Methods

1. RSA grading

RSA grading was done in accordance with the Grading Regulations for maize, as published in the Government Gazette No. 32190 of 8 May 2009, Regulation No. R.473.

Description of deviations relating to RSA grading

1.1 Defective maize kernels

The following definition of Defective maize kernels is quoted from the Grading Regulations:
"Defective maize kernels" means maize kernels and pieces of maize kernels –

(a) that are shrivelled, obviously immature, frost-damaged, heat damaged, water damaged, mouldy or chalky;
(b) that are discoloured by external factors such as water and sun: Provided that discoloration on both sides of the maize kernel limited to less than a quarter from the bottom tip of the maize kernel shall not be considered as defective, oxidation stained maize kernels, coffee stained maize kernels and pinked maize kernels shall not be considered as defective;
(c) that have sprouted, including kernels which the shoot (plumule) in the germ is visibly discoloured;
(d) that have cavities in the germ or endosperm caused by insects or rodents;
(e) that are visibly soiled (smeared) or contaminated by smut, fire, soil, smoke or coal-dust;
(f) all matter that can pass through the 6.35 mm round-hole sieve; and
(g) that are of subspecies other than Zea mays indentata or Zea mays indurata
Provided that –
(i) irregularity of shape and size of maize kernels shall not affect the grading thereof;
(ii) chipped or cracked maize kernels or pieces of maize kernels which are in a sound condition and which appear in a sample of maize, but which do not pass through a 6.35 mm round-hole sieve, shall not be regarded as defective maize kernels under these regulations."

1.2 Foreign matter

The term "foreign matter" means all matter above the sieve other than maize, glass, stone, coal, dung or metal.

1.3 Other colour

"Other colour maize kernels" in relation to-

(a) white maize, means maize kernels or pieces of maize kernels of which the endosperm as a result of genetic (characteristics) composition have another colour than white, excluding pinked maize kernels;
(b) yellow maize, means maize kernels or pieces of maize kernels of which the endopserm as a result of genetic (characteristics) composition have another colour than yellow.

1.4 Total deviation

The term "total deviation" means the sum of defective kernels (above and below the 6.35 mm sieve), foreign matter and other colour kernels.

1.5 Pinked kernels

The term "pinked maize kernels" means kernels and pieces of kernels of white maize of which the pericarp or part thereof is shaded red or pink in colour.

The specification, according to the Grading Regulations for classes 1 to 3 of white maize is a maximum of 12 %. No specification for yellow maize according to the Grading Regulations.

1.6. Fungal infection

Kernels which are mouldy (fungi infected) are reported as defective kernels according to the grading regulations.

"Mouldy" means kernels and pieces of kernels that –

(a) are visibly infected by fungi and are characterised by black, blue, green, yellow or white fungi growth anywhere on the kernel, or are characterised by fungi growth underneath the bran layer of the kernel;

(b) are infected by ear-rot and are characterised by red, pink or brown discolorations. The kernel are partially to completely infected.

For this survey all samples were also inspected for the visual symptoms of Diplodia and Fusarium cobrot and reported separately.

Fusarium spp infections are localized on the cob with discoloured maize kernels, which become reddish (light pink to lilac).

Diplodia maydis normally rots the entire maize cob and infected maize kernels are recognized by a light ash colour to black colour that appears at the germ and can infest the whole kernel.

% Cobrot reported are the percentage maize kernels that are both Fusarium and Diplodia infected.

2. USA Grading

USA grading was determined in accordance with the method of the American Grading Regulations (United States Department of Agriculture).

There are seven grades or standards in US grading, Grades nos. 1 to 5, sample grade and mixed grade. No.1 is the most desirable followed by no. 2 down to sample grade and mixed grade.

Description of deviations relating to USA grading

2.1. Damaged kernels

Kernels and pieces of corn kernels that are badly ground-damaged, badly weather-damaged, diseased, frost-damaged, germ-damaged, heat-damaged, insect-bored, mould-damaged, sprout-damaged or otherwise materially damaged.

2.2. Heat damaged kernels

Kernels and pieces of kernels which are materially discolored by excessive respiration, with the dark discoloration extending out of the germ through the sides and into the back of the kernel as well as kernels and pieces of kernels which are puffed or swollen and materially discolored by external heat caused by artificial drying methods.

2.3. Broken corn and foreign material

Broken corn is all matter that passes readily through a 12/64-inch (4.76 mm) round-hole sieve and over a 6/64-inch (2.38 mm) round-hole sieve.

Foreign material is all matter that passes readily through a 2.38 mm round-hole sieve and all matter other than corn that remains on top of the 4.76 mm round-hole sieve after sieving.

Broken corn and foreign material is all matter that passes readily through a 4.76 mm round-hole sieve and all matter other than corn that remains in the sieved sample.

2.4. Bushel weight

The specific mass (or grain density) of maize (expressed as hectolitre mass or bushel weight) is a quality characteristic which is important to some maize consumers and is applied as a grading factor in the USA grading regulations.

The Test weight per bushel apparatus is used to determine the approximate weight of a bushel of a particular lot of grain.

Bushel weight was determined on the maize crop samples and the results converted to hectoliter mass by multiplication with a factor of 1.2872.

2.5. Other colour

Maize samples are deemed to be mixed grade when maize kernels of another colour for white maize exceeds 2 % and for yellow maize exceeds 5 %.

3. Nutritional value

The fat, protein and starch contents are measured with the Infratec 1241 Whole Grain Analyzer. The measurements are based on the fact that the constituents to be measured in the grain, absorb electromagnetic radiation in the near-infrared region of the spectrum. Since the Infratec 1241 Grain Analyzer uses transmission absorption, the test is done on intact maize kernels.

The Infratec 1241 Grain Analyzer (Near Infrared) (NIT) was calibrated against international chemical methods for the determination of nutritional values.

The chemical methods used to establish a set of calibration samples were:
a) Fat: Petroleum ether extraction (Soxhlet) method (AACC 30-25, latest edition)
b) Protein: Dumas (Leco) method (AACC 46-30, latest edition)
c) Starch: Hydrochloric Acid dissolution method (Polarimeter) In house method 019 (Zeiss Polarimeter manual).

These sets of calibration samples were used to calibrate the Infratec 1241 Grain Analyzer (NIT) and results were checked by analysing every tenth sample by means of the primary methods.

4. Physical characteristics

4.1 Hectolitre mass (See USA grading- Bushel weight)

Hectolitre mass means the mass in kilogram per hectolitre. The specific mass (or grain density) of maize expressed as hectolitre mass is influenced by the following factors e.g cultivar, moisture content, foreign matter, other grain and damaged kernels like insect damaged and immature kernels. (See USA grading- Bushel weight).

4.2 Hundred (100) kernel mass - Industry accepted method 001

100 kernel mass is the weight in grams of one hundred whole maize kernels and provides a measure of grain size and density.

4.3 Kernel size - Industry accepted method 017

Kernel size is important to the sophisticated starch manufacturing industry. Kernels that are too small hamper the separation of kernel fractions in the wet milling process. The result is a lower starch yield. A mixture of small and large kernels causes additional problems, as homogeneous steeping cannot be achieved. On the other hand, very large kernels can also cause problems since the ratio between volume and mass is unfavourable to proper steeping.

The dry milling industry also prefers fairly larger maize kernels. However, uniform kernel size is of particular importance to this industry, since too large kernels create problems especially when mixed with smaller kernels.

Kernel size is less important to the animal feed manufacturing industry. Larger kernels are nevertheless preferred, as small kernels are easily lost during the screening stage of processing. The determination of kernel size comprises the sieving of a 100 g representative whole maize sample through both 8 mm and 10 mm round-hole grading sieves, normally used in the seed industry.

4.4 Breakage susceptibility - Industry accepted method 007

Maize is normally cleaned before processing. In the cleaning process, broken kernels are removed together with other impurities, causing losses. Broken kernels are further broken during handling, resulting in excesive grain dust being generated. This creates the potential for dust explosions, health hazards, hygiene problems, etc. Maize containing a high percentage of broken kernels is more prone to insect infection and is subject to general deterioration.

In the modern dry milling industry, maize is cleaned first and then conditioned by dampening before the germ is removed. Broken kernels cause many problems during these stages of processing. Broken kernels can also lead to a lower extraction of the so-called high-quality products, like samp and maize grits. The presence of many broken kernels cause problems with the fibre and fat content of maize products, for example the various grades of maize meal, because the quantity of germ required to be returned to the milled endosperm cannot be determined accurately.

In the wet milling process broken kernels steep more rapidly than whole kernels and by the time the whole kernels have been sufficiently steeped, the broken kernels have been over-steeped, causing an ineffective separation of protein and starch.

In the livestock feed industry breakability is not an important quality characteristic, except for dust and hygiene reasons.

All samples were subjected to a breakage susceptibility test. After the sample of whole maize kernels was propelled in a Stein Breakage tester for 4 minutes, the fraction below the 6.35 mm and 4.75 mm sieves was collected and the percentage broken kernels < 6.35 mm and < 4.75 mm was determined.

4.5 Stress cracks - Industry accepted method 006

Stress cracks are determined by visual inspection of a certain amount of whole maize kernels examined on top of a light box for small internal cracks in the endosperm. Some kernels may even have two or more internal cracks. Any form of stress may cause internal cracks, for example rapid moisture loss in the field, during harvest or during drying.

4.6 Milling index - Industry accepted method 015

Milling index is an indication of the milling abilities and milling quality of maize kernels where a higher milling index means a higher extraction of the high-grade and most profitable products like samp, maize rice and maize grits (degermed products) that are manufactured from the corneous part of the endosperm. The milling index is an indication of the relative differences between samples tested. The milling index is measured with the Infratec 1241 Grain Analyzer. The SAGL uses a calibration developed by the Grain Crops Institute of the ARC.

4.7 Milling of maize on Roff maize mill - Industry accepted method 013

The Roff 150 Series maize mill is used to mill representative samples of 500 g. The mill should be pre-set to the following specifications: Break 1 roll nip - 0.3 mm, Break 2 roll nip - 0.18 mm and Break 3 roll nip - 0.08 mm. These settings are according to the specifications in the method developed by the ARC Grain Crops Institute. Every mill has three separations, namely germ, grits and maize meal. The grits from Break 1 are transferred to the Break 2 rolls and the grits from Break 2 are transferred to Break 3 rolls.

The following fractions are weighed and determined as percentage: Break 1 meal, Break 2 meal, Break 3 meal and Break 3 grits. Break 1, 2 and 3 germ and bran are combined and then weighed for determination of Bran/Germ %. Break 3 grits are weighed for determination of % Grits. Break 1, 2 and 3 meal are weighed for determination of % extraction total meal.

4.8 Whiteness index - Industry accepted method 004

Whiteness index of white maize meal was determined with the Hunterlab colorflex 45°/0°. Whiteness is associated with a region or volume in colour space in which objects are recognized as white. The degree of whiteness is measured by the degree of departure of the object from a perfect white. The higher the whiteness index value, the whiter the sample.

Whiteness index was done on unsifted and sifted maize meal obtained from Break 2 and 3 of the Roff mill. The sifted samples were sifted with a 300 µm sieve and then mixed to contain 87 % of maize meal >300 µm and 13 % of maize meal <300 µm.

5. Mycotoxin analyses

The pathogenic nature of certain species of fungi to plants has been observed virtually since the beginning of agriculture. These plant pathogens can produce metabolites (mycotoxins) that show toxic effects when they are ingested.

During 2010 SAGL implemented a multi-mycotoxin screening method using UPLC - MS/MS. 90 of the 800 maize crop samples were tested for Aflatoxin G_1; B_1; G_2; B_2, Fumonisin B_1 and B_2, Deoxynivalenol, T2 - Toxin, Zearalenone and Ochratoxin A.

6. GMO (Genetically Modified Organisms)

90 samples of the 800 maize crop samples were tested for Bt (MON810) and RUR (NK603) Modified maize.

Quantitative analyses for MON810 maize were done using the procedure supplied with the Strategic Diagnostics Incorporated GMO Bt maize test kit. Cry 1 Ab protein in corn is produced from a gene derived from Bacillus thuringiensis (Bt). This method is a quantitative enzyme-linked immunosorbent assay (ELISA) test for the determination of Bt modified corn in corn flour. Proprietary antibodies specific for Cry 1 Ab protein are used.

The GMO Soya test kit from Strategic Diagnostics Incorporated (SDI) were used to quantitatively determine Roundup Ready (RUR). The procedure was adapted by SDI for maize.

7. Sampling Procedure

All the samples tested and received from the grain storers are drawn in the following way:

With each consignment at the silos a 10 kg grading sample is drawn for grading purposes according to the Grading Regulations.

After the grading sample has been divided, 500 g of each of the 10 kg samples are transferred to a 50 kg bag representing a certain class and grade. When this bag is full, it is divided and a 3 kg sample according to class and grade per silo bin is sent to the SAGL.

A working sample is obtained by dividing the representative sample of the consignment according to ICC101/1 method.