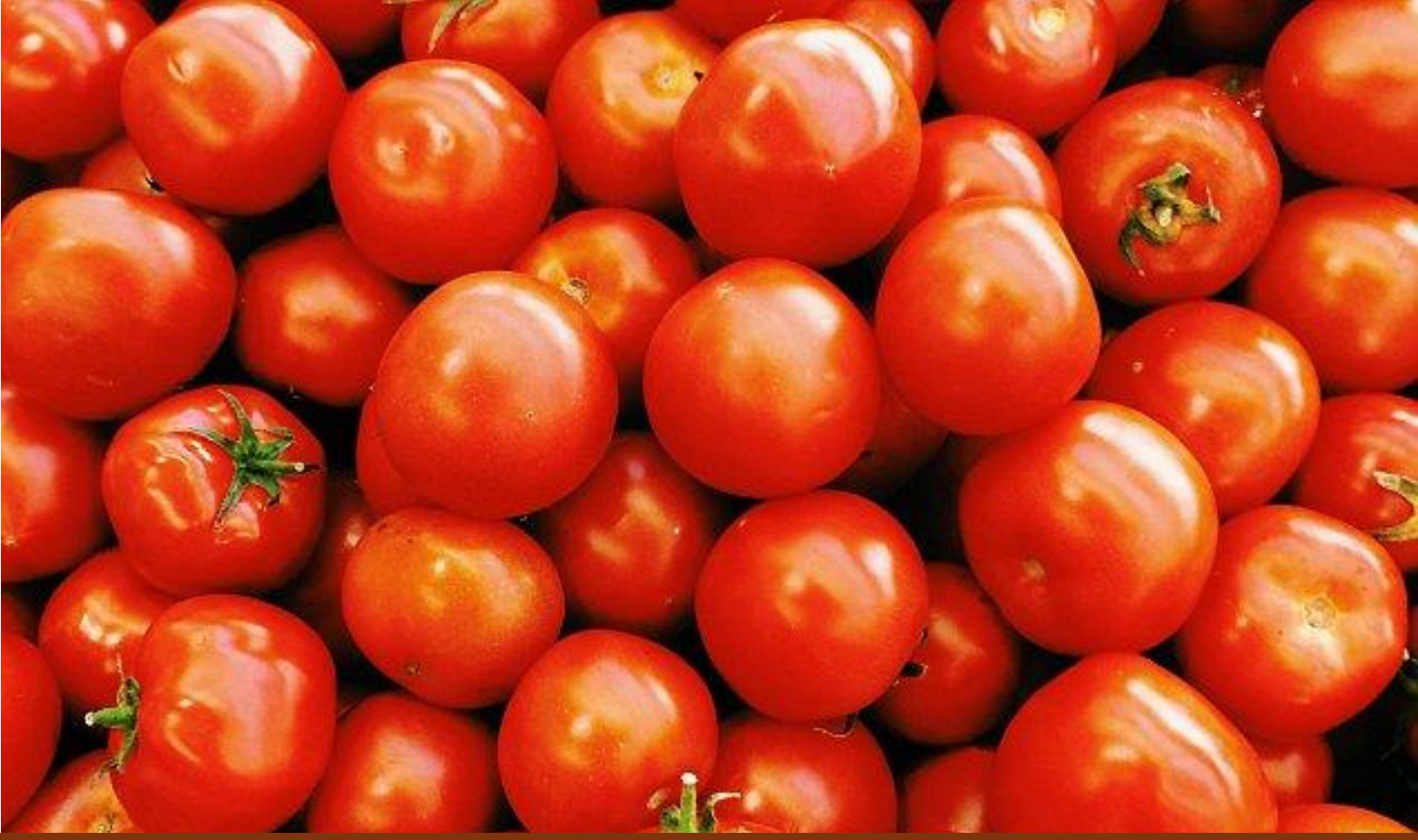


Tomato (*Solanum lycopersicum*)

Seed Certification

Standard Operating Procedure

NASC

COLLABORATIVE SEEDPROGRAMME
Nigeria-Netherlands

Contents

Glossary

- **Seed certification** - Process of quality assurance to ensure genetic purity and physical quality of seeds
- **Varietal purity** – composition of the true-to-type in seed lot
- **Off-types** - Variant plants differing from the description of the standard variety
- **Roguing** - Removal of off-types or diseased plants from the seed crop on the field
- **Isolation distance –** 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.
- **Seed tags –** A tag is of specified design and colour granted by the certification agency upon successful completion of certification process. It constitutes third party guarantee which confers the responsibility of the quality of certified seed lot on the certification agency.
- **Field inspection** - Visual observation of seed crop by certification agency or its appointed representative to verify conformity to standards
- **Seed sampling** - Drawing representative portions from seed lot for testing as per ISTA standards. Grow-out test - Planting samples from seed lot to assess varietal characteristics and purity
- **Genetic purity -** Breeding true-to-type with respect to key morphological and qualitative traits
- **Physical purity -** Percentage by weight of pure seed as against inert matter and other crop seeds
- **Seed testing -** Laboratory analysis to determine germination, purity, moisture content and seed health
- **Germination -** Percentage of seeds capable of producing normal seedlings under ideal conditions
- **Seed vigour -** Measure of overall health, viability and activity of seed lot
- **Seed borne diseases -** Pathogenic infections carried by seeds internally or as surface contamination
- **Phytosanitary certificate** - Document certifying pest/disease status of exported seeds based on field/lab tests
- **Quarantine -** Confinement and observation of imported seeds to prevent entry of exotic pests and diseases
- **Seed processing** - Post-harvest operations like drying, cleaning, grading and sorting to achieve genetic, physical, physiological purity and uniformity in size and shape.
- **Seed labeling –** Means of identification and traceability usually of different design and color different from that of certification tag, usually affixed by the producer at the time of packaging and contains information on the quality attributes of the seed in the container and details of the producers.
- **Seed sampling -** Drawing representative portions from seed lot for testing as per statistical methods
- **Moisture content -** Percentage of water present in the seed sample affecting storability
- **Seed treatment -** Application of protective chemicals like fungicides to protect from storage pests and diseases
- **Seed storage -** Maintenance of seeds in controlled environment to preserve and protect its quality attributes.

- **Seed law -** Legal provisions governing seed quality assurance including seed sales and importation
- **Variety release -** Process of testing and approving a new variety for cultivation based on value for cultivation and use
- **Truthful labeling -** Providing accurate information on the seed label regarding quality parameters
- **Post control test -** Field evaluation conducted on samples of traded seeds to verify conformity to standards and genetic purity
- **Seed merchant -** Person or company involved in trading, importing and distribution of seeds
- **Seed analyst -** Technical person qualified to undertake seed sampling and conduct laboratory seed testing
- **Seed inspector -** Person authorized to undertake field inspection of seed crops, draw samples and monitor production
- **Seed standards -** Prescribed minimum quality parameters for each seed certification class
- **Seed lot -** Defined quantity of seeds identifiable by source, variety and producer for sampling and testing
- **Seed legislation -** Laws governing quality control, testing, certification and sale of seeds
- **Variety descriptor -** Official document with botanical details, origin, traits and identification guidelines for a variety
- **Breeder seed -** Original pure seed produced by the breeder to maintain genetic purity
- **Foundation seed -** Progeny of breeder seed produced under supervision of certifying agency
- **Certified seed -** Quality declared seed produced from foundation seed under stringent process control
- **OECD schemes -** International schemes for varietal certification of seeds moving in trade between member countries
- **Seed Act -** National legislation providing regulatory framework for seed quality assurance and control
- **Plant quarantine -** Legal restrictions on import/export of plant materials to prevent entry or spread of pests and diseases
- **Phytosanitary inspection -** Examination of consignments by quarantine authorities to verify freedom from diseases, insect pests and weed seeds

Chapter 1

Introduction

1.10 Concept and importance of tomato seed certification

Seed certification is a legal procedure designed to ensure continuous supply and availability of high quality tomato seeds to the general public. The process involves various steps required by law and minimum quality standards that must be met by seed producers before the seed can be made available to farmers and other end users.

1.20 Scope

The scope covers all steps and chains of activities needed to ensure production, dissemination and use of high-quality seeds capable of bringing good returns to farmers and increase/enhance continued crop production, improve household incomes, minimize risks of insect pests and plant diseases for sustainable agricultural production. The scope covers registered seed varieties developed and produced in the country or imported for suitable utilization in the general or selected prevailing agro-ecological conditions of the country either by licensed indigenous or foreign seed companies. This is intended to rid the tomato seed market from fake and substandard tomato seed as the purpose of seed certification is to ensure that seed sold to farmers meets specific standards for physical purity and genetic purity, viability, seed health and varietal identity.

1.30 Objective of tomato seed certification

The major objective of seed certification is to ensure uniformity in standards of quality, regulation of seed production, marketing/distribution in order to protect the producers and consumers of tomato seed. The process is also needed to ensure production of only registered, improved tomato seed varieties, adaptable to the existing agro-ecologies of Nigeria. Certification ensures that commercial seeds meet required minimum standards as specified and be of high genetic purity.

1.40 Criteria for eligibility of tomato seed certification

Only seeds of tomato varieties that have undergone the process of official variety registration and release by the National Variety Release Committee (NVRC) and those in the ECOWAS seed catalogue which Nigeria is a party are eligible for certification.

Seeds varieties produced under required field standards prescribed by the NASC seed Acts of 2019 having being registered in the country must comply with maximum tolerance level for seed certification. Imported seeds registered and tested following the prescribed procedures of NASC and having been certified free from seed borne diseases and weed seeds having been confirmed to be adaptable to selected agro-ecologies should be certified for production in such ecologies as shown by valid adaptation trials of at least two seasons.

Importers/Marketers and retailers for international seed companies are also covered under certification and must provide minimum conditions for seed handling that will not compromise seed damage, contaminations and abrupt decline in seed longevity.

1.50 The Role of NASC

Seed certification is statutorily a mandate of the NASC as established by the Seed Act. The agency is basically empowered to carry out all functions relating to seed certification and other associated roles. The chain of operations of NASC in collaboration with other agencies is to ensure compliance with laid down regulations are as stipulated in various statutory documents. However, in order to ensure efficient service delivery the NASC may license organizations, individuals trained for seamless certification process.

Chapter 2

Basic requirements for tomato seed certification

2.10 Classes of seed and standard requirements for certification

There are basically three major classes of seeds produced by public institutions and private companies that are eligible for certification. However, the names given may differ from country to country but the characteristics or features remain same. In accordance to the OECD standards, the three classes are –Pre-basic (Breeder), Basic (Foundation), and certified seed stocks. In addition, the certified seed may further be classified into first or second generations depending on the availability and the quality in accordance with the approval from NASC. Each class of seed must be supplied in a bag or container with proper truthful label bearing information on the content and the appropriate certification tag. Information such as Crop, variety, class of seed, lot Number, purity, germination (%), date of production, seed weight etc. are contained on the label.

2.11. Pre-basic seed

This is the first class of seed for certification. It has the highest purity of the new cultivar and maintained/multiplied by breeder or produced under his/her supervision. It is provided by the breeder/his institution to seed companies for multiplication into foundation or multiplied by breeder's institutions. This class of seed is used to increase foundation seed. The analytical/ variety purity is expected to be 99 -100% as other classes of seed are derived from it. Physical purity is expected to be high (99%) and germination must not be less than 80%. The seed tag shall be white with red stripe. Seed moisture content may range between 6-8%.

2.12. Basic seed

This class of seed is produced from the Pre-basic seed by recognized seed producing agencies in public and private sectors under the supervision of NASC or its licenced agents. Physical purity should not be less than 98% while variety purity should be 97% or above. The germination must be 80% or above. It may go to basic I or II based on NASC approval. The seed tag is also white.

2.13. Certified seed

Progeny of Basic seed produced by registered seed growers under supervision of NASC in order to maintain the seed quality as per minimum seed certification standards. Certified seed may

be produced from certified seed provided that the physical and genetic purity are not compromised and has received the approval of the NASC. The physical and analytical purity for certified seed must not be less than 95% while germination must be 75% and above. The tag colour for certified seed is blue. Seed moisture content may range between 6-8% but must not be more than 10% (Table 1).

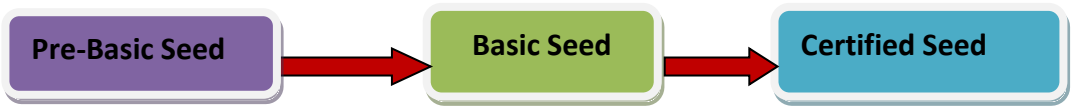


Figure 1. Flowchart for the seed classes

Table 1. Required seed standards for the different classes of seeds in tomato

Seed class	Physical Purity (%)	Analytical/variety Purity (%)	Germination (%)	Tag Colour	Seed Moisture (%)
Pre-Basic	99	99	80	White with red stripe	6 -10%
Basic	98	97	80	White	
Certified	95	95	75	Blue	

2.20. Open Pollinated Variety (OPV)

For open pollinated varieties, the above seed certification standards apply. Field inspection and other related standards are critical to ensure maintenance of genetic purity.

2.30. Hybrid

In case of hybrid seed production, stringent supervision is required for the parental lines (A & B lines). Isolation distance should be increased to prevent outcrossing. Only Basic I seed of parental lines can be used for hybrid seed production. The ideal physical and variety purity of 98% and germination of 85% is required for hybrid seed. Hybrid seed should be inscribed boldly on the label of hybrid seeds.

2.40. Application for seed certification (Procedure)

Eligibility criteria: Growers intending to produce certified seed must be registered with the NASC before they can apply for seed certification. They must also in addition have the necessary infrastructure needed to produce certified tomato seed. This include, trained personnel, production facilities (adequate area of land that will allow maintenance of isolation distance or green houses, irrigation kits, seed processing and drying facilities among others)

Application process: the intending growers will obtain the official seed certification application form from the NASC or her authorized offices. This form can also be downloaded from the NASC website. The form is expected to contain information such as particulars of the grower, farm location and size, available production and processing facilities, production personnel, class of seed to be produced, source of planting materials and crop history etc.

Notification of Certification: The NASC after receipt of the duly completed form will notify the grower of the intention for visitation prior to commencement of operation.

Chapter 3

Stages of seed certification in tomato

3.10 General guidelines

The National Agricultural Seeds Council (NASC) is empowered to prescribe seed certification standards and implement (Seeds Act 2019 and Regulations therein). However, the NASC may give authorization to a capable body to carry out seed certification on her behalf in accordance with the law

The general guidelines for seed certification of different classes of tomato shall be as follow:

3.20 Submission of Information by Eligible applicant

All eligible applicants for tomato seed certification shall provide detailed information on the class of seed and other detailed as contained in the application form such as:

- Class of seed
- Variety
- Location of the seed production field.
- Seed source: Indicate the origin of the seed used for planting.
- Type of seed: OP (Open-Pollinated).
- Proposed planting date.
- Agronomic practices: Describe the cultivation practices, including planting density, irrigation, pest control etc.
- Harvesting and post-harvest handling procedures.
- Seed processing
- Seed storage facilities.
- Quality control measures during production.

The NASC carry out facility inspection before certification application is approved which is accompanied by various charges as prescribed by law.

3.30 Field inspection

The NASC upon receiving the eligible applicant's request shall conduct field inspections at various stages in the crop life cycle to ensure compliance with prescribed standards. Field inspections are a critical part of the seed certification process to verify that crop standards and requirements are met during the different stages of seed production. Stringent field inspections are to be conducted for Pre-basic, Basic and certified seed production of both open-pollinated varieties (OPVs) and hybrids of tomato in Nigeria.

The field inspection is aimed at ensuring varietal purity, seed crop health and compliance with isolation and other requirements. The process may include assessing crop isolation distances, crop health and genetic purity and absence of off-types among others.

3.31 Objectives of Field Inspections

The major objectives of field inspections during tomato seed production are:

- To confirm content of application form as true
- To verify source of seed, distinctiveness, uniformity and stability of variety as per DUS descriptors
- Monitor isolation distance standard and ensure that standards prescribed for tomato are met
- Check for admixtures, off-types, volunteer plants of other varieties
- Assess incidence of pests, diseases, weeds in the seed crop
- Verify true-to-type and authenticity of crop stage, rouging operations, etc.
- Issue crop inspection reports and recommend next steps

3.32 Stages of field inspection

There shall be at least three field inspections.

First inspection- this is done at the vegetative stage in the crop life cycle between 30 – 45 days after sowing or between 2-4 weeks after transplanting. The activities to be carried out here include-

- Verify location, sowing report, isolation distance,
- Conduct walk-through and observe level of uniformity
- Record plant population, spacing, missing hills, etc.
- Check for volunteer plants, admixtures of other varieties
- Assess incidence of diseases, pests and weeds
- Verify true-to-type nature up to this stage

Second inspection – this will be done at active flowering and fruiting stage. This important to confirm that no other tomato cultivars are within the prescribed isolation distance and that flowers and fruit traits conform to the traits of the exact variety being multiplied. Other activities include –

- Confirm stage, duration of variety to flowering and pattern
- Check for morphological characters as per DUS descriptor
- Assess variant plants and enforcement of roguing where applicable
- Assess pest/disease incidence and crop condition
- Verify field sanitation, agronomic practices, crop maturity

Third inspection – this is done at fruit maturity stage when 50% (or more) of the plant have mature ripe fruits. This is a pre-harvest inspection and recommend harvesting where necessary.

- Confirm uniformity of morphological traits
- Check for major fruit diseases, lodging, and seed borne diseases
- Verify seed crop is true-to-type at maturity stage
- Assess field sanitation and harvest readiness
- Recommend harvest of entire field or approved portions of the field

Additional inspections may be required in specific cases to confirm adherence to recommendations especially if the field requires certain corrections etc. The required minimum field standards for different classes of seed are indicated in table 2. For hybrids, inspections of parental lines are also conducted. After every inspection a report in favour or otherwise is written on the observations on the field for field performance and references.

Table 2 Field standards for different classes of seed

Parameters	Pre basic	Basic	Certified
Isolation distance (m)	40 - 50	40- 50	15 - 20
Off-types (maximum)	0.1%	0.1%	0.2%
Plants affected by seed borne diseases (early blight, leaf spot, TMV, bacteria canker, bacteria spot)	0.1%	0.1%	0.5%
Septoral leaf spot	1%	1%	1%
Objectionable diseases (Tomato rugose, tomato yellow leaf curl virus)	0	0	0
Variety purity	99%	97%	95%

3.33 Inspection Procedures for Hybrids

The procedure for field inspection of hybrid tomato seed production has additional requirements based on the peculiarities of the type seed to be produced. The stages are as outlined -

1. Inspection of parental lines: This is done after establishment on the field at the vegetative stage.

- Authenticate seed source and purity of parental lines
- Male to female plant ratio
- Check for pollen shedders in male-sterile line
- Observe plant morphology traits in both parents
- Assess pest/disease incidence in parental lines
- Identify pollination method
- Confirm isolation distance from other tomato varieties within the area

2. Inspection at flowering stage

- Confirm stage synchronization in parental lines
- Verify prescribed planting ratio of parental lines
- Observe floral morphology in both parents
- Check orientation within and between parental rows
- Observe bee activity for cross pollination
- Assess fruit setting to gauge hybridization rate

3. Inspection at maturity

- Verify hybrid purity by morphological observation
- Assess hybrid seed crop maturity and harvest readiness
- Check for incidence of seed borne diseases
- Confirm isolation distance between hybrid and OPV plots

4. Inspection of seed processing (additional)

- Verify segregated processing of parental lines
- Check packaging and labeling of hybrid seed lots

- Draw representative samples for laboratory tests

3.40 Report of Inspection

Observations from the field inspection are to be documented in a prescribed format covering verification points and observations made and recommendations at each stage. The inspection report is signed by the grower or his representative and the inspector. The signed report documents are to be made in triplicates. A copy each to the grower, the NASC and last copy to the inspector for reference purpose. The report should clearly indicate approval, rejection or any action required. The report must be submitted to NASC within a specified time period. The next course of action is based on inspection report recommendations.

3.50 Inspection Team

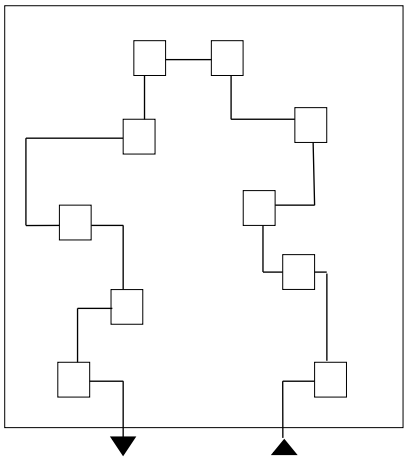
The inspector/inspection team must be comprised of certification officers, trained technical officers from NASC or accredited agencies for specific crops and/or crop specific experts. He should be versatile in recognising the characteristics that are used for distinguishing varieties, and have a sound knowledge of the varieties to be inspected. Information on the description of the variety, or of the parental lines/components in the case of hybrid production should be provided. The inspector should also be informed of the history of the seed used to sow the seed crop. The inspector may be informed of the history of the seed used to sow the seed crop.

An unscheduled visit by monitoring team to check effectiveness and adherence to crop specific standards may occur. Therefore, growers are expected to be up and doing at all times. The team should be provided with all information about the seed crop. The information provided should include a description of the variety, or of the parental lines/components in the case of hybrid production.

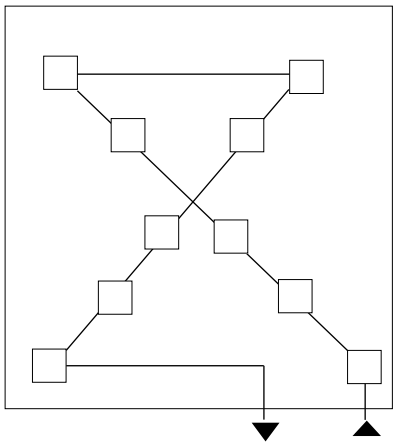
3.60 Inspection Walk

The inspector/team walks through the entire field in a zig-zag pattern to check for any variants that can affect varietal purity. Fields exceeding maximum limits of offtypes are rejected for certification other observations recorded during field inspection include flowering synchrony, isolation distance from other varieties, disease incidence, roguing etc. The general techniques of walking through the field during inspection are to enter from the beginning/end which is noted down. As he moves within the field, samples are taken or examined at random.

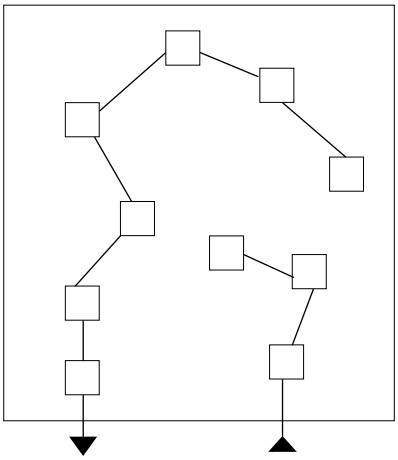
Estimates of diseased crops, off types, crop conditions etc. are made. The different travel pattern is as shown diagrammatically in figure 2.



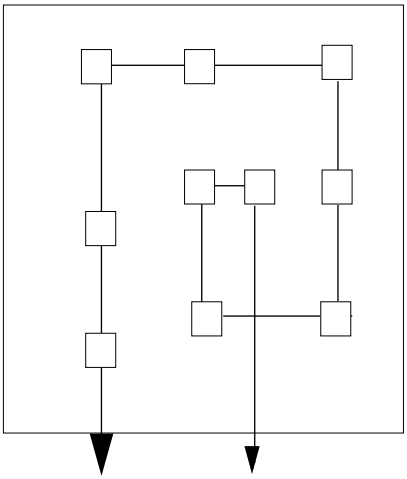
A: Observation of 75% of the field



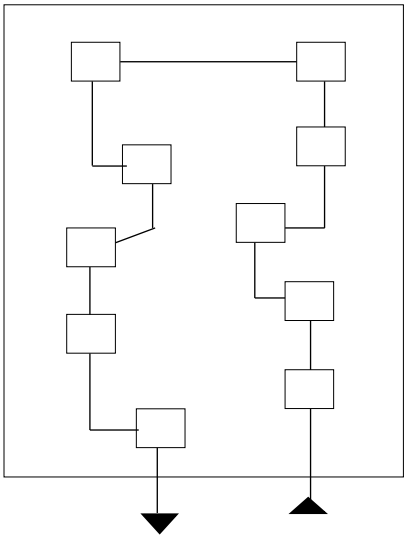
B: observation of 60% of the field



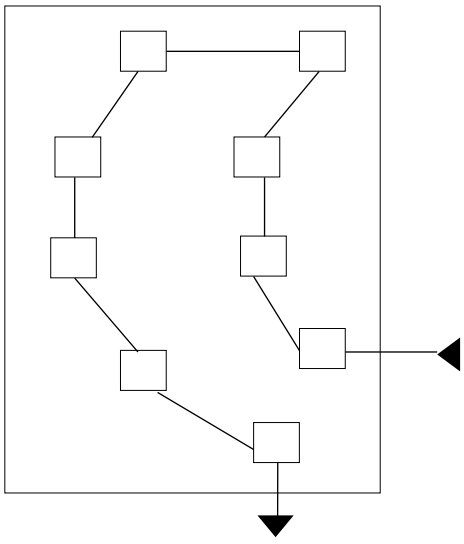
C: Movement at random



D clockwise travel pattern



E: Observation of 85% of the field



E: Observation of 60% of the field

3.70 Post field evaluation – this involve seed quality assurance and control measures needed to ensure that seed quality meets standard such as -

- Physical purity
- Freedom from diseases (especially seed borne), disease causing organisms and insect pests
- Germination capacity
- Other quality based on prevailing circumstances
- Seed processing standards & procedures
- Seed storage, sampling & laboratory testing
- Proper seed tagging & sealing

A report is also made for the post field evaluation. Various tests and evaluations are to be conducted on the seed samples from the harvested seed crop which include

3.80 Grow-out Tests of Representative Samples

Grow-out tests are conducted by planting a representative samples of processed seeds in the store and traded seeds on the shelve of the marketer. It gives a reliable check on varietal purity, double check the work of the field inspector as any variant can easily be spotted in the compact test plot. These are called pre and post control tests.

- The test plot could be 1/100th or 1/1000th of the seed lot size depending on the pollination biology of the crop and seed harvest (quantity)
- The plot is visually observed throughout the crop growth and off-types must not exceed maximum tolerance level for the class of seed being produced/considered
- Grow-out tests give a reliable check on actual varietal purity as any variants can be easily spotted in the compact test plot. But it requires time, space and resources.
- Independently verify if certified seed lots conform to prescribed quality standard
- Determine effectiveness of field inspections and seed testing during certification process
- Identify weaknesses in seed quality assurance process and provide corrective measures
- Build farmers' confidence in seed certification system through transparent disclosures

Biochemical and Molecular Tests - The use of these tests depend on the available expertise and resources. Biochemical and molecular tests require specialized equipment and technical expertise. Molecular assays provide precise results but may not be cost-effective. For stringent certification standards, combination of visual, grow-out and laboratory tests is required.

Biochemical tests like protein profiling can be done to verify varietal identity and check for seed mixtures. Similarly, molecular tests like DNA finger-printing can accurately determine varietal purity in seed lots. PCR-based assays can detect even very low levels of impurities. These tests provide precise quantitative results on purity levels rather than visual observations. They are useful as additional checks or for validating controversial decisions.

Seed certification programs use field inspections, grow-out tests and lab assays to ensure varietal purity is maintained during seed production. For tomato, field inspections to remove off-types and grow-out tests of representative samples are routinely employed to check purity.

3.90 Seed crop health

Monitoring of the seed crop health is a critical aspect as disease-free seeds ensure healthy seedlings and higher yields for farmers. Seed crop health is observed in two ways; through assessment of seed crop health on the field and seed testing in the laboratory for seed Borne Pests and Pathogens.

Adequate health standards are essential to deliver healthy planting material and prevent disease spread tomato with regards to seed-borne pathogens.

- The crop is visually examined for signs and symptoms of any pest or disease infection at each inspection stage.
- Key tomato diseases like bacterial wilt, early blight, late blight, fusarium wilt are monitored. Insect pests like fruit borer, whitefly are also observed.
- General crop health, field sanitation, previous crop history and roguing operations are checked.
- On the field pathogen-infected plants are uprooted and removed to prevent disease spread.
- Pest and disease incidence in the field is recorded through counts or measuring affected area. Severity of damage is assessed.
- If infections exceed the tolerance limits, the field may be rejected or given conditional certification with specific remarks.

- Post-harvest inspection of produce is done for diseases like bacterial canker that manifest on fruits. Infected fruits are discarded to prevent contamination.
- Field hygiene, sanitation and roguing help restrict spread and minimize pest/disease levels in the seed crop.

1. Laboratory Testing of Seed Samples

- Seed samples are drawn from the produce and tested in the lab to detect seed-borne diseases.
- Standard pathogenicity tests include agar plate assay, blotter test, embryo count, seed wash test, and grow-out tests are carried out
- Specific biochemical and molecular tests may be used to accurately detect pathogens like bacteria, viruses in seed samples. E.g. ELISA for TSWV.
- Seed health testing determines presence of latent infections which may not be visible externally. It confirms field inspection observations.
- Testing protocols and tolerances for each disease are followed to assess if the seed meets certification standards.
- Lots exceeding the tolerance limits for a disease are rejected or downgraded. Pathogen-free seeds ensure healthy seedlings and risk of further spread

2. Harvest and storage requirements

Seed certification aims to maintain seed quality right from the seed crop stage through processing, testing and storage stages before distributing certified seed to farmers. Proper harvesting and scientific storage are key aspects of the quality assurance process.

4.00 Field Supervision during Harvesting

- Harvesting of the seed crop is done under supervision of certification agency staff.
- The field is thoroughly inspected before opening for harvest to verify if it has met all requirements for certification.
- Harvesting is done when fruits are physiologically mature but before over-ripeness to maximize seed recovery.
- Mechanical damage and build-up of disease inoculum is prevented by avoiding over-ripe or rotten fruits.
- Harvested produce is properly labeled indicating variety and field details to maintain traceability.
- Containers and transport vehicles are inspected to ensure they are clean to avoid seed contamination.

- Any produce found to be mixed-up, infested or rotten is identified and discarded before processing.
- Field supervision ensures seed quality is maintained during harvest by preventing contamination.

4.10 Seed Processing Standards and Procedures

Seed processing is another phase in certification where admixture is often encountered which may be due to improper cleaning of equipment. Seed processing plants/equipment must be properly cleaned, sterilized and well-maintained. In tomato, seeds are extracted from fruits by depulping. Extracted seed with pulp and mucilaginous coating may be removed by treatment chemicals or fermentation followed by washing in water. Where available, tomato seed extraction machines with rollers are used before washing in water. Seed drying is done immediately after processing to bring down moisture to safe levels of 8-10%. Seeds are further cleaned to meet required physical purity level for the class of seed being produced. Treating seeds with protective chemicals like fungicides is allowed to protect against storage fungi.

4.20 Proper Storage Conditions (cool, dry place)

Seed storage is meant to protect the genetic, physical, physiological and health quality of seeds as well as prevent deterioration of seed germination and vigour until the seed is utilized by the farmer. The ideal seed storage conditions are 10-15°C (temperature) and 30-40% relative humidity. Cool and dry storage environment prevents loss of viability and maintains seed vigour. Seed should be stored in moisture/rodent-proof containers. Cloth or jute bags, inside plastic tins may also be used. The storage environment should have proper ventilation, be free from water seepage and insulated from heat. Seed quantity stored should be manageable allowing inspection of bags and fumigation if required. Storage losses can be minimized by maintaining optimal conditions. Monitoring for pests and diseases must continue as a routine activity.

4.30 Seed testing

Seed testing is a major component of the certification process. It is done to assess if seed lots meet the prescribed quality standards. Seeds produced are sampled randomly and tested following ISTA protocols. Reports after analysis are issued to determine marketability.

4.40 Seed Sampling

Samples are drawn from seed lots produced after processing following sampling standards laid down by ISTA and NASC. Sampling is done using triers and dividers to collect uniform aliquots from different locations in bags. The different samples drawn are then bulked and various tests are conducted by taking the required quantity. Recommended sample size is 5,000 seeds drawn from 50 random spots across the seed lot. The sample size may be less than 5000 depending on total quantity of seed produced for certification.

4.50 Test for Physical Purity, Germination, Moisture Content and Seed Health

Physical purity analysis is done manually or using electro-optical sorters or purity board. Pure seeds are sorted from inert matter and other crop seeds. The purity percentages are calculated based on weight of pure seeds. Percentage purity must not be less than specified for each class of seed.

Germination test may be done by paper towel, petri-dish, top of sand or soil methods with 4 replications of 100 seeds each. Normal seedlings are counted on final count day i.e. 7th day. Minimum germination standard specified for each class of seed must be met.

Hundred-seed weight is used to determine uniformity and seed rates.

Moisture tests are done using oven drying or electronic moisture meters. Moisture content should be 8-10% for tomato seed. Sample is oven dried at 130°C for 1 hour and reweighed to determine moisture loss. Alternatively, sensitive electronic moisture meters can be used to directly read moisture percentage.

The seed testing is done by strictly adhering to procedures, tolerances and reporting formats prescribed by ISTA. There may be need to do the test in more than one laboratory/locations to enable comparison of results as this will enable taking certification decisions objectively based on ISTA standards.

4.60 Issuance of Laboratory Certificate

Laboratory certificates will be issued based on scientific testing (ISTA procedure) to either invalidate or validate if quality standards are met before certifying the seed lot. The summaries of findings, recommended certification status and concerns or rejections are highlighted for decision making. This will be based on test reports for each seed lot indicating results of purity,

germination, moisture, seed health and other tests. The seed tests conducted will aid truthful labeling and as well ensure that good quality seed is made available to farmers.

Completion of field inspection and post field evaluations

At the end of the post field evaluation the NASC shall issue certificate of seed certification to successful growers whose field and post field evaluation meets the minimum certification standard prescribed for the class of seed.

4.70 Action on Default

Growers whose field fails or falls short of field inspection may face field rejection or downgrading of the class of seed and in extreme cases, destruction of the seed lot.

Chapter 4

Quality control for imported seeds

Seed importation is required in Nigeria to augment domestic production, access to superior tomato varieties that meet the requirements of farmers. Tomato seed importation must be done by only registered, licensed seed companies who indicated interest in importing seed are expected to submit duly completed seed importation form from NASC which contains the following information: The crop, variety, quantity and the country of origin of the seed intended to be imported. NASC in turn grants approval for obtaining seed import permit from NAQS. However, effective quality control at the time of import is crucial to prevent entry of inferior quality or disease-contaminated seeds. This requires systematic procedures for sampling, testing and release of imported seed lots.

5.00 Phytosanitary certificate from country of origin

A phytosanitary certificate which certifies that the seeds were inspected and verified to be free from specified diseases and pests based on field/lab tests issued by competent authority/agency in the exporting country is required for all seed consignments. The certificate also provides details of place of origin, Variety name, exporter, quantity, treatment if any, port of shipment, etc. The certificate should not be more than 14 days old at the time of shipment. This will enable checking the disease status as per exporter’s certification.

5.10 Laboratory testing on arrival for quality parameters

On arrival, seed samples shall be drawn by officers from the Nigerian Agricultural Quarantine services (NAQS) and NASC following ISTA sampling guidelines for laboratory testing. Seed tests such as physical purity, germination, moisture content, seed health, seed purity among others will be conducted. Test results on the seed lot's quality status will be compared to exporter's documentation. Sub-standard lots may be detained/confiscated (or treated if amendable) or rejected in order to prevent potential introduction of diseases.

5.20 Quarantine inspection and release

The NAQS is basically concerned with phyto-sanitary evaluation (tests and inspection) of the imported tomato seeds. Seed importers need to visit NAQS to make enquiries on procedure and steps involved before a phyto-sanitary certificate can be issued. Often imported tomato seeds come in sachets and cans and the samples are picked at random from each batch of the consignment.

The quarantine inspection focuses on freedom from soil particles, plant debris, insects, and weed seeds. If contamination is detected or live insects (tolerated) are found and is localized, disinfection and fumigation may be required or recommended otherwise the consignment will be rejected and destroyed. Fungal infections like Alternaria, bacterial canker and viral diseases are key concerns. After documentary checks and lab tests, if the consignment is found to be compliance, quarantine release certificate will be issued by NAQS.

5.30 Lab Tests

Physical purity, Germination and Moisture content are similar to that of certified seed previously discussed additional information is as stated in table 2 (below).

Table 2. Physical purity, Germination and Moisture content are similar to that of certified.

Imported seeds/parameters	**Hybrid**	**OPV**
Physical purity	98	95
Germination	80	75
Moisture content	8 -10%	8 -10%
Bacterial canker	0.1%	0.1%
Bacterial spot	(0.5%).	(0.5%).

5.40 Sample size

Sampling should be done in accordance with ISTA sampling procedures. However, most imported tomato seed come to Nigeria in 5g sachets, 1000 seeds/sachet, 50g tin or 100g tin. Sampling should be done to conform with international standard where 5000 seeds are drawn from lots up to 100 kg, therefore 2-5 sachets from every 1000 sachets and 2-5 tins from every 1000 tins is proposed or as may be determined by the agency in such a way that will reflect a representative samples, sample size is 1 kg drawn from 100 increments across the seed bags. This is important and required for the reliability of the results. Sample size of not less than 0.2% of lot size and at least 3000 seeds has been suggested in other climes for reliable disease detection.

Annexes

List of some tomato diseases

- Bacterial canker (*Clavibacter michiganensis*)
- Bacterial spot (*Xanthomonas campestris*)
- Bacterial wilt (*Ralstonia solanacearum*)
- Early blight (*Alternaria solani*)
- Septoria leaf spot (*Septoria lycopersici*)
- Fusarium wilt (*Fusarium oxysporum*)
- Tomato mosaic virus
- Tomato yellow leaf curl virus
- Blossom end rot
- Anthracnose
- Damping off

Rejection criteria

- More than 0.5% off-types at final inspection
- Less than 75% germination
- Over 12% moisture content
- Presence of seed borne pathogens above tolerance limit e.g. 0.1% bacterial canker
- Admixture of other crop/variety seeds above 20/kg

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