DETERMINE MOISTURE LEVEL OF SEED

A Unit Standard for the Seed Industry

Unit Standard 114675
NQF Level 3
Credits: 5

Compiled by:
Michael Zingel, Peter Froneman & Rina Blomerus

S A N S O R

Learner Name: 
Learner Number: 
Table of Contents

UNIT 1: DETERMINE MOISTURE LEVELS ................................................................. 4
  1.1 Introduction ........................................................................................................... 4
  1.2 Definition of seed moisture content ................................................................. 4
  1.3 Importance of determining moisture content ..................................................... 4
  1.4 Determination of seed equilibrium moisture content ......................................... 5
  1.5 Determination of seed moisture content .............................................................. 7
  1.5.1 How to determine seed moisture content ....................................................... 10
  1.5.2 Oven Moisture test method .......................................................................... 11
  1.5.3 Equipment necessary for oven moisture test ................................................. 11
  1.5.4 Standardization of Oven Moisture Test ......................................................... 12
  1.5.5 Procedure ........................................................................................................ 13
  1.6 Other methods for Seed Moisture Content Testing .......................................... 14
  1.6.1 Determination of moisture content by moisture meters ................................... 14

ANNEXURE 1 : REFERENCES ................................................................. 17

ANNEXURE 2 : UNIT STANDARD ............................................................... 18
Table of Figures

FIGURE 1: DETERMINE MOISTURE CONTENT ............................................................9

TABLE 1: EQUILIBRIUM MOISTURE CONTENTS OF SOME COMMON CROP SEEDS AT 25 °C 6

TABLE 2: SPECIES WHOSE MOISTURE CONTENT SHOULD BE DETERMINED BY ISTA METHODS ..................................................................................................................7

TABLE 3: SPECIES WHOSE MOISTURE CONTENT SHOULD BE DETERMINED BY ISTA METHODS ..................................................................................................................8

US: Determine moisture level of seed

Unit Standard Specific Outcomes

SO1  Prepare unit area for conducting the test

SO2  Prepare moisture sample and relevant documentation.

SO3  Complete the moisture determine test.
UNIT 1: DETERMINE MOISTURE LEVELS

1.1 Introduction

The testing of the moisture in seeds is an important part of seed testing. Knowing the seed moisture contents helps to determine the optimum time for harvest and identifies appropriate seed storage and drying recommendations. It also helps establishing the susceptibility of seeds toward mechanical damages and the potential for invasion by pathogens and insects. Throughout this manual the ISTA rules for seed testing was used as the main source of reference. It is important that all the companies where the moisture content of seed are determined are in possession of the latest version of the ISTA rules for reference when conducting these seed tests.

1.2 Definition of seed moisture content

The moisture content is the amount of water in the seed and is usually expressed as a percentage. It can be expressed on either a wet weight basis (where it is expressed as a percentage of the fresh weight of the seed) or on a dry weight basis (where it is expressed as a percentage of the dry weight of the seed). Seeds either give or take up water from the atmosphere until the moisture content of the seed and the relative humidity (RH) of the air are in equilibrium. This moisture content is called the equilibrium moisture content and because it is constant for any species at known temperature and relative humidity, it can be used as an approximation of the actual seed moisture content. Different crops absorb different amounts of water. Seeds high in protein and starch typically possess higher equilibrium seed moisture content at the same relative humidity compared to seeds high in oil content.

The seed moisture content can either be accurately determined experimentally by scientific techniques, or it can be predicted approximately from the information available.

1.3 Importance of determining moisture content

A small change in seed moisture content has a large effect on the storage life of the seeds. Therefore it is important to know the moisture content in order to make a reasonably accurate prediction of the possible storage life of each lot. The methods for determination described in the following pages are mostly according to the International Seed Testing Association (ISTA) regulations. Other methods are available and can also
be used provided that the results give an accurate determination of moisture content and are calculated on a wet weight basis.

### 1.4 Determination of seed equilibrium moisture content

- For this test use either excess seeds or those which are being discarded because they have lost viability.
- Take two lots of seeds of the species of known weight and leave them in open containers in the environment of your genebank to equilibrate. It may take a few days for small seeds and longer for large seeds. The seeds will have reached equilibrium with the moisture content of the air when there is no change in weight on different days.
- By using an aspirated hygrometer, measure the relative humidity of the atmosphere where the seeds have been held for the past few days. Then measure the mean temperature.
- Remove a sample of seeds and do an accurate determination of moisture content for each seed lot.
- Because seed lots of the same species should equilibrate at similar moisture content under the same conditions, the mean of the two tests can be used as a guide.
- To make sure that the moisture content is stable and that the equilibrium has been reached, repeat the determination the following day.
- The work can be repeated using a number of species which are of interest at a range of relative humidity that are common in your country at different times of the year.
- It is a good idea to construct a table of the equilibrium moisture content at different temperatures and relative humidity and use this as future reference. See example.

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<tr>
<td>Barley (Hordeum)</td>
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<tr>
<td>Beet (Beta)</td>
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</tr>
<tr>
<td>Buckwheat (Fagopyrum)</td>
<td>6.7</td>
</tr>
<tr>
<td>Crop</td>
<td>5.4</td>
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<tr>
<td>---------------</td>
<td>-----</td>
</tr>
<tr>
<td>Cabbage (Brassica)</td>
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<tr>
<td>Carrot (Daucus)</td>
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<tr>
<td>Cucumber (Cucumis)</td>
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<tr>
<td>Eggplant (Solanum)</td>
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<tr>
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<td>Lima bean (Phaseolus)</td>
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<td>Maize (Zea)</td>
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</tr>
<tr>
<td>Mustard (Brassica)</td>
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<tr>
<td>Oat (Avena)</td>
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</tr>
<tr>
<td>Okra (Abelmoschus)</td>
<td>8.3</td>
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<td>Onion (Allium)</td>
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<td>Radish (Raphanus)</td>
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<td>Rye (Secale)</td>
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<td>Sorghum (Sorghum)</td>
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<td>Soyabean (Glycine)</td>
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<td>Tomato (Lycopersicon)</td>
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<td>Turnip (Brassica)</td>
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<tr>
<td>Watermelon (Citrullus)</td>
<td>5.1</td>
</tr>
<tr>
<td>Wheat (Triticum)</td>
<td>6.5</td>
</tr>
<tr>
<td>Winter squash (Cucurbita)</td>
<td>5.6</td>
</tr>
</tbody>
</table>

Table 1: Equilibrium moisture contents of some common crop seeds at 25°C

1.5 Determination of seed moisture content

Seed moisture content can be experimentally determined by various methods. The IBPGR Advisory Committee on Seed Storage has advised that, for use in genebanks, the ISTA methods are accurate and acceptable. However, considering that the cost of germplasm is high and moisture content determination is destructive, it has been recommended that the ISTA methods should be modified by reducing the weight of seeds required for each replicate whilst increasing the accuracy of the weighing.

The ISTA Rules have only recommended standard methods for common crop seeds as indicated in the ISTA textbook for seed testing. (Table 9B & 9C). There are therefore no standard methods for many of the species stored in genebanks. The ISTA methods can be applied to seeds of these species and appropriate work site procedures should be available for these species.

<table>
<thead>
<tr>
<th>TABLE 9B: Modified low constant temperature oven method</th>
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<tr>
<td>Brassicas</td>
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<tr>
<td>Castor (Ricinus)*</td>
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<tr>
<td>Pepper (Capsicum)</td>
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<tr>
<td>Cotton (Gossypium)*</td>
</tr>
<tr>
<td>Eggplant (Solanum)</td>
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<tr>
<td>Falseflax (Camelina)</td>
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<td>Flax (Linum)</td>
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Table 2: Species whose moisture content should be determined by ISTA methods
<table>
<thead>
<tr>
<th>Table 9C: Modified high constant temperature oven method</th>
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<tbody>
<tr>
<td>Alfalfa (Medicago)</td>
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<tr>
<td>Asparagus (Asparagus)</td>
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<tr>
<td>Barley (Hordeum)*</td>
</tr>
<tr>
<td>Bean (Phaseolus)*</td>
</tr>
<tr>
<td>Beet (Beta)</td>
</tr>
<tr>
<td>Bentgrass (Agrostis)</td>
</tr>
<tr>
<td>Bermuda grass (Cynodon)</td>
</tr>
<tr>
<td>Black salsify (Scorzonera)</td>
</tr>
<tr>
<td>Bluegrass (Poa)</td>
</tr>
<tr>
<td>Brome (Bromus)</td>
</tr>
<tr>
<td>Buckwheat (Fagopyrum)*</td>
</tr>
<tr>
<td>Canarygrass (Phalaris)</td>
</tr>
<tr>
<td>Caraway (Carum)</td>
</tr>
<tr>
<td>Carrot (Daucus)</td>
</tr>
<tr>
<td>Chervil (Anthriscus)</td>
</tr>
<tr>
<td>Chickory (Cichorium)</td>
</tr>
<tr>
<td>Chickpea (Cicer)*</td>
</tr>
<tr>
<td>Clover (Trifolium)</td>
</tr>
<tr>
<td>Cocksfoot (Dactylis)</td>
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<tr>
<td>Cress (Lepidium)</td>
</tr>
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<td>Crested dogtail (Cynosurus)</td>
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<td>Cucumber (Cucumis)</td>
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<td>Cumin (Cuminum)</td>
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<tr>
<td>Dallisgrass (Paspalum)</td>
</tr>
<tr>
<td>Fescue (Festuca)</td>
</tr>
<tr>
<td>Foxtail (Alopecurus)</td>
</tr>
<tr>
<td>Lettuce (Lactuca)</td>
</tr>
</tbody>
</table>

Table 3: Species whose moisture content should be determined by ISTA methods
Figure 1: Determine moisture content
1.5.1 How to determine seed moisture content

STEP 1: DETERMINE HOW MANY SEEDS ARE AVAILABLE FOR THE TEST

- The ISTA rules for seed testing recommend that two replicates of seeds are used for the determination of moisture content for official seed testing.
- The lower the weight of seed used, the more accuracy is required to achieve a true result.
- The submitted sample is only accepted if it is in an intact, moisture-proof container and as much air as possible has been excluded (sealed for official purposes).

STEP 2: DETERMINE IF PRE-DRYING IS REQUIRED

ISTA requires pre-drying for seeds of the species which require grinding (as listed in Table 2 & 3) if the moisture content is more than 17%, for seeds of soyabean of more than 10% moisture content, seeds of rice of more than 13% moisture content and seeds of other species of more than 30% moisture content.

STEP 3: DETERMINE IF GRINDING IS NECESSARY

Check the ISTA list of species to see if the seeds require grinding (Table 2 & 3). Large seeds must be ground before drying unless their high oil content makes them difficult to grind. Tree seeds with very hard seed coats and large tree seeds may be cut into smaller pieces instead of ground.

STEP 4: DECIDE WHICH METHOD IS APPROPRIATE TO USE

Two methods are recommended: one for oily seeds and one for all others.
- The Low Constant Temperature Oven method shall be used for seeds of the species in ISTA Table 9B.
- The High Constant Temperature oven method shall be used for seeds of the species in ISTA Table 9C.
- If the species are not included in Table 2 & 3, but has oily seeds, use the modified ISTA Low Constant Temperature Oven Method.

STEP 5: PROCEED WITH THE DETERMINATION OF MOISTURE CONTENT

- Place working sample in oven according to ISTA Rules / worksite procedures.

STEP 6: USE THE RESULTS OF THE WEIGHING TO CALCULATE MOISTURE CONTENT

- Moisture content is calculated on a wet weight basis.
It is calculated to one decimal place by means of a formula.

Measurement of tolerance where replicates should not differ by more than 0.2%.

For samples tested without pre-drying use the following formula:

\[
\text{% Moisture Content} = \frac{\text{Weight of fresh seeds} - \text{Weight of dry seeds}}{\text{Weight of fresh seeds}} \times 100\%
\]

For samples which have been pre-dried, use the following formula:

\[
\text{Final % moisture content} = S1 + S2 - \frac{S1 \times S2}{100} \%
\]

where

- \( S1 \) = Percentage moisture content from first stage of drying, and
- \( S2 \) = Percentage moisture content from second stage of drying.

### 1.5.2 Oven Moisture test method

The procedure for the oven moisture tests method requires that a weighed quantity of seed be dried in an oven at a certain temperature for a specific time, cool in a desiccator and the loss in weight calculated as percentage moisture content on a fresh or dry weight basis.

### 1.5.3 Equipment necessary for oven moisture test

**Constant temperature oven and accessories**

There are two kinds of ovens that can be used: gravity-convection or mechanical-convection. The oven should be electrically heated with thermostatic and accuracy should be within ± 0.5°C. It should be well insulated, be able to maintain the required temperature within ± 1.0°C, and a recovery time of 15min or less.

The moisture dishes or containers at best would be an aluminium dish with a lid which fits tight, or dishes made of non-corrosive metal or glass. The desiccator should consist of a thick metal plate and the lid should be air-tight, to enhance rapid cooling, with an air-valve to allow the heated air to escape.

**Grinder**

The Grinding mill must meet certain requirements:

- Be constructed of non-absorbent material.
Be so constructed that both the seeds to be ground and the resulting ground material are protected from ambient air during grinding, to the maximum extent possible.

- Grind evenly at a speed that the sample is not exposed to air or excessive heat.
- Be adjustable so that the specific particle size can be obtained according to ISTA regulation and worksite procedures.

**Analytical Balance**

The scale should be accurate and capable of weighing to 0.001g.

**Sieves**

Wire sieves are required with meshes of 0.50mm, 1.00mm and 4.00mm.

**Cutting tool**

A scalpel or hand pruning shears with blades of at least 4.0cm long should be used for cutting large tree seeds and hard-seeded tree species.

### 1.5.4 Standardization of Oven Moisture Test

The results of the tests can be affected by some factors if they are not controlled or conducted. Some of these factors are:

**Oven**

The temperature should be the same throughout the entire oven. The thermometer must be inspected and certified for its accuracy.

**Drying temperature**

The moisture test methods must identify drying periods and temperatures that have enough water in the seed to compensate for the weight of volatiles lost during drying.

**Drying period**

The required drying temperature must be obtained before timing of the drying period should start and before the samples are put in the oven.

**Moisture dish**

Flat aluminium dishes are good for drying because the seed depth is excessive and it will increase drying time. The diameter of the dish is relative to the amount of seed (in grams) placed in it. Refer to the ISTA Rules on how to determine the size of the container for the amount (gm) of seed to be placed in it.
Grinding

It is important to grind large seeds in order to shorten the drying period of the seed moisture test. It is also possible that grinding can reduce the seed moisture content of the sample. Take note that seeds with high moisture content as well as seeds with a 25% or more oil content should not be ground.

Desiccant

Sample should be put into a desiccator for at least 45 min (or until cool to the touch) before weighing. A suitable desiccant should be used such as phosphorus pentoxide.

1.5.5 Procedure

The ISTA procedures for grinding, cutting and pre-drying should be followed.

Oven Moisture Testing Procedure

- Turn on oven and set to appropriate temperature.
- Seeds must be sent to the laboratory in moisture proof container to assure the results are reflective of the seed lot.
- Stir the seeds briefly to allow for a random sample to be taken. Place the container with lid on the scale and weigh the two sub-samples. Cover immediately and place in desiccator.
- Record the weight of the “wet” seed and the container (W) in grams with the lid on.
- Open the container, evenly spread the seed (quick gentle shake) and together with lid place into the moisture oven set at the prescribed temperature. Wait the required time (15 min) for the oven to reach temperature and start recording the time.
- Remove moisture containers after specified time and cover immediately with lid. Place in desiccator for 45 min or until cooled to touch.
- Record the weight of the “dry” seed and container.
- Calculate the Moisture Content Percentage.

The following are two examples of the formulae used to calculate seed moisture content. You must however know the appropriate formulae used at the workplace to calculate the seed moisture content for the applicable species.
Wet weight

\[
\frac{\text{Weight before drying} - \text{Weight after drying}}{\text{Weight before drying}} \times 100\% = \text{Moisture content (Wet weight basis)}
\]

Dry weight

\[
\frac{\text{Weight before drying} - \text{Weight after drying}}{\text{Weight after drying}} \times 100\% = \text{Moisture content (Dry weight basis)}
\]

**Reporting results**

The moisture content must be reported to the nearest 0.1% in the space provided on the ISTA International Seed Analyses Certificate or Laboratory Seed Analysis Certificate.

### 1.6 Other methods for Seed Moisture Content Testing

- **Capacitance Meters**

  These electrical devices are used for indirect seed moisture testing. Seeds with a known weight are exposed to a high frequency voltage in the test cell. The dielectric constant identifies the amount of water in the cell. These meters must be calibrated using a direct seed moisture test method (according to ISTA methods) and have the greatest accuracy for moisture contents between 6% and 25%.

- **Resistance Meters**

  The operational principle of resistance meters is the fact that seeds increasingly conduct a current of electricity as the seed moisture content increases. These meters function best for seeds with a moisture content between 7 and 23%. The conductivity of the seed surface can also be measured with this device. These meters can easily be standardised with other meters.

#### 1.6.1 Determination of moisture content by moisture meters

Calibrations should be done on equipment every one hundred determinations or at least once a year. For each species that is analysed by means of a moisture meter a calibration report is required.

**Method 1**

**Apparatus**

Depending on the method used, the following apparatus is necessary:
Moisture meter
Airtight containers
Appropriate sieves for species to be tested
Grinder
Analytical balance

Procedures

Precautions

There are many variables that might affect the calibration of moisture meters such as, temperature, humidity, ripeness, species, level of impurities and varieties.

The sample and moisture meter should be at the same temperature before any assessments are made. Exposure of the sample to the atmosphere should be as little as possible.

Calibration sample

Five samples should be obtained from each of a minimum of two varieties of the species for which the moisture meter is being calibrated. The variety of samples should be able to cover the required measurement range of the moisture meter being checked.

The samples should be free of impurities as well as mustiness, fermentation and sprouted seed.

Working sample from calibration sample

Samples used for calibration should be put in moisture-proof containers which are well sealed and be used within 10 days.

Working samples should be drawn after thorough mixing and not be exposed to the air for more than 30 seconds.

Prescribe methods

The oven method is used to assess the moisture content of the calibration samples

Calculation of results

Follow ISTA regulations on calculations for calibrating of moisture meters.
**Method 2**
The object is to determine the moisture content of specified species of seed using a calibrated moisture meter.

**Apparatus**
- Moisture meter
- Containers
- Grinder
- Balance

**Procedure**

- **Precautions**
  The submitted sample shall be accepted for moisture determination only if it is in an intact, moisture proof container from which as much air as possible has been displaced. Exposure of the sample to the atmosphere should be as little as possible.

- **Working sample**
  Two independently drawn working samples, each of the weight working samples, each of the weight/volume required for the specific meter, shall be used for the determination. Working samples should be drawn after thorough mixing and not be exposed to the air for more than 30 seconds.

- **Calculation of results**
  The moisture content as a percentage by weight shall be calculated to one decimal place using the following formula:

  \[
  \frac{M_1+M_2}{2}
  \]

  M1 and M2 are the readings of the duplicates from the meter.

- **Tolerance**
  The difference between the two determinations should not exceed 0.2%.

- **Reporting results**
  The moisture content must be reported to the nearest one decimal place in the space provided on the ISTA International Seed Analysis Certificate or Laboratory Seed Analysis Certificate.
ANNEXURE 1: REFERENCES

This document does not claim to be an original publication. Various sources of information and documents were used when compiling this document. Any neglect to make reference of any source, including an author, website or publication is not through intent. Such omissions should be brought to the attention of SANSOR, who will gladly rectify the omission.

Plant Improvement Act (1976)
www.seedtest.org
www.aosaseed.com
www.seedburo.com

International Seed Testing Association (ISTA Rules)
### ANNEXURE 2 : UNIT STANDARD

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<td>Determine moisture level of seed</td>
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PURPOSE OF THE UNIT STANDARD
A learner who has achieved this unit standard will be competent in:

- Determining the moisture content of seed to determine fitness for use.

LEARNING ASSUMED TO BE IN PLACE AND RECOGNITION OF PRIOR LEARNING
To enter a learning programme for this unit standard or to be assessed against this unit standard, the learner is assumed to have:

- Understanding of general safety in the work place at NQF level 2.
- Literacy, numeracy and communication skills at NQF level 2.
- Introduction to the seed industry and relevant work place.

UNIT STANDARD RANGE
The learner is expected to perform the specific outcomes as reflected in this unit standard without direct supervision, but with access to work-site procedures, operating instructions and statutory requirements.

- Operational procedures are limited to International Seed Testing Association (ISTA) Rules.
- Equipment includes, but is not limited to: grinding mill, constant temperature oven, analytical mass meter, electronic measuring equipment and sieves.

Specific Outcomes and Assessment Criteria:

SPECIFIC OUTCOME 1
Prepare the work area for conducting the test.

OUTCOME NOTES

- Ensuring that work area and equipment are clean and dry according to work site- and operational procedures.
- Identifying and selecting appropriate equipment and test methods according to work site procedures and operational procedures.
- Reporting any defects pertaining to appropriate equipment or materials according to work site procedures and operational procedures.

ASSESSMENT CRITERIA

ASSESSMENT CRITERION 1
Assessors will observe, confirm and evaluate evidence that will indicate that learners have demonstrated competence in each of the specific outcomes. In this unit standard the following specific criteria should be used:

- Consequences of not sub-sampling accurately according to the operational procedures are explained.
- Consequences of not using clean and dry equipment are explained.
- Consequences of not identifying and reporting findings accurately according to the operational procedures and work site procedures are explained.
Consequences of not reporting deviations are explained.

The importance of using the correct equipment and methods for determining moisture content according to work site procedures are explained.

The importance of keeping records according to the operational procedures, work site procedures and statutory requirements are explained.

**SPECIFIC OUTCOME 2**

Prepare moisture sample and relevant documentation.

**OUTCOME NOTES**

- Familiarising with the peculiarities of the specific crop type according to operational procedures.
- Acquiring the working sample according to operational procedures.
- Preparing relevant documentation to record action taken according to work site- and operational procedures.
- Obtaining the moisture sample for placing in the relevant equipment, according to work site- and operational procedures.
- Obtaining action documentation and operation manuals according to work site- and operational procedures.
- Taking corrective action where deviations occur according to work site- and operational procedures.

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- Consequences of not identifying and reporting findings accurately according to the operational procedures and work site procedures are explained.
- Consequences of not reporting deviations are explained.
- The importance of using the correct equipment and methods for determining moisture content according to work site procedures are explained.
- The importance of keeping records according to the operational procedures, work site procedures and statutory requirements are explained.

**SPECIFIC OUTCOME 3**

Complete the moisture determination test.
OUTCOME NOTES

➢ Reporting deviations to relevant parties according to work site- and operational procedures.

➢ Recording findings on action documentation according to work site- and operational procedures.

➢ Completing documentation and forwarding to the relevant parties according to operational procedures and work site procedures.

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➢ Consequences of not using clean and dry equipment are explained.

➢ Consequences of not identifying and reporting findings accurately according to the operational procedures and work site procedures are explained.

➢ Consequences of not reporting deviations are explained.

The importance of using the correct equipment and methods for determining moisture content according to work site procedures are explained

➢ The importance of keeping records according to the operational procedures, work site procedures and statutory requirements are explained.

UNIT STANDARD ACCREDITATION AND MODERATION OPTIONS

➢ An individual wishing to be assessed against this unit standard may apply to an assessor accredited by SETASA.

Any training provider offering learning that will enable achievement of this unit standard must be registered and accredited by SETASA.

Moderation of assessment will be done by SETASA in its ETQA capacity at its discretion.

UNIT STANDARD ESSENTIAL EMBEDDED KNOWLEDGE

➢ Basic knowledge of the effects of moisture content of seed.

➢ Knowledge and theory of equipment to determine moisture levels.

**Critical Cross-field Outcomes (CCFO):**

UNIT STANDARD CCFO IDENTIFYING

Identify and solve problems by determining the moisture levels of seed.
UNIT STANDARD CCFO WORKING
Work effectively with others with whom the relevant function interfaces.

UNIT STANDARD CCFO ORGANIZING
Organise and manage oneself when preparing for moisture testing of seed.

UNIT STANDARD CCFO COLLECTING
Collect, analyse, organise and critically evaluate the information documents, samples and condition of work site.

UNIT STANDARD CCFO COMMUNICATING
Communicate with others in the process of determining the moisture levels of seed.

UNIT STANDARD CCFO DEMONSTRATING
Understand the world as a set of related systems in appreciating the importance of accurate analysis, identification of, irregularities and defects and the consequences of not reporting these with regard to the determination of the moisture content of seed.

UNIT STANDARD NOTES
Values:
All learners should demonstrate:

➤ An application of company ethics, values as well as general safety and customer care principles.

➤ An awareness of expectations and obligations of basic worker/management/customer relationships.