The East Africa Trade Hub (EATH) has produced a series of training tools to promote broad awareness, understanding and application of the regional harmonized staple foods quality standards which were approved and declared by the East Africa Standards Committee in July 2013. This trainer’s guide was created with stakeholder input and is intended to assist national and regional stakeholders facilitate widespread uptake of the regional standards along all segments of the staple foods value chains. EATH encourages stakeholders to update the trainers guide as needed so that it remains a relevant tool for all users.
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1. Introduction

1.1 Objective of the Trainers Guide
This trainer’s guide was created to assist farmers, traders, processors and certified graders to understand and apply the EAS 2:2013 correctly in the determination of maize quality. It aims at ensuring that maize farmers, traders, grain handlers, and processors meet relevant standards, reduce post-harvest wastage and provide safe, appropriate quality maize to consumers.

Specific Objectives:
- To explain to maize farmers, traders, grain handlers, and processors the meaning of the term quality, emphasizing that quality has two dimensions: “must-be quality” and “attractive quality”.
- To demonstrate to farmers, traders and dealers that the quality of maize is measurable.
- To acquaint the farmers and traders with the common physical defects in maize that can hinder market access and profitability.
- To demonstrate how physical defects are assessed in meeting standards requirements.

1.2 Basis of the Trainers Guide
- This is a training product for anyone working with maize farmers, traders, grain handlers and grain processors.
- It is based on the fact that the trainer has more technical knowledge than the trainees.
- This manual outlines grading based on the EAS 2:2013 Maize grain specifications.
- This training manual can be adapted to train various groups with different interests; farmers of production and delivery of quality crop; traders, grain handlers and processors, on grading delivered maize.

1.3 Uses of Maize
Maize grain is used for three main purposes: as a staple food, as feed for livestock and poultry, and as a raw material for many industrial products. In East Africa, nearly all maize grain is used and prepared in a variety of ways for human consumption. Maize is eaten fresh on the cob, roasted, or ground into a meal that is then boiled into porridge or fermented into beer. Maize is mainly consumed as thick porridge (‘ugali’) or light porridge (‘Uji’). It is commonly eaten with cooked vegetables and, when available, meat. It is also commonly given as a weaning food. In Kenya, local beer (‘Busaa’) and liquor (‘Changaa’) are prepared from maize grain malt. Popcorn is a popular snack sold commercially (like in cinemas) or hawked on the streets of urban centres.

The main maize-based industrial products are breakfast products such as cornflakes, starch, sugar and oil. Its main component, starch, is used for human consumption or made into syrup or alcohol. Maize can also be used in laundry starch or as a raw material for many food and chemical products. Most industrial products are produced using the wet-milling process. In wet-milling, grain is steeped in water, which separates the germ and bran from the endosperm. Maize-based products are then produced by physical or chemical processes. Sugars from maize now account for half of the sugars in human nutrition. Dry milling produces grits, consisting of coarsely ground endosperm from which most of the bran and the germ have been separated. The germ yields oil that can be refined for human consumption, widely used as cooking or salad oil and in margarines. The residues from the production of starch or oil, together with the bran, are used in animal feeds (corn gluten meal and corn gluten feed).

Unripe cobs are consumed as vegetable or green maize, boiled or roasted. Very young female inflorescences (‘baby cobs’) are a delicacy in Western countries and in Asia but are not

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commonly consumed in East Africa. Mature maize plants are used for animal feed. Silage maize is one of the leading crops in large-scale dairy and beef farming. The stalks are used for fuel, fodder, thatching and as compost.
2. Grain Quality and Grain Quality Standards

2.1 Overview
This section is the basis for the remainder of the handbook. It is intended to explain the importance of maize quality assurance starting from farm level. Farmers should know that maize quality assurance involves prevention of defects from the earliest stages of cultivation. This includes proper land preparation and using the right inputs.

2.2 Quality
The term “quality” as applied to food material refers to those attributes of the food which make it agreeable to those who consume it. Attributes of quality involve colour, flavour, texture, nutritional value and the absence of harmful substances such as microorganisms, insects, pest and their metabolic products, chemical residue and noxious seeds.

Grain quality is generally assessed based on general aspects (characteristics that give value to the user) and safety aspects (characteristics that pose a hazard to the end user). For example, broken grain, other coloured grain and high moisture grain reduce the amount and/or quality of flour a miller gets after milling. On the other hand, Aflatoxin and pesticide residue could harm the consumer. Therefore, any grain that does not meet safety requirements is rejected despite looking physically appealing or meeting the general quality characteristics.

Grain quality may have different meanings to different people and may depend on the grain type and its end use. Since the requirements of farmers, traders, millers and consumers are not necessarily compatible; Quality Standards have to be established to even the playing field.

2.2.1 Quality Standards
Standards refer to the measures that serve as a basis for making comparisons or judging the accuracy of unknown samples. Standards are established for a variety of purposes including facilitating smooth and fair trading and protection of consumers. An example of a quality standard is the EAS 2:2013 Maize grains – specification which was developed in order to harmonize maize quality requirements in East Africa.

Standards are developed by national, regional and international standards institutions often to enforce legislation. These bodies issue specifications for commodities as well as methods of testing. Examples of these bodies include Kenya Bureau of Standards (KEBS), East African Community (EAC), American Association of Cereal Chemists (AACC), Association of Analytical Chemists (AOAC), and International Standards Organization (ISO).

It is common for standards bodies to adopt standards issued by another body. For example, the EAS 2:2013 (Maize grains specifications) has adopted ISO 605 test methods to determine impurities, size, foreign odours, insects, other grains. All adopted Standards appear under “normative references”. When testing under a particular standard, all the standards referred to under “Normative references” have to be followed as well.

There are many standards, even for a particular crop depending on the origin and destination of the traded grain. For example, COMESA and EAC maize standards differ. Also Maize grains and dry beans standards are different. For proper grading of grain to be done to determine the quality, the grader has to use:

1) The correct standard for the particular grain and market e.g. EAS 2:2013 Maize Grains – specifications
2) The correct standard test method i.e. sampling and using the right procedure to grade
3) The correct standard test equipment e.g. using a 4.5mm round sieve to determine broken grain in maize.

2.2.2 Quality Control

Quality control refers to a system of maintaining standards in products by testing a sample to see if it meets the required standards. It involves use of a particular standard, test method and equipment to detect defects and assess the quantity of certain physical, sanitary or chemical quality parameters.

Grain grading is a process of categorising grain based on certain quality parameters. This informs decisions such as storage of the grain, uses of the grain, the purchase price and so on.

Figure 1: Grain grading
3. Maize Grain Quality Standards

This Trainers manual is based on the EAS 2:2013 Maize grain specifications, a maize standard that was passed by EAC and adopted by member countries for implementation in their respective countries.

3.1 Presentation

The Standard defines maize or corn as the shelled grains of the species (Zea mays indentata - dent maize) or (Zea mays indurate – flint maize) or their hybrids.

3.1.1 Colour

Maize comes in different colours: white, yellow, red, blue, black and mixed. For purposes of EAS 2:2013, maize is only classified as Yellow, White, Red, or Mixed. A maize kernel is considered of a certain colour if 50% or more of its surface is of that colour. For example, when grading white maize, maize which has yellow or pink colouration that is less than 50% of the surface is still considered white maize. Care should be taken not to grade grain of other colours as discoloured grain.

**Mixed maize** includes maize that does not fall in classes of White, Red or Yellow.

![Figure 2: Yellow maize](image1)
Maize is considered **Yellow** if it does not contain more than 5% of other colours.

![Figure 3: White Maize](image2)
Maize is considered **White** if it does not contain more that 2% of other colours.

![Figure 4: Red Maize](image3)
Maize is considered **Red** if it does not contain more than 5% of other colours.

![Figure 5: Mixed Maize](image4)

**Dent maize**, when fully ripe, has a pronounced depression or dent at the crown of the kernels. The kernels contain a hard form of starch at the sides and a soft type in the centre. This latter starch shrinks as the kernel ripens resulting in the terminal depression. Dent varieties vary in kernel shape from long and narrow to wide and shallow.

Maize is classified as Dent if it consists of 95% or more of Dent maize kernels.
Flint maize has the hard starch layer entirely surrounding the outer part of the kernel. Consequently, on drying the kernel shrinks uniformly and does not develop a depressed area. It has a very hard seed coat.

When grading maize, it has to be described by its colour and nature e.g. white flint maize or, yellow dent maize, etc.

3.2 Grain Defects

Sanitary Defects
These are defects in the grain that pose a health hazard to human beings and animals. If detected in the grain, the grain will be rejected and condemned as “not fit for human consumption’. Tests for sanitary defects include tests for mycotoxins and pesticide residue.

3.2.1 Diseased grains

Diseased grains appear rotten or unpleasing to the eye. They can often be observed without having to cut the grains to examine them. Mouldy grains have various colours depending on the mould or yeasts that could have afflicted them e.g. green, blue, black, grey etc.

Diseased grains are unsafe for human consumption due to decay, moulding, bacterial decomposition, or other causes. See pictures below:
Mouldy kernels
These are maize grains that have visible blue, white, green, mycelial growth on its tip or surface. Moulds, especially Aspergillus flavus are dangerous to humans and animals as they cause mycotoxins. Aflatoxins can cause aflatoxicosis and are known to be cancer inducing.

Aflatoxin contamination cannot be detected using eyesight. Good white maize could still have potentially high levels of Aflatoxin. Mouldy grain could have high levels of mycotoxins though.

When grading, mouldy kernels should be counted as part of diseased grains. Musty smell could indicate moulding. Grain with musty smell of generally appearing mouldy should be rejected.

Other Defects

3.2.2 Insect or vermin damaged maize
Insect or vermin damaged maize kernels are those that have been partially eaten by weevils, grain borers or other crawling pests. Some grains may have insects or insect webbing. Insect or their larvae may be present. The grain kernel may have the germ partly or wholly destroyed. Insect parts or their waste may also be an indicator of infestation, and renders the maize unsuitable for human consumption. The pictures below show some examples of insect or vermin damage.

3.2.3 Discoloured kernels
Discoloured grains are kernels that are materially discoloured (at least 25% of the surface) by excessive heat, including that caused by excessive respiration (heat damage) and dried damaged kernels. Kernels may appear darkened, wrinkled, blistered, puffed or swollen, often with discoloured, damaged germs. The seed coat may be peeling or may have peeled off completely, giving kernels a checked appearance.
3.2.4 Germinated kernels

Kernels showing visible signs of sprouting, such as cracked seed coats through which a sprout has emerged or is just beginning to emerge. At the early stages of germination, grains may be bulged.

3.2.5 Immature/shrivelled maize

These are maize grains which are under-developed and shrunken. The kernels are thin and papery in appearance. They are of low relative density compared to normal maize. They could be unfertilized ovules or kernels whose fertilization was not completed. See immature grain to the right in the photo below.

3.2.6 Broken kernels

This is maize and pieces of maize which have passed through a metal sieve with round holes whose diameter is 4.5 mm. This implies that maize that any broken kernels that are retained on top of the 4.5mm round sieve are not to be considered as broken grain. Any whole maize that goes through the sieve should be considered broken.
3.2.7 Other grains

When grading maize, “other grains” are all other cereals and pulses that are edible, whole or identifiably broken other than maize. Some examples of other grains are featured in the pictures below.

3.2.8 Foreign matter

Foreign matter is all organic and inorganic material other than maize, broken kernels and other grains. Organic matter is material of plant origin and includes seed coats, parts of stems, pods, leaves, etc. Inorganic matter includes lumps of earth, sand, soil, glass, fibre, etc.

3.2.9 Filth

Filth includes impurities of animal origin like animal waste, dead worms, insects, insect body parts, animal hair or fur, dead skins etc. See pictures below.
3.2.10 Stained kernels

These are maize kernels whose natural colour has been altered by external factors. This includes ground, soil or weather damaged kernels, which may have dark stains or discolorations with a rough external appearance. See picture below:

3.2.11 Frost damaged kernels

Kernels which appear bleached or blistered are damaged by frost. Signs of frost damage also include peeling seed coating, or dead or discoloured maize germs. This damage occurs when the ears of maize are exposed to very low temperatures before maturity of the grain.

3.2.12 Defective grains

This is a general term that includes grain that is Pest damaged, discoloured, diseased, germinated, mouldy, immature and shrivelled grains, or otherwise materially damaged. It does not include foreign matter, broken grain and other grains.
### 4. Standard Requirements

#### 4.1 Maize Specifications Table (Grades)

Maize grains are classified as Grade 1, Grade 2 or Grade 3 according to the limits indicated in the table below.

<table>
<thead>
<tr>
<th>Defect</th>
<th>Maximum limits</th>
<th>Method of test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grade 1</td>
<td>Grade 2</td>
</tr>
<tr>
<td>Foreign matter, % m/m</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Inorganic matter, % m/m</td>
<td>0.25</td>
<td>0.5</td>
</tr>
<tr>
<td>Broken grains, % m/m</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Pest damaged grains, % m/m</td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Rotten &amp; Diseased grains, % m/m</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Discoloured grains, % m/m</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Moisture, % m/m</td>
<td>13.5</td>
<td>13.5</td>
</tr>
<tr>
<td>Immature/Shrivelled grains, % m/m</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Filth, % m/m</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Total defective grains</td>
<td>3.2</td>
<td>7.0</td>
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<tr>
<td>Total Aflatoxins Max</td>
<td>10 ppb</td>
<td>10 ppb</td>
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<tr>
<td>Aflatoxin B1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Fumonisin</td>
<td>2</td>
<td>2</td>
</tr>
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</table>

(Note: The parameter, Total Defective Grains is not the sum total of individual defects. It is limited to 70% of the sum total of individual defects)

It is important to note that some of these defects can be corrected, changing the grade of the maize. For example, maize high moisture content, foreign matter and broken grain can be cleaned and dried. On correction of the defects, a new grade may be assigned after sampling and grading again.
5. Determination of Grades (Grading)

5.1 Non-standard Test Method (Subjective Tests)

Formal grading methods are not always practical in the field. This is because the farmers or traders may lack the equipment needed to grade the grain based on Standard Test methods. The tests below are useful for getting a rough estimate of the grade of maize. Some of the tests are known to give results that are above those of the standard test method while others lower. Official results should be those that have been reached using Standard Test Methods.

5.1.1 Determination of Maize Colour Classification

Maize could be classified as of a particular colour based on the procedure below. This is an example of grading yellow maize. The same technique is used for red and white maize.

i. Take a representative sample of the maize to be evaluated
ii. Fill the container provided with the maize sample
iii. Pour the maize on a bench
iv. Use the quartering method to subdivide the maize down to about 100 grains
v. Count the number of yellow grains (count₁)
vi. Select maize that has colours other than yellow
vii. Count the selected grains (count₂)
viii. Express the percentage of maize of other colours as:

\[
\frac{\text{Count}_2}{\text{Count}_1} \times 100
\]

The percentage of non-yellow maize should not exceed 5% of the total sample size. Yellow maize also includes maize grains that are yellow and dark red in colour, provided the dark red colour covers less than 50% of the surface of the grain.

White maize may not contain more than 2.0% total volume of different coloured maize. Maize grains that are white and/or light pink in colour are considered to be white maize. White maize also includes maize grains which are white and pink in colour, provided the pink colour covers less than 50% of the surface of the grain.

Red maize may contain no more than 5.0% of total volume of different coloured. Pink and white, grey or dark red and yellow maize grains are considered to be red maize, provided the pink or dark red or yellow colour covers 50% or more of the surface of the grain.

Mixed maize includes maize not categorized as white, yellow or red maize as defined in the previous sections. Thus, yellow maize with quantities of different coloured grains exceeding 5%, white maize with quantities of different coloured grains exceeding 2% or red maize with quantities of different coloured grains exceeding 5% as estimated as estimated above, are mixed maize. See picture below:
5.1.2 Determination of Maize Type (Flint and Dent Maize)

Type of grain can be estimated in the field, using the following method. For example if you want to grade flint maize:

i. Take a representative sample of the maize to be evaluated
ii. Fill the container provided with the maize sample
iii. Pour the maize on a bench
iv. Use quartering method to divide the sample down to about 100 grains
v. Count the number of grains (count₁)
vi. Select maize that does not have characteristics of flint maize
vii. Count the selected grains (count₂)

viii. Express the percentage of maize of other cultivar groups as:

\[
\frac{\text{Count}_2}{\text{Count}_1} \times 100
\]

The percentage of non-flint maize should not exceed 5% of the total sample size.

Other cultivar groups – pod maize, pop maize, flour maize, wet maize and waxy maize are not covered by the Standard.
5.1.3 Determination of Moisture Content
In the field, most farmers do not have moisture meters or a grading laboratory facility. Non-standard tests can be used to estimate the dryness of maize. To do this:

**Method 1**
1. Pick 10 grains at random.
2. Crush each grain between the teeth.
3. A reasonably dry grain will crush without leaving a pasty feel in the mouth.

**Method 2**
1. Select a random sample of maize.
2. Fill a glass half-way with the maize sample (the glass must be dry).
3. Add 2 teaspoons of dried salt (the salt should be previously dried in a pan over a fire for 15 minutes).
4. Shake the mixture for 2 minutes.
5. Leave to settle for 20 minutes.
6. Pour out the mixture.
7. Check for any salt clinging on the walls of the glass.
8. If any salt is found on the walls of the glass, then moisture content is greater than 14%.

5.2 Standard Test Methods

5.2.1 Visual and Organoleptic Test
These are tests that are conducted using senses of sight, smell and taste. Maize for human and animal consumption should be free from foreign odours, moulds, live pests, rat droppings, toxic or noxious weed seeds and other hazardous contaminants.

To check for this, the grain analyst needs to obtain a representative sample of the grain. Then s/he will use the senses of sight and smell to check the existence of these defects. This test is normally the first to be done. Other tests will follow if the maize passes this test. This test can easily be conducted in the field because it does not require any equipment.
5.2.2 Testing for Foreign Odour

1. General test for foreign odour
   
   i. Obtain a representative sample
   ii. Spread out the sample on a flat surface and smell it.
   iii. If no odour is detected, return the sample into the container and seal it.
   iv. Leave the sealed container for 24 hours and re-examine the sample.
   v. The smell should be typical of maize without other smells e.g. chemicals, mouldiness, earthy, rotten, musty smell, etc.

2. Rapid Test for foreign odour
   
   i. Obtain a representative sample
   ii. Put a small quantity of ground or un-ground maize kernels in a container
   iii. Pour some warm water (60 – 70 °C) into the maize and cover the container
   iv. After 2-3 minutes, decant the water and note whether foreign odour is present.

Any grain with objectionable odour should be rejected.

5.2.3 Testing for Presence of Visible Infestation

   i. Obtain a representative sample
   ii. Spread about 100 grams of the sample on a warm plate (at 40 °C).
   iii. Cover the plate with a glass jar (bell glass jar if possible) to prevent the insects from escaping
   iv. After 15 minutes, sieve the grain through an appropriate sieve, e.g. 4.5 mm round sieve
   v. Check for living insects, dead insects and insect larvae.
   vi. Using a scalpel, cut across maize kernels that are insect damaged, to check for live or dead insect (primary pests) harbouring in the grain.
   vii. Reject the grain of it has one or more live insects.

5.3 Objective Test Methods

5.3.1 Determination of Moisture Content

The EAS 2:2013 requires that the moisture content of clean, dry maize should not exceed 13.5% m/m determined by representative samples in accordance with ISO 711 and ISO 712. However, this requires expensive equipment, including a grinding mill and a constant-temperature oven electrically heated.

In the field, moisture meters can be used for the estimation of moisture content. To determine moisture content using moisture meters, follow the manufacturer’s instructions. Ensure that the moisture meters are maintained and calibrated often so as to get accurate results. Calibration of moisture meters is done by National Standards organization, appointed agents, and some manufacturers of the equipment.

Figure 29: Moisture meters
5.3.2 Determination of Foreign Matter

i. Place a clean dry basin (Bottom Pan) in place to receive any materials that may go through the sieve.

ii. Weigh 200 grams of the representative sample ($Weight_1$).

iii. Put the maize in the sieve provided (4.5 mm round hole).

iv. Shake the sieve horizontally for 30 times for about 15 seconds.

v. Collect all the foreign organic matter that has passed through the sieve.

vi. Hand pick all foreign organic matter retained on top of the sieve.

vii. Weigh all the foreign matter collected from the bottom pan and that handpicked from the top ($Weight_2$).

\[
\text{Foreign matter} = \frac{Weight_2}{Weight_1} \times 100
\]

Refer to 4.1 Maize Specifications Table (Grades) above for the foreign matter parameters.

5.3.3 Determination of Inorganic Matter

These are foreign materials of non-biological origin e.g. metals, stones, glass, plastic, soil, sand, dust etc.

i. From the working sample weighed in 5.3.2 above (200 grams) ($Weight_1$).

ii. Sort out all metallic matter, stones, plastics, glass or sand, etc.

iii. Weigh the matter inorganic matter ($Weight_2$).

iv. Express the results as a percentage.

\[
\text{Inorganic Matter} = \frac{Weight_2}{Weight_1} \times 100
\]

Refer to 4.1 Maize Specifications Table (Grades) above for the inorganic matter parameters.

5.3.4 Determination of Broken Grains

i. From the working sample weighed in 5.3.2 above (200 grams) ($Weight_1$).

ii. Collect all the whole and broken grains that passed through a 4.5 mm round-hole sieve.

iii. Weigh the broken grain ($Weight_2$).

iv. Express the percentage of broken maize as follows:

\[
\text{Broken Grain} = \frac{Weight_2}{Weight_1} \times 100
\]
Refer to 4.1 Maize Specifications Table (Grades) above for the broken grain parameters.

### 5.3.5 Determination of Pest-Damaged Maize

- From the working sample weighed in 5.3.2 above (200 grams) \( (Weight_1) \)
- Collect the maize grains retained by the sieve (after sieving off foreign matter, and broken grains).
- Pour maize on a bench.
- Pick the insect damaged grain kernels by hand.
- Weigh the insect damaged grain \( (Weight_2) \)
- Express the percentage insect damaged grains as:

\[
\text{Pest Damaged Grain} = \frac{Weight_2}{Weight_1} \times 100
\]

Refer to 4.1 Maize Specifications Table (Grades) above for the pest-damaged grain parameters.

### 5.3.6 Determination of Rotten and Diseased Grains

- From the working sample weighed in 5.3.2 above (200 grams) \( (Weight_1) \)
- Collect the maize grains retained by the sieve.
- Pour them on a bench.
- Pick the rotten and diseased grains by hand.
- Weigh the rotten or diseased maize grains \( (Weight_2) \)
- Express the percentage rotten and diseased grains as:

\[
\text{Rotten and Diseased Grain} = \frac{Weight_2}{Weight_1} \times 100
\]

Refer to 4.1 Maize Specifications Table (Grades) above for the rotten and diseased grain parameters.

### 5.3.7 Discoloured Grains

- From the working sample weighed in 5.3.2 above (200 grams) \( (Weight_1) \)
- Collect the maize grains retained by the sieve.
- Pour them on a bench.
- Pick the discoloured grains by hand (taking care not to include coloured maize).
- Weigh the discoloured grains \( (Weight_2) \)
- Express the percentage discoloured grains as:

\[
\text{Discoloured Grain} = \frac{Weight_2}{Weight_1} \times 100
\]

### 5.3.8 Immature/Shrivelled Grains

- From the working sample weighed in 5.3.2 above (200 grams) \( (Weight_1) \)
- Collect the maize grains retained by the sieve.
- Pour them on a bench.
- Pick the immature/shrivelled grains by hand.
- Weigh the immature/shrivelled \( (Weight_2) \)
- Express the percentage immature/shrivelled grains as:

\[
\text{Immature Grain} = \frac{Weight_2}{Weight_1} \times 100
\]
5.3.9 Filth

i. From the working sample weighed in 5.3.2 above (200 grams) \( (Weight_1) \)

ii. Collect all the filth that went through the sieve and that which remains on top.

iii. Weigh the filth \( (Weight_2) \)

iv. Estimate the percentage filth level as:

\[
\text{Filth} = \frac{Weight_2}{Weight_1} \times 100
\]

5.3.10 Total Defective Grains

This refers to all defects mentioned above. It is limited to 70% of the sum total of individual defects tested as per the 4.1 Maize Specifications Table (Grades) above.

i. From the working sample weighed in 5.3.2 above (200 grams) \( (Weight_1) \)

ii. Collect the maize grains retained by the sieve

iii. Pour them on a bench

iv. Put together all defective maize kernels handpicked above (diseased, discoloured, stained, immature/shrivelled, pest damaged, etc.)

v. Weigh the defective \( (Weight_2) \)

vi. Express the percentage total defective grains as:

\[
\text{Total defective grains} = \frac{Weight_2}{Weight_1} \times 100
\]

5.3.11 Determination of Mycotoxins

Mycotoxins are a group of chemicals produced by certain mould fungi. This broad category includes Aflatoxins and Fumonisins, which appear in the 4.1 Maize Specifications Table (Grades) above. These fungi, *Aspergillus flavus* and *Aspergillus parasiticus*, can be recognized by their yellow-green or grey-green, or pink colours.

![Figure 31: Mouldy grains colonized by Aspergillus mould](image)

The presence of Aflatoxin is tested using thin layer chromatography, high performance liquid chromatography or absorbance meters (e.g. Elisa readers), rapid test kits and Black light.

Aflatoxin may be found in good looking grain. Mouldy maize does not necessarily have high Aflatoxin levels. It could contain other mycotoxins though.
Representative samples have to be taken to a laboratory capable of testing for Aflatoxin. The results should not exceed **10 ppb** of total Aflatoxins and **5 ppb** for Aflatoxin B1.

For Fumonisin, the results should not exceed 2 ppb for any of the three grades.

![Figure 32: Elisa kit](image1)

![Figure 33: High Performance Liquid Chromatography Unit](image2)

**5.3.12 Examination of grain for Toxic or Noxious Seeds**

Maize must be free from toxic or noxious seeds (e.g. Datura, Striga etc.) These are seeds produced by weeds that grow in grain fields. See pictures below:

![Figure 34: Striga Seeds](image3)

![Figure 35: Datura Pod](image4)

![Figure 36: Datura Seeds](image5)

i. Fill the container provided with the maize sample.

ii. Pour them on a bench.

iii. Carefully check for datura, or striga seeds.

No toxic or noxious seeds should be present.

**5.3.13 Contaminants**

Maize must be free of heavy metals in amounts stipulated by the Codex Alimentarius Commission. The contaminant limits are:

<table>
<thead>
<tr>
<th>Element</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>0.1 mg/Kg</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.1 mg/Kg</td>
</tr>
<tr>
<td>Lead</td>
<td>0.2 mg/Kg</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.1 mg/Kg</td>
</tr>
<tr>
<td>Tin</td>
<td>0.1 mg/Kg</td>
</tr>
</tbody>
</table>

Mg/Kg is equivalent to ppm (parts per million)
Heavy metal quantities can only be determined by testing in a laboratory using a spectrophotometer.

Figure 37: Spectrophotometer

5.4 Assignment of Grades

5.4.1 Under-Grade Maize
Maize that does not meet the criteria of grades 1, 2 and 3 as described above and is not rejected is considered under-grade. Under-grade maize can be sorted or treated for either grade 1, 2 or 3. Any parameter may make a maize consignment under-grade by exceeding stated values. For example, if maize exceeds 13% moisture content, it is considered under-grade. It can be dried to moisture content below or equal to 13% when it can be graded to Grade 1, 2 or 3 depending on performance of other parameters.

5.4.2 Reject Maize
Reject maize which is mouldy, musty, chemically contaminated or otherwise hygienically objectionable rendering it unfit for human consumption. This is maize that is heavily damaged and cannot be sorted to either grade 1, 2 or 3. If it contains chemicals like pesticide residues or mycotoxins or any other harmful substances it is automatically considered rejected.

5.5 Hygiene
The product covered by the provisions of the EAS 2: 2013 Standard shall be prepared, packed, stored, transported and distributed under hygienic conditions. This implies that maximum care must be taken to ensure that maize is packaged in clean containers by clean people. The areas that the maize is stored should be clean and meet hygiene standards. These stores should be free from pests (e.g. rodents, cockroaches, weevils and other vermin). Modes of transport should also be clean.

When tested by appropriate methods of sampling and examination, the maize shall be free from pathogenic micro-organisms, substances originating from micro-organisms, or other poisonous or deleterious substances in amounts which may constitute a health hazard.

Pathogenic micro-organisms are minute living microbes that may cause diseases commonly referred to as germs. They include harmful bacteria, yeasts and moulds. A quick test for these harmful bacteria is done by determining the presence of coliforms. This is done by incubating a weighed sample in specific media at a specified temperature for a period of 48 hours.

It is not feasible to do this test in the field.
5.6 **Packaging**

Maize, when not handled in bulk, shall be packed in new bags (maximum 50 kg net weight) or similar acceptable protective containers which will safeguard the hygienic and other qualities of the maize. In East Africa it is common practice to package maize in second-hand bags. For a maize consignment to comply with the requirements of EAS 2:2013, new bags must be used.

The containers including packaging material shall be made only of substances which are safe and suitable for the intended use. These materials should be food grade and in the event of need for verification, a certificate from the supplier should be available to demonstrate that the materials have been declared for use in foods and foodstuff.

5.7 **Labelling**

The following information shall be provided in order to comply with the requirements of EAS 2:2013

5.7.1 **Product Identification**

The name of the product to be declared on the label should be as follows: “White Maize Grains”, “Yellow Maize Grains” or “Mixed Maize Grains”.

The product must be labelled by the crop year. This is the year in which the maize was harvested.

5.7.2 **Type and Grade**

The Grade of Maize must be indicated on packaging. Include a statement regarding genetically modified organisms (GMO) status. Considering that maize is normally open-pollinated, it is important to know whether the maize was grown in close proximity with genetically modified grains. In the absence of this information it is necessary to carry out a laboratory test for verification.

5.7.3 **Net Contents**

The net contents shall be declared by mass in kilograms.

5.7.4 **Name and Address**

The name and address of the producer, packer, distributor, importer, exporter or vendor of the food should be declared.

5.7.5 **Country of Origin**

The country of origin of the maize shall be declared (e.g. Product of Tanzania)

5.7.6 **Lot Identification**

Each container or bag must be permanently marked in code to clearly identify the packer and the lot. This is important for traceability and recall during all stages of the product chain should any safety issues arise.

5.7.7 **Non-Retail Containers**

For non-retail containers, required product information should be labelled on the container or in accompanying documents. The name of the product and the name and address of the manufacturer or packer must appear on the container. However, the name and address of the
manufacturer or packer may be replaced by an identification mark provided that such a mark is clearly identifiable with the accompanying document.
6. ANNEX A. Laboratory Testing
(Normative)

A Method for sampling and grading of maize grains

A.1 Sampling

Sampling grain shall be done according to EAS79 and ISO 13690.

A.2 Procedure for grading

A.2.1 Bags of maize which are not of the same quality as the bulk of the consignment shall be graded separately.

A.2.2 The representative sample shall be reduced by a riffle type divider to obtain a portion weighing 1000 — 1050 g. Sub samples weighing about 200 g shall be drawn from the representative sample by use of a riffle divider.

Quartering method could be used where no riffle divider is available.

A.2.3 The sub sample shall be sieved through a 4.5 mm round-hole screen.

A.2.4 Foreign matter shall be determined by weighing the portions of foreign matter passing through the screen, adding this to larger fragments of foreign matter retained on the screen and expressing the weight as a percentage.

A.2.5 The percentage of broken kernel grains shall be determined by weighing the portion of maize grains which have passed through the 4.5-mm round-hole screen and expressing the weight as a percentage.

A.2.6 The percentage of insect damaged grains shall be determined by hand picking and weighing such grains from the portion of the sub sample retained by the 4.5 mm round hole screen and expressing the weight as a percentage.

A.2.7 The percentage of shrivelled, shall be determined by hand picking and weighing such grains from the portion of the sub sample retained by the 4.5 mm round hole screen and expressing the weight as a percentage.

A.2.8 The percentage of diseased shall be determined by hand picking and weighing such grains from the portion of the sub sample retained by the 4.5 mm round hole screen and expressing the weight as a percentage.

A.2.9 The percentage of discoloured grains shall be determined by hand picking and weighing such grains from the portion of the sub sample retained by the 4.5 mm round hole screen and expressing the weight as a percentage.

A.2.10 The percentage of other grains shall be determined by hand picking and weighing such grains from the portion of the sub sample retained by the 4.5 mm round hole and expressing weight as a percentage.