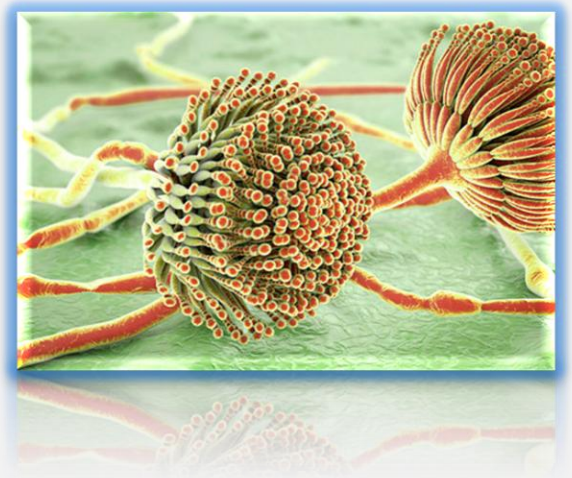
# Aflatoxin Prevention and Control Technologies: Solutions for Smallholders






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September 10, 2026

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# CONTENTS


01 Source prevention

02 Post-harvest treatment

03 Quick detection

04 Detoxification remediation

# Background

- Aflatoxin, also known as yellow mold toxin, is toxic secondary metabolites produced by molds. It is the most potent naturally occurring carcinogenic substance discovered to date, closely related to liver cancer.
- Over 1mg/kg (corresponding to a tiny particle at sesame size into 1 ton of grains) *Aflatoxin* might cause cancer. It will transmit and accumulate through food chain. Highly thermostable, decomposing at over 280℃.
- About 25% of agro-products are contaminated by mold toxin each year in the world, leading to economic loss of thousands of billion dollars per year. maize and peanuts are particularly prone to severe contamination.








# Source Prevention

# 1.1 Selection of resistant varieties

◆ The selection of crop varieties resistant to Aspergillus flavus is the most economical and effective measure to reduce contamination risks from the source.

**Technology:** NIR spectroscopy for rapid, non-destructive screening.

**Developer:** Council for Scientific and Industrial Research – Savanna Agricultural Research Institute (CSIR-SARI), Ghana.

**Principle:** Identifies antifungal markers (2,5-dihydroxybenzaldehyde & ferulic acid) in peanut seed coats to select A. flavus-resistant varieties.

**Advantages:** Fast, chemical-free, high-throughput, low cost

**Outlook:** Ready for large-scale deployment in Sub-Saharan Africa.

**Impact:** Source-level aflatoxin control, improved food safety, and better market access for smallholders.





# 1.1 Selection of resistant varieties

**Practice:** The Kenyan agricultural department recommends farmers to plant high-yield, Aspergillus flavus tolerant peanut varieties such as Ndovu and Mwangaza, which exhibit stronger antifungal abilities in the field.

**Suggestions for smallholder:**

- Varieties certified for resistance to Aspergillus flavus should be prioritized in selection.
- When saving seeds for the next planting, damaged, insect infested, and moldy seeds need to be discarded.






## 1.2 Soil microbiota regulation

**Technology:** The ARC (A: Toxin control; R: Nodulation and nitrogen fixation; C: Functional coupling) microbial agent technology

**Developer:** Oil Crops Research Institute, Chinese Academy of Agricultural Sciences

**Principle:** Negative correlation has been found between Aspergillus flavus and rhizobia in soil. By applying synthetic microbial communities to promote the growth of rhizobia, the production of aflatoxin can be effectively inhibited.

**Impact:** Application at across 658 demonstration sites in 22 provinces in China demonstrated: the abundance of aflatoxin-producing Aspergillus flavus has been reduced by over 60%, with field control rates exceeding 63% and aflatoxin levels in peanuts reduced by 85.6%; average yields increased by over 19% for peanuts and over 15% for soybeans.






ARC microbial agent

# 1.3 Avoiding drought stress

Aflatoxin contamination mainly occurs after crops are subjected to drought stress, especially during flowering and podding periods, which significantly increases the risk of toxin contamination before harvest. Drought leads to a decrease in crop resistance, making Aspergillus flavus more susceptible to infection.

## Suggestions for smallholder:

- Ensure irrigation during critical growth periods (flowering and podding).
- Drought tolerant varieties should be selected for drylands that cannot be irrigated.
- Pay attention to field drainage to avoid root damage caused by waterlogging.





# 1.4 Pest control

Insect bites cause surface damage to crops, opening a pathway for the infection of Aspergillus flavus. Pests and fungi often form a vicious cycle, pests spread fungal spores, and fungal infections attract more pests.



**Suggestions for smallholder:**

- Prevention and control of pests such as corn borer, cotton bollworm, and pod borer.
- Check the pest situation in the field before harvesting and prioritize harvesting in areas with severe pest infestations.
- Adopting crop rotation measures to reduce the accumulation of pathogens caused by continuous cropping.






# Post-harvest Treatment

# 2.1 Selection of drying technology





## Core principle:

- Reduce the moisture content of grains to below 13% (corn) or below 10% (peanuts).
- Use waterproof cloth or plastic film to isolate ground moisture.
- Spread grains out on a sunny day to dry, flip them frequently to ensure uniform drying.

**Comparison of the effects of different drying methods (based on field trial data in Mozambique)**

| Drying Method | Initial moisture content | Time required to dry for safe moisture content | Effect evaluation |
|---|---|---|---|
| **Waterproof cloth drying** | 19.4% | 6 days | Recommended, the fastest drying to avoid moisture on the ground. |
| **Cement floor drying** | 19.4% | About 10 days | Acceptable, frequent flipping is required. |
| **Grass/bamboo mat drying** | 19.4% | More than 15 days | Not recommended, easy to absorb moisture and mold. |

# 2.2 Selection of storage technology

## Core principle: Sealed and isolated from oxygen

**Principles of Sealing Technology:** Purdue improved crop storage (PICS) bags bags and metal drums completely block the growth and toxin production conditions of Aspergillus flavus by blocking oxygen (reduced to below 5%) and stabilizing humidity.

**Comparison of different storage methods (based on 12-month tracking experiment data in Mozambique)**

| Storage method | Condition after 12 months | Aflatoxin level | Cost |
|---|---|---|---|
| **PICS sealed bag** | Corn is intact with moisture content of 11% | <0.5 μg/kg | About 3 €/50 kg |
| **Metal drum** | Corn is intact with moisture content of 11% | <0.5 μg/kg | High one-time investment(cleaned waste oil drums as alternative) |
| **Conventional barn** | Losing more than half within 3 months | Exceed the standard | Breathable structure ✗ |
| **Gunny sack** | 76% insect infestation within 3 months | 2.77 μg/kg | Moisture absorption and insect infestation ✗ |

# 2.2 Selection of storage technology




GrainPro airtight bag










Mini Steel Silo



# 2.3 Storage environment management

**Storage principle:**

- Humidity control: The humidity in the warehouse should be controlled below 12%.
- Reasonable stacking: Bagged grain should be placed 30 cm away from the wall, with wooden pallets at the bottom to maintain ventilation.
- Mold inhibitor assistance: Under the guidance of the agricultural technology department, nationally approved mold inhibitors (such as propionic acid and sorbic acid combination) can be used as auxiliary measures.








# Quick Detection

# 3.1 Detection plan for smallholder

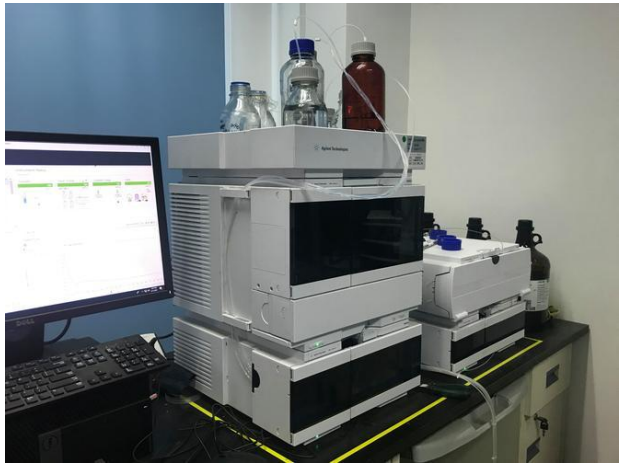
**Common detection methods**

| Detection method | Time | Application scenes | Cost |
|---|---|---|---|
| ELISA Kit | 15 min | Initial screening, capable of detecting 6 types of toxins simultaneously | Low |
| Fluorescence Quantitative Detection Card (FD-500) | 5 min | Accurate quantification of $AFB_1$ residue | Moderate |
| Third-party testing（HPLC） | Several days | Confirmation testing | USD 45/sample |









# 3.1 Detection plan for smallholder

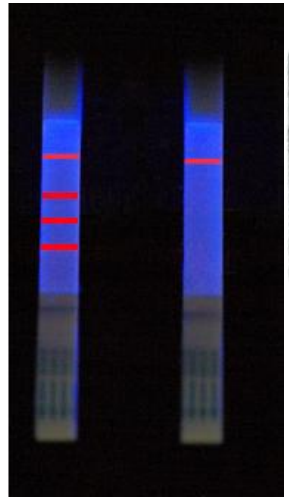
## Low-cost portable detection equipment

Both the United States Department of Agriculture-Agricultural Research Service (USDA ARS), and Oil Crops Research Institute of Chinese Academy of Agricultural Sciences, have developed low-cost, portable fluorescence detection devices specifically designed for smallholders in developing countries.



## Usage

Under UV light, corn kernels contaminated with aflatoxin will emit characteristic blue-green fluorescence. Users take photos through a tablet, and the software automatically identifies and marks contaminated seeds, which can be manually picked out and removed.





# 3.1 Detection plan for smallholder

## Verification effect

High contamination corn (71.18 ppb): The removal rate (of severely contaminated kernels) is 1.02%, total toxin reduction is 99.3%.
Moderate contamination corn (1.22 ppb): The removal rate 1.34%, total toxin reduction is 40.7%.

## Application scenes

Smallholders can quickly screen for contaminated seeds after harvest or before consumption, especially suitable for resource limited rural areas.








# 3.1 Detection plan for smallholder

## Mobile application detection

The Lab on Mobile Device (LMD) technology developed by Donald Cooper's team of the University of Colorado converts smartphone into aflatoxin detection tool and has received funding from the Bill and Melinda Gates Foundation.




## Testing procedure

- Users insert immunochromatographic test strips into the sample;
- Take photos for test strips with a mobile phone;
- Application analysis of ribbon pixel density;
- Output quantitative results (toxin concentration range).

## Advantage

- 100 times more sensitive than the human eye;
- Low operational errors;
- Automatically upload data to the cloud and build real-time aflatoxin outbreak maps;
- The cost of testing is much lower than laboratory testing.

# 3.2 Weekly detection

- **New harvested grain must be inspected before entering the warehouse**
- **Monthly sampling during storage period**
- **Timely detection for suspicious mold growth**

A case study of a chicken farm in Shandong Province, China showed that after adopting a weekly testing system of the chicken feed, the mortality rate of poultry decreased from 5.8% to 1.2%, equivalent to an annual income increase of USD 17,892.








# 3.3 Emergency response plan

**When toxins are found to exceed the standard during testing:**

- Mild exceedance: Mix with qualified new grain in a ratio of 1:3 for use.
- Serious exceedance: retest after physical adsorption or biodegradation treatment.
- Not suitable for consumption: It is processed for non-food purposes to avoid entering food.





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# Detoxification Remediation

# 4.1 Physical adsorption

**Montmorillonite adsorption:** Adding montmorillonite (3 kg/t) to feed can achieve an adsorption rate of over 85% for aflatoxin.

**Smallholder operation:** It is necessary to thoroughly mix montmorillonite with moldy feed before use.

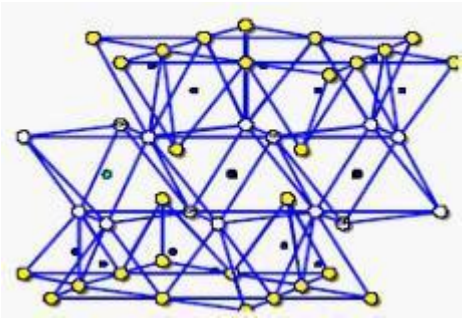
**Attention:** Some adsorbents may simultaneously adsorb nutrients such as vitamins. It is recommended to conduct small-scale experiments first.

**Composite adsorbent technology:** The use of optimized composite adsorbents can effectively remove aflatoxins without affecting the quality indicators of oils and fats.



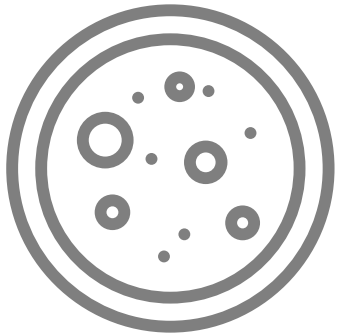


Crystal structure of montmorillonite



# 4.2 Biodegradation

The latest achievements of the research team at Weihai Ocean Vocational College:



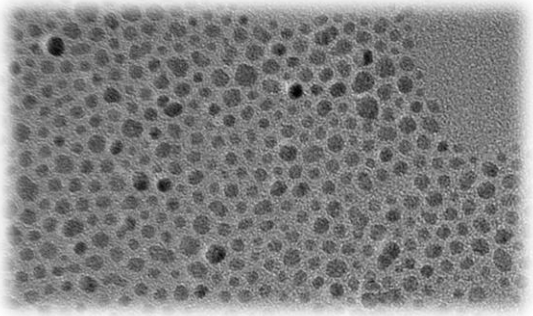
*Bacillus subtilis*

Efficient degradation strains screened from peanut continuous cropping soil



Aflatoxin degradation enzyme

Separation and purification from the metabolites of the strain



Magnetic nanoparticle immobilization

Conversion of free enzymes into reusable stable enzyme preparations

**Practical effect:** The contamination rate of peanut aflatoxin in the pilot area has been reduced by 60%, and farmers have increased their income by 15%.

# 4.2 Biodegradation

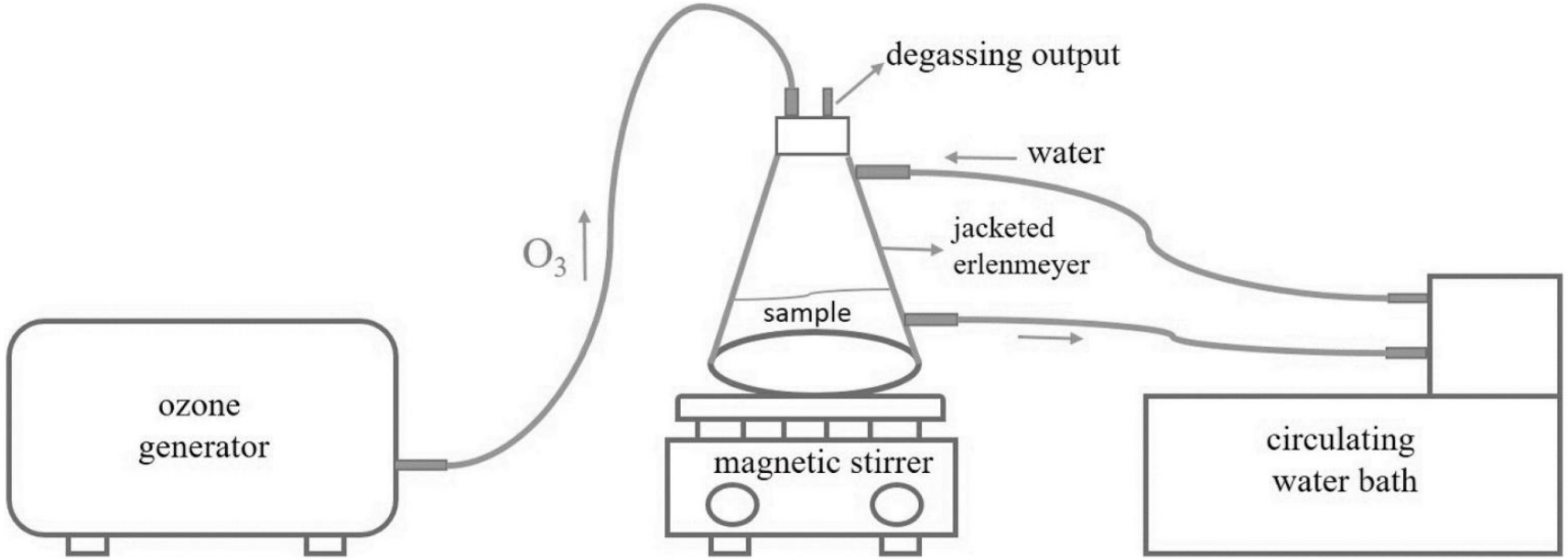
**Kenya smallholder verification:** Field trials conducted by the International Food Policy Research Institute have shown that providing biological control products combined with one application training can reduce corn aflatoxin by 34%. After additional training on the application timing by phone reminder, the reduction can reach 52%.

**Smallholder operation:** It is necessary to consult the local agricultural technology department to see if there are any promotion programs for biological control products (such as commercial products Aflasafe), which usually receive government subsidies or free distribution.



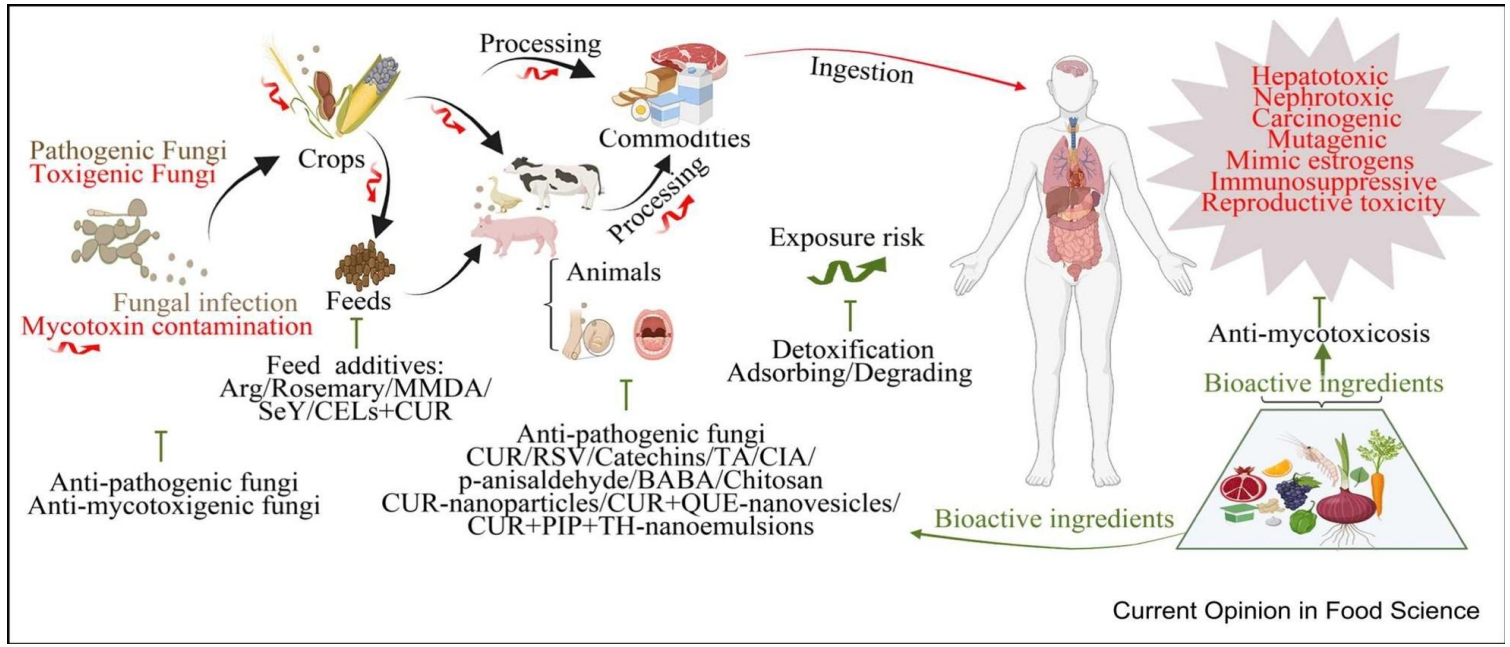
# 4.3 Ozone treatment

Data shows that ozone treatment for 2 h can lead to a degradation rate of 90.7% for zearalenone in corn. It is suitable for small- and medium-scale processing, which requires guidance from professionals.



# 4.4 Safety warning

- **Do not feed moldy grains or sell them at low prices:** Toxins can be transmitted through the food chain.
- **After removing the moldy parts, toxins may still be present:** Mycelium and toxins that are not visible have spread.
- **Protective masks must be worn:** KN95 masks should be worn in a standardized manner during harvesting, handling, and threshing to reduce the inhalation of mold spores.



## In conclusion:

Aflatoxin control should be implemented throughout the entire chain, covering field management, harvest processing, safe storage, and detection/detoxification.

In the field, priority should be given to resistant varieties, soil microbiota regulation, drought prevention, and pest control. At harvest, waterproof cloth drying should be used to reduce moisture content to safe storage value, and moldy kernels should be removed manually. For storage, grains must be thoroughly dried before storage, sealed in PICS bags or metal drums to isolate oxygen, and inspected regularly. For detection, ELISA kits or fluorescence test cards can be used for rapid screening; when contamination exceeds limits, physical adsorption or biodegradation treatments should be applied. These interconnected measures are essential to effectively minimize contamination risks.

WFP World Food Programme

2 ZERO HUNGER

# Thanks for your listening !

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