Rice Seed Production

- Video Seminar on Rice Seed Production -
  organized by CARD Secretariat

April 23 - 24, 2014
1. Objective of Seed Production

1. To ensure cultivation in the next crop season
2. To harvest high quality and homogeneous products

Seeds have direct effects on the product. Hence, farmers have to use high quality seeds

High quality seeds enables farmers to attain crop;
   1. Most economical planting rate;
   2. Higher % of emerging in the field
   3. A more uniform plant stand
   4. Uniformity in ripening
   5. Uniformity of product
1. Objective of Seed Production: Factors Affecting Quality

1. Genetic factors
   - Genetic makeup
   - Seed size
   - Seed density

2. Physical / environmental factors
   - Growth condition during seed development
   - Nutritional condition of the mother plant
   - Damage during production or storage (including pest)
   - Moisture and temperature during storage
   - Age or maturity of seeds
1. Objective of Seed Production: Genetic impurity

Factors increasing genetic impurity
1. Natural mutation (10^-5 - 10^-6 per gene)
2. Out-crossing with other varieties
3. Physical mixture with other varieties
   (harvesting, threshing, drying; all steps from harvest to storage)
2. Structure of Seed Production

- From breeding to Seeds -

From breeding to Seeds:

Parent 1 × Parent 2

1. F1
2. F2
3. F3
4. F4
5. F5
6. F6
7. F7 (PYT)
8. F8 (AYT)

Variety Release

Breeder Seed has to be 100% genetically pure

Selection and Fixation

Nucleus Seed

Breeder Seed

Foundation Seed

Registered Seed

Certified Seed
2. Structure of Seed Production

- Terms for Stages in Seed Production -

Breeder Seed

Foundation Seed

Registered Seed

Certified Seed

Breeder Seed
Semence Souches

Foundation Seed
Semences pre base

Certified Seed
Semences certifiees
2. Structure of Seed Production

- Quality Standard in Each Class of Seed -

The quality standards become less stringent toward downstream of seed phase. However, genetic purity should be maintained at a high level.

<table>
<thead>
<tr>
<th>Country</th>
<th>Purity</th>
<th>Unit</th>
<th>Breeder</th>
<th>Foundation</th>
<th>Registered</th>
<th>Certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sierra Leone</td>
<td>Variety</td>
<td>%</td>
<td>99.9</td>
<td>99.9</td>
<td>99.7</td>
<td>99.7</td>
</tr>
<tr>
<td></td>
<td>Specific</td>
<td>%</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Red rice</td>
<td>Seed / kg</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Weed seed</td>
<td>Seed / kg</td>
<td>10</td>
<td>10</td>
<td>0.5%</td>
<td>0.5%</td>
</tr>
<tr>
<td></td>
<td>Other species</td>
<td>Seed / kg</td>
<td>10</td>
<td>10</td>
<td>0.5%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Arkansas (USA)</td>
<td>Other variety</td>
<td>Grain / 500 g</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Pure seed</td>
<td>%</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Other crop</td>
<td>Grain / 500 g</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weed seed</td>
<td>%</td>
<td>0.03</td>
<td>0.03</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Red Rice</td>
<td>Grain / 500 g</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td>Other variety</td>
<td>Grain / 500 g</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Pure seed</td>
<td>%</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>Weed other</td>
<td>%</td>
<td>0</td>
<td>0</td>
<td>0.05</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>crop</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Red Rice</td>
<td>Grain / 500 g</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>ECOWAS</td>
<td>Varietal purity</td>
<td>%</td>
<td>99.9</td>
<td>99.9</td>
<td>99.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Analytical purity</td>
<td>%</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Other crop</td>
<td>Grain / kg</td>
<td>10</td>
<td>10</td>
<td>0.5%</td>
<td>0.5%</td>
</tr>
<tr>
<td></td>
<td>Weed</td>
<td>Grain / kg</td>
<td>10</td>
<td>10</td>
<td>0.5%</td>
<td>0.5%</td>
</tr>
<tr>
<td></td>
<td>Red Rice</td>
<td>Grain / kg</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>
2. Structure of Seed Production

- Definition of Purity -

• Genetic Purity:
  Varietal purity, varietal mixture, other variety, or off-type

  Genetic purity can be checked at a field by careful observations.

• Seed purity:
  Specific purity, pure seed, analytical purity

  The Seed Purity is based on seed shape, size, and coloration, but not genetic nor off-type.

  Other rice seeds appearing as off-types should be placed under varietal mixture or off-type.
### 2. Structure of Seed Production: An example

<table>
<thead>
<tr>
<th>Class of Seed</th>
<th>Production</th>
<th>Inspection</th>
<th>Storage</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nucleus Seed</td>
<td>Breeding institute</td>
<td>Breeding Institute</td>
<td>Breeding Institute</td>
<td>Breeding Institute</td>
</tr>
<tr>
<td>Breeder Seed</td>
<td>Breeding institute</td>
<td>Breeding Institute</td>
<td>Breeding Institute</td>
<td>Breeding institute</td>
</tr>
<tr>
<td>Foundation Seed</td>
<td>Commission to Farmer Coop by State</td>
<td>Seed center of Farmers Coop</td>
<td>Breeding Institute</td>
<td>Breeding institute</td>
</tr>
<tr>
<td>Registered Seed</td>
<td>Commission to Seed Farmer by State</td>
<td>Farmer’s coop seed centers</td>
<td>Farmers cop’s seed storage center</td>
<td>Prefecture to Farmers coop</td>
</tr>
<tr>
<td>Certified Seed</td>
<td>Contracted farmer by Farmers Coop</td>
<td>Seed center of Farmers coop</td>
<td>Farmer’s cop seed storage center</td>
<td>Farmers coop to Farmers group</td>
</tr>
</tbody>
</table>
3. Seed Class: Breeder Seed

What is the Breeder Seed?
Seed of a new variety with highest purity, produced, developed, controlled and provided directly by the breeder or institution for further multiplication.

Varietal Purity
Should be very close to 100%.
Each country decides % as shown before
A single plant per hill has to be secured for the production

How to maintain purity?
1. By isolation of plot for breeder seed
2. By careful checking plant in the field (Next Slide)
   As frequent as possible
3. Seed Class: Breeder Seed

- How to maintain genetic purity -

Throughout entire growth stage, as frequent as possible, with special emphasis on the following stage, observe and remove any off-type

1. Vegetative Stage
   1) seedlings floating in a plot,
   2) hill out of row,
   3) plant shape (number of tiller, plant height, leaf sheath and leaf color)

2. Heading Stage
   1) hill out of row,
   2) uniformity of heading,
   3) uniformity of plant height

3. Maturing Stage
   1) uniformity of maturing,
   2) panicle length,
   3) uniform seed shape and size
   4) color of the glume,
   5) sterility
3. Seed Class: Foundation Seed

What is the Foundation Seed?
Progeny of the breeder seed, produced by trained officers of an agricultural station in accordance with national standards, handled to maintain genetic purity and identity of the variety.

Varietal Purity
Each country decides % as shown before

A single plant per hill has to be secured for the production

How to maintain purity?
1. By isolation of plot for breeder seed
2. By careful checking plant in the field mainly focusing on the three stages
3. Seed Class: Foundation Seed

Inspection on the plants in the field should be done by scientists, technicians and inspectors who are fully familiar with a variety.

1. Vegetative Stage
   1) seedlings floating in a plot,
   2) hill out of row,
   3) plant shape (number of tiller, plant height, leaf sheath and leaf color

2. Heading Stage
   1) hill out of row,
   2) uniformity of heading,
   3) uniformity of plant height

3. Maturing Stage
   1) uniformity of maturing,
   2) panicle length,
   3) uniform seed shape and size
   4) color of the glume,
   5) sterility
3. Seed Class: Registered Seed

What is the Registered Seed?
Progeny of the foundation seed, grown by selected farmers, handled to maintain genetic purity and identity and undergone field inspections to ensure the standards.

Varietal Purity
Each country decides % as shown before.

How to maintain purity?
1. By isolation of plot for registered seed
2. By careful checking plant in the field mainly focusing on the three stages.
3. Seed Class: Certified Seed

What is the Certified Seed?
Progeny of the foundation, registered seed or certified seeds handled to maintain sufficient variety identity and purity, grown by selected farmers, under prescribed conditions and culture and isolation and subjected to field and seed inspection by certified agency.
Harvest from certified seeds is used for commercial planting

Varietal Purity
Each country decides % as shown before

How to maintain purity?
1. By isolation of plot
2. By careful checking plant in the field mainly focusing on the three stages
3. Seed Class: Seed multiplication Rate

- Multiplication rate from one seed class to the next class will be influenced by:
  - cropping ecology,
  - varieties,
  - cultivation condition.
- A good estimate can be obtained by pre-cultivating a variety of concern under the same condition as seed production.
- The table below is an expected rate in three different ecologies.

<table>
<thead>
<tr>
<th>Seed Class</th>
<th>Cultivation Ecology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upland</td>
</tr>
<tr>
<td>Breeder</td>
<td>20</td>
</tr>
<tr>
<td>Foundation</td>
<td>20</td>
</tr>
<tr>
<td>Registered</td>
<td>20</td>
</tr>
<tr>
<td>Certified</td>
<td>20</td>
</tr>
</tbody>
</table>

Even an upland variety, seed production is better to be done in irrigated condition, to ensure higher multiplication rate.
3. Seed Class: Seed amount for each seed class

Following factors have to be considered to calculate the necessary amount of seeds for each level of seed:

1. Number of plant per
2. Spacing
3. Germination rate (80%, as standard)
4. Insurance for an emergency (20 – 30%)
5. Method of transplanting
6. Cultivation environment (upland, lowland, irrigated)
7. Variety
### 3. Seed Class: Example of Seed Production Plan

One of examples of seed production plan

<table>
<thead>
<tr>
<th>Seed Class</th>
<th>Producing Party</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeder (kg)</td>
<td>NARS</td>
<td>10</td>
<td>20</td>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Foundation (kg)</td>
<td>NARS</td>
<td>500</td>
<td>1000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Registered (ton)</td>
<td>Registered Coop</td>
<td></td>
<td></td>
<td>25</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Certified (ton)</td>
<td>Registered Farmers</td>
<td></td>
<td></td>
<td>1250</td>
<td>2500</td>
<td></td>
</tr>
</tbody>
</table>

For each variety, following points need to be clear

1. Place of production
2. Multiplication rate
3. Parties involved in seed production
4. Amount of certified seed required in year xx
4. Inspection

Flow of Quality check

Field designated for Seed Production → Inspection of Plants at Field → Inspection of produced Seeds in Labor → Certified Seed

State Governor

Seed Inspectors appointed by Governor
4. Inspection: Roles of Public Institute

- Development of seed policy
- Establish seed production agency
- Establish standard of seed quality
- Develop seed production plan, annually
- Quality Check
  - Field inspection
  - Plant inspection in the field
  - Quality inspection of seeds produced
- Issuance of seed certificate
4. Inspection : Field

Timing of the Inspection
1. Vegetative stage
2. Heading stage
3. Maturing stage (dough-ripe stage)

Points to be checked

- Vegetative Stage
  1. Seedlings floating in a plot
  2. Hill out of row,
  3. Plant shape; number of tiller, plant height, leaf sheath
     leaf color (if applicable)

- Heading Stage
  1. Hill out of row
  2. Uniformity of heading
  3. Uniformity of plant height

- Maturing Stage
  1. Uniformity of maturing
  2. Panicle length
  3. Uniform seed shape and size
  4. Color of the glume
  5. Sterility

Field inspection is mainly for removal of off-types.
(Lab inspection rarely detects off-types)
Variety Catalogue:

Usually available at a variety release committee or an institute

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### Fiche descriptive de la variété Sahel 329

Nom de sélection: WAS 169-B-4-2-9
Parents: Jaya / Basmati 370
Origine: AfricaRice / Saint-Louis
Espèce: Sativa
Groupe variétal: Indica
Date de création: 1997
Date de Vulgarisation: 2009

#### Caractéristiques Agronomiques

- Ecologie: Irrigé
- Cycle semi-épiaison: 87 jours
- Maturité: 116 jours
- Rendement potentiel: 7 t/ha
- Résistance à la verrine: Moyenne

#### Caractéristiques Morphologiques de la Plante

- Hauteur: 107 cm
- Taillage: Bon
- Couleur de la gaine: Vert pale
- Port de la plante: Semi-érigé
- Port de la feuille paniculaire: Erigé
- Panicule: Semi-compacte
- Exsertion panicule: Bonne

#### Caractères du grain (paddy)

- Longueur: 8 mm
- Largeur: 2.5 mm
- Poids de 1000 grains: 23 g
- Aристация: Moutue
- Couleur glande: Jaune paille
- Couleur de l’apex à maturité: Incolore
- Couleur caryopse: Blanche, translucide
- Forme de la graine: Mince longue

#### Caractéristiques Organoleptiques et Technologiques

- Amylose: 30.9%
- Rendement à l’usinage: 61%
- Arôme: Parfumé
4. Inspection : Reference

Variety Catalogue:
What kind of information can be used as a reference of purity?

- Identification
  Name, pedigree, origin
- Morphological characteristics
  Height, leaf color, flag leaf angle, panicle exertion, panicle length, shuttering
- Agronomical characteristics
  Duration, 50% flowering, tillering, yield
- Grain characteristics
  Size, color, awn
- Grain quality
  Aroma, amylose, Cooking property

Inspection on plants

Inspection on seeds
4. Inspection: Produced Seed

**Item to be checked**
- Germination rate
- Seed moisture content
- Mixture of other rice varieties
- Mixture of other crop seeds
- Mixture of weed seeds
- Seed infected by noxious diseases
- Seed infected by other diseases
- Inert matter (soil, stones others)

<table>
<thead>
<tr>
<th>Country</th>
<th>Items</th>
<th>Breeder</th>
<th>Foundation</th>
<th>Registered</th>
<th>Certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sierra Leone</td>
<td>Germination %</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Moisture %</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Inert matter %</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Arkansas (USA)</td>
<td>Germination %</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Moisture %</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Inert matter %</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Philippines</td>
<td>Germination %</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Moisture %</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Inert matter %</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>ECOWAS</td>
<td>Germination %</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Moisture %</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Inert matter %</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
Pure Seed

The true seed of the variety based on seed shape, size, coloration.

Other rice seeds appearing as off-types should be placed under varietal mixture or off-type.
5. Seed Production: Preparation

1. Site Selection
   Field used for growing certified seeds must meet several criteria
   - Not have grown rice for the previous year, unless the same variety is planted
   - Separation from other field of same variety to avoid out cross (next slide)
   - Eliminate volunteer plants and weed through land preparation

2. Original seed to multiply
   Seeds for propagation must be original officially approved.
   This may be proved by the presentation of certificates and bags of seeds use or purchase invoices.
## 3. Planting Density (Spacing)

<table>
<thead>
<tr>
<th>Seed Class</th>
<th>Isolation 1) distance (m)</th>
<th>Between row (cm)</th>
<th>Within row (cm)</th>
<th>Number of plant per hill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nucleus</td>
<td></td>
<td>40</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Breeder</td>
<td>10 m</td>
<td>40</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Foundation</td>
<td>5 m</td>
<td>20 – 30</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Registered</td>
<td>5 m</td>
<td>20</td>
<td>20</td>
<td>3 - 4</td>
</tr>
<tr>
<td>Certified</td>
<td>3 m</td>
<td>20</td>
<td>20</td>
<td>3 - 4</td>
</tr>
</tbody>
</table>

REF: 1) ECOWAS
1. **Time of harvesting**
   Optimal stage to harvest:  
   - 20-25% grain moisture
   - 80-85% of grain the **grains yellow coloring**.
   (about 30 days after flowering)

2. **Harvesting**
   The higher the quality of the seeds, the greater the care at harvest and threshing
   - Breeder seed
     Hand harvested and threshed with a self cleaning thresher
   - Foundation, Registered seed
     Harvest by a machine with thorough cleaning
Importance of harvesting time

Effect of harvest time after anthesis on seed longevity

Seeds stored hermetically in laminated aluminum foil packets at 35C

Ref:  N. KAMESWARA RAO, M. T. JACKSON
Seed Longevity of Rice Cultivars and Strategies for their Conservation in Genebanks
Rice seed should be dried to less than 14% moisture content as soon as possible after threshing. For long term storage, it should be dried to 12 % or less and preferably stored in a sealed container.

<table>
<thead>
<tr>
<th>Storage Period</th>
<th>Optimal Moisture Content (%)</th>
<th>Potential Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 – 3 weeks</td>
<td>14 – 18%</td>
<td>Fungi, Discoloration, Respiration loss</td>
</tr>
<tr>
<td>8-12 months</td>
<td>Less than 13%</td>
<td>Insect damage</td>
</tr>
<tr>
<td>More than 1 year</td>
<td>Less than 9%</td>
<td>Loss of viability</td>
</tr>
</tbody>
</table>

Ref: Seed Quality, IRRI Rice Knowledge Bank
5. Seed Production: Cleaning

- Threshed seed contains all kinds of trash
  Vegetative parts, chaff, straw, empty grains, foreign seed soil and stones

- Seeds should be cleaned as soon as possible after harvesting and threshing
  Mechanical winnower can be used
5. Seed Production: Storage

For storage for extended period:
Less than 13 – 14% moisture content
Protected from insects and rodents
Restricted form re-absorbing moisture through rain or atmosphere

Storage Condition
1. LTLH storage conditions: temperature: 15°C; relative humidity: 30%
2. Ambient condition

80% of germination

<table>
<thead>
<tr>
<th></th>
<th>LTLH</th>
<th>Ambient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germination</td>
<td>60 months</td>
<td>24 months</td>
</tr>
</tbody>
</table>

Germination after 60 months

<table>
<thead>
<tr>
<th></th>
<th>LTLH</th>
<th>Ambient</th>
<th>Polylined jute bag</th>
<th>Jute bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germination</td>
<td>86.1%</td>
<td>61.9%</td>
<td>75.3%</td>
<td>72.8%</td>
</tr>
</tbody>
</table>

6. Remarks : Terminology

● Improved seeds vs Improved varieties
  Improved seeds are not equivalent to improved varieties.

● High quality seeds vs improved seeds
  Improved seeds are not equivalent to high quality seeds.
Important points for genetic resource conservation
(except for breeder seed conserved in Genebank)

1. Maintain genetic diversity of accessions
2. No selection (except for off-type removal)
3. No intensive selfing
4. Just maintain the diversity at the collection

6. Remarks : Conservation of Germplasm at Genebank

Video Seminar on Rice Seed Production April 23 – 24, 2014
PVS = Participatory Variety Selection

- **Objective**
  
  By letting farmers grow promising breeding lines by their hands,
  1) learn farmers preference,
  2) facilitate smooth dissemination upon the release of a variety.

- **Seed System**
  
  No direct contribution in seed system
  If the variety of farmers preference is not released, the seeds remained in the farmers might contribute in producing a new variety by themselves.

- **Only fixed lines shall be provided to PVS**
7. Conclusion

1. Quality should not be compromised in seed production / multiplication.

2. The higher levels of seed (e.g. breeder seeds, foundation seeds) of requires more care and intensity of quality control efforts.

3. The cost and time required for quality control is smaller at the higher stages of seed production/multiplication, while its impacts are larger. it makes sense to strengthen quality control measures at higher levels.

   Thus, the roles and responsibility of NARS is important; it will affect both formal and informal seeds.

4. Seed genetic purity maintenance requires purity control measures (observation, identification and removal of off-types) at field level, and it calls for significant efforts by researchers and their appropriate demonstration and instruction to workers, inspectors and seed producers.
Thank you!

This is the key for quality seed production

Thank you!