CODEX ALIMENTARIUS COMMISSION

Food and Agriculture Organization of the United Nations

World Health Organization

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Viale delle Terme di Caracalla, 00153 Rome, Italy - Tel: (+39) 06 57051 - E-mail: codex@fao.org - www.codexalimentarius.org

Agenda item 14 **CX/CF 24/17/14**

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JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON CONTAMINANTS IN FOODS

17th Session
15-19 April 2024
Panama City, Panama

DISCUSSION PAPER ON THE
REVIEW OF THE *CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF ALATOXIN CONTAMINATION IN PEANUTS* (CXC 55-2004)

(Prepared by the Electronic Working Group chaired by Brazil)

BACKGROUND

1. Work on the review of Codex standards for contaminants resulted in the establishment of an "Overall Highest Priority List of Codex Standards and Related Texts for Contaminants in Food and Feed" (OHPL), which identifies the need for review of existing standards and related texts for contaminants by the Codex Committee on Contaminants in Foods (CCCF). At CCCF16 (2024), the *Code of Practice for the Prevention and Reduction of Aflatoxin Contamination in Peanuts* (CXC 55-2004) was identified for possible review.

2. Due to the fact that aflatoxins exposure from peanuts continues to be a public health concern and that new information on risk management measures to reduce aflatoxins in peanuts may have become available since the adoption of the CoP in 2004, CCCF16 agreed to establish an Electronic Working Group (EWG) chaired by Brazil to develop a discussion paper to explore whether there are new measures supporting revision of the CoP.[1]

3. The proposal for new work is presented in Appendix I. The discussion paper summarizing key points of discussion in the EWG, including an assessment of the information on new risk management practices available to the EWG, is presented in Appendix II. Based on this summary, a preliminary revised CoP is presented in Appendix III. The list of participants is available in Appendix IV.

WORK PROCESS

4. A search of the literature was done in order to identify publications that could help in the revision of the CoP. A first draft of the document was circulated in the EWG for comments, asking that members to identify new information, including new measures, proven to be effective in reducing or preventing aflatoxin contamination in peanuts, and to attach scientific references. Only the USA provided comments on the first draft and then a second one was issued with the inputs received and, including a project document proposal. Comments in the second round of discussion were provided by the USA, Thailand, Peru and FoodDrinkEurope.

CONCLUSIONS

5. Based on the discussion paper provided in Appendix II, it can be concluded that there is new information available that justifies the revision of the CoP.

RECOMMENDATIONS

6. CCCF is invited to consider if there is sufficient information available on new mitigation measures to justify the revision of the *Code of Practice for the Prevention and Reduction of Aflatoxin Contamination in Peanuts* (CXC55-2004) based on the information provided in Appendices II and III.

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1 REP23/CF16, paras 105 (iv) (a)

7. If CCCF supports the revision of the CoP:

8.1 to review the project document accordingly in order to forward it to the Executive Committee (CCEXEC) and the Commission for approval as new work for the Committee (see Appendix I); and

8.2 to consider the issuance of a circular letter following CCCF17 to support the further development of the CoP by an electronic working group for consideration by CCCF18.

APPENDIX I

PROJECT DOCUMENT

Proposal for a new work on the revision of the
***Code of Practice for the Prevention and Reduction of Aflatoxin Contamination in Peanuts* (CXC55-2004)**

(For consideration by CCCF)

1) Purpose and scope of the project

The purpose and scope of the proposed new work is to revise the *Code of Practice for the Prevention and Reduction of Aflatoxin Contamination in Peanuts* (CXC55-2004) to reflect new information available to prevent and reduce aflatoxin contamination in peanuts.

2) Relevance and timeliness

The 16th Session of the Codex Committee on Contaminants in Foods (CCCF16, 2023) identified this code of practice (CoP) for revision as part of an overall work on the review of Codex standards for contaminants. There is already a maximum level (ML) of 15 ug/kg for peanuts for further processing adopted by the Codex Alimentarius Commission (CAC) and a proposed ML for ready-to-eat (RTE) peanuts under consideration by CCCF. Aflatoxins were last evaluated by the 83rd Meeting of the Joint FAO/WHO Expert Committee on Food Additives (JECFA83, 2017). JECFA83 reaffirmed the conclusions of JECFA49 (1997) that aflatoxins are genotoxic human liver carcinogens. Given the health concerns associated with aflatoxin, the new work aims to continue to reduce exposures by updating the existing CoP.

3) Main aspects to be covered

The work will address risk management measures to prevent or reduce aflatoxin contamination in peanuts, supported by scientific data, that have become available since adoption of the code of practice (CoP) which are proven to be effective and are widely applied across regions. It will also address information to contextualize aflatoxin formation in peanuts such as the identification of aflatoxigenic species and the stages of peanut reproductive growth.

4) Assessment against the criteria for establishment of work priorities

(a) Consumer protection from the point of view of health and fraudulent practices.

A revised CoP that includes measures proven to prevent and reduce aflatoxin production would result in a reduction in aflatoxins exposure from peanuts.

(b) Diversification of national legislations and apparent resultant or potential impediments to international trade.

A revised CoP is needed to ensure that the most updated information on recommended practices to prevent and reduce aflatoxin exposure from peanuts is available to all member countries. It will also provide the means to enable exporters to reduce aflatoxins levels and to assist in compliance with the current ML of 15 ug/kg for peanuts for further processing and a proposed ML for RTE peanuts under consideration by CCCF.

(c) Scope of work and establishment of priorities between the various sections of the work.

The revision of the CoP should prioritize the inclusion of relevant and efficient practices to prevent and reduce aflatoxin contamination in peanuts that are effectively and worldwide applicable.

(d) Work already undertaken by other international organizations in this field.

JECFA assessments.

5) Relevance to Codex Strategic Goals

(a) Goal 1 Address current, emerging and critical issues in a timely manner.

The proposed new work will support competent authorities and food business operators to implement practical interventions that can be used to reduce risk of aflatoxins in peanuts.

(b) Goal 2 Develop standards based on science and Codex risk-analysis principles.

Additional guidance by Codex might assist countries in reviewing their legislation to reduce the risk of aflatoxins and support fair practice in international peanuts trade.

(c) Goal 3 Increase impact through the recognition and use of Codex standards.

A revised CoP containing updated risk management practices to prevent and reduce aflatoxin contamination in ready to eat peanuts will facilitate compliance with Codex MLs for aflatoxins in peanuts.

(d) Goal 4 Facilitate the participation of all Codex Members throughout the standard setting process.

Peanuts are an important commodity in international trade and there are new measures that have been identified that contribute to the reduction and prevention of aflatoxins in peanuts.

(e) Goal 5 Enhance work management systems and practices that support the efficient and effective achievement of all strategic plan goals.

This work will help developing and maintaining efficient and effective work management practices and systems to prevent or reduce aflatoxin contamination in peanuts to achieve the Codex goals of ensuring public health protection and trade facilitation.

6) Information on the relationship between the proposal and other existing Codex documents

The CoP is important to support the implementation or development of MLs for aflatoxins contamination in peanuts (see points 1 and 4b).

7) Identification of any requirement for any availability of expert scientific advice

JECFA83 has already provided needed expert scientific advice.

8) Identification of any need for technical input to the standard from external bodies

Currently, there is no identified need for additional technical input from external bodies, as there is information available published by ICMSF (International Commission on Microbiological Specifications for Foods) (2018) as well as other publicly available literature that can support the inclusion/revision of the CoP to include new management measures that were proven to be effective in reducing or preventing aflatoxin contamination in peanuts.

9) Timeline for completion of the new work

Work will start following approval by CAC in 2024. Completion of work is expected by 2027 or earlier.

APPENDIX II

DISCUSSION PAPER

Review of the *Code of Practice for the Prevention and Reduction of Aflatoxin Contamination in Peanuts* (CXC 55-2004)

(For consideration by CCCF)

BACKGROUND

1. Aflatoxins (AF) are the most potent liver carcinogens known, based on studies in test species and human epidemiological studies, as classified by the forty-ninth and reaffirmed by the eighty-third meeting of the Joint FAO/WHO Expert Committee on Food Additives (JECFA)[1]. Moreover, aflatoxins have acute, chronic, genotoxic, and immunosuppressive properties. Several species of *Aspergillus* section *Flavi* producing aflatoxins have been described, but the most common in food are *Aspergillus flavus, A. parasiticus* and *A. nomius* and related species.

2. Given the importance of reducing aflatoxin exposure from peanuts, in 2004 the Codex Alimentarius Commission established a *Code of practice (CoP) for the prevention and reduction of aflatoxin contamination in peanuts* (CXC55-2004). The CoP includes recommended practices for aflatoxin reduction at pre-harvest, harvest, transport, storage, and manufacturing stages.

3. AFs (B_1, B_2, G_1 and G_2; AFT) were evaluated by the JECFA at its 49th Meeting (1998) and it was concluded that aflatoxins are human liver carcinogens with AFB1 as the most potent one. No tolerable daily intake was proposed since aflatoxins were considered genotoxic carcinogens. Thus, adoption of the ALARA (as low as reasonably achievable) principle was recommended to reduce the potential risk. At its 83rd meeting, JECFA (FAO/WHO, 2017) re-evaluated toxicological data and dietary exposure to AFs and reaffirmed the conclusions of the 49th JECFA meeting (FAO/WHO, 1998).

CoP INTRODUCTION

4. Currently there is no introduction to the COP, so inclusion of an introduction is needed, including information on aflatoxins in peanuts, such as the main aflatoxigenic species in peanuts.

DEFINITIONS

5. The definition of water activity in the current COP includes a range of water activity considered safe as regards to *Aspergillus flavus* and *Aspergillus parasiticus*, which is not a definition of water activity. More details on water activity can be found in paragraph 39.

3. RECOMMENDED PRACTICES BASED ON GOOD AGRICULTURAL PRACTICES (GAP)

3.1 Pre-harvest

6. New information has been added to paragraph 10 to review the use of soil amendments to reduce *A. flavus* seed infection and aflatoxin formation.

7. New information has been added to paragraph 12 to explain the impact of water stress on fungal growth.

8. New information has been added to paragraph 13 on the period of crop growth in which drought stress is critical. As this period may vary depending on the crop, the COP should identify that this corresponds to pod/seed filling.

9. The practice of biological control methods is included as a possible practice to mitigate aflatoxin contamination.

3.2 Harvest

10. An illustration is included in order to elucidate the stages of peanut reproductive growth.

4. GOOD MANUFACTURING PRACTICE (GMP)

4.2 Sorting

11. Sorting practices (such as colour sorting, density flotation, blanching and roasting) used to reduce aflatoxin levels have been added.

4.3 Blanching

12. More details about the blanching process and its effect on reducing aflatoxins were included

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[1] JECFA. Safety evaluation of certain contaminants in food. Prepared by the eighty-third meeting of the Joint FAO/WHO Expert Committee on Food Additives (JECFA). WHO FOOD ADDITIVES SERIES: 74, 2018.

5. A COMPLEMENTARY MANAGEMENT SYSTEM TO CONSIDER IN THE FUTURE

13. The text was clarified, and some examples were added to make practices evident.

14. A summary of the most important good farm practices and the major GMP measures in the shelling plant was included.

References in support of the revised provisions in the CoP

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Torres, A. M., Barros, G. G., Palacios, S. A., Chulze, S. N., & Battilani, P. (2014). Review on pre- and post-harvest management of peanuts to minimize aflatoxin contamination. *Food Research International*, *62*, 11-19. https://doi.org/10.1016/j.foodres.2014.02.023

Waliyar, Farid & Kumar, Lava & Traoré, Aoua & Ntare, B.R. & Diarra, Bamory & Kodio, Ondié. (2008). Pre- and Postharvest Management of Aflatoxin Contamination in Peanuts. 10.1079/9781845930820.0209.

APPENDIX III

PROPOSED REVISED CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF AFLATOXIN CONTAMINATION IN PEANUTS (CXC55-2004)

(For information)

1. INTRODUCTION

1. Aflatoxins (AF) are the most potent liver carcinogens known, based on studies in test species and human epidemiological studies, as classified by the forty-ninth and reaffirmed by the eighty-third meeting of the Joint FAO/WHO Expert Committee on Food Additives (JECFA)[1]. Moreover, aflatoxins have acute, chronic, genotoxic and immunosuppressive properties. Aflatoxins can be found in peanuts, peanut-derived products, and animal by-products, including milk when animals consume feed contaminated with aflatoxins.

2. Several species of *Aspergillus* section *Flavi* producing aflatoxins have been described, but the most common in food are *Aspergillus flavus, A. parasiticus* and *A. nomius* and related species. These species are commensal with peanuts and can grow with these plants under favourable conditions for fungal growth. The appropriate interaction of the host, fungus and environment determines the infection and the colonization of the peanut substrate and the consequent aflatoxin production. Drought stress and elevated temperatures (> 22°C) during seed filling and plant development are among the most important factors that influence aflatoxigenic fungal infection and aflatoxin production.

3. After harvest, the crop is cured, dried, stored and traded. Water activity of peanuts should be maintained to below 0.70 at 25°C and moisture content below 8% to prevent aflatoxigenic species growth and toxin formation, until the peanuts undergo further processing, e.g., roasting. Colour sorting, blanching and roasting are processing stages used for aflatoxin reduction in the peanut production chain.

2. SCOPE

4. This document is intended to provide guidance for all interested parties producing and handling peanuts for entry into international trade for human consumption. All peanuts should be prepared and handled in accordance with the *General Principles of Food Hygiene* (CXC 1-1969), which are relevant for all foods being prepared for human consumption. These codes of practice indicate the measures that should be implemented by all persons that have the responsibility for assuring that food is safe and suitable for consumption.

3. DEFINITIONS

5. ***"Blows"*** (Pops) means in-shell peanuts which are unusually light in weight due to extensive damage from physiological, mould, insect, or other causes and which can be removed, for example, by an air-separation process.

6. ***"Curing"*** means drying of the in-shell peanuts to a safe moisture level.

7. ***"Farmers' stock"*** peanuts means in-shell peanuts as they come from farms, after separation from the vines by hand and/or mechanical means.

8. ***"Safe water activity"*** means a water activity of in-shell peanuts and shelled peanuts that will prevent growth of micro-organisms normally present in the harvesting, processing, and storage environment.

9. **Water activity** (aw) is a measure of free moisture in a product and is the water vapour pressure of the substance divided by the vapour pressure of pure water at the same temperature. ~~Water activities above 0.70 at 25 degrees Celsius (77 ° Fahrenheit) are 'unsafe' as far as growth of *Aspergillus flavus* and *Aspergillus parasiticus* and possible aflatoxin production are concerned.~~

10. **Moisture content**, is a measure of water content in a product.

11. **Xerophilic fungi** means fungi that are able to grow below 0.85 water activity under at least one set of environmental conditions.

12. ***"Pegs"*** mean a stalk-like structure that goes underground and originate the pods.

[1] JECFA. Safety evaluation of certain contaminants in food. Prepared by the eighty-third meeting of the Joint FAO/WHO Expert Committee on Food Additives (JECFA). WHO FOOD ADDITIVES SERIES: 74, 2018.

4. RECOMMENDED PRACTICES BASED ON GOOD AGRICULTURAL PRACTICES (GAP

4.1 Pre-harvest

13. To be effective, pre-harvest control of aflatoxin contamination of peanuts must take into consideration all the varied environmental and agronomic factors that influence pod and seed infection by the aflatoxin-producing fungi, and aflatoxin production. These factors can vary considerably from one location to another, and between seasons in the same location. Some environments may be particularly favourable to fungal infection and subsequent aflatoxin contamination of peanuts ~~groundnuts~~, and in these circumstances, it would be necessary to consider whether or not the crop should be grown in such areas. However, for most situations it should be possible to devise agricultural practices that should reduce aflatoxin contamination in peanuts.

14. The continued cultivation of peanuts on the same land may lead to a build-up of high populations of *A. flavus/A. parasiticus* in the soil, which will increase the probability of infection and aflatoxin contamination. Some studies have been carried out on the effect of crop rotation on aflatoxin contamination. In semi-arid environments, populations of *Aspergillus* may be very high, and crop rotations may have little influence on the fungal activity. Cropping systems in some regions involve varied cultivation and fertilizer practices that individually or taken together may affect survival or build-up populations of the toxigenic fungi. There is evidence that peanuts grown in different soil types may have significantly different levels of infection by the moulds. Light sandy soils, for example, favour rapid proliferation of the fungi, particularly under dry conditions. Heavier soils have a higher water-holding capacity and, therefore, there is less likelihood of drought stress occurring, which may be partly responsible for the lower-than-average levels of aflatoxin contamination in peanuts grown on such soils.

15. In areas that are vulnerable to erosion, no-till practices may be required in the interests of soil conservation.

16. Utilize the results of soil tests to determine if there is a need to apply fertilizer and/or soil conditioners to assure adequate soil pH and plant nutrition, as well as soil structure to avoid plant stress, especially during seed development, which makes peanuts more susceptible to fungal infestation and infection. Utilizing soil amendment such as farmyard manure and gypsum/lime at sowing time is shown to reduce *A.flavus* seed infection and aflatoxin formation. Lime and gypsum as sources of calcium enhance cell thickness and pod filling and decrease fungal infection. Organic supplements, such as farmyard manure and crop residues improve the water-holding capacity of the soil, minimizing the effect of drought during plant development.

17. The choice of peanut variety can be important and therefore before planting, farmers should consult with the appropriate plant breeding authorities or agricultural extension services to ascertain the peanut cultivars that are best ~~have been~~ adapted to their region, and the availability of varieties that are resistant to various factors such as insect ~~attack~~ infestation and microbial and fungal ~~attack~~ infection that can have an impact on the safety and quality of the peanuts produced. A cultivar should be selected that is suitable for a particular growing season and mature at the end of the rainy season so that post-harvest field drying can be done under favourable conditions. It is undesirable that a variety should suffer from drought stress during pod maturation and some compromise may have to be effected between harvesting under dry conditions and avoidance of drought stress by using short-duration cultivars that mature before the rains have ended.

18. Irrigation, if feasible, is recommended to combat heat and drought stress. Water stress acts in three ways: first, by wilting the plant and reducing its metabolic activity, which decreases the plant's natural defenses against fungal infection; second, by reducing the water activity in the soil, which reduces growth and activity of competing microorganisms; and third, by promoting growth of *A. flavus/A. parasiticus*, which are xerophilic fungi.

19. Irrigation to ensure adequate soil moisture during the ~~last 4-6 weeks of crop growth~~ pod/seed filling and before harvest should minimize pre-harvest aflatoxin contamination of peanuts. 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.

20. Water used for irrigation and other purposes (e.g. preparation of pesticide sprays) should be of suitable quality for the intended use.

21. Avoid overcrowding of plants by maintaining the recommended row and intra-plant spacing for the species/varieties grown. Optimum plant populations should be established bearing in mind that too high a population may lead to drought stress where rainfall may be below the optimum required in a growing season.

22. Excessive weed growth may deplete available soil moisture. Effective weed control by use of registered herbicides, or cultivation is therefore advisable. Care should be taken during cultivation to avoid damage to pegs and pods.

23. Cultivation and crop protection practices that lower the incidence of soil insects, mites, and nematodes should help in reducing aflatoxin contamination. Minimize insect damage and fungal infection in the vicinity of the crop by proper use of registered insecticides, fungicides, and other appropriate practices within an integrated pest management program. Growers should consult with local or national authorities to determine insects and other pests that are commonly found in their region that might attack peanuts causing them to be more susceptible to fungal infections that can lead to aflatoxin production.

24. No fungicide, or combinations of fungicides, or other chemical treatments appear to have been adopted for the practical control of *A. flavus/A. parasiticus* infection and subsequent aflatoxin contamination of peanuts pre-harvest. The results of studies on the application of fungicides on freshly harvested or windrowed peanuts are equivocal.

25. An effective strategy aimed at mitigating pre-harvest aflatoxin contamination in crops may involve the utilization of biological control methods. This approach entails the deliberate introduction of competitive non-toxigenic strains of *A. flavus* or *A. parasiticus* into the soil of developing crops. Growers should consult with local or national authorities to check the availability of approved natural biocontrol agents.

4.2 Harvest

26. Trade associations as well as local and national authorities should take the lead in informing growers of the hazards associated with aflatoxin contamination of peanuts and how they may practice safe harvesting procedures to reduce the risk of contamination ~~by fungi, microbes, and pests~~. Personnel who will be involved in harvesting peanuts should be well-trained in the personal hygienic and sanitary practices that must be implemented throughout the harvesting season.

27. Make sure that all equipment, which is to be used for harvesting and storage of crops, is functional. A breakdown during this critical period may cause peanut quality losses and enhance aflatoxin formation. ~~Keep important spare parts available on the farm to minimize time loss from repairs.~~

28. Plan to harvest the peanuts at full maturity, unless allowing the crop to continue to full maturity would subject it to extreme heat, rainfall, ~~and~~ or drought conditions. 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~~ In addition, delayed harvest of infected peanuts ~~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.

29. Figure 1 represents the stages of peanut reproductive growth. The following stages correspond to the beginning of pod formation (R3), pod expansion (R4) and seed formation (R5). Once it reaches the ground, the peg with its swollen ovary doubles its width and the expansion of the pod begins. With the pod fully expanded, the growth of the seed's cotyledon begins. Seed formation begins approximately 60 days after planting. When the pod cavity is completely filled with seed, the plant reaches the R6 stage, around 74 days after planting. When 50% of the plants have at least one pod that shows colour on the inner part of the pericarp, the plantation reaches the R7 stage, indicating the beginning of maturation. Complete maturation (R8), indicating the moment of harvest, occurs when 70 to 75% of the pods are placed in the inner part of the pericarp. Stages R7 and R8 occur approximately in the last 30 days of the peanut planting cycle. Maturation can be observed by the colour of the cotyledons, which varies from white (immature grains) to pink (more mature grains).

Stage	Reproductive stages	Description	Figure
R1	Beginning bloom	One open flower at any node on the plant.	
R2	Beginning peg	One elongated peg (gynophore).	

Stage	Reproductive stages	Description	Figure
R3	Beginning pod	One peg in the soil with turned swollen ovary at least twice the width of the peg.	
R4	Full pod	One fully expanded pod, to dimensions characteristic of the cultivar.	
R5	Beginning seed	One fully expanded pod in which seed cotyledon growth is visible when the fruit is cut in cross-section.	
R6	Full seed	One pod with cavity apparently filled by the seeds when fresh.	
R7	Beginning maturity	One pod sharing visible natural coloration or blotching of inner pericarp or testa.	
R8	Harvest maturity	66-75% of all developed pods have testa or pericarp coloration.	
R9	Over-mature pod	One undamaged pod showing orange-tan coloration of the testa and/or natural peg deterioration	

Figure 1. Stages of peanut reproductive growth. A.

30. Individual plants that die from damages caused ~~attack~~ by pests, pathogens, such as *Sclerotium rolfsii* or *Fusarium* spp., and diseases, e.g. rosette virus, or insects, such as termites, earwigs, and false wireworms that cause damage to the pods, should be harvested separately, if possible, as their produce is likely to contain aflatoxin. Alternatively, visually damaged peanuts can be sorted out of the product stream using optical sorting.

31. If peanuts have been irrigated, care should be taken to separately harvest peanuts that are beyond the reach of irrigation systems to avoid mixing ~~aflatoxin-free peanuts with those that are potentially contaminated~~ irrigated and not irrigated peanuts.

32. Damage to pods at the time of harvest should be avoided as much as possible since this can lead to rapid invasion of the pods by *A. flavus/A. parasiticus*. Peanuts should be handled as gently as possible, and every effort made to minimize physical damage at all stages of harvesting and transportation procedures.

33. After harvest, pods should be exposed to sun and wind for maximum rate of drying. This may be accomplished by turning the vines to leave the pods uppermost where they are away from the ground and exposed to sun and wind. Curing should be completed as soon as possible to a safe water activity so as to prevent the growth of microorganisms, particularly moulds that produce aflatoxins. However, ~~drying~~ curing too rapidly may cause skin slippage and off-flavours in the peanut kernels. When curing by supplemental heat, excessive heat should be avoided since this impairs the general quality of the peanuts, e.g. causing splitting of kernels after shelling. Close checks of moisture content/water activity of lots of farmer's stock peanuts should be maintained.

34. Peanuts should be dried in such a manner that damage to the peanuts is minimized and moisture levels are lower than those required to support mould growth during storage. ~~(generally, less than 10%). This is necessary to prevent further growth of a number of fungal species in peanuts.~~ The precise combination of moisture level and maximum permitted drying period will vary with peanut variety and agriculture zone. It is envisaged that the preliminary windrow drying should achieve a moisture level of < 12%, whereas the second drying phase, on a flat surface, should attain a < 8% moisture level.

35. Freshly harvested peanuts should be cleaned and sorted to remove damaged peanuts and other foreign matter. Cleaning procedures such as density separators or air legs to remove light pods and slotted screens to remove pre-shelled kernels, may remove some infected peanuts.

4.3 Transport to Processing Facilities

36. The peanuts should be moved to a suitable storage ~~facility~~, or to the processing area for immediate processing as soon as possible after harvesting or drying.

37. ~~Containers~~ Vehicles (e.g. wagons, trucks) to be used for collecting and transporting the harvested peanuts from the farm to drying facilities, or to storage facilities after drying, should be clean, dry, and free of insects and visible fungal growth before use and re-use.

38. Transport containers should be dry and free of visible fungal growth, insects, and any contaminated material. As necessary, transport containers should be cleaned and disinfected before use and re-use and be suitable for the intended cargo. The use of registered fumigants or insecticides may be useful. At unloading, the transport container should be emptied of all cargo and cleaned as appropriate.

39. Consignments of peanuts should be protected from additional moisture ~~by using~~. Use covered or airtight containers or tarpaulins, if needed, but remove promptly to avoid moisture trapping that could make the consignment more conducive to mould growth and aflatoxin development. Avoid temperature fluctuations that may cause condensation to form on the peanuts, which could lead to local moisture build-up and consequent fungal growth and aflatoxin formation.

40. Farmers' stock peanuts should be screened for aflatoxin contamination to segregate for proper storage more accurately. Aflatoxin-free loads should be segregated from loads with low levels of aflatoxin contamination, destined for subsequent processing and clean-up, and from loads that are highly contaminated.

41. 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 of the peanuts.

4.4 Segregation of aflatoxin contaminated lots

42. The distribution of aflatoxin in peanuts has been thoroughly investigated. The results from the investigations indicate that sorting for quality removes a large part of the aflatoxin present at harvest. The distribution of aflatoxins is very heterogeneous in a lot of peanuts and consequently the sampling plan used is critical. Sampling plan for total aflatoxins in peanuts intended for further processing is established in the General Standard for Contaminants in Food and Feed (CXS 193-1995).

4.5 Storage

43. The post-harvest storage ~~of peanuts is the~~ phase is very significant for ~~that can contribute~~ most to the aflatoxin contamination problems in peanuts. The primary goal for aflatoxin prevention in storage is to prevent mould development of the peanuts due to condensation or leaks in the warehouse.

44. A properly ventilated warehouse with a good roof~~, preferably double sidewalls~~ and a concrete floor are required to prevent rewetting of peanuts. Make sure that the storage facilities include dry, well-vented structures that provide protection from rain, drainage of ground water, protection from the entry of insects, rodents, and birds, and minimum temperature fluctuations. Also, the following are examples of warehouse improvements proven to be effective. Painting warehouse roofs with white paint reduces solar heat load when compared to conventional galvanized material. The double roofing concept of installing a new roof over a defective, existing roof, with an air space in-between the two roofs, has proven effective in controlling warehouse condensation.

45. Water activity, which varies with Moisture content and temperature, should be carefully controlled monitored during storage.

46. Uniform loading of the warehouse allows excessive heat and moisture to escape and reduces favourable areas for insect infestation. Stock piling of peanuts can cause heat build-up and moisture accumulation with resultant mould growth and aflatoxin contamination.

47. Prevention of aflatoxin increase during storage and transportation depends on water activity and keeping a low moisture content, the temperature in the environment, and the hygienic conditions. *A. flavus/A. parasiticus* cannot grow or produce aflatoxins at water activities less than 0.7 and moisture content less than 8 percent. Relative humidity should be kept below 70% and temperatures between 0 and 10°C, are optimal for minimizing deterioration and fungal growth during long time storage.

48. The aflatoxin level in peanuts coming into a storage facility and peanuts going out of a storage facility should be monitored, using appropriate sampling and testing programs.

49. For bagged peanuts, ensure that bags are clean, dry, and stacked on pallets or incorporate a water impermeable layer between bags and the floor.

50. Store at the lowest temperature possible consistent with ambient conditions but avoid temperatures near freezing point. Where possible aerate the peanuts by circulation of air through the storage area to maintain proper and uniform temperature levels throughout the storage area.

51. Measure the temperature, when possible, of the stored peanuts at several fixed intervals during storage. A temperature rise may indicate microbial growth and/or insect infestation. Visually check peanuts for evidence of mould growth. Separate the apparently infected portions of the peanuts and send samples for analysis if possible. When separated, lower the temperature in the remaining peanuts and aerate. Avoid using visually infected peanuts for food or feed production. Peanuts used for feed should comply with national standards for aflatoxin allowed in animal feed.

52. Use good 'housekeeping' procedures to minimize levels of insects and fungi in storage facilities. This may include the use of suitable traps, registered insecticides or fungicides and fumigants. Care should be taken to select only those chemicals that will not affect or cause harm to the peanuts.

53. Document the harvesting and storage procedures implemented each season by making notes of measurements (e.g. temperature, moisture, water activity and humidity) and any deviation or changes from traditional practices. This information may be very useful for explaining the causes of fungal growth and aflatoxin formation during a particular crop year and help to avoid similar mistakes in the future.

5. GOOD MANUFACTURING PRACTICE (GMP)

5.1 Receiving and shelling

54. A buyer for a shelling plant, whether located at the plant or at an outlying buying point, should monitor the quality of peanuts offered to him and assist suppliers in eliminating improper practices. Buyers should encourage suppliers of farmers' stock peanuts to follow good production practices as described herein.

55. Farmers' stock peanuts received at the shelling plant should be inspected on arrival. It is advisable to know the origin and history of each lot of peanuts. The transport vehicle should be examined. If the vehicle is not fully enclosed, it should have a covering such as tarpaulin to keep out rain or other forms of water. The general appearance of the peanuts should be observed during the process of unloading. If the peanuts are wet to the touch, they should NOT be mixed with peanuts in a bulk warehouse. The vehicle which contains the peanuts should be set aside until a decision is made for their disposal. If possible, remove a sample from each lot, separate the "loose shelled" kernels and shell the remainder for peanut grade observation before an acceptance decision is made.

56. Specifications for the purchase of peanuts intended for further processing should include a maximum level for aflatoxin based in appropriate methods of analysis and a proper sampling plan.

57. Special precautions must be taken to reject peanuts showing signs of insect damage or mould growth because of the danger of their containing aflatoxins. Aflatoxin test results should be known before allowing lots of raw peanuts to be processed. Any lot of raw peanuts with unacceptable levels of aflatoxins, which cannot be reduced to permitted levels by the available sorting equipment, should not be accepted.

58. The peanut processor must be satisfied himself that the supplier of shelled peanuts is able to control properly control his own operations to assure that the finished product is within the maximum limit for aflatoxin.

59. Examine all loose-shelled, damaged "Blows" and under-sized kernels for possible presence of mould. If no external mould is visible, split the kernels to disclose possible hidden mould growth. Excessive mould or presence of mould resembling *A. flavus* warrants a chemical test for aflatoxin or rejection of the lot.

4.2 Sorting

60. Several procedures are used by processors to reduce aflatoxin levels by approximately 99%, such as colour sorting, density flotation, blanching and roasting. Aflatoxins in peanuts can be decreased at any stage of production by removing defective peanuts and other foreign matter by sorting (electronically or manually by hand), winnowing, separating by gravity or other methods. Sorting is the final step for removing defective kernels. In electronic or laser sorting, shelled peanuts are inspected individually by an electronic or laser sorting system and discoloured peanuts are removed. The rationale for aflatoxin reduction by colour sorting is that the growth of a fungus in a peanut, results in discoloration, so removal of discoloured peanuts sorts out those containing aflatoxins as well. Hand sorting may also be performed. Sorting belts should be well lighted, with peanuts passing through no more than one layer deep and operated at a speed which enable hand sorters to assure effective removal of foreign material and defective kernels. Sorting machines should be adjusted as often as practicable against standards to assure removal of all defective kernels. Adjustment should be checked frequently and regularly.

61. To remove mould-contaminated nuts effectively, sorting should be performed before and after blanching and roasting. Where splitting is part of the processing operation, nuts that resist splitting should be removed. The effectiveness of sorting techniques should be checked by regular aflatoxin analyses of the sorted peanuts stream or of the finished product, or both. This should be done frequently enough to ensure that the product is completely acceptable.

62. Defective (mouldy, discoloured, rancid, decayed, shrivelled, insect or otherwise damaged) kernels should be bagged separately and tagged as unsuitable for human consumption. Containers of defective peanuts should be removed as soon as practicable from ~~form~~ the processing area. Materials which carry the danger of contamination by aflatoxin, or which are contaminated should be diverted to non-food uses or to animal feed, if meeting acceptable standards.

63. Rejected peanuts from the sorting procedure should be destroyed or segregated from edible products. If they are to be used for crushing, they should be separately bagged and tagged as unsuitable for direct human consumption in their present state.

5.3 Blanching

64. Blanching is a process which involves the partial drying of raw shelled peanuts with the aim of loosening skins/coats for easy removal by blanching rollers. The blanched nuts are then sorted for discoloration using electronic colour sorters or by hand. Blanching used in conjunction with gravity tables and manual or electronic sorting is very efficient in removing aflatoxin-contaminated kernels. Colour sorting, combined with blanching have been shown to reduce aflatoxin contamination by as much as 90%. If the colour sorting process is ineffective for blanched peanuts, as can occur when severe drought stress causes peanuts to commence drying in the soil before harvest, it is common practice to roast the blanched peanuts and perform the colour sorting process again. This accentuates the darkening process and facilitates colour sorting.

65. Electronic colour sorting after blanching is believed to be more efficient for removing the damaged nuts (which may contain aflatoxins) than colour sorting nuts prior blanching, because of the increased contrast between the damaged and undamaged peanuts. Those peanuts that have a different colour are removed from the process by a jet of compressed air. Therefore, damaged peanuts will be detected by the colour sorters and removed from peanut stream.

5.4 Packaging and storage of end product

66. Peanuts should be packed in clear jute bags, cartons, or polypropylene bags. If using jute, ensure bags are not treated with mineral hydrocarbon-based oils. All bags/cartons should be lot identified to facilitate traceability of the product before being moved to controlled storage facilities or transported.

67. Peanuts that have been processed should be stored and transported under such conditions as will maintain the integrity of the container and the product within it. Carriers should be clean, dry, weatherproof, free from infestation, and sealed to prevent water, rodents, or insects from reaching the peanuts. Peanuts 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 peanuts from cold storage or from a refrigerated vehicle. In warm, humid weather, the ~~groundnuts~~ peanuts should be allowed to reach ambient temperature before exposure to external conditions. This tempering may require 1-2 days. Peanuts that have been spilled are vulnerable to contamination and should not be used for edible products.

~~5. A COMPLEMENTARY MANAGEMENT SYSTEM TO CONSIDER IN THE FUTURE~~ 6. HAZARD ANALYSIS CRITICAL CONTROL POINT (HACCP) SYSTEMS

68. The Hazard Analysis Critical Control Point (HACCP) system is an all-encompassing integrated food safety management system that is used to identify and control hazards within the production and processing system. The general principles of HACCP have been described in ~~several documents~~ in the General Principles of Food Hygiene (CXC 1-1969).

69. Aflatoxins in peanuts is both a microbial and a chemical issue. When properly implemented, this system should result in a reduction of the levels of aflatoxins in peanuts. The use of HACCP as a food safety management system has many benefits over the types of management control systems in some segments of the food industry. Control of aflatoxin production in the field is mainly achieved through minimizing the insect infestation and controlling the irrigation. ~~At farm level there are many factors that influence the aflatoxin contamination of peanuts most of which are environmentally related, such as weather and insects, and these are difficult, if not impossible, to control.~~ Particular attention should be paid to the soil population of the fungus, the health of seed material, soil moisture deficit stress at the pod formation and pod maturity stages, and rains at harvest. The critical control points often do not exist at the pre-harvest level. However, after harvesting, the critical control points may be identified for aflatoxins produced by fungi during drying and storage. ~~For example, a critical control point could be at the end of the drying process and one critical limit would be the water content/water activity.~~ For example, aflatoxins can be formed while peanuts are being dried, which is usually carried out in the field, and can also continue to form during farm storage if drying has been inadequate or when storage is carried out at high relative humidity (RH) and/or temperature. During manufacturing, sorting and roasting are the main steps in the reduction of aflatoxin and thus potential critical control points.

70. It is recommended that resources be directed to emphasizing the Good Agricultural Practices (GAPs) at the pre-harvest level and during drying and storage and Good Manufacturing Practices (GMPs) during the processing and distribution of various products. A HACCP system should be built on sound GAPs and GMPs.

71. Integrated ~~mycotoxin~~ aflatoxin control programs should incorporate HACCP principles in the control of risks associated with ~~mycotoxin~~ aflatoxin contamination of foods and feeds. The implementation of HACCP principles will minimize aflatoxin contamination of peanuts through applications of preventive controls to the extent feasible in the production, handling storage and processing of each peanut crop.

APPENDIX IV

LIST OF PARTICIPANTS
CHAIR
Brazil

Larissa Bertollo Gomes Pôrto
Health Regulation Expert
Brazilian Health Regulatory Agency – ANVISA
Brasília
Brazil

ARGENTINA

Mr. Augusto José Frías Calvo
Coordinador General de Piensos y Granarios
SENASA

Mr. Martín Rhodius
Analisita profesional en Inocuidad y Calidad Agroalimentaria
SENASA

Ms. Silvana Ruarte
Directora de Fiscalización y Control
INAL-ANMAT

Mr. Martin Fernandez
Profesional de laboratorio
INAL ANMAT

Ms. Gisele Simondi
Profesional de laboratorio
INAL ANMAT

BRAZIL

Lígia Lindner Schreiner
Health Regulation Expert
Brazilian Health Regulatory Agency – ANVISA
Brasília, Brazil

Carolina Araujo Vieira
Health Regulation Expert
Brazilian Health Regulatory Agency – ANVISA
Brasília, Brazil

Mrs Marta Hiromi Taniwaki
PhD in Food Science and Technology
Instituto de Tecnologia de Alimentos
Av Brasil, 2880 Campinas Brazil

Mr Rafael Ribeiro Goncalves Barrocas
Federal Food Inspector
Ministry of Agriculture and Livestock - MAPA

EGYPT

Noha Mohammed Attiya
Food Standards Specialist
Egyptian Organization for Standardization & Quality (EOS)
Ministry of Trade and Industry

EUROPEAN UNION

Mr Frans VERSTRAETE
Deputy Head of Unit
European Commission / Directorate General for Health and Food Safety

GHANA

Abdul-Malik Adongo Ayamba
Quality and Safety Coordinator
Ghana Standards Authority

Abena Yiwaa Oppong-Mensah
Research Officer
Quality Control Company-COCOCBOD

HONDURAS

Maria Eugenia Sevilla
Technical Manager for Food Safety - SENASA

HUNGARY

Dr. Attila Nagy
Director
National Food Chain Safety Office

INDONESIA

Desiardy Muharyadi Putra
Food Security Analyse
National Food Agency

Yeni Restiani
Coordinator of Raw Material, Food Category, Food Labelling, and Food Standard Harmonization
Indonesian Food and Drug Authority

MADAGASCAR

Rafalimanana Halitiana
Expert scientifique
Enseignante chercheur
Université d'Antananarivo

MALASYA

Ms. Shazlina Mohd Zaini
Principal Assistant Director
Ministry of Health, Malaysia

Ms. Rodiyah Mohamed
Senior Assistant Director
Ministry of Health, Malaysia

NIGERIA

Babajide Jamodu
Principal Standards Officer

Maimuna Mazai
Principal Standards Officer

NEW ZEALAND
Jeane Nicolas
Senior Adviser Toxicology
New Zealand Food Safety

Fiapaipai Auapaau
Adviser Risk Assessment
New Zealand Food Safety

PANAMA

Eng Joseph Gallardo
Ingeniero de Alimentos / Punto de Contacto Codex
Ministerio de Comercio e Industrias

PARAGUAY

Lic. Alba Luz María Domínguez
Lic. en Química pura
Directora del Laboratorio de Residuos-Servicio Nacional deCalidad y Sanidad Vegetal y de Semillas (SENAVE).

PERU

Javier Neptali Aguilar Zapata
Coordinador Titular de la Comisión Técnica sobre contaminantes en los alimentos.

PHILIPPINES

Mr. Phelan Apostol
Food and Drug Regulation Officer III
Chairperson, Sub-Committee on Contaminants in Food
Food and Drug Administration
Department of Health (DOH)

REPUBLIC OF KOREA
Jooyeon Kim
Researcher
Food Standard Division, Ministry of Food and Drug Safety (MFDS)

SAUDI ARABIA
Mohammed A. Ben Eid
Head of Chemical Risks, Food
Saudi Food and Drug Authority, Kingdom of Saudi Arabia

Yasir A. AlAqil
Senior specifications and regulations Specialist |
Saudi Food and Drug Authority, Kingdom of Saudi Arabia

Nimah M. Baqadir
Standards and Regulations Specialist I, Food Sector
Saudi Food and Drug Authority, Kingdom of Saudi Arabia

Lama A. AlmaimanRisk assessment expert, Food Sector
Saudi Food and Drug Authority, Kingdom of Saudi Arabia

Dr. Mohammed M. Al-Shehri
Risk assessment expert, Food Sector
Organization or country: Saudi Food and Drug Authority, Kingdom of Saudi Arabia

SENEGAL
Madame Sokhna NDAO
Ingénieur en industrie agroalimentaire
Université Cheikh Anta DIOP /DAKAR

Safiétou Sabaly DIALLO
Chef Bureau Contrôle Qualité
Direction de la Protection des végétaux

Babacar BEYE
Chef laboratoire de mycotoxines
Institut de technologie alimentaire

Docteur Alé KANE
Enseignant Chercheur
Université Gaston BERGER / Saint-Louis

SINGAPORE
Joachim Chua (Official)
Specialist Team Lead (Foodborne & Natural Toxins)
Singapore Food Agency

Leyau Yu Lee
Senior Scientist
Singapore Food Agency

Er Jun Cheng
Specialist Team Lead (Exposure Assessment)
Singapore Food Agency

SOUTH AFRICA
Masuku Juliet
Medical biological scientist

SWITZERLAND
Ms. Judit Valentini
Scientific Officer
Federal Food Safety and Veterinary Office FSVO

UNITED KINGDON

Craig Jones
Senior Policy Advisor
Food Standards Agency

Holly Howell-Jones
Policy Advisor
Food Standards Agency

UNITED STATES OF AMERICA
Anthony Adeuya
Chemist/US Delegate
FDA/ United States

Lauren Robin
Branch Chief/US Delegate
FDA/United States

Quynh-Anh Nguyen
Biologist/US Delegate
FDA/ United States

Tabitha Miller
Chemist/US Delegate
FDA/ United States

FAO

Cornelia Boesch
Food Safety Officer, Dr. sc. tech. ETH
FAO (HQ Rome)

Ms. Irene Gironès
Statistics and Technical Projects Manager
INC International Nut and Dried Fruit Council