Participatory Varietal Selection of Rice

The Technician's Manual

M. Sié, S. Dogbé and M. Diatta
About Africa Rice Center (AfricaRice)

The Africa Rice Center (AfricaRice) is a leading pan-African research organization working to contribute to poverty alleviation and food security in Africa through research, development and partnership activities. It is one of the 15 international agricultural research Centers supported by the Consultative Group on International Agricultural Research (CGIAR). It is also an autonomous intergovernmental research association of African member countries.

The Center was created in 1971 by 11 African countries. Today its membership comprises 24 countries, covering West, Central, East and North African regions, namely Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Democratic Republic of Congo, Egypt, Gabon, the Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Madagascar, Mali, Mauritania, Niger, Nigeria, Republic of Congo, Senegal, Sierra Leone, Togo and Uganda.

AfricaRice’s temporary headquarters is based in Cotonou, Benin. Research staff are also based in Senegal, Nigeria, Tanzania and Côte d’Ivoire.

For more information visit:

www.africarice.org

Africa Rice Center (AfricaRice) Headquarters
01 BP 2031, Cotonou, Benin
Tel: (229) 21 35 01 88; Fax: (229) 21 35 05 56
Email: AfricaRice@cgiar.org

Sahel Research Station
AfricaRice, B.P. 96
Saint-Louis
Senegal
Tel: (221) 962 6493
Fax: (221) 962 6441
E-mail: AfricaRice-sahel@cgiar.org

Nigeria Research Station
c/o International Institute of Tropical Agriculture (IITA)
Oyo Road, PMB 5320
Ibadan
Nigeria
Tel: (234-2) 241 2626
Fax: (234-2) 241 2221
Email: AfricaRice-ibadan@cgiar.org

Tanzania Research Station
Avocado Street
PO Box 33851
Dar es Salaam, Tanzania
Tel: (255) 222 775 568
Fax: (255) 744 788 495
Email: a.huzi-kihupi@cgiar.org
Participatory Varietal Selection of Rice

The Technician’s Manual

M. Sié, S. Dogbé and M. Diatta

2010
# Contents

Preface ................................................................................................................................................... iv

Module 1. Knowledge of the rice plant ...................................................................................................2
  1.1 Introduction ........................................................................................................................................3
  1.2 Plant morphology ..............................................................................................................................3
  1.3. Rice growth cycle .............................................................................................................................5
  1.4. Yield component notion ....................................................................................................................8
  1.5 Conclusions .......................................................................................................................................9

Module 2. Participatory plant breeding concepts ..................................................................................11
  2.1. Introduction ....................................................................................................................................13
  2.2. Definitions ....................................................................................................................................13
  2.3. Objectives and scope of analysis ....................................................................................................14
  2.4. Advantages of the participatory approach ......................................................................................15
  2.5. Conclusions .....................................................................................................................................16

Module 3. Participatory varietal selection (PVS)...................................................................................17
  3.1. Introduction .....................................................................................................................................19
  3.2. Objectives .......................................................................................................................................19
  3.3. Methodology ...................................................................................................................................20
  3.4 The PVS-Research and PVS-Extension approach ............................................................................29
  3.5. Conclusions ....................................................................................................................................29

Module 4. Varietal release and seed production .....................................................................................31
  4.1. Introduction ....................................................................................................................................33
  4.2. Varietal release ...............................................................................................................................36
  4.3. Seed systems ...................................................................................................................................40
  4.4. Rules for rice seed production ........................................................................................................45
  4.5 Conclusions ......................................................................................................................................51

Annexes .................................................................................................................................................53
  Annex 1 ..................................................................................................................................................55
  Annex 2 ..................................................................................................................................................56
  Annex 3 ..................................................................................................................................................67
  Annex 4 ..................................................................................................................................................70
  Annex 5 ..................................................................................................................................................72
Foreword

Rice, which is produced and consumed in about 40 African countries, is experiencing the fastest increase in production of all food crops. To address this trend, research institutions have developed several improved varieties that are now available to farmers. However, most of the varieties proposed are not adapted to the needs of small-holder farmers and breeders are often unaware of the range of problems that farmers face in adopting new varieties.

Participative varietal selection (PVS) involves farmers while defining breeding objectives and also while conducting the breeding and varietal creation process. One advantage of this methodology is to shorten the time lapse between varietal development and release to 3 years for PVS when compared to 7 years for conventional breeding. Since 1996, the Africa Rice Center (AfricaRice) has adopted this methodology that enabled countries from the subregion to have a quick access to new NERICA varieties. PVS can also be considered as a technology transfer tool that has facilitated the adoption and release of new rice varieties in various countries where the process for introducing new varieties still have many bottlenecks. Based on the success of this methodology, it is necessary to compile the Center’s and partners’ know-how and experience in a publication.

In addition to introducing the rice plant, this manual explains the concept and methodology of participatory varietal selection (PVS) and its practical application.

The manual has four modules:

Module 1: Knowledge of the rice plant
Module 2: Participatory plant breeding concepts
Module 3: Participatory varietal selection (PVS)
Module 4: Varietal release and seed production

I hope that this manual will help breeders, agronomists as well as other stakeholders in agricultural development to improve their knowledge on participatory varietal selection.

Dr Papa A. Seck
Director General
Africa Rice Center (AfricaRice)
Module 1

Knowledge of the rice plant
1.1 Introduction

The success of a breeding program depends on a thorough knowledge of the physiology, botany and floral biology of the plants involved. It is therefore necessary to review those components of the rice plant that will be considered in the evaluation of varieties. This module focuses on a description of the rice plant and its growth.

1.2 Plant morphology

Rice is an annual herbaceous plant with a round stem covered with flat sessile leaves in a blade shape and a flag panicle. Two species are cultivated: *Oryza glaberrima* (African origin) and *Oryza sativa* (Asian origin).

The mature plant bears:

- Nodal roots with absorbing hairs.
- A stem with a number of alternating nodes and internodes. Each node bears a leaf and bud that can produce a secondary tiller. Secondary tillers shoot up from a master stem in an alternate order. The primary tiller emerges from the lowest node and produces secondary tillers. Secondary tillers produce tertiary tillers in turn (Fig.1).
- Leaves consist of a sheath and a blade. Each node produces a leaf. The sheath wraps up the whole internode and, in some cases, even the following node. The blade or the tail end of the leaf is attached to the node by the sheath. The last leaf under the panicle is called a flag leaf.
- A panicle comprises a group of spikelets growing on the last node of the stem.
Spikelets stem from the pedicel, which links them to the panicle shoot. Each spikelet consists of two small glumes at the base of a flower (Fig. 2). The flower has six stamens and one pistil. Each stamen has two anthers attached to the tail end of a fine filament. The pistil is made up of the ovary, style and stigma.
1.3. Rice growth cycle

The rice plant has 10 growth stages, 0-9, where 0 represents sprouting/germination and 9 maturity (Table 1). The vegetative phase is the period between germination and stem elongation; the reproductive phase lasts from panicle initiation to flowering; while the maturity phase is the period between heading and maturity.

Vegetative phase

The vegetative phase comprises germination, emergence and stem elongation. It extends from sowing to panicle differentiation (panicle initiation). Depending on temperature, the germination phase lasts 5 to 20 days (5 days in high temperatures and 20 days in low temperatures). Emergence, which lasts from sprouting to the appearance of the first four leaves, lasts for 15 to 25 days depending on temperature (low temperatures extend the emergence period). During this phase, the plant gradually develops its independence from the grain’s nutritional reserves. The plant is fully independent once three leaves have appeared. For nursery sowing, it is necessary to wait for this stage before transplanting.
**Table 1.** The ten development stages of the rice plant

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprouting/Germination</td>
<td>From sowing to coleoptile emergence from the grain</td>
<td>0</td>
</tr>
<tr>
<td>Seedling</td>
<td>From coleoptile emergence to appearance of the 5th leaf (counting the first bladeless leaf as first leaf)</td>
<td>1</td>
</tr>
<tr>
<td>Tillering</td>
<td>From first tiller appearance to maximum tillering</td>
<td>2</td>
</tr>
<tr>
<td>Stem elongation</td>
<td>Stem growth</td>
<td>3</td>
</tr>
<tr>
<td>Panicle initiation-Booting</td>
<td>From panicle formation to panicle growth in flag leaf sheath</td>
<td>4</td>
</tr>
<tr>
<td>Heading/flowering</td>
<td>From first appearance of panicle tip outside panicle leaf to &gt;90% panicle emergence. Heading is followed by flowering</td>
<td>6</td>
</tr>
<tr>
<td>Milk stage</td>
<td>The grain has begun to fill with a white, milky liquid.</td>
<td>7</td>
</tr>
<tr>
<td>Dough stage</td>
<td>The milky portion of the grain first turns into a soft dough and later into a hard dough.</td>
<td>8</td>
</tr>
<tr>
<td>Mature grain</td>
<td>The individual grain is mature, fully developed, hard, and has turned yellow. Last stage is reached when 80-90% of panicle grains are mature.</td>
<td>9</td>
</tr>
</tbody>
</table>

Tillering starts from the appearance of the fifth leaf and covers variable periods depending on climatic conditions (temperature) and the variety. It is the length of this phase that segregates the short, medium and long cycle varieties. Generally, a long cycle variety will have a higher tillering capacity than a short cycle variety.

**Reproductive phase**

The reproductive phase lasts from panicle initiation to heading/flowering. It generally takes 21 to 30 days and involves panicle initiation, booting, heading and flowering. Tillering stops at panicle initiation. During the reproductive phase, the rice plant is particularly susceptible to unfavorable conditions (e.g., drought or low temperatures).
Grain filling and maturity phase

The grain filling and maturity phase spans flowering to maturity. During this phase, grain filling occurs through a movement of plant nutritional components to the grains. Grains progress from a milky stage through a doughy stage to maturity. This phase lasts 30 to 45 days, depending on environmental temperature and moisture.

The fruit is a laterally compressed caryopsis that is included in two closely nested lemmas (Fig. 3). On the external side of the caryopsis, the tegument or ovary wall is hairless or pubescent and generally yellowish white in color. It can however be black or any color in the red, brown and violet range.

The mature grain, free from its glumes and lemmas (husk), has three parts: the tegument, albumen and embryo. The tegument fully nests the albumen and embryo. The albumen consists of a parenchymatous tissue with starch-filled polygonal cells. It can be starchy (hard, translucent) or glutinous (opaque, matt). The embryo is in the lower part of the albumen and is oblique to the axis of the caryopsis.

Figure 3. Cross-section of a rice grain
1.4. Yield component notion

The yield (YD) of a crop is its grain output per unit area. It is generally recorded in quintals or tonnes per hectare. The objective of every producer is to maximize yield at an acceptable economic cost. This yield can be broken down into various components as follows:

\[ YD = NP \times NT \times Np \times NG \times PG \]

*Yield component notion*

With:
- \(YD\) = yield (T/ha)
- \(NP\) = number of plants per m²
- \(NT\) = number of tillers per plant
- \(Np/T\) = number of panicles per tiller
- \(NG\) = number of grains per panicle
- \(PG\) = grain weight (grams)

Each of these components develops at a specific period of the plant’s growth cycle:

<table>
<thead>
<tr>
<th>Yield Component</th>
<th>Component Development Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of plants/m²</td>
<td>Germination – emergence</td>
</tr>
<tr>
<td>Number of tillers/ plant</td>
<td>Tillering initiation – final tillering</td>
</tr>
<tr>
<td>Number of panicles/tiller</td>
<td>Final tillering – booting initiation</td>
</tr>
<tr>
<td>Number of grains/panicle</td>
<td>Booting-Heading – pollination</td>
</tr>
<tr>
<td>Grain weight</td>
<td>Grain filling – maturity</td>
</tr>
</tbody>
</table>

Yield will depend on the magnitude of all the components and the environmental conditions during development. Environmental conditions are closely linked to the cropping techniques used by the farmer. Environmental conditions at sowing will depend on soil preparation (tillage, off set, leveling and basal dressing), sowing method (in nursery or direct sowing) and seeding rate. Environmental conditions at tillering will depend on conditions prevailing at sowing (plant density/m², basal dressing), top dressing, manual and/or chemical weeding, subsequent treatments, irrigation management, etc. A rice field is an artificial environment under the control of the producer, whose modification of the environment should create optimal developmental conditions for the plant.
1.5 Conclusions

Understanding the rice plant morphology and growth enables the participants to identify parameters for segregating lines or varieties during participative varietal selection. Each of these parameters is assessed at different stages of crop growth. The combination of observations will determine the characteristics of varieties of interest. These will present compulsory traits such as rapid growth at the beginning of the cycle, high tillering to be weed competitive, short and erect leaves to allow an optimal use of sunlight, short and tough straws that resist lodging even when the nitrogen application is high. The observations will also present associated traits such as a vegetative cycle between 100 and 120 days, varieties non susceptible to photoperiod, thick and hard leaves to resist strong winds, leaves that age slowly, resistance to medium and low temperatures in order to expand the area under rice cultivation to high altitude regions, resistance to main diseases, resistance to the most damaging insects, grains that present a sufficient dormancy period, grains presenting good technological (aspect and grain dimension) and good organoleptic qualities (cooking qualities and digestivity).
Module 2
Participatory plant breeding concepts
2.1. Introduction

Participatory research was established by breeders initially for using varieties adopted by farmers as parents in crosses. More recently, other types of participatory research have been developed (Table 2).

Table 2. Participatory approaches in plant breeding and levels of farmer involvement.

<table>
<thead>
<tr>
<th>Serial N°</th>
<th>Participatory approaches</th>
<th>Level of farmer involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Participatory plant breeding (PPB)</td>
<td>Choice of parents and involvement from segregation stages</td>
</tr>
<tr>
<td>2</td>
<td>Participatory varietal selection (PVS)</td>
<td>On-farm tests of fixed lines (varieties)</td>
</tr>
<tr>
<td>3</td>
<td>Participatory crop improvement (PCI)</td>
<td>In all crop improvement processes (breeding, seed supply and agronomic practices)</td>
</tr>
<tr>
<td>4</td>
<td>Decentralized varietal improvement</td>
<td>Field varietal tests on farmers’ farms</td>
</tr>
<tr>
<td>5</td>
<td>Non-participatory decentralized varietal improvement</td>
<td>Limited involvement; varietal tests conducted on farms by breeders</td>
</tr>
<tr>
<td>6</td>
<td>Centralized participatory varietal improvement</td>
<td>Involvement in varietal tests on-station</td>
</tr>
<tr>
<td>7</td>
<td>Centralized non-participatory varietal improvement</td>
<td>No farmer involvement</td>
</tr>
<tr>
<td>8</td>
<td>Decentralized varietal and environmental improvement</td>
<td>On-farm varietal tests in hotspots for biotic stresses (e.g., diseases, insects, Striga, weeds) with farmer involvement</td>
</tr>
</tbody>
</table>

2.2. Definitions

Conventional breeding

Conventional breeding is defined as a centralized, sequential and linear process in which the breeder collects and evaluates germplasm under controlled conditions and makes crosses with elite materials. Under such circumstances, the output often fails to meet heterogeneous requirements and systemic realities but the final product is forced on the end user. This process is efficient for highly homogenous cropping systems, similar to those on experimental stations, but poorly adapted to situations where $G \times E$ interactions are high. Under tropical conditions, such interactions are amplified because the term ‘environment’ includes both the agro-physical and socio-technical components.
Participatory breeding

Participatory breeding involves all stakeholders in the value-chain (in particular farmers) in the definition of breeding objectives, implementation of the breeding process, and varietal development. In other words, it is decentralized breeding, coupled with the involvement of farmers early in the process. Participatory breeding is thus an efficient method that can be adapted to species cultivated in a range of biophysical as well as socio-economical conditions, and which takes into account the needs and knowledge of farmers.

2.3. Objectives and scope of analysis

The objective of participatory breeding is to ensure that the research undertaken meets the needs of farmers. The scientists work with farmers and the majority of trials are conducted in farmers’ fields. Rather than play a secondary role, farmers are full partners in the process. In fact, farmers frequently take the lead and compare their existing cultivars with the material provided by breeders. Since farmers’ varieties are adapted to local conditions, the results are often more convincing than for conventional breeding. This approach provides the foundation for a dynamic conservation and breeding process.

Participatory breeding covers the full cycle of development and research activities related to plant improvement, specifically:
- Determination of breeding objectives;
- Production of genetic variability or diversity;
- Breeding within variable populations to develop new materials;
- Evaluating these materials (known as participatory varietal evaluation or participatory breeding of varieties);
- Material distribution; and
- Seed production and distribution.

The approach also involves the evaluation of existing legislative policies and/or measures, and the development of new provisions, if necessary. Farmers, breeders and other stakeholders (such as varietal release committees, traders, manufacturers, dealers and consumers) are required to play various roles at various stages, but all working together.

An analysis in line with the needs of end-users is generally one of the essential components of any serious research in agriculture. This type of analysis examines
results on the basis of a range of factors, which take into account economic and power inequities, as well as social gaps (gender, age, education, class, and ethnic group and origin). Important differences that are ignored in a conventional breeding approach are consequently noticed and taken into account. For example, we may discover that women and men use different criteria for selecting varieties, or that different ethnic groups in the same region have different preferences for a number of food attributes, such as taste or cooking properties.

Policy analysis is also an important part of crop breeding projects. For example, government policies on pricing and marketing can influence the management mode chosen by farmers. The significance of other challenges, specifically intellectual property rights and accession certification, is increasing in parallel with increased demand for a number of rice varieties (aromatic varieties in particular).

2.4. Advantages of the participatory approach

The potential advantages of the participatory approach – specifically the fast pace at which the variety gets to the producer, the increase in adoption rates of new varieties, and the biological diversity within the species through the breeding of different types – will only be achieved if new accessions are multiplied to meet the needs of a larger number of farmers. In many countries, this approach is associated with the official recognition of new varieties. This procedure is generally conducted by a committee in the ministry of agriculture, which has the power to accept or reject, on the basis of a scientific report that evaluates the performance, agronomic characteristics, response to diseases and insects and the technological characteristics of new varieties. Because farmers’ advice is not taken into account in this registration process, many varieties are cultivated but never registered, while many registered varieties are never cultivated. In both cases, the investment in the production of a variety and the multiplication of its seeds fails to benefit anybody. It has been shown that economic cost incurred in the registration of a bad variety is far lower than the cost incurred in the failure to register a good variety.

The participatory approach to varietal improvement can considerably increase the production efficiency of a variety if farmer acceptance is taken into account as a breeding and registration criterion. In this system, varieties are registered only after the evaluation of their adoption by farmers (Fig.4) so that seed multiplication only focuses on those varieties that are needed and accepted by farmers.
In conventional breeding, seed registration and production occur before it is known if farmers will accept the new variety. In the participatory approach, seed registration and production are undertaken after initial adoption by farmers.

### 2.5. Conclusions

The design of a participatory breeding program evolves over time. In addition to meeting the basic aim of developing new varieties that meet farmers’ expectations, a participatory breeding program requires a relatively short-term resolution on procedural objectives related to the social organization of the group and which must be managed over the long-term. It is therefore acceptable that some stakeholders withdraw from the program when certain pragmatic objectives are achieved, thus allowing the group to evolve into a new configuration.
Module 3
Participatory Varietal Selection (PVS)
3.1. Introduction

Small-holder farmers do not have the financial resources to buy inputs to improve their cropping conditions with the use of inputs and have been neglected. Hence, low yields, poverty and even famine remain common features of most of the tropics. Participatory breeding aims to eliminate the problems that come when breeder develop varieties without reference to the needs of farmers and other stakeholders in the rice value-chain. The impact from research is higher when it takes into consideration the farmers needs within their social setting.

PVS occurs at the evaluation phase of participatory breeding and includes advanced fixed lines provided by breeders and farmers’ local/traditional varieties. This phase mobilizes various stakeholders depending on whether it is a final breeding process or a registration process. For the final breeding evaluation, plant phenotypic evaluation occurs in farmers’ networks and on-station – often jointly by farmers and scientists using criteria based on agronomic, technological and post-harvest properties. Comments by all stakeholders in the value-chain (scientists, extension officers, farmers, processors, traders and consumers) are considered in the selection of varieties for the next stage.

3.2. Objectives

Participatory varietal selection (PVS) helps:
- To shorten the period between varietal development and varietal adoption by farmers (3 years for PVS compared with 7 years for the conventional method);
- To strengthen farmers’ autonomy and to increase their freedom to select varieties;
- Rural communities to maintain genetic diversity, to access it, and to contribute to the development of new varieties that meet their expectations;
- To strengthen groups that are traditionally left out of development;
- To increase adoption of new improved varieties by farmers;
- To weight selection criteria appropriately according to gender preferences;
- To know more precisely farmers’ varietal selection preferences and criteria so as to include them in breeding objectives; and
- To increase the dissemination of new varieties in farmers’ field conditions.
Farmers and scientists interact in three ways:

- Consultative, with information sharing, where the farmer plays the role of an expert;
- Collaborative, with task sharing, where the farmer hosts the plant material; and
- Collective, with joint responsibility, decision making and cost sharing.

3.3. Methodology

**PVS cycle**

The participatory varietal selection cycle takes 3 years, including seed production in the dry season (Fig. 5). In year 1, an observational nursery is established on a farmer’s plot or a plot in the research station. In year 2, the varieties selected are tested at two levels: multi-location trials or ‘mother trials’ conducted by scientists with or without farmer collaboration; and scattered tests or ‘baby trials’ in farmers’ fields, which are the responsibility of the farmer and are carried out using farmers’ management practices. At this stage, the varietal release committee of the ministry of agriculture joins the evaluating farmers and scientists to ascertain the Value for Cultivation and Utilisation (VCU) and the Distinction Uniformity and Stability (DUS), which are the two indices of evaluation prior to varietal release (registration into the official catalog). In year 3, baby trials are repeated by farmers (to account for annual variability in weather) for confirmation and possible extension to other farmers. VCU and DUS are also checked at this stage. At the baby trial, the observations of both experimenting and visiting farmers are taken into account.
Figure 5. Participative varietal selection cycle
**Participatory diagnosis**

It is necessary to involve social scientists at the beginning of PVS to develop appropriate methods for dialogue and consultation with farmers. This will help to incorporate local knowledge, evaluate the varieties, and communicate results to other farmers and decision-makers for the next tests and seed production. Two types of participatory diagnosis can be considered: global and specific.

Global participatory diagnosis helps to:

- Identify test sites and their main agro-ecological characteristics;
- Characterize the cropping systems in the area;
- Identify environmental variables in the rice-based cropping systems;
- Contribute to the varietal composition of the nursery taking into account the existing environmental stresses;
- Share knowledge with other stakeholders; and
- Identify organized and motivated farmers’ groups.

After a global diagnosis, a specific participatory diagnosis can be considered to deepen the understanding of a given issue (e.g., farmer-to-farmer seed exchange channels). Participatory diagnosis also serves as a tool for defining the objectives of the PVS.

**Experimental sites**

Site selection must be made in agreement with farmers based on participatory diagnosis. It should meet a number of criteria depending on the year of implementation.

In year 1, the site of the rice observational nursery (or rice garden) must meet the following requirements:

- Easy accessibility;
- Proximity to a water source;
- Shelter from damage caused by domestic or wild animals;
- Minimal drying and conservation infrastructure;
- Located at a reasonable distance from surrounding villages (a ratio of one site for 5–10 villages within a maximum radius of 5 km from the nursery is generally used). Fund availability also determines the distribution and number of trial points.
Nursery composition and establishment design

Every stakeholder proposing a variety is expected to know its strengths and weaknesses. The material should limit the effects of the environmental stresses identified in the global diagnosis. It may come from breeders (fixed lines) and/or farmers (traditional or local varieties). The nursery composition may include 30 to 100 entries that suit the intensity or complexity of the environmental stresses. The test is generally conducted in a non-replicated block design with complete randomization of varieties. Each variety must be sown in 5 rows of 5 meters at a spacing of 20 cm × 20 cm, with 40 cm between varieties.

Organized evaluation visits

During the season, three guided visits are undertaken by all stakeholders at the tillering, heading/flowering and maturity stages of the rice plants to comment on the agronomic characters and productivity of the varieties (Annex 2).

Step 1: At the beginning of each session, the scientist in charge introduces the trial and outlines its objectives while highlighting the purpose of the exercise. Participants have one hour to visit the plot.

Photograph 1. Presentation of tests to farmers
Step 2: At the end of this first phase, farmers are placed in groups of 10 men or 10 women. Every group member evaluates the varieties separately. A fact sheet is allocated to every farmer (Annex 2).

![Photograph 2. Group separation by gender](image)

Step 3: Every farmer should respond to the following: ‘Among all the varieties, select 3 to 5 that you would like to sow in your farm and explain why.’ Standing in front of his or her selected varieties, the farmer gives his or her reasons.

Step 4: After selecting his or her best varieties, each farmer must answer another question: ‘Which rice varieties do you think are not performing well and why?’

Step 5: This step requires each farmer to respond to another series of questions: ‘What are the most significant characteristics for you when selecting rice varieties to grow in your farm? After listing these characteristics, rate each one (1 = very significant; 2 = significant; 3 = more or less significant; 4 = less significant; 5 = not at all significant).’
Step 6: Scientists and extension officers collect socio-economic information on each farmer.

Step 7: At the end of the exercise, a 30-45 minutes wrap-up meeting is held to review the evaluations (Photograph 4). Steps 1 to 7 are repeated at each visit:

- 1st visit during the vegetative phase: Comments are recorded on tillering capacity, emergence vigor, crop establishment, tolerance of biotic and abiotic stresses. The practical exchanges between participants will relate to cropping practices (secondary application of urea, crop maintenance, roguing, etc.)

- 2nd visit at reproductive phase: Comments are recorded on the crop establishment, timing, homogeneity, etc. The practical exchanges will be on cropping practices and post-harvest activities.
• 3rd visit at maturity phase: Comments will be on timing, homogeneity, panicle characteristics (exsertion, branching, density, length, number of grains, etc.) and quality. The practical exchanges will cover cropping practices (secondary application of urea, crop maintenance, roguing, etc.) and post-harvest activities.

**Photograph 5.** Third visit at the maturity stage

**Step 8:** Following all evaluations, a wrap-up session is held to draw conclusions from the experimentation and establish the varietal preferences of farmers.

In finalizing the preferences, only the top ten (10) varieties will be listed, taking into account each farmer’s two or three best selections.

Experiences in a number of West African countries showed that the main selection criteria for varieties for lowland conditions are: tillering, vigor, the position of the flag leaf, the panicle length and density, the shape and hairiness of the paddy, and productivity. The importance of these criteria always varies with gender.

From the results of year 1 evaluations, the seed of selected varieties is multiplied in the dry season by researchers for use by farmers in year 2. Recommended seed quantities per farmer are about 500 to 1 000 grams per variety. Together with seed multiplication, researchers also establish a design for (G0/G1) production.
Second year activities

Varieties with the best acceptance scores are replicated in two categories of tests: researcher-managed comparative multi-location varietal tests (mother trials) and scattered farmer-managed and multi-stakeholder tests (baby trials). The mother trials compare the selected 10 best varieties in a randomized block design with three to four replications and at least one test per village. Baby trials help the farmers to comment on the new varieties in their own cropping conditions and with regard to their own production objectives. These tests generally involve two to three new varieties in addition to the local check. The tests are conducted in a block design without any replication (i.e., scattered blocks) with complete randomization of varieties (one test per farmer). They involve both experimenting farmers and other farmers, who only participate in the evaluation of the new varieties. These tests will help to rapidly increase the diffusion of the new varieties.

Organoleptic test

After the field evaluation in year 2 of the agro-morphological characteristics of the varieties selected by farmers, a post-harvest evaluation is conducted to assess grain quality. For this exercise, the panel should be diversified; in addition to farmers, extension officers and scientists, it may include members of the general public, processing equipment dealers, millers, restaurant owners, male and female traders, and village chiefs. Grain quality components taken into account include hulling capacity through pounding as well as traditional and modern milling; white grain texture (translucent or chalky); cooking time and water quantity used; swelling capacity; and aroma and taste.

For each grain quality character, comments are made on the same scale at five levels. As for agronomic characters, an average grain quality score is calculated for each variety from the basic scores of each characteristic (Annex 2).
Photographs 6 and 7. Organoleptic tests in rural and urban areas

Third Year Activities

The researcher-managed comparative multi-location varietal tests (mother trials) and the tests in farmers’ fields (baby trials) are conducted again because in a tropical environment characterized by large inter-annual variability of rains and pest outbreaks, this represents the minimum replication for evaluating a new variety. At this stage, new farmers, who may have assessed the varieties during guided tests in year 2, can become involved in the experimentation by buying small quantities of seed of the varieties they are interested in. Thereby, the circle of farmers exposed to the new varieties expands.

In year 3, researchers can propose a number of varieties for release (registration in the national catalog) and undertake steps to ensure the availability of breeder seed for candidate varieties. At the end of year 3, the seed production system can be established. This could be a non-conventional system (e.g., a mini-dose system or a
community-based seed system) or a conventional system (certified seed production by farmers’ associations or individual farmers under contract with government, and seed production systems by private firms with a selling price guaranteed by government).

### 3.4 The PVS-Research and PVS-Extension Approach

AfricaRice undertakes two PVS approaches: PVS-Research and PVS-Extension. PVS-Research is the approach referred to in this manual as described by many authors (Sthapit et al., 1996; Eyzaguirre and Iwanaga, 1996; Courtois et al., 2001; Joshi et al., 2001; Sperling et al., 2001; Trouche et al., 2001; Da et al., 2001; Sié et al., 2006 Virk and Witcombe, 2008).

PVS-Extension uses the results of PVS year 1 to expose a larger number of farmers (about 500) to the new varieties. It supplements PVS-Research activities to reach locations or zones that were not covered previously. In this case, baby trials are conducted for two years by farmers, who perform four significant roles:

- Performing all cropping operations;
- Evaluation of varieties;
- Diffusion of results to other farmers; and
- Seed distribution at the community level.

At the end of the PVS-Extension program, the varieties adopted by farmers are reported to the research service, which will develop fact sheets for the national release committee to initiate the registration of the new varieties in the national catalog.

### 3.5. Conclusions

There is no model for the manner in which farmers must participate in varietal selection. However, to appropriately lead the process, it is critical to agree on and clearly define the responsibilities of all stakeholders. The PVS model presented is a 3-year cycle model, which is reasonable in view of the agricultural development challenges in the target environments. The PVS-Extension model developed by AfricaRice is not contradictory to the PVS-Research model, serving mainly to extend the process beyond 3 years. Both approaches are complementary and aim to facilitate the adoption of new varieties by a large number of farmers in a short period. However, it is necessary to establish a decentralized PVS design in order to better tap genotype × environment interactions and to best address the needs, and also the interests, of farmers in a very diverse setting.
Module 4

Varietal Release and Seed Production
4.1. Introduction

After the farmers select the varieties the release and seed production stages follow. The first phase consists on an official acknowledgement of the material as a variety which should be registered with the national or regional catalog of varieties and species. The second phase concerns plant material management so as to make available to farmers quality seed (purity, cleanliness, viability etc). It describes “who”, “what”, “when”, “where” regarding the activities and the sequences that have to be followed.

Improving farmers’ access to quality seed should be at the top of the priorities for increasing production since seeds remain the main constraint to achieving this objective. There are two seed systems: the conventional and the non conventional one. The latter includes the traditional systems, distribution of small packets and the community-based seed systems. It is necessary to examine them and to define which system would be appropriate for each production system.

**Overview of seed systems in a selection of AfricaRice member states**

There are very few private enterprises that specialize in the production and distribution of improved rice seed in most West African countries today. In addition, due to lack of planning the seed farms painstakingly established by governments in the 1970s and 1980s as critical links for a modern seed industry rapidly proved maladjusted to the realities of tropical food agriculture (e.g., the cost of seed production was higher than the selling price, inappropriate seed distribution, and inequities between supply and demand). In East Africa, however, significant involvement by the private sector has resulted in better access to improved seed. Further, the private sector often has its own selection networks. For example, the private NASECO seed company in Uganda popularizes NERICA 4 seeds under the name SUPARICA 2 through its test networks and in 2004 produced 90 tonnes of seeds.

Given this situation, a number of studies in different countries proposed evolving models of seed production and distribution in farmers’ fields. These models promote, at various levels, the complementary involvement of farmers’ organizations and small-scale private structures. These entities operate at seed multiplication and distribution stages within the framework of a local network of seed farmers and village marketing shops.
To make NERICA varieties available to farmers, AfricaRice has proposed a model based on networks of farmer seed multipliers. The design is based on the distribution of “good to sow” seeds or acceptable quality seeds for which the production can be controlled by farmers themselves. In most cases, this AfricaRice-provided seed is not subject to any official quality control.

On the other hand, the implementation for decades of a policy of free and subsidized seed to farmers has worked against the development of a commercial rice seed market. The policy of subsidy and government involvement at each stage (research, seed farm, farmer multipliers) of the improved seed marketing process did not allow appropriate pricing of improved seed. After the withdrawal of subsidies, private producers – who tried to sell seed at its actual price – met resistance from farmers, who found the improved seed too expensive.

In addition, the lack of an adapted agricultural credit mechanism on one hand, and the inadequate organization of the marketing of paddy rice on the other hand, discouraged private enterprises from taking the risk of participating in the sector. For example, the Pioneer company, which operated in Côte d’Ivoire from 1989 to 1991, pulled out suddenly because of the small size of the market which was willing to pay.

Despite this observed failure of the various private and public initiatives and the considerable human and financial investments made, rice producers retain a genuine need for quality seed expressed through a market with the following characteristics:

- An atomized and very diversified demand mirroring the size of the farms;
- A demand that is often unable to pay cash, with little or no access to credit;
- A non-structured demand (diversified and at small quantities at individual level, no grouping of needs per village or association, and with very high handling and approach costs).

**The notion of seed**

Seed is referred to as an organ or plant fragment capable of producing another individual. The ‘grain’ organ of various sown plant species is called seed. The seed derived from productive varieties is a factor of genetic progress of dissemination and improved agricultural production. Seed ensures the link between researchers and farmers in what is called the ‘seed chain’. This chain requires such interventions as field production, processing, distribution, promotion and quality assurance. All these activities must be efficiently coordinated and managed if farmers are to have access to
good quality seed of high-performing varieties in sufficient quantity, at the right time, at the right place and at the right cost. Handling or mechanical cleaning that improves seed quality is the most important and specialized link of the chain.

Seed production involves stakeholders at various links of the value-chain:

- Scientists make available the breeder seed or foundation seed of the varieties they develop (Figure 5). They are thus responsible for the first seed multiplication. Each variety is accompanied with a descriptive fact sheet.
- Seed producers (agricultural development agencies, nongovernmental organizations, farmers’ associations or the private sector) acquire seed from researchers (foundation seed) and multiply it for economic purposes.
- Seed controllers are government workers whose role is to ensure that seed production complies with established standards for its certification. Control occurs at three stages: the first stage involves two or three trips to the seed field at specific periods of plant development; the second stage is the laboratory analysis of collected samples; the third stage is the acceptance or the declassification of the seed.

Seed quality is very important because it affects crop yield substantially. Good quality seed must:

- Have a high rate of germination;
- Be dry enough;
- Be pure: all grains should belong to the same variety and have the same weight and color;
- Be clean: not mixed with other inert bodies, such as glumes, debris, weeds, stones or sand;
- Not be damaged, broken, bruised, withered, affected by mold or rotten; and
- Be free of insects and diseases.
Figure 5. Conventional seed system

(G0) breeder seed supply from mother lines; breeder seed multiplied in 3 seasons (G1, G2, G3); G3 may be given to contract farmers to produce G4 foundation seed and R1 and R2 commercial seed.

4.2. Varietal release

Release is an official act aiming at establishing the originality of a variety. As per convention, before being released, a variety must go through two types of tests: the Distinction, Uniformity and Stability (DUS) test and the Value for cultivation and Utilisation (VCU) test (Annex 5). These tests aim to check the consistency of the characteristics of varieties with the standard fact sheets provided by the breeder (Annex 1). Release is generally conducted by a National Varietal Release and Registration Committee, the composition of which varies in each country.
After monitoring trials and demonstrations over two seasons, the national committee makes recommendations to the relevant institution (often the ministry of agriculture) on registering a given variety into the official catalog. In practice, release procedures are complex and at times subjective. To streamline the process in West African countries, the Economic Community of West African States (ECOWAS) has recommended the following six criteria for registering a variety into the national/regional catalog:

a) **Distinction**
The variety is known as distinct if it is clearly different from any other known variety at the time of submission. In addition, the leading seed multiplication and certification institution must be able to easily distinguish and identify the variety in question. This distinction may be morphological or agronomic, but morphological distinction is preferable in order to facilitate genetic purity maintenance.

b) **Homogeneity**
The variety is known as homogeneous if it is sufficiently uniform in its specific characters. For the agronomist in charge of multiplication or certification, a non-uniform variety is a mixture of undetermined purity, which can under no circumstances be identified or distinguished from other varieties.

c) **Stability**
The variety is known as stable if its specific characters remain unchanged after successive reproductions or multiplications, or in the case of specific reproduction or multiplication cycles, at the end of each cycle.

d) **Novelty**
The variety is known as new if, at the date of submission for breeder’s right or vegetative reproduction or multiplication, a harvest product of the variety has not been sold or given to third parties by the breeder to use with his or her consent:
   i. on the territory of the contracting party to which the request has been submitted for over 1 year, and
   ii. on a territory other than that of the contracting party to which a request has been made for over 4 years.

e) **Agronomic performance**
This is the most critical aspect. A variety may have good qualities in many areas but it must be suitable agronomically for large-scale use. Agronomic performance involves yield, maturity, response to fertilizers, tolerance of climatic conditions, and resistance to diseases and insects.
f) Production value

This relates to production quality regarding use, processing and organoleptic quality. In particular, the variety must:

- Follow the multi-location trials process and receive a favorable comment from the national release committee;
- Have yields sufficient to raise the monetary income of farmers in the country;
- Mature early, be tolerant of diseases and insects, and must not carry viruses;
- Be drought-resistant;
- Have a specific and simple name.
Harmonized Varieties Release Procedures and Registration into West Africa Plant Varieties and Species Catalog.

Two harmonization initiatives of seed regulations were concomitantly initiated by CILSS on the one hand and UEMOA and ECOWAS on the other hand.

A regional workshop held in Accra from 27 February to 3 March 2007 brought together representatives of various institutions from 17 member states. It helped to assemble the draft texts of ECOWAS-UEMOA and CILSS into a seed regulatory framework common to the 17 member states of the three inter-governmental organizations.

On 8 November 2007, ECOWAS Ministers of Agriculture and Food in their Ouagadougou meeting, made the following recommendations:

1- A West African Catalog of Plant Varieties and Species (COAfEV), which is the official document listing all the varieties released in member states and national catalogs.

2- A West Africa Seed Committee (COASem), which enforces seed control, certification and marketing regulations.

On 17 and 18 May 2008, the Sixtieth Ordinary Session of the ECOWAS Council of Ministers met in Abuja and adopted regulation C/REG. 4/05/2008 pertaining to the harmonization of the rules governing quality control, certification and marketing of plant seeds and plants in the ECOWAS region.

An initial transitional version of the West Africa Catalog was developed by listing the released varieties within ECOWAS, UEMOA and CILSS Member countries.

To avoid double registration of varieties in the West Africa Catalog of Plant Varieties and Species, it is critical to standardize the evaluation criteria, specifically their distinction, uniformity and stability (DUS) and their Value for cultivation and utilisation (VCU) criteria.

Regulation C/REG. 4/05/2008 involves 11 plant species including 4 cereals (rice, maize, sorghum and millet), 2 grain vegetables (peanut and cowpea), 3 root plants and tubers (cassava, yam and potato) and 2 vegetables (tomato and onion).

Box 1. Harmonization of varietal release procedures within ECOWAS
4.3. Seed systems

In sub-Saharan countries, there are two large categories of seed system: conventional and non-conventional. The latter group involves traditional systems, farmer initiatives and the community-based seed system.

**Conventional system**

The conventional seed system is governed by the public sector (ministry of agriculture), which is usually organized around six activities:

- Seed sector organization;
- Breeder seed production;
- Production of foundation seed and first- and second-generation certified seeds;
- Quality control;
- Treatment and storage; and
- Marketing.

This system aims to ensure smooth operation at all levels: areas, zones, and regions. It includes program production activities, training of seed producers, registration, and production contracts. It also determines the varieties to be cultivated at the various sites. It promotes smooth organization of the release and dissemination process of new varieties as well as their marketing.

Breeder seed production is generally devoted to a research institution following the panicle/row method under strict conditions (Annex 3). It aims on the one hand to reconstruct G0 breeder seed and on the other hand to supply the stakeholders in charge of the production of foundation seed.

The production of foundation seed and first- and second-generation certified seed is conducted by seed farms or contracted farmers and farmers’ groups, and is monitored by the extension service.

Quality control helps to check whether the seed producer has complied with the seed legislation and whether the standards of seed production techniques are met. These standards are to date based on the international rules developed by the International Seed Trials Association (*ISTA*) and cover all seed aspects including choice of land, identification of crop background, compliance to isolation standards, crop maintenance, roguing, crop protection, harvest treatment and storage.
Treatment is conducted before marketing. It relates to seed quality improvement after harvest and includes three operations:

- Cleaning, grading and sorting;
- Insecticide/fungicide treatment; and
- Packaging and labeling.

During handling, seed samples are collected from various plots. These samples are analyzed in a laboratory to check for the following characteristics:

- Germination power;
- Foreign matter content;
- Varietal purity; and
- Health status.

Laboratory analysis and field observations are conducted by the relevant control unit to permit the issuing of an administrative note certifying the acceptance of the production as seed. Seed marketing is carried out by public seed institutions or producer monitoring agencies, which buy the production of contract farmers, treat it and distribute it to farmers. Farmers pay cash or make the purchase through a local financial institution or in the form of campaign credit. Access to campaign credit is subject to the advice of agricultural oversight services. The organization of seed production in the conventional system follows a very long itinerary (figure 5). Therefore, producers should also produce seed in the off-season to fast-track the breeder seed multiplication process.

**Traditional seed system or farmer initiatives**

Based on the recurrent input supply difficulties faced by farmers, they have often resorted to self-seed production, which is a millennium old practice in Africa. It essentially relates to traditional farming, which is practiced by about 90% of farmers. Since this practice is becoming obsolete because of the requirements for modern rice production, the national research services have proposed the ‘mini-dose’ seed technique, an easy channel for making high quality and less costly plant materials available by disseminating new, high-performance varieties in a relatively short time.

The technique is based on making the farmer accountable for seed production and dissemination, specifically for upland and lowland rice because of the socio-economic, agronomic and institutional constraints characteristic of these two types of rice farming. It may also be used for irrigated rice farming. It aims to ensure regular supply of low-cost improved seed to farmers by avoiding the costs of certified seed multiplication and quality control.
The mini-dose seed technique involves the supply of a small quantity of foundation or certified seed to the farmer (e.g., 1 to 2 kg), who multiplies them on his or her plot to meet his or her own needs and subsequently the needs of other farmers. The mini-dose seed principle is to help every farmer produce all his or her high quality seed requirements from very small quantities of commercial seed. It relies critically on two typical rice characteristics:

- Rice is an autogamous species. The risk of any cross-pollination is minimal, so varietal purity is easily achieved when care is taken to avoid mixing the varieties at harvest and during treatment and distribution operations.
- Rice has a very high multiplication weight. In irrigated rice farming with transplanting, the seed requirement is about 40 kg/ha. With current yields around 4 t/ha, this represents a multiplication weight of about 100. In other terms, a 100 m² seed field is enough to produce the seed required for one hectare the following season. Conditions are less favorable in upland rice, where crop establishment is by direct sowing, which requires about 100 kg/ha to produce yields of around only 2 t/ha. In this case, a 500 m² seed field is needed for one hectare, that is, a 1/20 ratio.

In irrigated or lowland rice with transplanting, it is therefore sufficient for the farmer to buy about 0.5 kg of selected seed annually for each hectare he or she plans to cultivate the following season. In upland rice, the seed quantity required will be about 5 kg for each hectare to be sown. It must, however, be emphasized that the successful implementation of this technology requires farmers to complete three practical workshops as well as guided tours with seed producers.

**Community-based seed system**

The Community-Based Seed System (CBSS) is a new approach that combines aspects of both conventional and traditional seed systems. It emphasizes the ownership of the main seed activities by village communities (farmers’ organizations and innovative farmers) and promotes the production and use of acceptable quality seed. CBSS fosters the involvement of farmers’ organizations in many activities: foundation seed production, acceptable quality seed production, seed quality control, seed treatment and dissemination (Figure 6).
In CBSS, breeder seed production is reserved for research institutions. However, a number of other institutions with the appropriate tools may participate on the condition that the seed produced (G2) is subjected to certification. This caution is designed to ensure the quality of the seed that will be introduced into a wholly decentralized system managed by farmers.

Foundation seed production is done by farmers’ organizations and innovative farmers selected for their dynamism and technical capacity. Foundation seed is not subject to certification, but its production must be performed in good conditions (fertilizer input, weeding whenever necessary, regular roguing, treatment, etc.).

Acceptable quality seed is produced by multiplying foundation seed and this can be done by any innovative farmer. Practical training is provided to limit the risk of seed being contaminated by foreign matter, especially weed seeds.

Treatment is conducted after threshing, drying and winnowing to remove impurities of all sorts (plant debris, weed seeds and seeds of other rice varieties). After these operations, the seed must be protected from storage pests by chemical or natural pesticides.

Seed is disseminated through traditional channels, which are very diverse. The process benefits from the support of the extension services, which facilitate access to information on available stocks, farmers’ needs and current prices. Regardless of the seed production system used, the basic rules governing rice seed production must be known.
Innovative farmers and farmers’ organizations organize foundation seed renewal to meet their own needs and facilitate production in collaboration with senior technicians.

Figure 6. The Community-based seed system
4.4. Rules for rice seed production

Any new entrant to rice seed production must take a number of precautions from initial selection to harvest. The following measures are strongly recommended to avoid the contamination of seed plots by grains or pollens of other rice varieties and to ensure quality production.

Plot selection

Producers must meet several standards relating to crop backgrounds and plot isolations (Tables 4 and 5).

Table 4. Crop backgrounds

<table>
<thead>
<tr>
<th>Generations in production</th>
<th>Breeder seed</th>
<th>Foundation seed</th>
<th>R1</th>
<th>R2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authorized backgrounds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• New plot</td>
<td>• New plot</td>
<td>• New plot</td>
<td>• New plot</td>
</tr>
<tr>
<td></td>
<td>• Cropping of another plant species</td>
<td>• Cropping of another plant species</td>
<td>• Cropping of another plant species</td>
<td>• Cropping of another plant species</td>
</tr>
<tr>
<td></td>
<td>• Long fallow (more than 2 years)</td>
<td>• Long fallow (more than 2 years)</td>
<td>• Long fallow (more than 2 years)</td>
<td>• Long fallow (more than 2 years)</td>
</tr>
<tr>
<td></td>
<td>• Foundation seed plot of the same variety</td>
<td>• Foundation seed plot of the same variety</td>
<td>• Foundation seed or R1 plot of the same variety</td>
<td>• Foundation seed, R1 or R2 plot of the same variety</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Forbidden backgrounds</strong></td>
<td>• Any rice crop (paddy or seed), whatever the variety</td>
<td>• Any rice crop of another variety (seed or paddy)</td>
<td>• Any rice crop of another variety (seed or paddy)</td>
<td>• Any rice crop of another variety (seed or paddy)</td>
</tr>
<tr>
<td></td>
<td>• R1 and R2 seed crop of the same variety</td>
<td>• R2 seed crop of the same variety</td>
<td>• R2 seed crop of the same variety</td>
<td>• R2 seed crop of the same variety</td>
</tr>
</tbody>
</table>
**Table 5. Plot isolation**

<table>
<thead>
<tr>
<th>Generations in production</th>
<th>Breeder seed</th>
<th>Foundation seed</th>
<th>R1</th>
<th>R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same crop species, another variety</td>
<td>30 m</td>
<td>20 m</td>
<td>10 m</td>
<td>2 m</td>
</tr>
<tr>
<td>Same species, same variety</td>
<td>2 m (1m between G2 and G3)</td>
<td>1 m</td>
<td>1 m</td>
<td>0 m</td>
</tr>
</tbody>
</table>

**Mother seed selection**

The mother seed must be from a previous generation of the seed under production (Table 6). This seed must have been certified or authorized by the seed service to be used as reproduction seed for the generation under production. The producer must keep all mother seed documents for presentation to the officers of the quality seed and plant control service and should be able to give the exact seed quantity sown for a given area.

**Table 6. Authorized mother seeds (the case of irrigated rice)**

<table>
<thead>
<tr>
<th>Generation in production</th>
<th>Foundation seed</th>
<th>R1</th>
<th>R2</th>
</tr>
</thead>
</table>
| Authorized mother seed         | Breeder seed    | Breeder seed         | R1
| seeded in authorized cropping rules |                  |                      | Foundation seed
|                                 |                  |                      | Breeder seed         |
| Seed requirements under authorized cropping rules | About 20 kg/ha   | About 30 kg/ha       | About 50 kg/ha       |

For R2, use foundation seed as mother seed to ensure less intense roguing in cropping.

**Cropping mode**

The cropping mode is determined by the technical regulations (Table 7). The cropping mode imposes relatively tight constraints for foundation seed production, because of the need to maintain strict quality standards and to make roguing as easy as possible.
Table 7. Cropping Mode

<table>
<thead>
<tr>
<th>Generation in production</th>
<th>Foundation seed</th>
<th>R1</th>
<th>R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authorized cropping mode in irrigated rice</td>
<td>Nursery and transplanting in line of 1 stand per hole</td>
<td>Nursery and transplanting</td>
<td>Nursery and transplanting or direct sowing</td>
</tr>
</tbody>
</table>

To make the nurseries (foundation seed, R1 and eventually R2), a number of rules must be followed without fail:

- Background: avoid any site where rice was produced previously, whatever the variety;
- Prepare the nursery in a manner that allows it to be irrigated separately without any contact with another nursery or rice crop (seed or paddy); and
- Establish nurseries as close as possible to the plots into to which the seedlings will be transplanted (it is recommended that nurseries are established in the plots themselves).

**Soil preparation**

In irrigated farming, submerge the plot immediately after harvest with 10 to 25 cm of water for 2 to 4 weeks (to ensure destruction of shattered rice grains left over from harvest). After this submersion period, the soil will be dry at the surface and wet below the surface. Next, the soil is tilled to a depth of 20 to 25 cm, followed by harrowing. After tillage, the rice field should be puddled and leveled before transplanting.
Photograph 8. Land preparation

Photograph 9. Plot tillage by animal traction
In upland rice cultivation and on more or less leveled soils, plowing is necessary for better emergence. After tillage, weeds must be prevented from growing. Animal traction or motorized cultivation may be used for tillage, which should take place at an appropriate depth (about 25 cm), immediately after harvest and from time to time until sowing to avoid weeds. Timely and appropriate tillage results in better soil preparation and makes harrowing and leveling easier and more efficient.

Harrowing is critical for ensuring that sowing takes place at a regular depth and to promote even seed germination. It also helps to control weeds efficiently at the early stages of rice growth and improves rain water infiltration and conservation.

**Nursery sowing and transplanting**

Sowing date depends on the transplanting period. One thirtieth (1/30) of the transplanting area is generally sufficient (i.e., about 300 m² of nursery for each hectare to be transplanted). For nurseries, make long and narrow seedbeds (1.20 m × 15 m), perfectly leveled and separated by drains of 40 cm width and 20 cm depth. To obtain vigorous seedlings, apply mineral fertilizer to the nursery four days after sowing at the following dose per acre: 1 kg of urea, 2.5 kg of triple superphosphate and 3.5 kg of potassium chloride.

To gain time, it is preferable to sow in pre-germinated conditions. This method requires seeds to be soaked in water for 24 hours and kept under straw for 48 to 72 hours. The plants are removed at the 3 to 4 leave stage, i.e., after 15 days in the rainy season and up to 30 days in the off-season.
Photograph 10. Nursery sowing

Photograph 11. Transplanting
4.5 Conclusions

The procedures for varietal release and registration into national catalogs of plant species in West African countries are long, complex and not efficient enough. This is due mainly to non-implementation of existing legislation, inadequate financial and logistical means, and a lack of national strategies supported by efficient awareness-raising campaigns. In Senegal, for example, the release of new varieties used to take 10 years (e.g., 1987–1997, 1997–2007).

It is in this light that PVS trials can help as confirmation trials for the national release committee to register the varieties into the official catalog. This committee would be made up of all partners involved in PVS for each rice ecology (rainfed, lowland and irrigated). Release time will thereby be cut to 3 years, and costs will also be reduced.
# Annex 1

## Standard fact sheet for rice varieties

<table>
<thead>
<tr>
<th>1. Identification</th>
<th>3. Specific Morphological Traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1. Name of the variety:</td>
<td>Plant: Height :</td>
</tr>
<tr>
<td>1.2. Other names of the variety:</td>
<td>Leaf: (color, hairiness, shape)</td>
</tr>
<tr>
<td>1.3. Origins:</td>
<td>Tillering:</td>
</tr>
<tr>
<td>1.3.1. Genetic</td>
<td>Ear Length</td>
</tr>
<tr>
<td>1.3.2. Geographic</td>
<td>Panicle:</td>
</tr>
<tr>
<td>1.4. Accession or Introduction Year:</td>
<td>Form:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Agronomic Traits</th>
<th>4. Organoleptic and Technological Traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1. Preferential Cropping Zones:</td>
<td>4.1 Nutritional Component Content</td>
</tr>
<tr>
<td>2.2. Cycles:</td>
<td>4.2 Processing Capacity</td>
</tr>
<tr>
<td>2.2.1. Heading 50%</td>
<td>4.3 Cooking Qualities.</td>
</tr>
<tr>
<td>2.2.2. Maturity</td>
<td></td>
</tr>
<tr>
<td>2.3. Yield:</td>
<td></td>
</tr>
<tr>
<td>2.3.1. Potential</td>
<td></td>
</tr>
<tr>
<td>2.3.2. Actual Environment</td>
<td></td>
</tr>
<tr>
<td>2.4. 1000 grains weight</td>
<td></td>
</tr>
<tr>
<td>2.5. Photo susceptibility</td>
<td></td>
</tr>
<tr>
<td>2.6. Resistance to pests:</td>
<td></td>
</tr>
<tr>
<td>2.6.1. Insects:</td>
<td></td>
</tr>
<tr>
<td>2.6.2. Diseases:</td>
<td></td>
</tr>
<tr>
<td>2.6.3. Others:</td>
<td></td>
</tr>
<tr>
<td>2.7. Other Specific Traits</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hairiness of the lemma:</td>
</tr>
<tr>
<td></td>
<td>Coloration of the apex:</td>
</tr>
<tr>
<td></td>
<td>Color of the caryopsis:</td>
</tr>
</tbody>
</table>
Annex 2

PVS experimental protocol

Introduction

Over the years, AfricaRice has increasingly focused on participatory research and development to make technologies applicable to rice-based production systems and to ensure that they address priority constraints. The basic strategy actively involves farmers and other stakeholders in rice research and development. AfricaRice and partners gradually used participatory varietal selection (PVS) as an adjunct to conventional breeding, to confront the numerous production environments used by small-holder rice farmers and the diverse and multiple quality demands of consumers.

In PVS year one, farmers select from a range of new lines/varieties those seen as better adapted to their own farms and with the appropriate agronomic characteristics for their cropping activities. In the two following seasons of field evaluation under farmer management, farmers identify those lines better adapted to their production system and with the quality characteristics desired for personal consumption or for the market. In a given agro-ecological zone, four or five of the most popular lines are multiplied and distributed to farmers for evaluation after two seasons. The lines that are most popular with farmers are then recommended for zonal release. Many newly released rice varieties in West Africa emerged from PVS activities.

Specific objectives

1. Demonstrate the performance of improved varieties in farmers’ field conditions and their adaptability to biotic and abiotic stress conditions.
2. Allow farmers to identify and select the varieties that meet their needs.
3. Build the capacity of farmers to multiply and disseminate the varieties they have selected themselves.
Year 1
Farmers select from a centralized rice garden under stress conditions. Selected varieties are multiplied in the dry season (breeder seed) and in the wet season (foundation seed).

Year 2
Farmers sow their selected varieties on their own farms and in stress conditions, to compare with their traditional varieties. The varieties selected are multiplied in the dry season (foundation seed).

Year 3
Farmers buy the seed of the varieties they have selected for their own needs.

Materials and methods

Plant Material: 80 varieties from the collection of the various partners (AfricaRice, IRRI, CIAT, NARS, etc.).

Experimental design

Site Characterization

1. Characterize the sites for the evaluation of varieties.
2. Parameters included in characterization: soil texture, pH/Ec of the soil, Total N, organic C, P available, exchangeable cations, Fe and Zinc extractible and any other relevant parameter (cf. Annex 1).
3. Longitude, latitude, minimum and maximum monthly temperature, hygrometry, monthly rainfall, hours of solar radiation and photoperiod, for example.

Plot: 5 rows of 5 meters, 0.20 m × 0.20 m spacing. Total area = 5 m²
Plot used: 3 rows of 4.6 m, Area = 2.76 m²
Sites: Burkina Faso, Ghana, Guinea and Nigeria
**Sowing method:**

Direct sowing immediately after soil preparation at five grains/hill or transplanting with 20 cm spacing between rows and within rows is recommended.

**Fertilizer application**

**Basal:**  200 kg/ha of NPK at sowing or transplanting

**Surface:**  35 kg/ha of urea after the first weeding (2 weeks after emergence or transplanting)
              65 kg/ha of urea at panicle initiation

**Maintenance:**  Manual weeding when necessary

**Harvest and post-harvest**

The plots are harvested when 85 to 90% of the panicles of each plot are mature. The grains are threshed, dried and winnowed, and yield is ascertained at 14% moisture.

**Water table fluctuation**

With the use of piezometers installed at each site, the height of the water table is measured daily during the vegetative phase of the rice plants.

The piezometers measure up to 1.50 m and should be buried 1 m deep in the alleys. Three piezometers should be installed per trial.
Observations

A multidisciplinary team observes the trials. The table below presents the series of observations. Scores are given according to the IRRI Standard Evaluation System (SES).

<table>
<thead>
<tr>
<th>a) Agro-morphological Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>11</td>
</tr>
<tr>
<td>12</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b) Scores over diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>
Guided tour monitoring sheet

Country: _____________________________
Site/village: __________________________
Year: __________________________________
Ecosystem: rainfed upland □; rainfed lowland □; irrigated lowland □; irrigated Sahel □
Season: rainy season □; dry season □.

**SHEET 1: AGRONOMIC DATA OF THE RICE GARDEN VARIETIES**

### A. Environmental data
1. Rainfall: _______ mm of rain in the cropping season
2. Type of soil: _____________________________________________
3. Crop rotation: Number of cropping years □; Last season crop: _____________________________________________

### B. Management practices
1. Land preparation: type: _____________________________ date: _____________________________
2. Seed treatment: _____________________________
3. Sowing: type: _____________________________ date: _____________________________
4. Transplanting: date: _____________________________
5. Weed management: dates: 1st weeding: __________ ; 2nd weeding: __________ ; 3rd weeding: __________
Herbicide utilization: type: _____________________________ dose/ha: _____________________________ date: _____________________________

6. Fertilizer use:
   1. Type: _____________________________ dose/ha: _____________________________ date: _____________________________
   2. Type: _____________________________ dose/ha: _____________________________ date: _____________________________
   3. Type: _____________________________ dose/ha: _____________________________ date: _____________________________

7. Insecticide or fungicide use:
   1. Type: _____________________________ dose/ha: _____________________________ date: _____________________________
   2. Type: _____________________________ dose/ha: _____________________________ date: _____________________________
Country: ________________________________
Site/village: ________________________________
Year: ___________________________________

YEAR 1 – SHEET 2: FARMER EVALUATION

For farmers involved in the evaluation of the varieties cultivated in the garden (1 sheet per farmer)

A. General Information
1. Name of the farmer: ________________________________
2. Age: ________________________________
3. Sex: ________________________________
4. Village (origin): ________________________________

B. Farmer evaluation at tillering and heading/maturity
1. Garden Visit Date: ________________________________
2. Which rice varieties do you want to sow on your farm and why?

<table>
<thead>
<tr>
<th>Variety (number)</th>
<th>Reasons for selection</th>
<th>More detailed explanations</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Which rice varieties do you think are not performing, or which varieties would you not like to sow on your farm and why?

<table>
<thead>
<tr>
<th>Variety (number)</th>
<th>Reasons why you do not like these varieties</th>
<th>More detailed explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. What are the most significant traits for you when you select the rice varieties you would sow on your farm (see reasons for the scores given in the second column under numbers 2 and 3)?

**NB:** After listing these traits, can you give a score for each criterion?

<table>
<thead>
<tr>
<th>Trait</th>
<th>Score (1, 2, 3, 4 or 5)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 = very significant; 2 = significant; 3 = more or less significant; 4 = less significant; 5 = not significant at all
5. Can you evaluate the extent to which these traits are shown by the variety you have just selected? Check “×” in the column (a, b or c) that tallies with the selection of the variety (write the name and number of the variety).

<table>
<thead>
<tr>
<th>Trait</th>
<th>Variety</th>
<th>Variety</th>
<th>Variety</th>
<th>Variety</th>
<th>Variety</th>
<th>Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a</td>
<td>b</td>
<td>c</td>
<td>a</td>
<td>b</td>
<td>c</td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a= very good; b= good; c= bad
C. Farmer evaluation after harvest

1. Garden visit date: ____________________________

2. Which rice varieties would you like to sow on your farm and why?

<table>
<thead>
<tr>
<th>Variety (number)</th>
<th>Reasons for selection</th>
<th>More detailed explanations</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Which rice varieties do you think are not performing, or which varieties would you not like to sow on your farm and why?

<table>
<thead>
<tr>
<th>Variety (number)</th>
<th>Reasons why you do not like these varieties</th>
<th>More detailed explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Year 1 - Sheet 3: Socio-economic data on the farm and the farmer (1 sheet per farmer)

Name of farmer: ______________________________

- Ethnic group: ______________________________

- Are you the head of farmhold? no □ yes □

- Marital status: married □ single □ widow(er) □

- If the farmer is married, number of wives in the household ________________

- If the farmer is a married woman, what is her status? ________________________

- How many people are there in the farmhold? men _____ women_____

- How many people work on the farm on full time basis? men_____ women_____

- What is the area of the farm? _____ ha

- What is the area cropped in rice? _____ ha

- What percentage of the rice is consumed at home? _____% and sold: _____%

- Do you sow other cash crops? no □ yes □

  If yes, which ones? ________________________________

- Do you have other sources of income? no □ yes □

  If yes, which ones: ________________________________

- Do you often take credit? no □ yes □

  If yes, which type?

- How many heads of cattle do you have? ___

- Do you use animal traction? no □ yes □
- How many pairs of bullocks do you have? □

- How many rice varieties do you regularly sow? ____________________________

- Do you often test new rice varieties? no □ yes □

- How do you get the seed of these new varieties? __________________________

- What is your main source of information in agriculture? ____________________

- What is your education level? _________________________________________

- Are you a member of a farmers’ association? No □ Yes □ ;

Which one? specify; ____________________________________________________
Annex 3

Breeder seed production protocol

Introduction

Objectives

Global objective

Improve rice production through rational use of natural resources and the protection of the environment.

Specific objectives

- To monitor and maintain the varietal purity of the introduced varieties to facilitate their dissemination;
- To ensure the production of good quality foundation seed of released varieties to supply extension institutions;
- To study the performance of NERICA and other improved varieties in terms of varietal segregation;
- To gradually organize stakeholders for the production of acceptable quality seed (AQS); and
- To foster the geographical extension of rice farming to increase national rice production.

Materials

The plant material will include panicles of the ten most popular varieties identified through PVS-Research in the previous season. The four best plants per variety are selected using a ratio of 10 panicles/plant. A total of 40 panicles per variety are obtained.
Methods

Experimental design

There is no appropriate experimental design. Single plots (20 m × 10 m) are selected for each variety in compliance with isolation distance. The panicle par row methodology is used: it involves sowing a whole panicle per row. Hence, there will be 40 rows per variety.

At plant maturity, the 4 most homogeneous rows are selected and the 10 best plants/row are harvested at a ratio of 4 panicles/plant. The 40 panicle batches will be G0. The heterogeneous lines will be removed. The other lines will be harvested in bulk and threshed; they are G1 and will help to produce G2.

<table>
<thead>
<tr>
<th>Seed categories</th>
<th>Main Stakeholder</th>
<th>Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeder Seed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G0</td>
<td>Sowing: panicle/row</td>
<td>Rice Research Program</td>
</tr>
<tr>
<td></td>
<td>Harvest: panicles for G0 return</td>
<td>(RRP)</td>
</tr>
<tr>
<td>G1</td>
<td>The rest for G1</td>
<td></td>
</tr>
<tr>
<td>G2</td>
<td>Sowing G1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Harvest G2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off-season of 2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>at Koussin- lélé</td>
</tr>
</tbody>
</table>

Trial implementation

• Soil Preparation
The soil is mowed, stumped and ploughed 15 days before sowing at 15–20 cm deep. Next, it is cleared and leveled. Finally, harrowing (or soil spraying) is conducted before sowing.

• Sowing and sowing density
Sowing is conducted on 320 m² plots, i.e., 40 rows of 20 m with inter-row spacing of 0.40 m and identical intra-row spacing of 0.20 m. Sowing should be done at the rate of 2 to 3 grains per hill. The rows are then thinned at the 3 to 4 leaves stage, i.e., at 15 to 20 days after sowing (DAS).
• **Fertilization**

Mineral fertilizers should be applied as follows:

- 200 kg/ha of cotton fertilizer (NPK, 14-23-14) before or at sowing
- 35 kg/ha of urea at 1st weeding (2 to 3 weeks after sowing)
- 65 kg/ha of urea at panicle initiation, i.e., 40–50 DAS

• **Maintenance**

Maintenance work should be limited, if possible, to manual weeding (upon request), roguing of varieties and replacement of missing hills.

Roguing should be conducted throughout the cropping season, but more importantly from panicle initiation to harvest.

**Observations and variable measurements**

Data collection should be done per variety and per row of each variety for G0/G1 seed production.

a) **Agro-morphological observations**

- Germination percentage (Germ %)
- Average number of tillers at 60 days after sowing per plant (T60)
- Plant vigor (Pvig)
- Average height of plants at maturity (Pht)
- Flowering days (FLW) (date of the first heading/line and scores every 3 days of the number of hills headed/row);
- Maturity days (MAT)
- Panicle Exertion (PEx)
- Number of panicles per square meter (Pm²)
- Shattering (Shatt)
- Panicle Length (PanL)
- Average weight of panicle (Panwght) on an average of 10 panicles/variety
- Number of secondary branches (Secbranch)
- Percentage (%) of filled grains (%Ster)
- Weight of a thousand grains (1000Gwt)
- Plot weight (Yld)

**b) Scores on diseases and insects**

- Leaf blast (SES 35,42,47 and 56 DAS )
- Neck blast ( SES 15 and 30 DAE )
- RYMV (SES)
- Insects (onion tubes, dead hearts and white panicles) 20,40,60 and 80 DAS
- Iron toxicity (SES)
### Annex 4

#### Naming the various types of seed

<table>
<thead>
<tr>
<th>Generations in multiplication</th>
<th>EOCD Pattern</th>
<th>French Pattern</th>
<th>AOSCA Pattern (United States)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeders’ sample</td>
<td>Matériel parental</td>
<td>Plante initiale G0</td>
<td>Breeder seed</td>
</tr>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; generation</td>
<td>Semence de prébase</td>
<td>Génération G1</td>
<td>Foundation seed</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; generation</td>
<td>“”</td>
<td>Génération G2</td>
<td>“”</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; generation</td>
<td>“”</td>
<td>Génération G3</td>
<td>“”</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt; generation</td>
<td>Semence de base</td>
<td>Génération G4</td>
<td>“”</td>
</tr>
<tr>
<td>5&lt;sup&gt;th&lt;/sup&gt; generation</td>
<td>Semence certifiée de 1&lt;sup&gt;ère&lt;/sup&gt; génération (C1)</td>
<td>Semence certifiée de 1&lt;sup&gt;ère&lt;/sup&gt; reproduction (R1)</td>
<td>Registered seed</td>
</tr>
<tr>
<td>6&lt;sup&gt;th&lt;/sup&gt; generation</td>
<td>Semence certifiée de 2&lt;sup&gt;e&lt;/sup&gt; génération (C2)</td>
<td>Semence certifiée de 2&lt;sup&gt;e&lt;/sup&gt; reproduction (R2)</td>
<td>Certified seed</td>
</tr>
<tr>
<td>7&lt;sup&gt;th&lt;/sup&gt; generation</td>
<td>Semence certifiée de 3&lt;sup&gt;e&lt;/sup&gt; génération (C3)</td>
<td>Semence certifiée de 3&lt;sup&gt;e&lt;/sup&gt; reproduction (R3)</td>
<td>Commercial seed</td>
</tr>
</tbody>
</table>

EOCD: European Organization for Cooperation and Development  
AOSCA: Association of Official Seed Certifying Agencies
Annex 5

West Africa Procedure Manual excerpt:
DUS and VCU

PROCEDURE MANUAL FOR VARIETY REGISTRATION IN
THE NATIONAL CATALOGUE FOR CROP SCIENCES AND
VARIETIES IN WEST AFRICAN COUNTRIES
### RICE: (DUS)*

Request Number : .............

<table>
<thead>
<tr>
<th>1-</th>
<th>Species</th>
<th>Oryza sativa L.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-</td>
<td>Applicant (Name and Address)</td>
<td></td>
</tr>
<tr>
<td>3-</td>
<td>Proposed Denomination</td>
<td></td>
</tr>
<tr>
<td>4-</td>
<td>Information of origin, maintenance and reproduction of the variety</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.1 Breeding Method</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Pure line</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Hybrid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Other (specify)</td>
<td></td>
</tr>
<tr>
<td>5-</td>
<td>Characteristics of the variety to be given</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.1 Characteristics marked with the * are mandatory</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Similar varieties and differences from these varieties</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Denomination of similar variety</th>
<th>Characteristics in which the similar variety is different</th>
<th>State of the expression of similar variety</th>
<th>State of expression of candidate variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-</td>
<td>Additional information which may help to distinguish the variety</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-</td>
<td>Resistance to pests and diseases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9-</td>
<td>Special conditions for the examination of the variety</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-</td>
<td>Other information</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Annex I

Material required

The material is to be supplied in the form of seed. The minimum quantity of plant material, to be supplied by the applicant, should generally be 2 kg.

Hybrid varieties: if requested, an additional 2 kg of seed of each component should be submitted.

Panicles: if requested by the competent authority, at least 100 panicles should also be submitted. The panicles should be well developed and not obviously affected by any pest or disease. They should contain a sufficient number of viable seeds to establish a satisfactory row of plants for observation.

The seed should meet the minimum requirements for germination, species and analytical purity, health and moisture content, specified by the competent authority. In cases where the seed is to be stored, the germination capacity should be as high as possible and should be stated by the applicant.

The plant material supplied should be visibly healthy, not lacking in vigor, nor affected by any important pest or disease.

The plant material should not have undergone any treatment which would affect the expression of the characteristics of the variety, unless the competent authorities allow or request such treatment. If it has been treated, full details of the treatment must be given.

Method of examination

3.1 Duration of Tests

The minimum duration of tests should normally be one season.
3.2 Testing Place

The tests should be conducted in at least one member state. If any characteristics of the variety, which are relevant for the examination of DUS, cannot be observed at that place, the variety may be tested at an additional place.

3.3 Conditions for Conducting the Examination

The tests should be carried out under conditions ensuring satisfactory growth for the expression of the relevant characteristics of the variety and for the conduct of the examination.

3.3.1 Stage of development for the assessment
The optimal stage of development for the assessment of each characteristic is indicated by a number in the second column of the Table of Characteristics.

3.3.2 Type of observation – visual or measurement
The recommended method of observing the characteristic is indicated by the following key in the second column of the Table of Characteristics:

MG: single measurement of a group of plants or parts of plants
MS: measurement of a number of individual plants or parts of plants
VG: visual assessment by a single observation of a group of plants or parts of plants
VS: visual assessment by observation of individual plants or parts of plants

Those characteristics marked with an asterisk (*) should be used every growing period for the examination.

3.4 Test Design

3.4.1 The design of the tests should be such that plants or parts of plants may be removed for measurement or counting without prejudice to the observations which must be made up to the end of the growing cycle.

3.4.2 Each test should be designed to result in a total of, at least 1500 plants, which should be divided between two or more replicates. Single panicle-rows: If tests on panicle-rows are conducted, at least 50 panicle-rows should be observed.
3.5 Number of Plants / Parts of Plants to be Examined

Unless otherwise indicated, all observations made on individual plants or determined by measurement or counting should be made on at least 20 plants or parts taken from each of the 20 plants.

3.6 Additional Tests

Additional tests, for examining relevant characteristics, may be established.

Assessment of Distinctness, Uniformity and Stability

4.1 Distinctness

4.1.1 General Recommendations
It is of particular importance for users of these Test Guidelines to consult the General Introduction prior to making decisions regarding distinctness. However, the following points are provided for elaboration or emphasis in these Test Guidelines.

4.1.2 Consistent Differences
The minimum duration of tests recommended reflects, in general, the need to ensure that any differences in a characteristic are sufficiently consistent.

4.1.3 Clear Differences
Determining whether a difference between two varieties is clear depends on many factors, and should consider, in particular, the type of expression of the characteristic being examined, i.e. whether it is expressed in a qualitative, quantitative, or pseudo-qualitative manner.

4.2 Uniformity

4.2.1 It is of particular importance for users of these Test Guidelines to consult the General Introduction prior to making decisions regarding uniformity. However, the following points are provided for elaboration or emphasis in these Test Guidelines:
4.2.2 Self-pollinated varieties

(a) Plots: For the assessment of uniformity of characteristics on the plot as a whole, a population standard of 0.1 % with an acceptance probability of at least 95% should be applied.

In the case of a sample size of 1,500 plants the maximum number of off-types allowed would be 4.

(b) Single panicle-rows: For the assessment of uniformity of characteristics on single panicle-rows, plants or parts of plants, a population standard of 1% with an acceptance probability of at least 95% should be applied. In the case of a sample size of 50 panicle rows, the maximum number of aberrant panicle-rows should not exceed 2.

4.2.3 Hybrid varieties

For the assessment of uniformity of single hybrids, a population standard of 1% with an acceptance probability of at least 95% should be applied. In the case of a sample size of 1,500 plants the maximum number of off-types allowed would be 39.

4.3 Stability

4.3.1 In practice, it is not usual to perform tests of stability that produce results as certain as those of the testing of distinctness and uniformity. However, experience has demonstrated that, for many types of variety, when a variety has been shown to be uniform, it can also be considered to be stable.

4.3.2 Where appropriate, or in cases of doubt, stability may be tested, either by growing a further generation, or by testing a new seed stock to ensure that it exhibits the same characteristics as those shown by the previous material supplied.

Grouping of varieties and organization of growing trial

5.1 The selection of varieties of common knowledge to be grown in the trial with the candidate varieties and the way in which these varieties are divided into groups to facilitate the assessment of distinctness is aided by the use of grouping characteristics.
5.2 Grouping characteristics are those in which the documented states of expression, even where produced at different locations, can be used, either individually or in combination with other such characteristics: (a) to select varieties of common knowledge that can be excluded from the growing trial used for examination of distinctness; and (b) to organize the growing trial so that similar varieties are grouped together.

5.3 The following have been agreed as useful grouping characteristics:
(a) Leaf: anthocyanin coloration of auricles (characteristic 9)
(b) Time of heading (50% of plants with heads) (characteristic 19)
(c) Non-prostrate varieties only: Stem: length (excluding panicle) (characteristic 26)
(d) Decorticated grain: length (characteristic 58)
(e) Decorticated grain: colour (characteristic 61)
(f) Decorticated grain: aroma (characteristic 65)

5.4 Guidance for the use of grouping characteristics, in the process of examining distinctness, is provided through the General Introduction.
Introduction to the table of characteristics

Asterisked Characteristics

Asterisked characteristics (denoted by *) are those included in the Test Guidelines which are important for the harmonization of variety descriptions and should always be examined for DUS.

*States of Expression and Corresponding Notes*
States of expression are given for each characteristic to define the characteristic and to harmonize descriptions. Each state of expression is allocated a corresponding numerical note for ease of recording of data and for the production and exchange of the description.

*Example Varieties*
Where appropriate, example varieties are provided to clarify the states of expression of each characteristic.

*Legend*

(*) Asterisked characteristic
QL Qualitative characteristic
QN Quantitative characteristic
PQ Pseudo-qualitative characteristic
MG Single measurement of a group of plants or parts of plants
MS Measurement of a number of individual plants or parts of plants
VG Visual assessment by a single observation of a group of plants or parts of plants
VS Visual assessment by observation of individual plants or parts of plants
## TABLE OF CHARACTERS

<table>
<thead>
<tr>
<th>Characterization</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Coleoptile: anthocyanin coloration</td>
<td>□ absent or very weak</td>
</tr>
<tr>
<td></td>
<td>□ weak</td>
</tr>
<tr>
<td></td>
<td>□ strong</td>
</tr>
<tr>
<td>2- Basal leaf: sheath color</td>
<td>□ green</td>
</tr>
<tr>
<td></td>
<td>□ green with purple lines</td>
</tr>
<tr>
<td></td>
<td>□ light purple</td>
</tr>
<tr>
<td></td>
<td>□ purple</td>
</tr>
<tr>
<td>3- Leaf: intensity of green color</td>
<td>□ light</td>
</tr>
<tr>
<td></td>
<td>□ medium</td>
</tr>
<tr>
<td></td>
<td>□ dark</td>
</tr>
<tr>
<td>4- Leaf: anthocyanin coloration</td>
<td>□ absent</td>
</tr>
<tr>
<td></td>
<td>□ present</td>
</tr>
<tr>
<td>5- Leaf: distribution of anthocyanin coloration</td>
<td>□ on tips only</td>
</tr>
<tr>
<td></td>
<td>□ on margin only</td>
</tr>
<tr>
<td></td>
<td>□ in blotches only</td>
</tr>
<tr>
<td></td>
<td>□ even</td>
</tr>
<tr>
<td>6- Leaf sheath: anthocyanin coloration</td>
<td>□ absent</td>
</tr>
<tr>
<td></td>
<td>□ present</td>
</tr>
<tr>
<td>7- Leaf sheath: intensity of the anthocyanin coloration</td>
<td>□ very weak</td>
</tr>
<tr>
<td></td>
<td>□ weak</td>
</tr>
<tr>
<td></td>
<td>□ medium</td>
</tr>
<tr>
<td></td>
<td>□ strong</td>
</tr>
<tr>
<td>8- Leaf blade: pubescence of surface</td>
<td>□ absent or very weak</td>
</tr>
<tr>
<td></td>
<td>□ weak</td>
</tr>
<tr>
<td></td>
<td>□ medium</td>
</tr>
<tr>
<td></td>
<td>□ strong</td>
</tr>
<tr>
<td></td>
<td>* 9- Leaf: anthocyanin coloration of auricles</td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>10-</td>
<td>Leaf: anthocyanin pigmentation of collar</td>
</tr>
<tr>
<td>11-</td>
<td>Leaf: shape of ligule</td>
</tr>
<tr>
<td>12-</td>
<td>Leaf: color of ligule</td>
</tr>
<tr>
<td>13-</td>
<td>Leaf blade: length</td>
</tr>
<tr>
<td>14-</td>
<td>Leaf blade: width</td>
</tr>
<tr>
<td>* 15-</td>
<td>Stigma: anthocyanin coloration</td>
</tr>
<tr>
<td>* 16-</td>
<td>Floag leaf: attitude of blade</td>
</tr>
</tbody>
</table>
| 17- Culms: habit | □ erect  
|                | □ semi-erect  
|                | □ open  
|                | □ spreading  
|                | □ prostrate  
| 18- Prostrate varieties only: culms kneeling ability | □ absent  
|                | □ present  
| 19- Time of heading | □ very early  
|                | □ early  
|                | □ medium  
|                | □ late  
| 20- Male sterility | □ absent  
|                | □ partially male sterility  
|                | □ male sterile  
| 21- Lemma: anthocyanin coloration of keel | □ absent or very weak  
|                | □ weak  
|                | □ medium  
|                | □ strong  
| 22- Lemma: anthocyanin coloration of area below apex | □ absent or very weak  
|                | □ weak  
|                | □ medium  
|                | □ strong  
| 23- Lemma: anthocyanin coloration of apex | □ absent or very weak  
|                | □ weak  
|                | □ medium  
|                | □ strong  
| 24- Spikelet: color of stigma | □ white  
|                | □ light green  
|                | □ yellow  
|                | □ light purple  
|                | □ purple  

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
</table>
| **25- Stem: thickness** | □ thin  
 □ medium  
 □ thick |
| **26- Non-prostrate varieties only: stem length** | □ very short  
 □ short  
 □ medium  
 □ long  
 □ very long |
| **27- Stem: anthocyanin coloration of the nodes** | □ absent  
 □ present |
| **28- Stem: intensity of the anthocyanin coloration of nodes** | □ weak  
 □ medium  
 □ strong |
| **29- Stem: anthocyanin coloration of internodes** | □ absent  
 □ present |
| **30- Panicle: length of the main axis** | □ short  
 □ medium  
 □ long |
| **31- Panicle: number per plant** | □ small  
 □ average  
 □ large |
| **32- Panicle: awns** | □ absent  
 □ present |
| **33- Panicle: color of the awns** | □ light gold  
 □ gold  
 □ brown  
 □ reddish brown  
 □ light red  
 □ red  
 □ light purple  
 □ purple  
 □ black |
### 34- Panicle: distribution of awns
- tip only
- upper quarter only
- upper half only
- upper three quarters only
- whole length

### 35- Panicle: length of longest awns
- very short
- short
- medium
- long
- very long

### 36- Spikelet: pubescence of lemma
- absent or very weak
- weak
- medium
- strong
- very strong

### 37- Spikelet: color of tip of lemma
- white
- yellowish
- brown
- red
- purple
- black

### 38- Panicle: color of awns
- light gold
- gold
- brown
- reddish brown
- light red
- red
- light purple
- purple
- black

### 39- Panicle: attitude in relation to stem
- upright
- semi-upright
- slightly drooping
- strongly drooping

### 40- Panicle: presence of secondary branching
- absent
- present
| 41- Panicle: type of secondary branching | □ type 1
  □ type 2
  □ type 3 |
|-----------------|-----------------|
| * 42- Panicle: attitude of branches | □ erect
  □ semi-erect
  □ spreading |
| 43- Panicle: exertion | □ enclosed
  □ partly exerted
  □ just exerted
  □ moderately-well exerted
  □ well exerted |
| 44- Time of maturity | □ very early
  □ early
  □ intermediate
  □ late
  □ very late |
| 45- Leaf: time of senescence | □ early
  □ intermediate
  □ late |
| 46- Lemma: color | □ light gold
  □ gold
  □ brown
  □ reddish brown
  □ purple
  □ black |
| 47- Lemma: ornamentation | □ absent
  □ gold furrows
  □ brown furrows
  □ purple spots
  □ purple furrows |
<p>| | | | | | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>48- Lemma: anthocyanin coloration of keel</td>
<td>□ absent or very weak</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ weak</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ strong</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>49- Lemma: anthocyanin coloration of area below apex</td>
<td>□ absent or very weak</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ weak</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ strong</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ very strong</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50- Lemma: anthocyanin coloration of apex</td>
<td>□ absent or very weak</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ weak</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ strong</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ very strong</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51- Glumes: length</td>
<td>□ short</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ long</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>52- Glumes: color</td>
<td>□ straw</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ gold</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ red</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ purple</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>53- Grain: weight of 1000</td>
<td>□ low</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ high</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>54- Grain: length</td>
<td>□ short</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ long</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55- Grain: width</td>
<td>□ narrow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ broad</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>Lemma: phenol reaction</td>
<td>□ absent</td>
<td>□ present</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>Lemma: intensity of phenol reaction</td>
<td>□ light</td>
<td>□ medium</td>
<td>□ dark</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 58</td>
<td>Decorticated grain: length</td>
<td>□ short</td>
<td>□ medium</td>
<td>□ long</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>Decorticated grain: width</td>
<td>□ narrow</td>
<td>□ medium</td>
<td>□ broad</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 60</td>
<td>Decorticated grain: shape</td>
<td>□ round</td>
<td>□ semi-round</td>
<td>□ half spindle shaped</td>
<td>□ spindle shaped</td>
<td>□ long spindle shaped</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 61</td>
<td>Decorticated grain: color</td>
<td>□ white</td>
<td>□ light brown</td>
<td>□ variegated brown</td>
<td>□ dark brown</td>
<td>□ light red</td>
<td>□ red</td>
<td>□ variegated purple</td>
<td>□ purple</td>
<td>□ dark purple/black</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>Endosperm: type</td>
<td>□ glutinous</td>
<td>□ intermediate</td>
<td>□ non-glutinous</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
63- Endosperm: content of amylase
- State 1
- State 2
- State 3
- State 4
- State 5
- State 6
- State 7

64- Alkali digestion
- not digested
- low digested
- intermediate
- completely digested

* 65- Decorticated grain: aroma
- absent or very weak
- weak
- strong

* UPOV Guiding Principles for distinctness, uniformity and stability.
Reporting

Report of DUS test for national/regional variety catalogue

Application number: ...........................................................................................................

Variety name: ....................................................................................................................

Species: ..............................................................................................................................

Applicant: ...........................................................................................................................

Reporting NSA: ...................................................................................................................

Season of evaluation: ...........................................................................................................

Trial sites:

The variety has been evaluated and the result of the DUS evaluation is:

The variety conforms to the distinctness             [  ]          [  ]

The variety conforms to the uniformity            [  ]          [  ]

The variety conforms to the stability              [  ]          [  ]

Recommendation:

The variety does/does not conform to the DUS requirements.

Signed: .................................................            Date: ..............................................
Rice: Value for cultivation and utilisation (VCU)

Introduction

Seeds or plants of a vegetal variety can be marketed only when the variety is registered in a national catalogue of species and varieties cultivated. This registration follows particular rules of procedures which help to ensure that vegetal varieties marketed have, quite well, characteristics which are contained in the descriptive form of each of these varieties. Any variety proposed for registration must be investigated by a department of the Ministry of Agriculture selected to this end hereinafter referred to as “Seed Technical Committee”. This selected department can conduct the investigations itself or entrust them to a Body specialized in the analysis of plant genetic variability. Usually this Body is the National Agricultural Research Department (SNRA).

Two types of tests are conducted to ensure that the variety proposed meets quite well conditions defined by the national legislation for the registration of vegetal varieties in the National Catalogue. These conditions include: (i) the investigation on distinctive characteristics, uniformity and stability. Test on identification characteristics or DUS; and (ii), the investigation on the Value for Cultivation or Use VCU.

The VCU focuses on the investigation on production (and its components) and factors related to the evenness of the production, especially biotic (pests, diseases, etc.) and abiotic (climatic, edaphic environment, etc.) constraints on the one hand and constraints related to the investigation of the use value, on the other hand, at the end of two years of observations.

The study on production is achieved through the National Experimentation Network (RNE) gathering experiments settled in the stations of the SNRA, Rural Development Regional Services (SRDR) and other agricultural institutions (training centres, co-operatives, etc.). Even when they are entrusted to SNRA, experiments for the registration of vegetal varieties in catalogue, remain the responsibility of the Seed Technical Committee. This Committee organizes and schedules experiments, their approval and use of the results, in close collaboration with the SNRA. The Network has, depending on the specificity of the crop studied, one or two experimental areas, with a number of experiments ranging from 7 to 21.

Experiments must be achieved by strictly abiding by the Protocols approved by the group of experts set up by the Seed Technical Committee.
The study of factors influencing the expression of production (production variability, diseases, climatic accidents, etc. resistance) is achieved, on the one hand, through specific experiments in research stations of the SNRA as well as in some stations selected depending on their agro-climatic characteristics, their experimental opportunities and their specific abilities and, on the other hand, on the entire experiments of the National Network.

Finally, the study on technological characteristics must enable to define the potentials for the use of a variety, namely, for example, the ability of a variety of rice to be cooked without getting glued and releasing a specific aroma expected, etc. These characteristics, influencing decisions on the registration of a variety derive from analyses made on RNE experiments and are subjected to specific technological protocols implemented in specialized laboratories.

New varieties are tested in different geographical areas. At each stage of this experimentation, well known reference varieties are referred to, for their consistent behaviour from one year to another: production reference (selected among the most multiplied varieties during the previous year), specific reference varieties for the study on production evenness and technological quality reference. These reference varieties are defined every year by the panel of expert of the Seed Technical Committee.

Given the development of the types of varieties and the lines of research, the needs of seed users and professionals, experimental protocols were improved over the years. This document is a draft protocol that will be considered by WAEMU experts to improve it and make it a reference document for all member States within the context of developing the WAEMU Common Catalogue, which should be a summary of national catalogues of its member States.

**Implementation and experiment conducting conditions**

**1. Supply of seeds for experiment**

The variety lists are made up of new varieties of rice on VCU study and reference varieties defined every year per multi-local experimental areas. In some cases, varieties registered are added to the official lists with the consent of the Expert Panel of the Seed Technical Committee. When the number of the rice varieties on study is very high, the list can be subdivided in variety series. The variety lists are similar for the whole network involved.
The Seed Technical Committee receives, treats, packages and sends to SNRA, experimenter batches of seeds divided into experiment and variety series. Any addition of varieties must be subjected to the approval of the Seed Technical Committee, the only body entitled to make changes (addition, withdrawal,) on the variety list. The doubling of varieties on study for experimentation on roadside or “filling up” plots is prohibited. Within this context, only reference varieties or registered varieties can be used.

2. Experimental Design
In all official experiments, the objective is to evaluate the production of the varieties. The “variety” factor is the main factor. It is supplemented in some case by a study of a second factor : the “phytosanitary treatment factor” factor so as to provide information on the “variety factor” and this second factor (annex 1).

Depending on species considered, the adapted designs (annex 1) under the RNE experiments include:
i) one- studied factor: Fisher Bloc or alpha-plan;
ii) two-studied factors : two-factor blocs, Split-plot, Criss-Cross or Alpha Plan

The one-factor studied tests (variety factor) must have 4 blocs minimum. The Two-factor studied experiments must have 2 blocs by level. To the extent possible, for result analysis and test validation purpose, it recommended to set up 3 blocs per level. The objective of the tow-factor studied is to assess the productivity of a variety with and without chemical protection against cryptogamic diseases.

3. Developing an experiment

3.1. Selecting the experimental place

The experiment must be based on a representative field of the agro-pedo-climatic area for rice growing. The plot selected must be as homogenous as possible. It urgent to have a sound knowledge on the plot (nature of the soil and the under-ground, regrouping, cultural practices and especially fertilizer, etc.) ban any location likely have heterogeneity risk, such as difference in soil depth, previous differences, proximity to a fence, etc. The experiment must be settled, as much as possible, on a well-levelled plot.
3.2. Preparing sowing and seedling cropping

All superficial practices before cropping are made on a perfectly levelled soil and at right angles to the direction provided by cropping rows so that all plots of the same blocs are influenced in the same way by the work of the soil (especially the wheel way).

3.3. Size and basic plots

The minimum area of the plot recommended is 8 to 10sqm. Under these circumstances, basic plots of 6 to 12 rows, with a compromise spacing between 15 and 20 cm on a length of 6m minimum, providing an area of about 8 to 10 sqm which can be harvested. To reduce efficiently competing effects (due to surrounding plots) and roadside effects (due to spacing between plots which are greater than spacing between rows), it recommended that the central part of plots be harvested while leaving two rows of hedge which are harvested, on each side. Thus, sowing on 11 rows on a length of 10m and harvesting the 7 central rows deemed to be an acceptable solution. The total area of a plot is then about 10m X 1.8m = 18 sqm and the harvested area is about 10m X 1.2 = 12 sqm.

Each experimental bloc is surrounded by roadside plots. The “missing” plots due to cropping problem must be sowed again preferably with the same variety used for the roadside, or failing that with registered variety.

3.4. Precedent

The Precedent must be classical for a given region and enable the development of experiments under good conditions.

3.5. Seedlings and Stand

All plots for an experiment are sowed on the same day. Stands expected during the emergence must be similar for all the varieties. Plot seed quantity must be calculated accurately, taking into account the weight of 1000 grains and the viability of each variety, as well as the density and area actually sowed. This area is higher than the plot area that can be harvested (ongoing vegetation alignment).
For transplanting, 40kg/ha correspond to the dosage of seedlings for transplanting one ha. The area of the nursery accounts for the 20th (1/20) of the area to sow. The dates of cropping and density of stand must oscillate around the regional average. The plants will be transplanted when they have 5 leaves, i.e. after 21 to 25 days in nursery, for raining season, and after about 30 days for hot-dry off-season. The density of transplanting is 20cm between lines and 15cm in the line, at the rate of three saplings by planting hill.

### 4. Conducting cultivation

Cultivation practices are those applied in the experimental area

#### 4.1 Weeding

It urgent to have a clean plot where weeds must no way influence the assessment of varieties. Herbicides that can be toxic for some species or varieties must of course be prohibited. However, dosages required by research for the treatment of rice weeds will be applied in compliance with practices recommended for the experimental area.

#### 4.2 Nitrogenous Fertilization

The rate of nitrogenous fertilization is calculated according to the evaluation method. The dosage is similar for the whole experiment, and is divided into two applications:

- 1st application during the early to bare stage of tillering, i.e. 15 days after transplanting;
- 2nd application during the heading stage of very early varieties, i.e. 35 to 45 days after transplanting, depending on the vegetative cycle of the crop (short cycle/medium cycle). The second application must be divided up if the dosage to apply so requires (50% during the “heading” stage and 50% two weeks later).

#### 4.3. Fungicides

For two-level factor experiments, treatment of plots is made with fungicides, with products proposed every year, based on recommendations of the Regional Vegetal Protection Department in view to achieving uniform full protection of the experiment.
4.4 Pests

In case of aphids or other pests attack, insecticide treatment must cover the whole experiment. The experimenter must consult recommendations of the Vegetal Protection Department of his region.

5. Ratings

The remarks below are all important. They will help to appraise the agricultural value of experiment and provide additional information to the department in charge of the study on factors of production evenness.

Ratings must be made on 2 blocs minimum, if the characteristic observed is expressed homogeneously during the experiment. Otherwise, it must be made on all the blocs.

5.1. Ratings related to the development of the crop

For the determination of the development stages, it is necessary to refer to the Feekes or Zadoks scales (Annex 2).

Date of emergence
It corresponds to the date when most lines are visible. It is expressed in days of the calendar year.

Stand during emergence
A first counting of plants must be made, at least for reference varieties, during the stage when the seedling has 2 to 3 leaves. The stand is calculated on the basis of the numbering of foots found on 3 small areas of 2 linear meters (1m over 2 rows), excluding roadside rows, out of 2 repetitions in case of regular emergence. In case of the emergence is irregular, the counting must be made also for varieties involved, and for all repetitions. The selection of the small areas is made at random. Two data are required: the number of plants counted and the area of counting to determine the number of plants/sqm. When there is no emergence problem, the stand can also be evaluated by visual rating (note to 1 to 9) of the whole experimental plots. It then expresses the percentage of plants emerged compared to the stand expected (annex 3 – table 1).
**Date of heading**
This stage is reached when 50% of panicle are drawn by half (visible).
The date is expressed in days. It must be determined on the basis of two weekly visits
at least for the varieties as a whole.

**Plant Height**
Measurements are made on all the varieties after blossoming (lodging is prominent )
and until maturity over 3 or 4 repetitions; they are expressed in centimètres.

**Plant maturity**
The evaluation of the stage of maturity of plots expresses the maturity earliness of each
variety. The visual rating is made in one round at the pasty stage for medium earliness
varieties (annex 3 – Table 2).

**Rating of factors of production evenness (FRR) : diseases and other accidents**
These ratings express the visual evaluation of the level of attack of a plot by a disease,
parasite or the scope of damages due to a climatic accident. The rating scale ranges
from 1 to 9 for all qualitative characteristics observed.

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Very sensitive</td>
</tr>
<tr>
<td>1</td>
<td>Resistant or unharmed</td>
</tr>
</tbody>
</table>

Ratings must necessarily contained the date and stage of plants at the time of rating.
The ratings must be made over 2 blocs minimum, when the characteristics observed is
expressed homogeneously during the experiment. Otherwise, it must made over all the
blocs. Rating scales that should be used are described in (annex 3).

**Parasites**
Attacks of mosaic yellow, pyriculariosis, nematodes, aphis, etc. can cause harms. They
are observed on the whole foliage by using the same scale. The experimenter will
report possible attacks of his experiment and will make a visual rating.

**Climatic and physiologic accidents**

**Sensibility at lodging**
Ratings must be made as soon as lodging occurs and over all the repetitions.

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>very sensitive (fully lodged)</td>
</tr>
<tr>
<td>1</td>
<td>very resistant (no lodging)</td>
</tr>
</tbody>
</table>
Other accidents (toxicity, warming, various harms)
They must be reported, coupled as much as possible, with a rating of harms (annex 3-table 5).

6. Harvest

The harvest of an experiment is made at the maturity of the reference varieties and on the same day (when it impossible to complete the harvest of an experiment, the work must be stopped at the end of a bloc). For rice, the harvest must be made manually at physiologic maturity, e.i. about 40 days after heading.

The organization of the harvest and weighting work, the setting of equipment, the supervision of threshing to reduce loss of panicles or grains, are the basic operations conditioning the final value of the experiment.

6.1. Determination of water content

This measurement of the humidity of the grain, which must be made at the time of weighting or in the following hours, is essential for the calculation of productions at standard humidity (15%).

The water content is determined for each basic plot or failing that, for a sample by variety and “treatment” factor level, constituted with all the repetitions of the same “treatment” factor level.

The method of dosage recommended is the change from sample to slow incubation (Chopin type of incubation – 17 hours to 130°C, Lequeux type of incubation – 48 hours to 105°C). This measurement is made with sample of about 500g. The experimenter may possibly use an electronic humidimetre approved and make the measurement with sample of about 100g.

6.2. Medium sampling

Some experiments of the RNE are subjected to analysis and technological tests. The experimenter is informed during the season whether his experiment is involved in these analyses. The sample for analysis must be representative of each variety (medium sample) from the harvest of all the repetitions.
For rice, the following characteristics are usually investigated in technological tests:
- Format of the grain (length, width, thickness of the grain, width/length ratio);
- Usage rate (cargo, husks, full, intermediate, breaks, bran, ...);
- Chemical characteristics (protein, starch amyllose and amylopectine; lipids, mineral salt, etc.); and
- Sensorial characteristics (taste, colour, aspect of the grain, splinter of the grain, slenderness during cooking, succulence, consistency, etc.).

7. Centralization of information and use of results

The experimenter (SNRA) centralizes all the information collected and make the statistical analysis of this information. Results are sent to the Seed Technical Committee which gathers a group of experts to assess the agricultural and statistical value of the experiments.

As far as production characteristics is concerned, only experiments selected by this group of experts are taken into account for groupings over several years.

List of annexes
Annex A : Experimental plans
Annex B : Feekes scale – Zadocks scale
Annex C : Visual rating scale
Annexe A
Experimental plans

Following are six main designs in force in the National Experimentation Network and the Regularity and Production Factor Study Sector.

1. Only one factor studied: variety

1.1. Bloc fisher

<table>
<thead>
<tr>
<th>Direction of the seedling crop</th>
<th>Repetition 1</th>
<th>Varieties drawn at random</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V9 V8 V2 V4 V7 V1 V3 V6</td>
<td></td>
</tr>
<tr>
<td>Repetition 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cultitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practice</td>
<td>Repetition 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gradient of heterogeneity</td>
</tr>
</tbody>
</table>

NB: Varieties must be drawn at random in all repetitions.

1.2. Reply plan or latinize alpha plan

This type of plan enables to take into account a double gradient of heterogeneity. A latinized alpha-plan is made up of r lines et r columns with, at the intersection of each line and each column, a sub-bloc k. size. The number of varieties must be equal to rk, and each line and column contain each variety exactly once. Lines and columns form
therefore two systems of cross reply. In practice, on the file, « columns » of latinized alpha-plan will usually be made up actually of $k$ columns of consecutive plots. An example is given below.

<table>
<thead>
<tr>
<th></th>
<th>C1</th>
<th></th>
<th>C2</th>
<th></th>
<th>C3</th>
<th></th>
<th>C4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>8</td>
<td>12</td>
<td>4</td>
<td>1</td>
<td>6</td>
<td>10</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>L2</td>
<td>3</td>
<td>11</td>
<td>6</td>
<td>9</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>L3</td>
<td>1</td>
<td>5</td>
<td>9</td>
<td>4</td>
<td>11</td>
<td>7</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>L4</td>
<td>2</td>
<td>7</td>
<td>10</td>
<td>5</td>
<td>3</td>
<td>12</td>
<td>4</td>
<td>9</td>
</tr>
</tbody>
</table>

*Latinized Alpha-plan for $v = 12$ varieties and $r = 4$ repetitions with $s = 4$ sub-blocs with size $k = 3$ per reply (L1 à L4 et C1 à C4).*

For further information on this type of design, you can consult the brochure (Alpha plans, carré semi-latins and other designs in reply – How to use them?) jointly achieved by l’INRA, l’ITCF and the GEVES and is available at the Arvalis-Institut du Végétal in Boigneville.

### 2. Two factors studied: variety factor and fungicide treatment factor

Two factors were studied: Factor 1 = variety

Factor 2 = vegetation fungicide. Treatment with two levels

(1 = untreated and 2 = treated).

The varieties must be drawn at random in all repetitions and for each level. Roads between repetitions must be wide enough to avoid fungicide deviations.
### 2.1. Two-factor blocs

**Directions of the seedling crop**

<table>
<thead>
<tr>
<th>Repetition</th>
<th>At the level of factor 2</th>
<th>Varieties drawn at random</th>
<th>Varieties drawn at random</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 (untreated)</td>
<td>V9 V8 V2 V4 V7 V1 V5 V3 V6</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1 (untreated)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cultivation Practices**

**Restriction**: the two levels of the fungicide treatment factor must be conducted on the same plot.

### 2.2. Split-plot

**Directions of the seedling crop**

<table>
<thead>
<tr>
<th>Repetition</th>
<th>At the level of factor 2</th>
<th>Varieties are drawn at random</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 (treated)</td>
<td>V9 V8 V2 V4 V7 V1 V5 V3 V6</td>
</tr>
<tr>
<td>1</td>
<td>1 (untreated)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1 (untreated)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2 (treated)</td>
<td></td>
</tr>
</tbody>
</table>

**Cultivation Practices**

**Gradient of heterogeneity**
### 2.3. Criss-cross

This design must be used in case strong practical constraints. This design is actually a crossing of horizontal sub-blocs (TREATMENT factor) and vertical sub-blocs (VARIETY factor) where the variety is found at the same place in sub-blocs TREATED and UNTREATED.

<table>
<thead>
<tr>
<th>Repetition</th>
<th>At the level of factor 2</th>
<th>Varieties are drawn at random</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 (treated) V9 V8</td>
<td>V2 V4 V7 V1 V5 V3 V6</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1 (untreated) V9 V8</td>
<td>V2 V4 V7 V1 V5 V3 V6</td>
<td>Gradient heterogeneity</td>
</tr>
<tr>
<td>2</td>
<td>1 (untreated) V3 V1 V9</td>
<td>V2 V5 V6 V7 V4 V8</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2 (treated) V3 V1 V9</td>
<td>V2 V5 V6 V7 V4 V8</td>
<td></td>
</tr>
</tbody>
</table>

### 2.4. Reply plan or latinized alpha plan

This type of plan enables to take into account a double gradient of heterogeneity. A latinized alpha plan is made up of r lines et r columns with, at the intersection of each line and each column, a sub-bloc k. size. The number of varieties must be equal to rk, and each line and column contain each variety exactly once. Lines and columns form therefore two systems of cross reply. In practice, on the filed, « columns » of latinized alpha-plan will usually be made up actually of k columns of consecutive plots.

In the case of pit-plot two factors were studied – there are several possibilities. We recommend the one consisting in developing a design for all the replies on varieties,
without taking into account the levels of the second factor and then assign the levels of the second factor to different lines. An example is given below.

<table>
<thead>
<tr>
<th></th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>Repetition</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>8</td>
<td>12</td>
<td>4</td>
<td>1</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>L2</td>
<td>3</td>
<td>11</td>
<td>6</td>
<td>9</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>L3</td>
<td>1</td>
<td>5</td>
<td>9</td>
<td>4</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>L4</td>
<td>2</td>
<td>7</td>
<td>10</td>
<td>5</td>
<td>3</td>
<td>12</td>
</tr>
</tbody>
</table>

*Latinized Alpha-plan for v = 12 varieties and r = 4 repetitions with s = 4 sub-blocs k size = 3 per reply (L1 à L4 et C1 à C4).*

For further information on this type of design, you can consult the brochure « Semi-Latin square Alpha-plans, and other designs in reply – How to use them ? » jointly achieved by l’INRA, l’ITCF and the GEVES and is available at the Arvalis-Institut du Végétal in Boigneville.
Feekes or Zadocks scales are scales for rating of the various stages of development. Accurate and comparatively simple, they have, in addition, authority to detail the periods of strong physiological activity.

Dates are expressed in days of the current year. A stage of development is deemed achieved by a plot when more than half of plants reached this stage.

<table>
<thead>
<tr>
<th>Feekes</th>
<th>Zadocks</th>
<th>Stage</th>
<th>Growth reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10-11-12(2f)</td>
<td>Three-leaf Emergence</td>
<td>Seedling crop-emergence</td>
</tr>
<tr>
<td>2</td>
<td>13(3f)-21(1)</td>
<td>Beginning of tillering</td>
<td>Tillering</td>
</tr>
<tr>
<td>3</td>
<td>22-23</td>
<td>Full tillering</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>24-25</td>
<td>End of tillering</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Z30</td>
<td>Panicle 1 cm</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Z31</td>
<td>1 nod</td>
<td>High growth</td>
</tr>
<tr>
<td>7</td>
<td>Z32</td>
<td>2 nods</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Z37</td>
<td>Emergence of the last leaf</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Z39</td>
<td>Ligule is visible</td>
<td>Swelling</td>
</tr>
<tr>
<td>10</td>
<td>Z45</td>
<td>Sheath of the last leaf is visible</td>
<td></td>
</tr>
<tr>
<td>10.1</td>
<td>Z49-51</td>
<td>Sheath fragmented</td>
<td></td>
</tr>
<tr>
<td>10.2</td>
<td>Z53</td>
<td>¼ of the panicle emerged</td>
<td></td>
</tr>
<tr>
<td>10.3</td>
<td>Z55</td>
<td>½ of the panicle emerged</td>
<td>Heading</td>
</tr>
<tr>
<td>10.4</td>
<td>Z57</td>
<td>¾ of the panicle emerged</td>
<td></td>
</tr>
<tr>
<td>10.5</td>
<td>Z59</td>
<td>Panicle emerged completely</td>
<td></td>
</tr>
<tr>
<td>10.5.1</td>
<td>Z61</td>
<td>Beginning of blossoming</td>
<td></td>
</tr>
<tr>
<td>10.5.2</td>
<td>Z65</td>
<td>Mid-blossoming</td>
<td>Blossoming</td>
</tr>
<tr>
<td>10.5.3</td>
<td>Z69</td>
<td>End of blossoming</td>
<td></td>
</tr>
<tr>
<td>10.5.4</td>
<td>Z71</td>
<td>Grain shaped</td>
<td>Maturation and formation du grain</td>
</tr>
<tr>
<td>11.1</td>
<td>Z75</td>
<td>Milky Grain</td>
<td></td>
</tr>
<tr>
<td>11.2</td>
<td>Z85</td>
<td>Pasty Grain</td>
<td></td>
</tr>
<tr>
<td>11.3</td>
<td>Z91</td>
<td>Yellow Grain</td>
<td></td>
</tr>
<tr>
<td>11.4</td>
<td>Z92</td>
<td>Ripe Grain</td>
<td></td>
</tr>
<tr>
<td>11.5</td>
<td></td>
<td>Over- maturity</td>
<td></td>
</tr>
</tbody>
</table>
Annex C

Visual rating scale

The visual rating from 1 to 9 is a method of visual evaluation of the level of attack of a plant or a set of plants by any disease, but also of the scope and intensity of harms due to a climatic accident of the stand, etc. This method is not quite much accurate but it enables to describe quickly and measuring the behaviour of a variety under study. It is especially suitable for foliage diseases.

Although it is comparable to the estimation of a percentage, the rating from 1 to 9 is qualitative by nature and consists in defining 9 classes, from 1 = absence or minimum possible, to 9 = maximum possible.

The accuracy of a rating on a uniform test is more or less than 1 point, error being at maximum, about 5. This accuracy is however sufficient for describing the behaviour of varieties. The scales of visual rating are adapted to the various types of characteristics.

Table 1. Stand at emergence

The rating expresses the visual estimation of the percentage of plants emerged out the stand expected per seedling crop (PL/PS).

<table>
<thead>
<tr>
<th>Note</th>
<th>PL/PS</th>
<th>Intensity of the characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 %</td>
<td>↑ Not valid</td>
</tr>
<tr>
<td>2</td>
<td>10 %</td>
<td>← Very questionable</td>
</tr>
<tr>
<td>3</td>
<td>25 %</td>
<td>↑ Valid to very valid</td>
</tr>
<tr>
<td>5</td>
<td>75 %</td>
<td>← To be defined during vegetation</td>
</tr>
<tr>
<td>6</td>
<td>100 %</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>125 %</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>150 %</td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Maturity
The estimation of the stage of maturity of plots expresses the precocity of maturity of each variety. The visual rating is made in only one round of the pasty grain of medium precocity varieties, preferably on plots treated against cryptogamic disease.

<table>
<thead>
<tr>
<th>Note</th>
<th>Stage of maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Panicles and collars of panicles are completely green</td>
</tr>
<tr>
<td>2</td>
<td>Panicles start to turn yellow</td>
</tr>
<tr>
<td>3</td>
<td>Panicles and collars of panicles start to turn yellow</td>
</tr>
<tr>
<td>4</td>
<td>25 % of panicle collars are yellow</td>
</tr>
<tr>
<td>5</td>
<td>50 % of panicle collars are yellow</td>
</tr>
<tr>
<td>6</td>
<td>75 % of panicle collars are yellow</td>
</tr>
<tr>
<td>7</td>
<td>100 % of panicle collars are yellow</td>
</tr>
<tr>
<td>8</td>
<td>100 % of panicles and collar of panicles yellow, nords green</td>
</tr>
<tr>
<td>9</td>
<td>100 % of panicles and collar of panicles yellow, nords green</td>
</tr>
</tbody>
</table>

Table 3. lodging e, warming, vigour at emergence and at tillering, etc.

<table>
<thead>
<tr>
<th>Note</th>
<th>Plants infected</th>
<th>Intensity of characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 %</td>
<td>Null</td>
</tr>
<tr>
<td>2</td>
<td>25 %</td>
<td>Strong</td>
</tr>
<tr>
<td>3</td>
<td>or 50 %</td>
<td>Medium</td>
</tr>
<tr>
<td>4</td>
<td>50 %</td>
<td>Strong</td>
</tr>
<tr>
<td>5</td>
<td>or 100 %</td>
<td>Medium</td>
</tr>
<tr>
<td>6</td>
<td>75 %</td>
<td>Strong</td>
</tr>
<tr>
<td>7</td>
<td>or 50 %</td>
<td>Medium</td>
</tr>
<tr>
<td>8</td>
<td>et 50 %</td>
<td>Strong</td>
</tr>
<tr>
<td>9</td>
<td>100 %</td>
<td>Strong</td>
</tr>
</tbody>
</table>

Example: the note of 5 in lodging corresponds to 50 % of the plot flatly lodged or 100 % incline to 45°, the note 7 in warming corresponds to 75 % of full grains or 50 % empty grains and 50 % shrivelled up grains.
### Table 4. Diseases

<table>
<thead>
<tr>
<th>Note</th>
<th>Plants infected</th>
<th>Area of foliage attacked or % of panicles attacked or % of stems attacked</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Absence of harms</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Traces</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>25 %</td>
<td>10 %</td>
</tr>
<tr>
<td>4</td>
<td>50 %</td>
<td>25 %</td>
</tr>
<tr>
<td>5</td>
<td>100 %</td>
<td>50 %</td>
</tr>
<tr>
<td>6</td>
<td>100 %</td>
<td>60 %</td>
</tr>
<tr>
<td>7</td>
<td>100 %</td>
<td>75 %</td>
</tr>
<tr>
<td>8</td>
<td>100 %</td>
<td>90 %</td>
</tr>
<tr>
<td>9</td>
<td>Maximum possible</td>
<td></td>
</tr>
</tbody>
</table>

### Table 5. Plot validity

This rating takes into account the stand of each plot, their uniformity at the beginning of high growth and during heading (« land effect ») and particular accidents likely to occur for seedlings (« lack ») or at the stage of vegetation (rabbits, boars, hail...). It does not take into account harms due to variety sensitiveness to diseases and climatic conditions (cool, verse...).

<table>
<thead>
<tr>
<th>Note</th>
<th>Validity of plots</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Not valid</td>
<td>Intermediate notes (2, 4, 6, 8) can also be used.</td>
</tr>
<tr>
<td>3</td>
<td>Very questionable</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Questionable</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Valid</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Very valid</td>
<td></td>
</tr>
</tbody>
</table>
References


About the Consultative Group on International Agricultural Research (CGIAR)

The Consultative Group on International Agricultural Research (CGIAR) is a strategic alliance of countries, international and regional organizations and private foundations supporting 15 international agricultural Centers that work with national agricultural research systems and civil society organizations including the private sector. The alliance mobilizes agricultural science to reduce poverty, foster human well-being, promote agricultural growth and protect the environment. The CGIAR generates global public goods that are available to all.

In a world where 75 percent of poor people depend on agriculture to survive, poverty cannot be reduced without investment in agriculture. Many of the countries with the strongest agricultural sectors have a record of sustained investment in agricultural science and technology. The evidence is clear; research for development generates agricultural growth and reduces poverty.

Agricultural research for development has a record of delivering results. The science that made possible the Green Revolution of the 1960s and 1970s was largely the work of CGIAR Centers and their national agricultural research partners. The scientists’ work not only increased incomes for small farmers, it enabled the preservation of millions of hectares of forest and grasslands, conserving biodiversity and reducing carbon releases into the atmosphere. CGIAR’s research agenda is dynamic, flexible and responsive to emerging development challenges. The research portfolio has evolved from the original focus on increasing productivity in individual critical food crops. Today’s approach recognizes that biodiversity and environment research are also key components in the drive to enhance sustainable agricultural productivity. Our belief in the fundamentals remains as strong as ever: agricultural growth and increased farm productivity in developing countries creates wealth, reduces poverty and hunger and protects the environment.

CGIAR Centers

AfricaRice  Africa Rice Center (Cotonou, Benin)
CIAT     Centro Internacional de Agricultura Tropical (Cali, Colombia)
CIFOR    Center for International Forestry Research (Bogor, Indonesia)
CIMMYT   Centro Internacional de Mejoramiento de Maíz y Trigo (Mexico, DF, Mexico)
CIP      Centro Internacional de la Papa (Lima, Peru)
ICARDA   International Center for Agricultural Research in the Dry Areas (Aleppo, Syria)
ICLARM   WorldFish Center (Penang, Malaysia)
ICRAF    World Agroforestry Centre (Nairobi, Kenya)
ICRISAT   International Crops Research Institute for the Semi-Arid Tropics (Patencheru, India)
IFPRI    International Food Policy Research Institute (Washington, D.C., USA)
IITA     International Institute of Tropical Agriculture (Ibadan, Nigeria)
ILRI     International Livestock Research Institute (Nairobi, Kenya)
IPGRI    Bioversity International (Rome, Italy)
IRRI     International Rice Research Institute (Los Baños, Philippines)
IWMI     International Water Management Institute (Colombo, Sri Lanka)