate/medium

Strong

SCALE

1 straight

3 slightly recurved

5 recurved

7 strongly recurved

9 very strongly recurved
Leaf: Anthocyanin coloration of sheath (leaf on the ear)

Recorded from flowering to milk stage

**Absent or very weak**
1. Absent or very weak
7. Strong

**Weak**
3. Weak
9. Very strong

**Medium**
5. Medium
Stem: Degree of zig-zag

Recorded at flowering

**SCALE**
1 absent or very slight  2 slight  3 strong
Leaf: Width of blade leaf on the ear

Recorded at milk stage; leaf of upper most ear measured in cm

Narrow

Medium

Wide

SCALE

1 very narrow
7 wide

3 narrow
9 very wide

5 medium
Tassel: Days to 50% anthesis

SCALE

1 very early
2 very early to early
3 Early
4 early to medium
5 Medium
6 medium to late
7 Late
8 late to very late
9 very late

Flowering plant

Halfway anthesis (50% flowering) at the middle third of main axis
Tassel: angle between main axis and lateral branches

Record at 50% pollen shed

Small

Medium

Large

SCALE

1 very small
7 large
3 small
9 very large
5 medium
Tassel: Attitude or recurve of lateral branches

Record at 50% pollen shed; in the lower third of the tassel

Slightly recurved

Recurved

Strongly recurved

SCALE

1 straight
7 strongly recurved
3 slightly recurved
9 very strongly recurved
5 recurved
Tassel: Length of main axis above lowest side branch

Record at milky stage

**SCALE**

1. very short
2. short
3. medium
4. very long

**EXIT**
Tassel: Length of main axis above upper side branch

Record at 50% pollen shed in cm

Short  | Medium | Long

1 very short | 3 short | 5 medium
7 long | 9 very long

SCALE
Tassel: Number of primary lateral branches

Record at 50% pollen shed

**Few**

**Medium**

**Many**

**SCALE**

1 absent or very few
7 many
3 few
9 very many
5 medium
Tassel: Closed anthocyanin ring at base of glume

Recorded before pollen shed; middle third of main axis at base of glume

**SCALE**

- **Absent or very weak**
  - 1 absent or very weak
  - 7 strong

- **Weak**
  - 3 weak

- **Medium**
  - 5 medium
  - 9 very strong
Tassel: Anthocyanin coloration of glumes excluding base

Recorded before pollen shed; middle third of main axis

**SCALE**

- **1** absent or very weak
- **7** strong
- **3** weak
- **9** very strong
- **5** medium
**Tassel: Anthocyanin coloration of anthers**

Record at 50% anthesis; from middle third of main axis on fresh anthers

<table>
<thead>
<tr>
<th>SCALE</th>
<th>Absent or very weak</th>
<th>Weak</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>absent or very weak</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>strong</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

**CIMMYT**
Tassel: density of spikelet

Recorded before pollen shed; from middle third of main axis

Scale

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>lax</td>
<td>5</td>
</tr>
</tbody>
</table>
Silk: time of 50% silk emergence

Record from upper most ear

SCALE

1  very early
2  very early to early
3  Early
4  early to medium
5  Medium
6  medium to late
7  Late
8  late to very late
9  very late

Flowering/silking plant
Silk: Anthocyanin coloration of silks

Record at 50% silking; from upper most ear

SCALE

1. Absent

9. Present
Silk: intensity of anthocyanin coloration of silks

Record at 50% silking; from upper most ear

1. Very weak
2. Weak
3. Medium
4. Strong
5. Very strong

SCALE

1 absent or very weak
7 strong

3 weak
9 very strong

5 medium
Stem: Anthocyanin coloration of internodes

Recorded at flowering to milk stage; from middle of the plant

Absent or very weak

Weak

Medium

SCALE

1 absent or very weak

3 weak

5 medium

7 strong

9 very strong
Stem: anthocyanin coloration of brace roots

Recorded at milk stage

Absent or very weak
Weak
Medium

SCALE

1 absent or very weak
7 strong
3 weak
9 very strong
5 medium
Ear: length of peduncle

Recorded at soft dough stage; from upper most ear

short

medium

long

SCALE

1  very short
7  long
3  short
9  very long
5  medium
Ear: length of husks off the tip of ear

Recorded at soft dough stage; from upper most ear

**SCALE**

<table>
<thead>
<tr>
<th>1</th>
<th>3</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>very short</td>
<td>short</td>
<td>medium</td>
</tr>
<tr>
<td>7</td>
<td>9</td>
<td>very long</td>
</tr>
</tbody>
</table>

*Short*  
*Medium*  
*Long*
Ear: length (cm)

Record at hard grain stage; from upper most ear

<table>
<thead>
<tr>
<th>SCALE</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>very short (&lt;10)</td>
</tr>
<tr>
<td>3</td>
<td>short (10-15)</td>
</tr>
<tr>
<td>5</td>
<td>medium (15-20)</td>
</tr>
<tr>
<td>7</td>
<td>Long (20 – 25)</td>
</tr>
<tr>
<td>9</td>
<td>very long (&gt;25)</td>
</tr>
</tbody>
</table>
Ear: shape

Record at hard grain stage; from upper most ear

Conical

Conico-cylindrical

Cylindrical

SCALE

1 conical  2 conico-cylindrical  3 cylindrical
Ear: type of grain

Record at hard grain stage; from middle third of ear

1 flint
2 flint-like
3 intermediate
4 dent-like
5 dent

SCALE
Ear: colour of top of grain

Record at hard grain stage

**SCALE**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>white</td>
<td>yellowish white</td>
<td>yellow</td>
</tr>
<tr>
<td>4</td>
<td>Yellow orange</td>
<td>orange</td>
<td>red orange</td>
</tr>
<tr>
<td>5</td>
<td>orange</td>
<td>dark red</td>
<td>blue black</td>
</tr>
</tbody>
</table>

*Images show examples of different colour stages.*
Ear: anthocyanin coloration of glumes of the cob

Record at hard grain stage

Absent

Present

SCALE

1 absent

9 present
Ear: intensity of anthocyanin coloration of glumes of cob

Record at hard grain stage

- **Very Weak**
- **Weak**
- **Medium**
- **Strong**

**SCALE**

1. absent or very weak
2. weak
3. medium
4. very strong

7. strong
9. very strong
Ear: number of rows of grains

Record at hard grain stage; from middle of the ear

**SCALE**

- Few: 1 very few, 7 many
- Medium: 3 few, 9 very many
- Many: 5 medium
Ear: Diameter (cm)

Measure at the middle of the ear; at hard grain stage

**Scale**

1 very short (<4.0)  3 short (4.1-5.0)  5 medium (5.1-6.0)
7 Large (6.1-7.0)    9 very large (>7.0)
Ear: color of dorsal side of grain

Measure at hard grain stage

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<td>7</td>
<td>red</td>
</tr>
<tr>
<td>8</td>
<td>dark red</td>
</tr>
<tr>
<td>9</td>
<td>blue black</td>
</tr>
</tbody>
</table>
MAIZE SEED CERTIFICATION & SEED FIELD INSPECTION
## OECD Seed Classes

<table>
<thead>
<tr>
<th>Seed Class</th>
<th>Code</th>
<th>Production from</th>
<th>Label Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-basic seed</td>
<td>A</td>
<td>Breeder’s Seed</td>
<td>Violet band on white</td>
</tr>
<tr>
<td>Basic Seed</td>
<td>B</td>
<td>Pre-basic or Breeder’s</td>
<td>White</td>
</tr>
<tr>
<td>Certified Seed (1st Generation)</td>
<td>C1</td>
<td>Basic or higher seed classes</td>
<td>Blue</td>
</tr>
<tr>
<td>Certified Seed (2nd Generation)</td>
<td>C2</td>
<td>C1 or higher classes of seed</td>
<td>Red</td>
</tr>
<tr>
<td>Quality Declared Seed</td>
<td>QDS</td>
<td>Complies with special requirements</td>
<td>Green</td>
</tr>
</tbody>
</table>
Field seed crop inspection

Field inspection parameters:
• Trueness to type i.e. variety conformity.
• Varietal purity i.e. varietal mixtures
• Isolation distances (based on seed status).
• Pests and diseases e.g. smut, bacterial wilt
• Noxious weeds
• Uniformity of growth
• De-tasselling
Maize Hybrid, Field certification standards

<table>
<thead>
<tr>
<th>Field Standards</th>
<th>Basic Seed</th>
<th>Certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum previous cropping season</td>
<td>1*</td>
<td>1*</td>
</tr>
<tr>
<td>Isolation (m)</td>
<td>400</td>
<td>300</td>
</tr>
<tr>
<td>Maximum off-types (%)</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Minimum number of inspections</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>
Pre-planting Inspection

- Identify and authenticate the production sites - follow proper recommended rotations. Monoculturing to be avoided
- To ascertain isolation - always has to be done with each visit. Be wary of hidden field portions.
Planting Inspection

- To ensure that the correct parents for a particular variety are being planted
- This will eliminate or reduce planting errors that are expensive to correct
- To ensure the seed is planted in the best possible conditions that will give it the best chance to emerge as required which helps in synchronisation. Where heat units are used to guide planting more frequent visits are needed. Some parent lines are too sensitive to adverse conditions at planting e.g. dry planting
Vegetative Stage

• To check on plant population (key factor in yield determination), weed pressure and nutrition adequacy. Nutritional levels will determine productivity levels as well physiological quality. This will also guide and inform replanting decisions.

• To check on disease and pest levels and immediately institute control measures. To also ensure off-types are rogued out.

At this stage it is highly prudent to cross every row in such a fashion that every row can be seen end to end.
Pre-flowering

• Check on roguing as a continual process, on both male and female parents
• Ensure no presence of noxious weeds and also those other weeds that cause discomfort to the detasseler
Flowering

- Check on detasseling precision if its hybrid maize
- Continue to check on rogues
- Nicking is important at this stage for genetic purity, as adequate pollen of the correct male will ensure the right hybrid
Post Flowering

• Examine grain filling and yield determination
• Examine cobs or heads for weevil and late worm infestations that create physical impurities and also secondary disease infections
• To determine the best period to harvest and lock in all quality in order to minimise field to floor losses.
Inspection Procedure

• Always ascertain that the crop is of the stated variety
• First obtain a general view of the crop
• Detailed investigations at random in the field then follow.
• Examine the whole crop thoroughly following a walking pattern
Walking Pattern

• 1. Observation of 75 % of the field

• 2. Observation of 60-75 %
Walking Patterns

3. Random-60% coverage

4. Clockwise travel pattern-85% coverage-thorough
Walking Patterns

5. Observation of 85% of the field
The OECD seed certification schemes

- Guidelines for seed field inspections
- Facilitate seed trade by reducing technical barriers
- Controlling the seed in previous generations
International Seed Testing Association (ISTA)

- Standard procedures for seed sampling and testing
- Promotes international trade
- International rules for seed testing
Variety registration and seed certification practices in Asian countries
Bangladesh

- Maize in Bangladesh:
  - Highest yield (~8.0 Mt/ha National Ave), 0.4 Million Ha (SYB, 2018)
  - It is the third most important cereal following rice and wheat

- Variety registration and seed certification system
  - Notified vs. non-notified crops
  - Notified crops need registration and seed certification before sale (e.g. rice, wheat, jute, potato, sugarcane, Mesta & Kenaf)
  - Minimum two years for DUS and VCU
  - Non-notified crops like maize do not need registration
  - Needs only varietal description and formal application to NSB
  - Three classes of seed: breeder (green), foundation (white) and certified seed (blue tags)

- Non notified crops via ruthless label system (yellow tag)
Thailand

- Maize in Thailand:
  - Cover app. 1.0 million Ha, Nat. Ave. 4.5 Mt/ha
- Variety registration and seed certification system
  - Registration is based on PVP act and voluntarily
  - Minimum two season and two location for DUS and not VCU
  - DUS trails are under the DOA PVP inspectors hosted at the seed company site
  - PVP registration lasts for 12 years for field crops
- Seed certification standards apply only to 37 plant species including maize (under Plants Act)
- Seed classes: breeders, foundation, registered seed and certified seed.
Pakistan

- **Maize in Pakistan:**
  - Covers app. 1.3 million Ha, Nat. Ave. 4.7 Mt/ha (PES, 2018/19)

- **Variety registration and seed certification system**
  - Two years NYUT (VCU) conducted by PARC and DUS by FSC&RD
  - Trials are hosted at representative sites of public and private stations (coded trials)
  - Includes spot examination
  - Enlisting/registration after approval of VEC
  - Provincial release after approval of seed councils

- **Seed certification only to major crops (wheat, maize, rice, cotton, potato...)**

- **Seed classes:**
  - Breeder, pre-basic (white color with diagonal violet), basic (white tag), certified (blue), approved (yellow) and TLS (pink for imported seeds by companies)
Nepal

- **Maize in Nepal**
  - Covers app. 0.9M.Ha, Nat. Ave. 2.55 Mt/ha (MoALD, 2018)

- **Variety registration and seed certification system**
  - Two years testing data at least from three locations
  - VCU trials are hosted by NARC-commodity programs
  - Registration (mostly for imports) vs. release (local seed)
  - Conducted by SQCC under the chairman of DG-DoA

- **Seed quality based on certification and TLS system**

- **Seed classes**: breeder, foundation, certified and improved seed (under certification system). Breeder, source seed, label seed and improved seed (under TLS)

- **Seed certification is voluntarily**
- **Hybrid seed certification standards not yet approved**
Indonesia

• Maize in Indonesia
  – Covers app. 3.7M Ha, Nat. Ave. 3.24 Mt/ha (USDA, 2019)

• Variety registration and seed certification system
  – Based on PVP act and DUS

• Four Seed classes:
  – Breeder seed (BS)- yellow label
  – Foundation seed (FS)- white label
  – Stock seed (SS)- purple label
  – Extension seed (ES)- green label
India

• Maize in India
  – Covers app. 9.2M.Ha, Nat. Ave. 2.96 Mt/ha (USDA, 2019)

• Variety registration and seed certification system
  – Based on PPVFR Act, 2001 (not a member of UPOV)
  – Central vs states variety release committee
  – Data generated via AICRPs-AICMIP
  – Voluntary seed certification
  – Both DUS and VCU data

• Notified vs. released cultivars
  – Notified cultivars Under Seed Act to control seed quality
  – Notification made by central government

• Three Seed classes: Breeder, foundation and certified seed
Acknowledgment

• Zewdie Bishaw (ICARDA)
• John MacRobert (Mukushi seeds)
• GMP Africa colleagues
Thank you for your interest!