



## **DRAFT TANZANIA STANDARD**

---

**Code of practice for the prevention and reduction of aflatoxin  
contamination in groundnuts**

*Draft for stakeholders comments only*

**TANZANIA BUREAU OF STANDARDS**

## Code of practice for the prevention and reduction of aflatoxin contamination in groundnuts

### 0. Foreword

In Tanzania, groundnut crop is cultivated and used as important ingredients in complimentary food. Furthermore, groundnuts can be eaten as snacks but also can be processed to be used in food industry especially in bakery industries and in domestic as an ingredient of vegetable sauces, smoothies and shakes for texture and flavour.

Unfortunately, groundnuts are vulnerable to aflatoxin contamination. Aflatoxins are naturally occurring toxins that are produced by certain fungi, mainly *Aspergillus flavus* and *Aspergillus parasiticus*. These fungi are considered the most important producers of aflatoxins in the world's food supply. The fungi can colonize and contaminate groundnuts before and after harvest, especially following prolonged exposure to a high temperature and humid environment, or to stressful conditions such as drought. These conditions exist in Tanzania where groundnuts are predominantly grown by small holder farmers and high levels of aflatoxin contamination have been reported.

Therefore, groundnuts consumers are potentially at risk to acute and chronic dietary exposure to aflatoxins. Both acute and chronic exposure increase liver cancer risk and can suppress the immune system. In children below the age of 5 years, aflatoxins lead to reduced growth or stunting. High doses of aflatoxins cause acute liver cirrhosis leading into illness and even death.

It is urgently needed that the aflatoxin contents in groundnuts are reduced to the tolerable levels for protecting public health and promoting the sustainable development of groundnuts value chain. To this effect, the code of practice for the prevention and reduction of aflatoxin contamination in groundnuts is developed. The recommendations for the reduction of aflatoxin in groundnuts are divided into three parts: Pre-harvest, harvest and post-harvest stage.

This code of practice has been prepared to provide recommendations for all interested parties producing and handling groundnuts along the value chain to ensure its safety and quality for human and animal consumption.

In preparation of this standard considerable help was derived from (CAC/RCP 55-2014) Code of Practice for the prevention and reduction of aflatoxin contamination in Peanuts.

### 1. Scope

This code of practice represents a standard of good practice for the prevention and reduction of aflatoxin contamination in groundnuts intended for human and animal consumption along the value chain. It recommends practices based on Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) and are generally consistent with Hazard Analysis Critical Control Point (HACCP) principles which are in cooperated in certification schemes.

### 2. Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

TBS/AFDC 19(290) CD3, *Sampling procedures for aflatoxin analysis in groundnuts and its products*

TZS 538, *Packaging and labelling of foods*

TZS 740, *Raw and roasted groundnuts – Specification*

### 3. Terms and definitions

For the purpose of this standard the following terms and definitions shall apply:

#### 3.1 curing

drying of the in-shell groundnuts to a safe moisture level

#### 3.2 water activity ( $a_w$ )

water that is not bound to food molecules that can support the growth of bacteria, yeasts, and fungi

#### 3.3 mechanical drying

process of removing water from the groundnut by forcing either ambient air or heated air through the groundnut bulk

#### 3.4 safe disposal

removal or destroying without compromising health and environmental effect

#### 3.5 pest

any organism that damage crops. It can include plant pathogens, insects, weeds, rodents, nematodes, birds and parasitic plants

## 4. RECOMMENDED PRACTICES BASED ON GOOD AGRICULTURAL PRACTICES (GAP) AND GOOD MANUFACTURING PRACTICES (GMP)

### 4.1 PRE-HARVEST

For land preparation and crop husbandry practices farmers are advised to consult agricultural extension services.

#### 4.1.1 CROP ROTATION

If possible practice an appropriate crop rotation/sequence to reduce the inoculum in the field which may originate from debris remaining after harvest that harbours toxigenic fungal spores. Some crops have been found to be particularly susceptible to certain species of toxigenic fungi and the use in rotation with each other should be adopted. Crops of low susceptibility to toxigenic fungi such as clover, Guatemala (*Panicum maximum*) and other legumes can be used in rotation to reduce the inocula in the field.

#### 4.1.2 TILLAGE AND MANAGEMENT OF CROP RESIDUES

Prepare the seed bed for each new crop by ploughing under or by destroying or removing old seed heads, stalks, and other debris that may have served, or may potentially serve as substrates for the growth of aflatoxin producing fungi. However, tilling may not be appropriate with respect to other economic and environmental benefits, such as moisture conservation, maintenance of soil organic matter, reduced erosion, lower fuel and water use. Hence its costs and benefits should be considered prior to application.

#### 4.1.3 SEED SELECTION/ HOST PLANT RESISTANCE

**4.1.3.1** Use seeds certified by responsible regulatory authority and avoid farmer saved seeds because seeds can be good source of inoculum for aflatoxin producing fungi.

**4.1.3.2** Where possible, grow varieties (cultivars) that were developed and selected for their traits of providing at least partial resistance to both non-toxigenic and toxigenic fungi and insect pests and for lower aflatoxin accumulation. It is important to plant only those varieties as listed by responsible regulatory authority for use in a particular area of a country by virtue of their specific physiological and agronomic traits.

#### **4.1.4 PLANTING**

**4.1.4.1 Timely planting:** As far as practical, crop planting should be timed to avoid high temperature and drought stress during the period of seed development and maturation. Predictive models, where available, should be used as a tool to plan for the best planting period.

**4.1.4.2 Planting density:** Ensure appropriate density of planting by maintaining the recommended plant spacing for the species/varieties grown. Information concerning plant spacing may be provided by seed companies, national authorities/institutes or extension services.

#### **4.1.5 CROP MANAGEMENT**

**4.1.5.1 Pest management:** Insect damage and fungal infestation in the vicinity of the crop should be minimised by proper use of approved pesticides and other appropriate practices within an Integrated Pest Management (IPM) programme. For Tanzania the IPM program for different crops and pests is detailed in the National Integrated Pest Management Plan (IPMP). Predictive weather models should be used to plan the best application timing and mode of pesticide application.

**4.1.5.2 Weed Management:** Managing weed in groundnuts by using mechanical methods, registered herbicides or other safe and suitable weed management practices. This is because certain weed species can act as hosts for toxigenic fungi and can increase plant stress during crop development stages especially flowering and podding.

**4.1.5.3 Irrigation:** Irrigation, if feasible, is recommended to combat heat and drought stress. It should ensure adequate soil moisture during the last 4-6 weeks of crop growth to minimize pre-harvest aflatoxin contamination of groundnuts. This may be achieved by growing a completely irrigated crop or by applying supplementary irrigation to a basically rain-fed crop. If irrigation is used, ensure that it is applied evenly and that all plants in the plot have an adequate supply of water. Water used for irrigation and other purposes (e.g. preparation of pesticide sprays) should be of suitable quality for the intended use.

**4.1.5.4 Fertilizer application:** Soil should be tested to determine if there is a need to apply fertilizer and/or soil conditioners to ensure appropriate soil pH and plant nutrition, especially during seed development stage of crop growth. Fertiliser should be applied to provide a balanced mineral nutrient supply to produce high quality and quantity groundnuts.

**4.1.5.5 Biocontrol application:** Where possible, apply biocontrol method to prevent aflatoxin contamination in groundnuts. Biocontrol products should be applied based on application details as approved by authorities.

**4.1.5.6 Mechanical damage:** Minimise mechanical damage to plants during earthingup, irrigation and pest management practices and other farm operations.

#### **4.2. HARVEST**

**4.2.1 Ideal harvesting time after physiological maturity:** Harvest the groundnuts at full maturity. It is very important to harvest the crop at optimum maturity, as excessive numbers of over-mature or very immature pods at harvest can be reflected in high levels of aflatoxin in the product. Also delayed harvest of groundnuts already infected may cause significant increase in aflatoxin content of the crop. A system by which the growing conditions of the farming crop is monitored (soil temperature and precipitation) may be very useful.

**4.2.2 Harvesting equipment:** Make sure that all equipment, which are to be used for harvesting and storage of groundnuts, are functional. A breakdown during this critical period may cause groundnuts quality losses and enhance aflatoxin formation. Keep important spare parts available on the farm to minimize time loss from repairs. Where the equipment needed for moisture content measurements are available, should be calibrated.

**4.2.3 Damage during harvesting:** Avoid damage to groundnuts at the time of harvest as much as possible since this can lead to rapid invasion of the pods by *A. flavus*/*A. parasiticus*. Groundnuts should be handled as gently as possible. Every effort should be made to minimize physical damage to groundnuts at all stages of harvesting and transportation procedures because it can create an entry points of toxicogenic fungi.

**4.2.4 Moisture content:** It is recommended to harvest groundnuts with moisture content range from 25% - 34%. High moisture content will lead to growth of fungi. If possible, before harvest inspect the field for fungal (mould) infestation so that nuts from the fields with high level of infection, can be harvested and stored separately.

**4.2.5** Attack of pest to groundnut plants may cause damage to pods which act as predisposing factors for fungal infections that are likely to produce aflatoxins. The attacked plants should be harvested separately.

**4.2.6.** Groundnut plants that have experienced drought stress should be harvested separately to avoid mixing the low risk aflatoxin contaminated groundnuts with those that are potentially highly contaminated.

**4.2.7** Where practical, harvest the groundnuts when the soil is moistened to avoid mechanical damage to the pods and increase harvest efficiency. After harvest, turn the vines to leave the pods uppermost where they are away from the ground and exposed to sun and wind.

**4.2.8** Avoid piling, heaping, or bin storage of freshly harvested groundnuts for more than a few hours prior to drying or threshing to lessen the risk of fungal growth. Ensure that any pile up is not prolonged but sufficiently aerated.

**4.2.9** Containers and conveyances (e.g., trollies, baskets, farm carts, wagons, trucks) to be used for collecting and transporting the harvested groundnuts from the field to drying facilities, should be clean, dry and free of crop residues, dust, insects and visible fungal growth before use and re-use.

**4.2.10** Consignments of groundnuts should be protected from all additional moisture by using tarpaulins or covered containers. Avoid temperature fluctuations that may cause condensation on the groundnuts, which could lead to local moisture build-up and consequently fungal growth and aflatoxin formation.

### **4.3 POST HARVEST MANAGEMENT**

#### **4.3.1 DRYING AND CLEANING BEFORE STORAGE**

**4.3.1.1** After harvest ensure that all equipment, to be used for drying, cleaning and storage of groundnuts, are in a good working order and cleaned to remove crop residues and dust as much as possible. A breakdown of equipment during this critical period may cause quality losses and enhance aflatoxins formation. Where possible, make sure that the equipment needed for moisture content measurements is available and calibrated.

**4.3.1.2** Freshly harvested groundnuts should be cleaned and sorted to remove damaged nuts and other foreign matter. Cleaning procedures such as density separators or air legs and slotted screens will remove light pods and pre-shelled kernels respectively. In this way some infected nuts could be eliminated and safely disposed.

**4.3.1.3** Groundnuts should be dried in such a manner that damage to the groundnuts is minimized and moisture levels are lower than those required to support fungal growth during storage (refer to TZS 740). To attain that level two methods are recommended which are;

**4.3.1.3.1 Sun and open-air drying:** Sun and open-air drying should be done on clean surfaces; to the extent possible. Avoid contact of the groundnuts with the soil to prevent the moisture uptake from the soil and fungal spores to infect the groundnuts. Dry the groundnuts on the mats, canvas and raised platforms. Groundnuts should be protected from rain, dew, soil, pests, bird droppings and other sources of contamination during this process. For more even and faster drying, mix or stir groundnuts frequently in thin layers.

**4.3.1.3.2 Mechanical drying:** Mechanical drying is preferred over sun and open-air drying. Flat bed and re-circulating batch driers are adequate for small scale operations while using a continuous flow-dryer is preferred for large scale drying prior to long storage periods. Avoid drying too rapidly as this may cause skin slippage and off-flavours. Avoid drying at extreme temperature because this may lead to production of polycyclic aromatic hydrocarbons (PAHs) and dioxins in the groundnut kernels. When curing by supplemental heat, excessive heat should be avoided since this impairs the general quality of the groundnuts, e.g. splitting of kernels after shelling. Close checks of moisture content/water activity of lots of farmer's stock should be maintained.

**4.3.1.4 Shelling methods:** Shelling should be done in a manner that does not subject the kernels into breakage which creates wounds through which a fungus (*A. flavus/A. parasiticus*) can infect and produce aflatoxins. Avoid shelling groundnuts when they are heaped direct in contact with soil surface.

#### **4.3.2 STORAGE AFTER DRYING AND CLEANING**

**4.3.2.1 Storage premises and containers:** Storage containers should be of food grade material. Storage premises and containers should;

- a) provide maximum possible protection from pests such as insect moulds, birds etc.;
- b) provide necessary facilities for inspection, disinfection, loading, unloading, cleaning and reconditioning;
- c) protect groundnuts from excessive moisture and temperature favourable to both insect and mould growth.

**4.3.2.2 Clean before fill:** Storage containers and premises should be cleaned before filling with newly harvested groundnuts. Perforated floors and air ducts also should be cleaned. Spilled and spoiled groundnuts in and around the containers should be cleaned to avoid cross contamination and rodent activity. Spraying recommended insecticides and fungicides inside the cleaned containers will help to eliminate carryover of insect and fungal spores from the previously stored groundnuts.

NOTE: Use of storage containers and premises after application of insecticides and fungicides should consider withdraw period as provided by manufacturers.

**4.3.2.3 Controlling warehouse condensation:** Warehouse should be built in such a way that it does not allow condensation. Painting warehouse roofs with white paint reduces solar heat load when compared to conventional galvanized material. Double roofing concept of installing a new roof over a defective, existing roof with an air space in-between the two roofs and the use of air flow controller has proven effective in controlling warehouse condensation.

**4.3.2.4 Clean the groundnuts:** Remove broken and mouldy groundnuts and other foreign materials before loading into the container to reduce insect infestation, nut rot and aflatoxin contamination caused by aflatoxigenic fungi.

**4.3.2.5 Filling of groundnuts in containers:** Use groundnuts spreaders during filling of container to help in distributing finely more uniformly and thus will help in reducing the risk of localised hot spot

development. Use of spreaders, however, packs the groundnuts thus increasing resistance to airflow. Whenever possible, use air tight containers. Avoid mixing newly harvested groundnuts with the groundnuts already in the containers/store because it may cause cross contamination inside the container.

**4.3.2.6** Avoid stock piling of groundnuts to prevent heat build-up and moisture accumulation which may lead to fungal growth and subsequently aflatoxin contamination. Uniform loading of the warehouse allows excessive heat and moisture to escape and reduces favourable areas for insect infestation.

**4.3.2.7 Bagged groundnuts:** For bagged groundnuts, ensure that bags are stacked on pallets and away from the wall or incorporate a water impermeable layer between bags and the floor.

**4.3.2.8 Monitor continuously:** To more effectively monitor the condition of stored groundnuts, it is recommended to measure the temperature, relative humidity and pest infestation in the storage facilities and the stored groundnuts at regular time intervals during storage.

**4.3.2.8.1 Monitoring temperature:** Check the temperature of the storage areas every 2 weeks. Temperature rise of 2-3 °C may indicate microbial growth and/or insect infestation. If the temperature or moisture becomes unacceptably high, aerate the groundnuts by circulation of air through the storage area to maintain proper and uniform temperature levels. Turn the groundnuts inside the container (moving from one container to another) to bring the groundnuts to an average temperature inside the container that would eliminate temperature gradients and thus moisture migration.

**4.3.2.8.2 Monitoring moisture content of groundnuts:** Check the moisture content of the stored groundnuts at a fixed time interval. Groundnuts with a moisture above storage requirement (Refer TZS 740) can create an environment conducive to insect and fungal growth development if it is not managed.

**4.3.2.8.3 Monitoring of Relative humidity:** Check the relative humidity regularly to make sure that it is kept below 70 %. Aeration should be conducted during periods of low ambient relative humidity of air being forced through the mass of stored groundnuts. Aeration during periods of high relative humidity can increase condensation and water activity in stored groundnuts whose temperature is below ambient air temperature. The groundnut can also be transferred from one storage container to another to promote aeration and disruption of potential hot spots during storage.

**4.3.2.8.4 Monitoring pest infestation:** Avoid pest infestation during storage since they can damage groundnuts and also their metabolic activities can increase temperature and moisture hence accelerate fungal growth and production of aflatoxin in stored groundnuts. A monitoring program for pest should include checking containers on a weekly basis. Visible insects or feeding damage are signs of an infestation. If spoilage, mould growth or pest infestation in groundnut is observed, separate the apparently infected portions of the groundnuts and collect samples for aflatoxin analyses by using appropriate sampling plans as per AFDC 19(291) CD2.

**4.3.2.8.5 Monitoring aflatoxin contamination:** The aflatoxin level in groundnuts coming into a storage and those going out of a storage should be monitored by using appropriate sampling procedures as per AFDC 19(291) CD2 and testing methods.

### 4.3.3 TRANSPORT FROM STORAGE

**4.3.3.1 Cleaning containers:** Transport containers should be dry and free of visible fungal growth, insects, and any contaminant. Transport containers should be cleaned and disinfected before use and re-use and be suitable for the intended cargo. The use of registered fumigants may be useful. At unloading, the transport container should be emptied of all cargo and cleaned as appropriate.

**4.3.3.2 Consignments of groundnuts:** Consignment of groundnuts should be protected from all additional moisture by using covered or airtight containers or tarpaulins. Avoid temperature fluctuations that may cause condensation on the groundnuts, which could lead to local moisture build-up and consequently fungal growth and aflatoxin formation.

**4.3.3.3 Pest management:** Avoid insect, bird, and rodent infestation during transportation by the use of insect and rodent proof containers or insect and rodent repellent chemical treatments provided they are approved for the intended use. The use of registered and recommended pesticides may be useful.

#### 4.3.4 PROCESSING AND CLEANING AFTER STORAGE

**4.3.4.1 Receiving raw materials:** Raw materials should be inspected for its quality and safety before processing. Specifications of the raw materials should include a maximum level for aflatoxin based in appropriate sampling procedures as per AFDC 19(291) CD 3 and methods of analysis. If raw materials received are unshelled, shelling should be done as in

**4.3.1.4.** Determination of groundnut quality should be done as per TZS 740.

**4.3.4.2 Sorting and cleaning:** Remove defective (mouldy, discoloured, decayed, shrivelled, insect or otherwise damaged) groundnuts to reduce the level of aflatoxins. Defective groundnuts should be bagged separately and tagged as unsuitable for human and animal consumption. Containers of defective groundnuts should be removed as soon as practicable from the processing area. Materials which carry the danger of contamination by aflatoxins, or which are contaminated should be safely disposed.

**4.3.4.3 Packaging:** Groundnuts should be packaged in containers made from food grade packaging material and sealed in a manner that will safeguard the hygienic, safety, nutritional and organoleptic properties of the product. All bags/cartons should be lot identified as per labelling standards TZS 538 to facilitate traceability of the product before being moved to controlled storage facilities or transported.

**4.3.4.4 Storage and transportation of end product:** Groundnuts that have been processed should be stored and transported under conditions that will maintain the integrity of the container and the product within it. Carriers should be clean, dry, weather proof, free from infestation, and sealed to prevent water, rodents or insects from reaching the groundnuts. Groundnuts should be loaded, held and unloaded in a manner that protects from damage or water. Well-insulated carriers or refrigerated vehicles are recommended for transport when climatic conditions indicate such a need. Extreme care should be taken to prevent condensation when unloading groundnuts from cold storage or from a refrigerated vehicle. In warm, humid weather, the groundnuts should be allowed to reach ambient temperature before exposure to external conditions. This tempering may require 1-2 days. Groundnuts that have been spilled are vulnerable to aflatoxin contamination and should not be used for edible products.