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# SEED POTATO INSPECTION AND CERTIFICATION GUIDELINE

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Seed Potato Inspection and Certification Guideline

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**NASC**

## **Seed Potato Inspection and Certification Guideline**

November 2022

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National Agricultural Seeds Council (NASc), Nigeria acknowledges the authors:

- § Dr. Ojo Phillip Olusegun, Director General NASC
- § Dr. Ishiak Othman Khalid, Director Seed Certification and Quality Control NASC
- § Osho-Lagunju Bankole, Chief Agricultural Officer NASC
- § Dr. Kalpana Sharma, International Potato Center (CIP)
- § Elly Ouma Atieno, International Potato Center (CIP)

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## Terms and interpretation

In this Protocol, unless the context otherwise requires:

**Authorized person:** A competent private or public person authorized by the National Designated Authority to perform specified functions in accordance with the NASC Act, 2019.

**Foundation Seed:** Seed produced from Breeder Seed under the control of a plant breeder or his or her agent; as per the NASC Act, 2019.

**Breeder Seed:** Seed of a variety produced by the breeder (owner) of the variety or his or her agent, under the plant breeder's supervision, which is the source of the initial and recurrent increase in seed production of a variety.

**Black leg:** A bacterial disease of potato, caused by *Erwinia carotovora* subsp. *atroseptica*. Similar symptoms may, however, be caused by *E. carotovora* subsp. *carotovora*, *E. chrysanthemi* and bacteria of the genus *Dickeya* and *Pectobacteria*.

**Certification:** An official control procedure that aims at ensuring the production and supply of seed potato which meets the requirements under this Protocol.

**Certified Seed:** Class of seed produced under a certification programme from Foundation Seed and can be of two or more generations.

**Compulsory certification:** Mandatory certification for varieties of crops that have been tested in national performance trials, officially released, and listed on the national variety list.

**Consignment:** A quantity of seed potato consisting of one or more lots destined to a party and covered by one set of official seed quality assurance documents.

**Contaminated field:** A field whose history and regulatory action indicates presence in the soil of a specific pathogenic organism classified as quarantine pests or diseases.

**Disease:** Any disturbance of a plant caused by pathogenic organisms which interferes with its normal structure, physiological function or economic value.

**Field:** A defined area of land used for cultivation of seed potato.

**Field inspection:** Examination of a seed crop fields including checking for effective isolation distance, area of the seed field, off-types, foreign cultivars and diseased plants as part of the seed certification process.

**Generation:** Number of growing cycles since the first introduction of a seed stock to open field cultivation.

**Inspection:** Examination of plants, tubers, units of presentation, equipment or facilities by National Designated Authority, to determine compliance with regulatory requirements.

**Isolation:** Minimum required distance or time between two crops of the same species or between two crops of closely related species to prevent contamination either mechanically, by pollination or pest infestation.

**Lot:** A quantity of seed potato bearing the same reference number, and being of the same variety, category, class, size and origin, and covered by one set of official quality assurance documents.

**National Agricultural Seeds Council (NASC):** The technical body responsible for seed certification, quality control and assurance services in Nigeria.

**Off-type plant:** Plant that does not exhibit the recognized and prescribed visible physical growth habits and characteristics of the variety being grown.

**Parental material:** Propagating material from which the Breeder Seed is raised.

**Variety:** A population of plants which have common ancestry and have specific characteristics, which when reproduced sexually or asexually, retain these distinguishing characteristics.

**Pest:** Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products.

**Post control:** Growing of plants from seed lots which have been previously tested and certified to further determine and confirm varietal purity and freedom from disease infestation.

**Pre-foundation Seed:** Breeder's seed of generations preceding Foundation Seed.

**Quality:** Sum of all characteristics that determine the acceptance of seed potato in relation to the specifications under this Protocol.

**Quarantine pest:** A pest of potential national economic importance to the country endangered thereby and not yet present there, or present but not widely distributed and being officially controlled.

**Sampling:** The procedure of drawing, at random, a number of potato tubers, potato plants or parts of plants, which may be taken as representative of the lot or field.

**Seed potato:** Tubers of *Solanum tuberosum* which are certified by the NASC for use as future propagation material

**Sealing:** Stage in seed processing where a seed container is sealed to prevent tampering.

**Seed class:** A generation in a seed multiplication system well defined in respect of the parental seed standards and seed quality under this Protocol.

**Seed health:** Level of freedom of either the seed or seed crop from seed-borne diseases and pests.

**Seed inspector:** A person appointed under the NASC Act, 2019, and authorized to conduct seed inspection assigned by the National Designated Authority.

**Seed lot:** A specified quantity of seed which measures to prescribed maximum weight or number and which is represented by one sample in laboratory seed testing or in post control plots and is homogeneous and physically identifiable by a unique reference number.

**Seed quality:** Seed that have met the minimum standards and hence are of high varietal, genetic and physical purity, are free from noxious weeds, seed borne pests and diseases and have high germination capacity.

**Seed testing:** Examination of a sample of seed with a view to determining its quality.

**Seed testing laboratory:** A laboratory for the testing of seed, declared by notice in the Gazette to be a seed testing laboratory.

**Sprout inhibitor:** Chemical substance, applied either to the plants during the growing season or to the tubers after harvest, which suppresses the normal development of sprouts.

**Standard:** Level of quality achieved during field inspection, or a laboratory test as defined in this Protocol.

**Storage:** A stage of seed processing in which seed is maintained in a condition such that minimum deterioration of seed lots occurs.

# 1. Introduction

Seed Potato Certification in Nigeria is designed to facilitate the production of top-quality seed potato tubers through the application of seed regulations and Seed Potato Certification Standards referred to as “seed potato specifications”. Failure to comply with these conditions and regulations shall be a cause for refusal or cancellation of any application for certification of any planting stock of potato as certified seed.

## 1.1. Purpose of the Seed Potato Certification Protocol

The purpose of this Seed Potato Certification Protocol is to provide the procedure that must be followed in Nigeria for Seed Potato Certification. It defines the requirements and standards for inspection and certification of seed potato production. The requirements are derived from the NASC Act, 2019, the Plant Variety Protection Act, 2021, and the ECOWAS Seed Regulation. The requirements cover all steps involved from tissue-culture plantlet production, mother plant multiplication, production of rooted apical cuttings and mini tubers in screenhouse or greenhouse conditions, field seed crop inspection, laboratory indexing and eventual certification of seed potato tubers.

## 1.2. Variety eligibility and entry of propagating material into certification

To enter the seed potato certification scheme, a variety must have been officially released by the National Variety Release Committee (NVRC) and be included in the National Seed Catalogue or ECOWAS West African Catalogue of Plant Species and Varieties to which Nigeria is party and subscribes to.

In seed potato multiplication, several sources of propagating material and various methods are used to increase the initial stocks of propagating materials. The purpose of the Certification Protocol is to identify and assimilate these sources and methods into the certification program. Propagating materials from local or international public or private agencies may be accepted at any generation level if the material can meet the minimum requirements and certification standards. Documentation on the source of propagating materials must be supplied to the National Agricultural Seed Council (NASC), including the identity of clone, seed class and results of previous seed testing.

## 1.3. What constitutes a Certified Seed Potato?

To qualify as Certified Seed Potatoes, the seed potato must be grown in accordance with the seed certification rules under the NASC Act, 2019, and this Protocol. In addition, the potato must pass the final field inspection, potato

laboratory testing for diseases, grading requirements of the seed regulation and this Protocol, and must be accompanied by an official Certificate of Completion issued by NASC.

Certification confirms that the seed potatoes have been subjected to field inspections and laboratory tests pursuant to this Protocol and meet the minimum requirements for certification. Official labels shall be issued by NASC and shall include the words “Certified Seed Potato”. The label shall have the producer's name, address, variety, seed class, percentage purity, lot number and the date on which the label was issued.

#### **1.4. Role of the National Agricultural Seed Council**

Certification of seed potato in Nigeria is conducted under the authority of the National Agricultural Seed Council (NASC). The role of NASC is to establish and administer the provisions of the Seed Potato Certification Protocol to ensure that seed potato to be marketed in Nigeria meets the minimum standards for certified seed potato in the country. The seed field inspection leading to seed certification is the only way to confirm that a seed is actually a “seed”.



## 2. Application for Seed Potato Certification

- i. Any grower intending to produce Certified Seed Potato must be registered with the NASC.
- ii. Any person applying for registration as a seed potato grower shall be required to have access to ample facilities for sorting, grading and storage of certified seed as may be approved by the NASC before approval of application is granted.
- iii. All applications will be accompanied by the prescribed fee, or proof of payment of the prescribed fee.
- iv. Any seed potato grower seeking to have seed potatoes certified by the NASC shall apply to the NASC within three weeks of planting. Applications made after this period will be rejected for late submission.
- v. All fields intended for seed potato production shall have been tested and found to be free of potato cyst nematode (*Globodera rostochiensis* or *G. pallida*) and bacterial wilt (*Ralstonia solanacearum*). NASC ensures the field has been tested by requesting the results of the soil test. The report shall accompany the application for Seed Potato Certification.
- vi. A field map with clear designation of each seed lot, all documentation relating to the seed source and any other information requested on the application form (including variety name, generation, quantity (tonnes) planted and crop rotation history), must be attached to the application.
- vii. Applications must be submitted for any seed lots, fields or varieties for which certification is sought. Failure of any grower to apply for certification of any seed lot, field or variety will result in that grower's seed lot, field or variety being ineligible for certification.
- viii. All new and inexperienced growers must serve a probationary period of two cropping seasons. During this period, they will grow a plot(s) of Foundation, Certified 1, or Certified 2 seed class to assess their capacity to grow seed and must attain a field inspection pass with a field rating of 1 or 2 (Annex 1).

### 3. General requirements for seed potato

- i. Seed potato shall be free from pests of quarantine importance and meet the thresholds stated in this Protocol and standards regarding regulated non-quarantine pests, injurious diseases and pests, and any defects likely to impair their quality to qualify the submitted lot as seed.
- ii. Seed potato shall be substantially dry outside and, in general, of normal shape and size as per the descriptor for the variety.
- iii. Seed potato or growing crops of potato intended for seed production shall not be treated with sprout inhibitors without permission from NASC.

### 4. Seed classes

Seed Potato Certification requires that an eligible variety must be officially released, after which the breeder can multiply the seed potato through several cycles (due to its low multiplication factor) to reach substantial quantities for use in the production of certified seed before using it to grow ware potato. The starter material for this multiplication phase will either be minitubers or disease/pest-tested mother plants. This initial disease/pest indexed stock will be used to produce Pre-foundation Seed, followed by Foundation Seed and Certified Seed in subsequent multiplication steps. The key stages of multiplications based on propagation generations are categorized as classes. Each seed class has a specific level of regulatory control, quality standards and tolerance levels for diseases, pests and the other prescribed quality parameters in this Protocol.

There will be four main classes of seed potato:

#### 4.1. Breeder Seed (stock seed)

This is the last stage of clonal selection produced by the breeder, authorized person, or entity in one of the following three ways:

- i. Minitubers: These will be a product of potato tissue-culture plantlets produced either by aeroponics, hydroponics or sand hydroponics, or in proven sterilized soil in approved screenhouses or greenhouses and released as Clone A. The harvested minitubers will then be planted in soil in the facility or field to produce Clone B seed tubers. Clone B will be planted in the field to produce Pre-foundation Seed.

- ii. Rooted apical cuttings (RAC): RAC obtained from tissue-culture potato plantlets as mother plants maintained in an approved screenhouse or greenhouse and multiplied in the field to produce Clone A seed tubers. The harvested minitubers will then be planted in soil in the facility or in the field to produce Clone B seed tubers. Clone B will be planted in the field to produce Pre-foundation Seed.
- iii. Semi Autotrophic Hydroponics (SAH) Plantlets: SAH is a licensed technology for the mass propagation of virus-free plants of tissue-culture origin. The plantlets can be used to as mother plants to produce RAC or transplanted directly in the field to produce Clone A seed tubers. The harvested minitubers will then be planted in soil in the facility or in the field to produce Clone B seed tubers. Clone B will be planted in the field to produce Pre-foundation Seed.

#### 4.2. Pre-foundation Seed

This is the progeny of Breeder Seed (stock seed) produced in the field, under the control of the breeder and is one step in bulking the Breeder Seed.

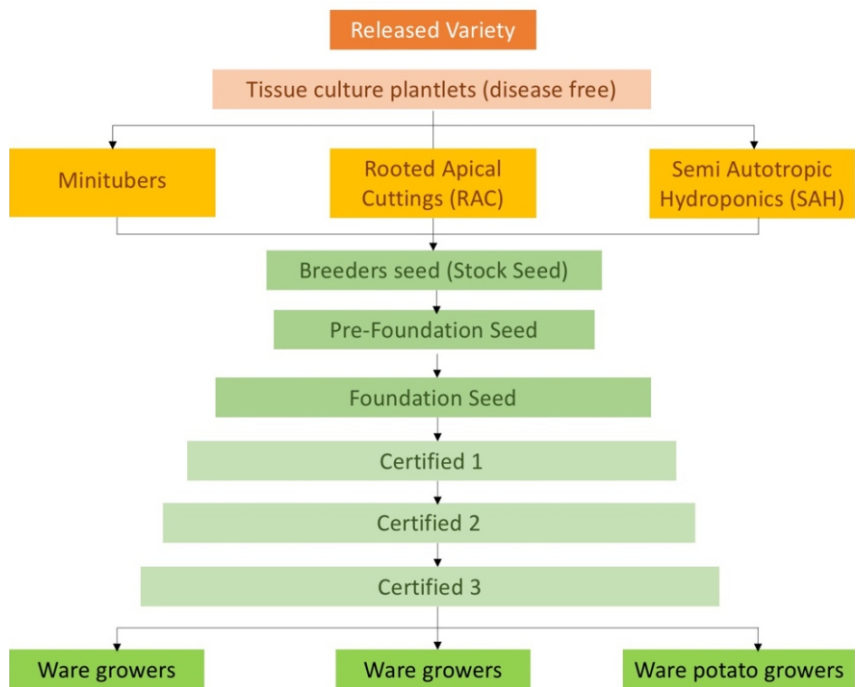
#### 4.3. Foundation Seed

This is the progeny of Pre-foundation/Breeder Seed produced in the field by the breeder or under the supervision of a breeder or produced by qualified seed potato producers.

#### 4.4. Certified Seed

This is the progeny of Foundation Seed or Certified Seed produced in the field by seed producers under certification by the NASC as C1, or further propagation to C2, which is sold to farmers for ware potato production.

The generations from mother plants through Clone A, B, C, and breeder stock represent the Breeder Seed, while Pre-foundation and Foundation represent the seed classes, and seed categories C1, C2 and sometimes C3 represent the Certified Seed classes (**Figure 1**). Breeder Seed is the responsibility of the breeder, who must ensure the maintenance and genetic integrity of the variety. Pre-foundation and Foundation Seed classes can either be bulked by the breeder or qualified institution while the Certified Seed classes are multiplied by seed producers.



**Figure 1.** Seed Potato Multiplication Chart in Nigeria

## 5. Inspection of Breeder Seed (stock seed)

1. The seed potato crop for each individual variety grown by a registered seed producer should be thoroughly inspected for both regulated and non-regulated disease symptoms, the presence of disease insect vectors and variety purity. Flowers and young leaves towards the top of the canopy should be examined for the presence of aphids and the infestation quantified. Yellow sticky traps must be set in the production facility or seed field. They should also be inspected to gauge insect activity in the seed production environment. It is recommended that yellow sticky traps are installed in the space between the outer and inner doors of screenhouses and greenhouses to help monitor possible aphid invasions at this point. They can also help to intercept aphids before they enter the growth area and for this reason, they should be recommended strongly for growers of Breeder Seed.
2. Where there is any doubt regarding disease symptoms expressed by a potato variety grown as Breeder Seed, the inspector should collect leaf samples and submit them to a NASC-approved diagnostic laboratory to be tested for relevant latent infections or confirmation of the infections.
3. There should be no other potato plants or any other *Solanaceous* plant material present in the production facility, except for the variety under application for certification as Breeder Seed. If there is a connection between protected environments, a secure pest-deterrent physical separation must be present between the Breeder Seed potato and all other plants being grown in a different protected environment on the same farm unit.
4. Breeder Seed propagative material must be grown in soilless media or in media or soil that has not been previously used to produce potato or any other related crop.
5. If containers are used, they must be new or if reusable, they must be thoroughly cleaned and disinfected with an appropriate disinfectant before being reused.
6. All varieties in an enclosed production facility must be physically separated from one another by means of physical barriers to maintain varietal integrity and purity. This could be achieved by using dividers in beds, or by growing individual varieties in individual containers or in different parts of the greenhouse.
7. During the inspection, the floor or seedbed plan should be compared, and its accuracy verified in relation to the varieties presented for inspection.
8. Enclosed seed potato production facilities must be aphidproofed at all possible entry points. An insect-proof screen mesh of size 70 microns or less at all air intakes, exhausts, vents including louvered vents should be installed. The structure should be inspected for holes or tears that could allow entry of aphids or other disease insect vectors.

## 6. Certification of Pre-foundation Seed

### 6.1. Inspection of production facilities for minitubers and rooted apical cuttings (RAC)

- i. Greenhouse and screenhouse facilities must be insect-proof and approved by NASC before planting.
- ii. Greenhouses and screenhouses must have adequate space, be properly constructed as an insect-proof glasshouse, screenhouse, or approved tunnel house with an insect-proofed door entrance, porch, headhouse or 'lock'. The entrance porch, headhouse or lock should be spacious, of sufficient size to permit the entry of people, plants, and trolleys, and to ensure that only one door may be open at a time.
- iii. All openings including evaporative cooling systems in the facility must be covered with permanently fixed insect-proof gauze of size not greater than 0.5 mm or 500 microns. Metal gauze is preferred, but synthetic meshes may be used. Synthetic meshes can be approved by NASC inspectors, provided they retain the minimum pore dimensions when fixed in place. For this reason, welded mesh is preferred to woven mesh synthetic types.
- iv. Premises must be securely locked when unattended and after-hours access to the premises must be limited to authorized persons only.
- v. It is the responsibility of the operator of the facility to ensure that the premises and all operations comply with all local and national laws and regulations.

### 6.2. Pathogen testing of Breeder Stock seed

- i. All potato stocks, both existing and new cultivars, from acceptable sources must be disease free and tested for the pathogens listed in **Table 1** before they can be used as starter material in the certification scheme. The tests may be done at the official quarantine facility, or by any other testing facility approved by NASC and test results of conformity filed.
- ii. A plant health certificate or equivalent declaring the results of the pathogen testing conducted for a given stock or multiplication material must be submitted to NASC to enable entry into the certification scheme.
- iii. Only pathogen-free stock will be allowed for further multiplication. However, additional pathogens and pests may be included as need arises.

### 6.3. True-to-type quality assurance for rooted apical cuttings

- i. True-to-type testing for cuttings will be conducted for the first cuttings made from the initial mother plant.

- ii. The cuttings will be grown and allowed to flower and form tubers, to ensure assessment of the characteristics and features conform to the variety. The conforming mother plants will consequently be used for cuttings for further multiplication.

**Table 1.** list of pathogens for which tissue-culture stocks must be tested before inclusion in the seed certification scheme

Pathogen	Disease
<b>Bacteria</b>	
<i>Pectobacteria</i> (formerly <i>Erwinia</i> spp.) and <i>Dickeya</i> spp.	Blackleg and related soft rots
<i>Ralstonia solanacearum</i> (formerly <i>Pseudomonas solanacearum</i> )	Bacterial wilt
<i>Clavibacter michiganense</i> pv. <i>sepedonicum</i>	Ring rot
<i>Streptomyces</i> spp.	Common scab
<b>Fungi</b>	
<i>Spongospora subterranean</i>	Powdery scab
<i>Rhizoctonia solani</i>	Black scurf
<i>Helminthosporium solani</i>	Silver scurf
<i>Phoma exigua</i>	Gangrene
<i>Fusarium</i> spp.	Wilt, dry rot
<i>Verticillium</i> spp.	Wilt, early dying
<i>Colletotrichum coccodes</i>	Black dot
<i>Phytophthora infestans</i>	Late blight
<b>Virus</b>	
Potato leaf roll virus (PLRV)	Leaf roll
Potato virus A (PVA)	Mosaic
Potato virus M (PVM)	Mosaic
Potato virus S (PVS)	Mosaic
Potato virus Y (PVY)	Mosaic
Tomato spotted wilt virus (TSWV)	Bronzing, necrotic spots, twisted and distorted leaves
Potato spindle tuber viroid (PSTVd)	Leaf curling, stunted growth
Potato virus X (PVX)	Mosaic
<b>Other</b>	
<i>Candidatus Liberibacter solanacearum</i>	Zebra chip disease complex

#### 6.4. Conditions for tuber seed production

- i. Initial planting stock sources must be tissue-cultured plantlets or microtubers produced by a NASC-approved source or laboratory.
- ii. New growth media shall be used for each planting cycle.
- iii. Applications for seed inspection should be made immediately after planting.
- iv. At least three field inspections by NASC inspectors are required.
  - § The first inspection will be performed during flowering or at the canopy cover (for non-flowering varieties) stage of plant growth.
  - § The second inspection will be performed just before dehauling while the plants are still green and just before the onset of senescence. Sampling tubers for latent bacteria wilt infection testing shall be done at this stage. It is the responsibility of the grower to schedule the inspections with NASC inspectors.
- v. Leaf testing for viruses: Plantlet populations or minitubers produced in an approved facility shall be randomly tested for all diseases of concern. At least 2.5% of plants in the greenhouse or screenhouse shall be leaf sampled prior to harvest and tested for the five potato viruses listed in **Table 2**.
- vi. Diagnostic tests shall be done at NASC or a NASC-authorized laboratory.
- vii. Leaf samples shall be collected in groups of 10 leaves and sealed in plastic bags.
- viii. The inspector may request additional tests and sampling based on observations and circumstances.
- ix. Copies of diagnostic results must be forwarded to the NASC within 10 days after the tests.

**Table 2.** Five viruses tested on leaf samples collected from greenhouse

Virus	Symptoms
Potato leaf roll virus (PLRV)	Leaf roll
Potato virus S (PVS)	Mosaic
Potato virus Y (PVY)	Mosaic
Tomato spotted wilt virus (TSWV)	Spotting, wilting
Potato virus X (PVX)	Mosaic



## 7. Requirements for production of Certified Seed Potato

### 7.1. Field crop history requirements

A field for growing seed potato should not have had a potato crop for the period as indicated for the corresponding seed class to be produced according to **Table 3**.

**Table 3.** Required period for a field to have been out of potato for various seed classes

Class to be produced	Seasons out of potatoes <sup>1</sup>
Breeder Seed	Six (new ground preferred)
Pre-foundation Seed	Four
Foundation Seed	Four
Certified I Seed	Three
Certified II Seed	Three
Certified III Seed	Three

<sup>1</sup> A field will not be eligible for certified seed production of any generation until the fifth year following identification of bacterial ring rot in the field.

### 7.2. Separation and seed potato crop isolation

A seed potato crop shall be separated from neighbouring vegetative commercial ware potato or other solanaceous plants by distances as shown in **Table 4**.

**Table 4.** Minimum isolation distance in metres for seed crop from commercial ware potato crops

Class to be produced	Isolation distance (m)
Breeder Seed	100
Pre-foundation Seed	100
Foundation Seed	100
Certified I Seed	50
Certified II Seed	50
Certified III Seed	50

A seed potato crop of the same class or different variety shall be separated from neighbouring seed potato crops by a space of at least five metres for Foundation Seed and at least two metres for Certified Seed. In the case of wet areas, appropriate measures should be put in place to avoid contamination from runoff storm water.

## 8. Seed potato inspection requirements

1. Seed potato is inspected during the growing season with special attention given to tuber-borne diseases, general appearance and development, trueness to type, and varietal purity.
2. At least one visual inspection of propagation materials in laboratory and/or greenhouse facilities will be made by NASC before such material is sold and/or planted for next generation bulking. Samples for testing should be taken as outlined in 6.2 above.
3. At least three field inspections shall be made during the growing season: the first inspection at early vegetative stage; the second at flowering or the canopy closure (for non-flowering varieties) or tuber initiation stage; while the third inspection will be before dehauling prior to onset of senescence to confirm compliance with field standards.
4. Rouging to remove weak plants, off-types, diseased plants, and objectionable weeds from the field should commence as soon as they become apparent and continue through the growing season. Rouging may be delayed until the first field inspection is made, and potential problems have been determined. Plants infected with virus or bacterial diseases should be removed from the field along with the seed pieces and young tubers.
5. If ring rot is found in any potato field on a farm or it is determined that any seed lot planted on the farm was contaminated with ring rot or was stored in a space with potato that were contaminated with ring rot, all seed potato fields on that farm may be downgraded to Certified 2 or for own use by the producer and its progeny would never be tendered for registration for future inspection as a seed potato crop.
6. Field inspection technique: Starting from a random position in the field, count 100 plants (equivalent to 30 metres or paces) along a row, skip three rows and continue the count on the fourth row until the seed field is completed (see **Table 5**).

**Table 5.** Minimum number of plants counts during field inspection

Area (ha)	No. of counts each of 30 m	Total number of plants <sup>1</sup>
< 1	10	1000
1-6	20	2000
6.1-8	24	2400
8.1-10	28	2800
10.1-12	32	3200
12.1-14	36	3600
14.1-16	40	4000
16.1-18	44	4400
18.1-20	48	4800

<sup>1</sup> For Foundation Seed, double the number of plants counted

## 9. Field standards

### 9.1. Field inspection

- i. Fields will be rejected when seriously infected or damaged by late blight, insects, drought, wind, hail, or frost, other diseases or causes which would interfere with proper inspection of seed potato. Poor stands, low soil fertility, poor culturing practices, or excessive weed infestation will also render the candidate seed field ineligible for certification.
- ii. Seed potato fields presented for inspection that may have symptoms of a disease that might be new in Nigeria will be disqualified or may have certification postponed pending further investigation.
- iii. Volunteer potato plants will not be permitted in any field, except where the previous potato crop was of a higher generation and of the same variety as the one currently growing.
- iv. Inspection tolerances for disease, insect and other damage are as indicated in **Annexes 1–3** which are based on the percentage of visible disease symptoms.
- v. Any disease or pest with zero tolerance that would have been recorded as absent (zero) means that it has not been found in the seed crop at that time during normal inspection procedures. However, absence of any pest or disease categorized for zero tolerance does not guarantee that the lot inspected is free of that disease or pest unless proved otherwise.
- vi. The foliage destruction or dehaulming date will depend on seed tuber size and prevailing aphid pressure. The inspector may advise the grower on the appropriate date to dehaulm the seed crop after approval.

### 9.2. Sampling for bacterial wilt (*Ralstonia solanacearum*) laboratory tests

Before the seed crop is dehaulmed, a grower should request for sampling for latent bacterial wilt indexing. Four hundred (400) medium-sized tubers per hectare shall be taken from 400 symptom-less plants in a seed potato crop. For seed potato crops that are less than 0.5 ha, the sample shall be taken from 1% of plants estimated from the plant population. Sampling in both cases shall be done in way that the collected sample is a true representative of the whole field. These samples shall be tested in the laboratory upon which the seed can be sorted, graded and packed, if free from bacteria wilt or any other pest or disease with zero tolerance.

## 10. Harvest and storage requirements

1. Growers who have fields eligible for certification should notify NASC prior to harvest and work out a satisfactory plan for maintaining the identity of the potatoes through harvest to storage. A lot is eligible for tags only when this identity is maintained. Harvesting equipment and storage areas must be properly disinfected before handling certified lots.
2. A seed lot that is eligible for certification in storage must be clearly distinguished from other seed lots and stored separately from ware potato. Empty containers, walls, wood, etc., that prevent mixing are acceptable approaches to separate the lots.
3. A clearly written chart or identification marks showing the variety, seed lot origin, and field from where the seed potato was harvested, for each container or store should be made to aid NASC or its representative to conduct accurate inspections.
4. If the inspector is unable to distinguish, to his or her own satisfaction, the identity of any seed in storage, all or any part of the seed in the storage may be declared ineligible for certification.
5. Storage inspection shall be made soon after harvest before the potatoes are sorted.
6. Any certified seed lot stored in a cellar with other potato found to be infected with ring rot (other seed lots or commercial potatoes) will be downgraded to the last generation prescribed in this Protocol. However, depending on circumstances, the seed lot may be rejected for certification.
7. Scab, *Rhizoctonia*, early and late blight tuber lesions, etc., are grade defects to be graded and/or removed during the sorting process.
8. Seed potatoes may be rejected for certification if they have been improperly stored as indicated by excessive black heart, sprouting, shrivelling, or soft rot breakdown, or are unappealing in general appearance due to dirt, blight, scab, or other malformations or conditions where sorting will not salvage the seed lot to qualify for passing as good quality seed potato.

## 11. Lot inspection

Seed potatoes are usually graded on the farm. Once the results of the laboratory tests show that the seed is free from diseases and pests that are specified in this Protocol, particularly bacterial wilt, the grower will be permitted to sort and grade the seed tubers. This will ensure that the damaged, rotten, misshapen, and diseased tubers are removed from the seed lot. The seed tubers are then graded in three sizes determined by tuber diameter. The seed tuber sizes (S) prescribed in this Protocol are S1 (28–35 mm), S2 (36–45 mm) and S3 (46–55 mm). Tubers below or above these seed diameter sizes are not permitted for marketing as seed. The approved seed potato shall be packaged in 50 kg, new sisal or jute bags. The seed inspector shall conduct the lot inspection, randomly selecting a seed-potato-filled bag, empty it on to a clean polythene sheet and check for:

- i. Conformity to the specified seed size (S1, S2 or S3)
- ii. Tuber diseases and defects (according to **Table 6**)
- iii. Physiological condition (seed tuber senility, excessive sprouting, damaged and misshaped tubers)
- iv. Contamination (e.g., adhering soil, presence of chaff)
- v. Accuracy of package weight (50 kg).

Lot inspection should ensure that the tolerances presented in **Table 6** are met.

**Table 6.** Tolerance to deformities in lot inspection

Abnormality	Tolerance (number of tubers per 50 kg bag)	
	Foundation Seed	Certified Seed
Pink rot ( <i>Phytophthora erythroseptica</i> ), soft rot ( <i>Erwinia</i> spp.)	0	1
Severe tuber moth	2	5
Deformed and damaged tubers, and severe millipede damage	0	5
Late blight ( <i>Phytophthora infestans</i> )	0	0
Early blight ( <i>Alternaria solani</i> )	0	6
Dry rot ( <i>Fusarium</i> spp., <i>Phoma</i> spp.)	0	6
Nematodes ( <i>Meloidogyne</i> spp., <i>Ditylenchus</i> spp.)	0	<5

## 12. Certified seed potato grading

Seed potatoes shall be graded into the sizes as described in **Table 7**. Tolerances for sizes 1–3 will not be more than five tubers per 50kg. Size 4 is applicable to mini tubers only.

**Table 7.** Description of size-based seed grading according to the diameter range of the tubers

Size	Diameter range (mm)
1	28–35
2	36–45
3	46–55
4	15–27 (minitubers)

## 13. Sampling for post control

1. For tubers, a sample of 120 tubers per seed lot shall be taken for post control purposes, where the maximum lot size shall be 40 tonnes.
2. For rooted cuttings, a sample of 60 rooted cuttings per seed lot shall be taken for post control purposes where the maximum lot size shall be 400,000 cuttings.

## 14. Other requirements for seed potato production

1. Certification fees: Certification of seed potato shall be done after payment of associated fees for inspection and certification.
2. No application will be accepted for land that was used to grow bulbs, corms or tubers imported from a country with known potato cyst nematode (PCN) infestation or planted with bulbs that were grown in PCN-infested States unless intense soil testing has been done.
3. Any seed stocks to be submitted for certification must be from a source or registered seed merchant approved by NASC prior to planting.

4. Growers must only use approved seed stocks with a label for further seed multiplication and shall provide NASC inspectors with records including proof of purchases.
5. Growers are responsible for securing planting materials from NASC-approved sources.
6. All seed from approved sources must be from fields that have been soil sampled and tested negative of potato cyst nematode or other quarantine pests and diseases. Supporting documented evidence of plant health status may be requested by plant health inspection services
7. All potatoes must meet the requirements of this section, including disease and other pest tolerances listed in **Annex 1, 2 and 3**.
8. Mandatory PLRV and PVY testing for all seed stocks for sale or transfer to another country is required.
9. Certified seed potato shall not be stored or graded in a storage facility containing non-certified or ware potato.

## 15. Rejection of a seed potato crop

A potato seed field or lot shall be rejected for certification for any of the following reasons:

1. A failure to plant NASC-approved seed or ability to demonstrate traceability of seed source.
2. Field(s) or any portion thereof, planted without adequate crop rotation (minimum of three seasons).
3. Blending or mixing of seed potato lots from different sources.
4. At the time of inspection or testing, potato plants failed to meet disease tolerance limits set in **Annexes 1–3**.
5. The presence of potato cyst nematode (PCN; *Globodera rostochiensis* and *G. pallida*) shall disqualify a field for future production of Certified Seed Potato until soil tests indicate the absence of the two pests to the satisfaction of NASC.
6. A positive diagnosis of bacterial wilt (*Ralstonia solanacearum*) shall disqualify all seed potato produced under that application for certification, or other applications for seed grown using the same equipment. All such fields shall be suspended from seed potato production for a period of six years, and no other *R. solanacearum* host crops will be grown in this period.



7. The inspector may reject the seed crop if it is excessively weedy or severely lodged to a degree that it adversely affects standard inspection procedure and possibly the quality of the seed.
8. If the field fails to meet the minimum physical separation between the seed potato crop to be inspected and ware potato fields as set out in **Table 4**.
9. In storage, if seed is stored together without demonstrable separation and clear labelling of different potato stocks, all the stored seed will be denied certification. Where a disqualifying disease is found in any of the potato stocks or lots in the storage, all the lots will be disqualified.

## 16. Zero tolerance levels for seed potato lots

Zero-tolerance criteria will apply to potato cyst nematode (PCN; *Globodera rostochiensis*, *G. pallida*), bacterial wilt (*Ralstonia solanacearum*) and potato spindle tuber viroid which automatically precludes the crop from being certified as seed. This tolerance is based on 200 tubers per seed lot (max 40 tonnes) of seed potato.

## Annexes

Irrespective of the generation, crops will be rated from 1 to 4, according to the following tolerances for foreign varieties, viruses, and other diseases in **Annexes 1 to 3**.

**Annex 1.** Maximum tolerances for diseases and foreign varieties (% of plants)

Inspection	Rating 1		Rating 2		Rating 3 <sup>3</sup>		Rating 4	
	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>
Foreign varieties (Group 4)	0.05	0.00	0.10	0.01	0.10	0.10	0.10	0.10
Virus diseases (Group 3)	0.10 <sup>1</sup>	0.01	0.25	0.10	1.00	1.00	4.00 <sup>2</sup>	4.00 <sup>2</sup>
Other diseases (Group 2)	0.25	0.10	0.50	0.25	2.00	2.00	2.00	2.00
Total diseased plants <sup>4</sup>	0.25	0.10	0.50	0.25	2.00	2.00	6.00 <sup>2</sup>	6.00 <sup>2</sup>

<sup>1</sup> 0.10 = 1 plant in 1000.

<sup>2</sup> Potato Virus Y only; all other virus tolerance as per rating 3.

<sup>3</sup> Any seed having a field rating of 3 or 4 cannot be further multiplied for certified seed.

<sup>4</sup> The highest rating score recorded in any category shall be the overall rating for that crop (for example, for a foreign variety rating of 1, virus rating of 2, and other diseases rating of 3 then the overall rating=3).

**Annex 2.** Disease tolerances for seed potato certification at final field inspection

Disease	Causal organism	Breeder TC	Final inspection rating %			
			R1	R2	R3	R4
<b>Group 1 restricted diseases<sup>3</sup></b>						
Brown rot (bacterial wilt)	<i>Ralstonia solanacearum</i>	Nil	0	0	0	0
Ring rot	<i>Clavibacter michiganensis sepedonicus</i>	Nil	0	0	0	0
Potato cyst nematode <sup>4</sup>	<i>Globodera rostochiensis</i> , <i>G. pallida</i>	Nil	0	0	0	0
Potato spindle tuber viroid	Pospiviroidae	Nil	0	0	0	0
Potato wart	<i>Synchytrium endobioticum</i>	Nil	0	0	0	0
Tobacco rattle virus	Tobacco rattle virus	Nil	0	0	0	0
Zebra chip	<i>Candidatus Liberibacter solanacearum</i>	Nil	0	0	0	0
<b>Group 2 crop assessment (bacterial and fungal diseases)</b>						
Fusarium wilt	<i>Fusarium</i> spp.	Nil	0.1	0.25	2	2
Verticillium wilt	<i>Verticillium dahlia</i> , <i>V. alboatrum</i>	Nil	0.1	0.25	2	2
Blackleg/soft rot	<i>Pectobacteria</i> ( <i>Erwinia</i> spp.), <i>Dickeya</i> spp.	Nil	0.1	0.25	2	2
<b>Total group 2 bacterial and fungal diseases</b>		<b>Nil</b>	<b>0.1</b>	<b>0.25</b>	<b>2</b>	<b>2</b>

<b>Group 3 crop assessment (viral diseases)</b>						
Potato leaf roll virus		Nil	0.01	0.1	1	4
Potato virus Y <sup>5</sup>		Nil	0.01	0.1	1	4
Potato virus X		Nil	0.01	0.1	1	4
Potato virus A		Nil	0.01	0.1	1	4
Potato virus S		Nil	0.01	0.1	1	4
Tobacco mosaic virus		Nil	0.01	0.1	1	4
Tomato spotted wilt virus		Nil	0.01	0.1	1	4
Purple top wilt		Nil	0.01	0.1	1	4
<b>Total group 3 virus diseases</b>		Nil	0.01	0.1	1	4
<b>Group 4 foreign cultivars</b>		Nil	0.05	0.10	0.10	0.10

Annex 3. Post-harvest tuber assessments for diseases, insects and defects for certified seed

Disease	Causal organism	Breeder TC <sup>1</sup>	Rating AA <sup>2</sup> : % by tuber count	Rating BB <sup>3</sup> : % by tuber count	
<b>Group 5 tuber assessment (diseases)</b>					Only one defect
Dry rots	<i>Fusarium</i> spp., <i>Phoma</i> spp.	Nil	2	2	
Black scurf	<i>Rhizoctonia solani</i>	Nil	-	-	
Silver scurf	<i>Helminthosporium solani</i>	Nil	-	-	
Black dot	<i>Colletotrichum coccodes</i>	Nil	-	-	
Common scab	<i>Streptomyces</i> spp.	Nil	2 (4 Tas)	4	
Powdery scab	<i>Spongospora subterranea</i>	Nil	2	4	
Root knot nematode	<i>Meloidgyne</i> spp.	Nil	2	4	
Soft rots	<i>Pythium</i> spp.	Nil	0.25	0.25	
Pink Rot	<i>Phytophthora ethyroseptica</i>	Nil	0.25	0.25	
<b>Group 6 tuber assessment (insects and defects)</b>					
Potato tuber moth damage	<i>Phthorimaea operculella</i>	Nil	2	2	
Insect damage	Other than <i>Phthorimaea operculella</i>	Nil	2	2	

<i>Total insect damage</i>		<i>Nil</i>	2	4	
Malformed tubers		n/a	2	4	
Mechanical damage		n/a	2	4	
Skinning		n/a	5	5	
Stem end discoloration		Nil	2	2	
Miscellaneous (e.g., sunburn)		Nil	1	1	
Foreign cultivars		Nil	0	0	

<sup>1</sup>Tissue culture

<sup>2</sup>High grade seed (first grade)

<sup>3</sup>Moderate grade seed (second grade)

**Annex 4.** Checklist for inspection of tissue culture laboratories

Facility	Requirements	Meeting standard: if yes (✓) if no (x)	Comments/ remarks
<b>Washing area</b>	Sinks (lead-lined to resist acids and alkalis), ceramic sinks.		
	Proper drainage system		
	Racks, and have access to water		
	Distiller or alternatives		
	Space for drying ovens or racks		
	Pipette and pipette washer		
	Storage cabinets		
<b>Media preparation area</b>	Storage space for the chemicals		
	Culture vessels and closures		
	Glassware required for media preparation and dispensing.		
	Bench space for hot plates/stirrers		
	pH meters and balances		
	Refrigerators and freezers for storing stock solutions and chemicals		
	A microwave or a convection oven		
Autoclave for sterilizing media, glassware and instruments.			

<b>Transfer area</b>	All surfaces in the room should be designed and constructed in a manner that dust and microorganisms do not collect, and the surfaces can be easily cleaned and disinfected. A room of such design is particularly useful if large numbers of cultures are being handled or large pieces of equipment are being used		
	Laminar flow hood or sterile transfer room utilized for making transfers. The ventilation should be equipped with a high-efficiency particulate air (HEPA) filter. A 0.3- $\mu$ m HEPA filter of 99.97–99.99% efficiency works well.		
	Source of power: electricity, gas or solar		
<b>Culture/ growth room</b>	All types of tissue culture should be incubated under well-controlled temperature, humidity, air circulation, and light quality and duration. These factors may influence the growth and differentiation process directly during culture or indirectly by affecting their response in subsequent generations. Typically, the culture room or growth of plant tissue cultures should have a temperature between 15 and 26°C.		
	Fluorescent lighting (10,000 lux) the lighting should be adjustable in terms of quantity and photoperiod duration. Both light and temperature should be programmable.		
Open	Air conditioner (the culture room should have fairly uniform forced-air ventilation, and a humidity range of 20–98% controllable to $\pm$ 3%)		
	Thermometers		



General requirements			
1.	Technical personnel with tissue culture knowledge		
2.	Isolation from foot traffic		
3.	Thermostatically controlled heat		
	Good lighting		
4.	Locate the building away from sources of contamination such as a gravel driveway or parking lot, soil mixing area, shipping dock, pesticide storage, or dust and chemicals from fields		
5.	The floor should be preferably tiled or concrete. Walls and ceiling should be insulated with a water-resistant material.		
6.	Windows, if desired, may be placed wherever convenient in the media preparation and glassware washing rooms.		
7.	Air conditioning for cooling in each room would be necessary.		
8.	Electric service capacity for equipment, lights and future expansion should be calculated. A minimum 100-amp service is recommended.		

Name of company.....

Contacts.....

Contact person/responsible.....Date.....Signature.....

Name of inspector/ officer/s.....Date.....Signature.....

Name of inspector/ officer/s.....Date.....Signature.....

**Annex 5.** Inspection checklist for greenhouse facilities (minitubers and rooted apical cuttings)

Requirement	Status	Comments
1. The facility should be insect-proof screen/glasshouse or facility.		
2. Cemented slabs or ground cover within the glasshouse provided with walking paths		
3. Have a double door entry		
4. Have protective clothing and the changing area		
5. Adequate but controlled ventilation		
6. Have competent personnel		
7. Have a pest monitoring and management system		
8. Have operational notifications and records including operating instructions		
9. A disinfecting trough (moat) on the entrance with disinfecting solution is required		
10. Not be accessible to un-authorized persons.		
11. The facility should be used exclusively for the specified purpose		
12. Be inspected regularly by NASC		

**Name of company**.....  
**Contact person/responsible**.....**Date**.....**Signature**.....  
**Name of inspector/officer**.....**Date**.....**Signature**.....



COLLABORATIVE  
**SEEDPROGRAMME**  
Nigeria-Netherlands



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