

Aflatoxin Management in Groundnut

Farmers' Friendly Techniques

Dr. M. S. Basu

Sub-programme on "Promoting Groundnut as a Food Crop
for Sustained Nutritional Security" under the GOI-UNDP
"Development of Oilseeds and Pulses Programme" implemented by
the National Research Centre for Groundnut, Junagadh, Gujarat

**DEDICATED TO THE
FARMING COMMUNITY IN INDIA**



Department of Agriculture & Cooperation
Government of India
Ministry of Agriculture
Krishi Bhawan, New Delhi-110001

Foreword

The Ministry of Agriculture, Department of Agriculture & Co-operation, launched the 'Development of Oilseeds and Pulses Programme' in a Mission Mode as part of the Government of India's efforts to develop and promote India's oilseed and pulses sector. The major objective of the programme was to support and strengthen the application of technologies for improving production and productivity and nutritive value of oilseeds, oils, oilmeals and the pulses. The United Nations Development Programme (UNDP) generously supported this Programme.

One of the initiatives of the Development of Oilseeds and Pulses Programme was to promote 'Groundnut as a Food Crop for Sustained Nutritional Security'. This sub-programme was implemented by the National Research Centre for Groundnut (NRCG), Junagadh, under the overall guidance of the Indian Council of Agricultural Research. NRCG, in collaboration with Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad, carried out the field activities in Anantpur district of Andhra Pradesh as it has a special relevance. On the one hand, groundnut produced here suffers from aflatoxin contamination risk and on the other the people in the district consume more groundnut directly and through various recipes in their daily diet. The third factor is that Anantpur district is the highest groundnut-growing district in the country.

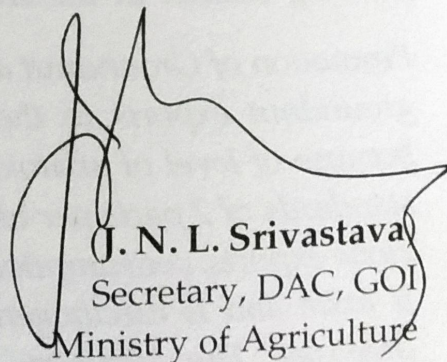
Promotion of Groundnut as a Food Crop was initiated at a time when India's groundnut exports to the European market suffered a huge loss. This is because of level of aflatoxin contamination, beyond the prescribed stringent standards of 2 parts per billion (ppb) set by the European Union (EU). Leave alone exports, consumption of groundnut contaminated with aflatoxin, which is toxin and is carcinogenic, is believed to cause liver cancer among other diseases. The Ministry of Agriculture, Department of Agriculture &

Co-operation, is extremely pleased with the outcome of this initiative. When the project completed its operations, it not only demonstrated that the aflatoxin contamination in groundnut can be reduced to 0.3 parts per billion, much less than the standards set by the EU, but has also developed and demonstrated technologies to reduce aflatoxin contamination risk for access by all groundnut producers in India.

Dr. M.S. Basu, Sub-Programme Co-ordinator, spearheaded the movement to achieve this outstanding success. My heartiest congratulations to him and the team of scientists, officials, worked with him. I am told that the technology is now spreading to Kutch-Bhuj region of Gujarat where farmers usually grow confectionery groundnut for export as well as consumption in the country. It is also spreading fast to other States.

The present Bulletin on Farmers' Friendly Techniques for Aflatoxin Management in Groundnut is to help the growers in the major groundnut growing states to keep aflatoxin in control. This should be used as a tool for capacity building of the farmers to improve groundnut quality and make it at par with international standards. This will definitely make Indian groundnut globally competitive and farmers to get better remunerative price. Apart from fetching remunerative prices to farmers, groundnut, with aflatoxin contamination free, will contribute to a better health and nutritional security to the consumers. I urge all KVK Centres, the extension officials in the States Departments of Agriculture, the non-governmental organisations and the community based organisations to use the Bulletin to bring awareness among the farming community.

I take this opportunity to sincerely thank Dr. M.S. Basu and Mr. B. Radhakrishnan in UNDP for their concerted efforts to disseminate the technology to the farming community



J. N. L. Srivastava
Secretary, DAC, GOI
Ministry of Agriculture



Indian Council of Agricultural Research
Department of Agricultural Research & Education
Krishi Bhawan, New Delhi-110001

Foreword

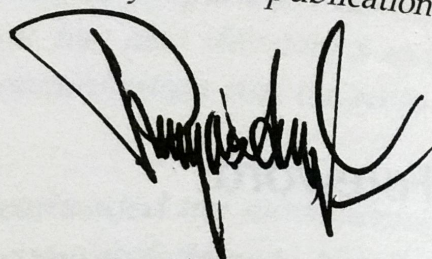
Aflatoxin contamination in food and feed has been a perpetual problem and is one of the major concerns throughout the globe. The fungal activities causing aflatoxin are usually high in tropical countries particularly where high temperature is associated with high humidity. A wide range of crops suffers from aflatoxin contamination if the suitable pre and post harvest precautions are not followed. The field crops like Maize, Groundnut, Jowar, Bajra and spices like Black Pepper, Chilli often gets contaminated with aflatoxin. The food quality standards on aflatoxin are different in different countries and usually vary from 5-30 ppb. However, the EU standard is most stringent and limit of b_1 (the potential carcinogen) is of 2 ppb. India despite being world's largest groundnut growing country our share of groundnut export is <2%.

The challenge to make groundnut aflatoxin risk free was conceived during late 90s by the NRCG-TMOP and a project was launched at Anantpur district of Andhra Pradesh which seems to be a high aflatoxin risk area, with the UNDP support.

Dr. M. S. Basu, the Sub-Programme Coordinator of the special project demonstrated 0-5 ppb aflatoxin even after 3 months of storage through participatory research programmes on pre- and post-harvest contamination levels. This is no doubt an unique development particularly when this technology is presently under the large scale application at Kutch Bhuj district of Gujarat where HPAS groundnut production takes place for export purpose as well as for confectionery use in the country.

The publication of Technology Bulletin on aflatoxin and DO AND DON'T in 5 major languages is an important step for spreading the technology and

assisting farmers in producing aflatoxin risk free groundnut not only to boost export but also keep consumers safe. I sincerely congratulate Dr. Basu and the efforts of TMOP-UNDP for bringing out this very useful publication for the first time in this direction.

A handwritten signature in black ink, appearing to read 'Panjab Singh', with a large, sweeping initial 'P'.

(Panjab Singh)

Secretary, DARE &
Director General, ICAR

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- Aflatoxins are produced by toxigenic strains of *Aspergillus flavus* and *Aspergillus parasiticus* fungi in various foods and feeds.
- Aflatoxins are highly toxic metabolites. These metabolites being carcinogenic, mutagenic and immuno-suppressive pose serious health hazards to humans and animals. Out of the 4 components of aflatoxin (B_1 , B_2 , G_1 and G_2) – B_1 is the most potential carcinogenic.
- A large number agricultural commodities like groundnut, maize, jowar /bazra, chilly, Cashewnuts, almond, black pepper etc. are often get contaminated with aflatoxin.



Mechanical damage of pod at the time of interculture

- Aflatoxin contamination depends on growing seasons and situations. Accordingly status of aflatoxin is different in different production environments in the country.
- At pre-harvest stage, prolonged drought /moisture stress (3-4 weeks) at pod maturity associated with high temperature (35° - 40° C), over maturity and mechanical and biological (soil pests) damage of pod leads to aflatoxin contamination.
- Aflatoxin contamination is due to certain problems at pre and post harvest levels. Delay in drying process, storing of produce at higher pod moisture (12% and above) along with damaged pods and high relative humidity, etc. promote mould growth and thereby toxin production.

About Aflatoxin



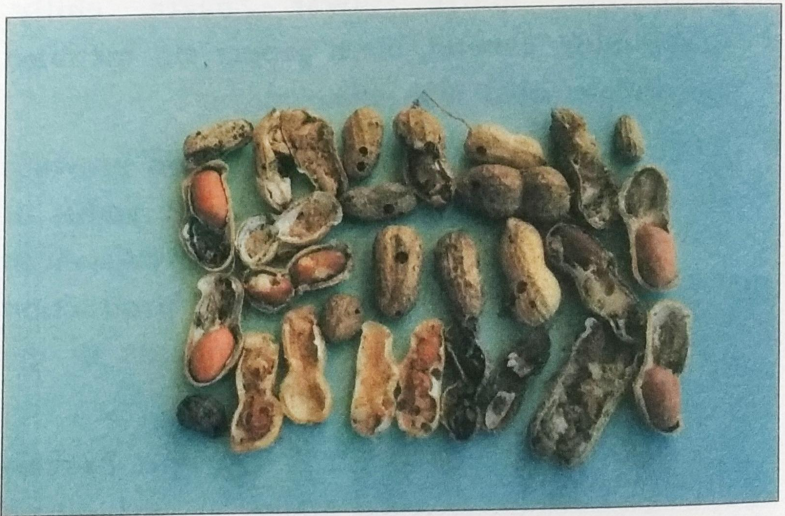
Groundnut pods containing aflatoxin infected seeds



Insect damaged pod/ seed

Reports on Aflatoxin Hazards to Humans and Livestock

- Thus maturity level of the produce, initial seed moisture at the time of bagging and storage condition (temperature and humidity) are major determinants for aflatoxin build up in the stock.
- Over one lakh Turkey poultry birds died in England after consuming aflatoxin contaminated groundnut meal from Brazil. The disease was named as Turkey 'X' disease.



Damaged groundnut pods in store

- Aflatoxins have been responsible for causing acute disease out breaks called aflatoxic hepatitis of Gujarat and Rajasthan in India, central Kenya in Africa and Malaysia that was due to consumption of mould infected maize.
- Indian childhood cirrhosis (ICC) a liver disorder found only among children is also caused by aflatoxin.
- Outbreaks of aflatoxicosis in animals and poultry birds has been recorded in India.



Aflatoxin contaminated seed inside the pod

<i>Country</i>	<i>Commodity</i>	<i>Limit g/kg.</i>
Australia	Groundnut	15
Belgium	All foods	5
Canada	Nuts & Nut products	15
China	Rice and other cereals	50
India	All foods	30
France	All foods	10
U.K.	Nuts and Nut products	4
U.S.	All foods	20

Permissible Limits for Aflatoxins in Different Countries

More precisely the safe levels of aflatoxins in food and feed purposes are:

<i>Sl. No.</i>	<i>Purpose</i>	<i>Limit g/kg.</i>
1.	Human consumption	20
2.	Cattle /Poultry feed	100
3.	Groundnut (unsorted)	5 B ₁ 10 B ₁ +B ₂ +G ₁ +G ₂
4.	Groundnut (sorted)	2 B ₁ 4 B ₁ +B ₂ +G ₁ +G ₂
5.	Milk	0.05 B ₁



Collar rot/ Stem rot infected plant

Major Groundnut Production Areas

About 92% of the total groundnut area and 93% of production occur in the states of Andhra Pradesh (2.4 m.ha; 2.2 m.t), Gujarat (1.9 m.ha; 1.2 m.t), Karnataka (1.2 m.ha; 1.0 m.t), Tamil Nadu (1.1 m.ha; 1.5 m.t), Maharashtra (0.6 m.ha; 0.6 m.t.) and Rajasthan (0.3 m.ha; 0.4 m.t). The remaining area is scattered mainly in the States of Orissa, Madhya Pradesh, Uttar Pradesh, Punjab, etc.



Diseased pods (Fusarium Wilt)

Nearly 83% of the total groundnut area (8.0 m.ha) is sown during rainy season with South-West monsoon (June-September). The crop usually suffers from moisture stress at various stages depending upon vagaries of monsoon. The end of season drought not only reduces yield adversely but also affect the quality.

Further, un-seasonal showers of rain at harvest especially in Southern States (October-November) disrupt the drying process. Slow or incomplete drying associated with high relative humidity lead to mould attack and aflatoxin contamination. Groundnut is an unique food legume "ready to eat" right at harvest either as raw/roasted or through to several forms of value addition /fortification in daily diet. The nuts contain 30% protein, 48% fat and 15% carbohydrate besides vitamins (Folate, Vitamin E, Niacin, Thiamine, Riboflavin, etc.) and minerals (copper, phosphorus, iron, magnesium, calcium, etc.).

In India, though groundnut is primarily an oilseed crop, but with the increased domestic production of Rapeseed & Mustard, Soybean, Sunflower and import of cheaper Pamolin oil, there is an increasing trend of groundnut consumption as snack food. Edible groundnut of uniform size usually fetches more prices in domestic market as well as in export trade. This is a welcome shift for our country of one billion population where people are mostly vegetarian but



Mould infected and damaged groundnut pod



Termite damaged scarified pods

production of pulses are low, to augment proteins in daily diet.

Moreover, with the liberalization of agricultural trade, there is an urgent need to address sanitary and phyto-sanitary issues and remove trade barriers. Reducing aflatoxin risk to a safer limit will make Indian

groundnut globally competitive which otherwise is liked due to its typical nutty flavour. This approach will, no doubt, benefit resource poor dryland farmers to generate additional income and improve economy.

The following facts about aflatoxin contamination in groundnut and measures to prevent it should be practiced methodically to: a) put growers in advantageous position by realizing better price for the quality crop; b) keep consumers away from toxin related health hazards by providing safe-to-eat nuts in their daily diet.

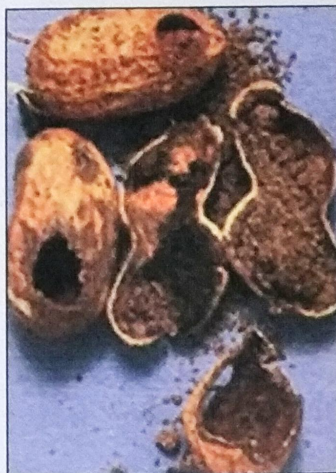
1. At Soil Level:

- Native population of *Aspergillus flavus* group of fungi varies from farm to farm depending on soil types and crop rotations. Number of colonies per gram of soil varies from thousand to ten thousands or even more in major production areas. Change in soil-water-nutrient balance during the crop growth period activates these funguses and that leads to contamination.



Wireworms larvae feeding on groundnut pods

Factors Responsible for Aflatoxin Contamination



Termite damaged pods

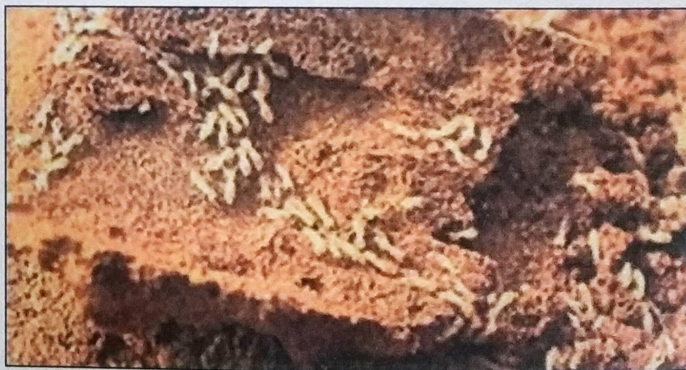
- Soil borne diseases such as stem and collar rots and pod rots are prevalent in many parts are likely to encourage *A. flavus* infection in the field.

- Soil pests like pod borer, wire worm and termite population induces fungus invasion and toxin production. Mechanical damage to pods during

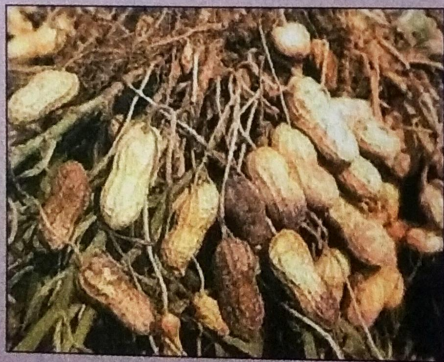
interculturing is also responsible for aflatoxin contamination.

2. At Plant Level

- Drought-prone sandy soils in which groundnut is grown year after year are hot spots for aflatoxin



Termite in soil



Pod rot (infected pods should be separated from good pods)

contamination. Prolonged drought (3-4 weeks) during seed formation and maturation stages triggers aflatoxin contamination.

- High atmospheric temperature (30° – 40°C) in conjunction with reduced soil moisture availability

at crop maturity results invasion of fungus into the pods.

- Over maturity of the crop has been identified as the potential factor for aflatoxin contamination. Delayed harvest not only results yield loss but also reduces quality and thereby gross returns.

3. At harvesting and post harvest processing level

- Mechanical damage to the pods at the time of threshing and or damage to the testa in the process of decortication are the key factors for aflatoxin contamination.

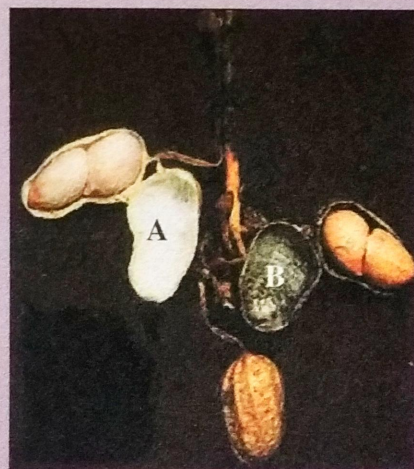


Diseased pods (should be removed before storage)

- Harvesting of crop immediately after irrigation and consequent high initial pod moisture at the time of processing and storage creates congenial condition for aflatoxin build up in the produce.
- Inefficient and slow drying process under the humid condition enhances aflatoxin contamination risk greatly.
- Storage of produce in warm and humid room with a large stack directly on the floor favours rapid multiplication of the fungus and thereby affects even good lots.

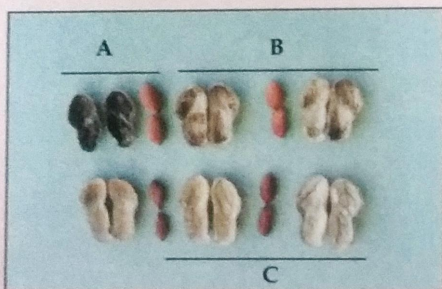


A. niger infected plant



*A. Immature pod-whitish inner shell
B. Mature pod-blackening of inner shell*

Aflatoxin Prevention Strategies Do's and Don't



Various stages of pod maturity:

- A. Over maturity - fully blackened inner shell
- B. Optimum maturity - slight blackening of inner shell
- C. Immature pod with whitish inner shell

PRE-HARVEST

(a) At the Soil Level

Do's

1. Undertake deep ploughing using blade /disc harrow – invert the soils.
Keep the soils exposed to hot sun for 2-3 weeks to capture benefit of soil solarization and reduce soil pests and fungal colonies.
2. Remove stubbles of previous crop /weed flora and keep the field clean.
3. Apply Neem Cake @ 1000 kg/ha or Neem and Castor Cake in combination @ 500 kg each in furrow at the time of sowing.
4. In rainfed production system, adopt skip-row method of planting.

Don't

1. Avoid shallow tillage and immediate laddering / leveling of soils.



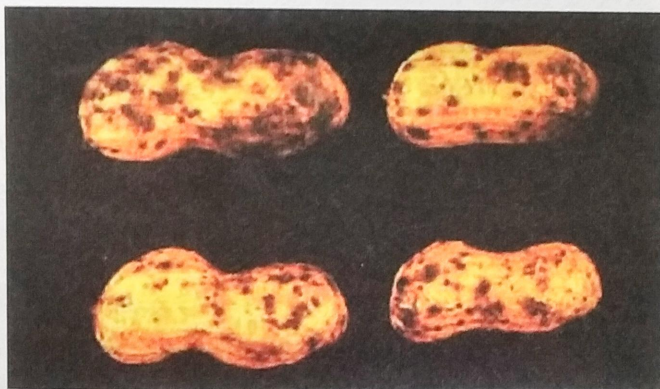
Field view of groundnut with lifesaving irrigation during acute moisture stress at pod filling/ maturity stage

2. Fields should not be weedy or left with crop residues.
3. Do not apply under-decomposed green manure or crop residues in the field.
Continuous sowing along the slope may be avoided in drylands.

(b) At the Crop Level

Do's

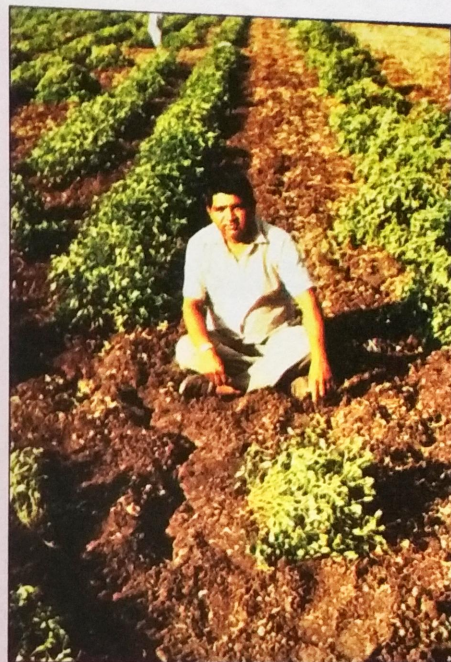
1. Select short /medium duration variety, which can escape end of season drought at maturity.
2. Augment sowing taking rainfall pattern into consideration.



Nematode infected pods

Advancement of sowing by a fortnight with a pre-sowing irrigation /pre-monsoon showers helps in evading adverse effect of end of season drought on yield and quality.

3. Use variety with better seed coat resistance and property of high shelling – where kernels firmly adhering with the inner shell.
4. One prophylactic spray of fungicide to control foliar fungal diseases like rust and leaf spot.



Field view of drought affected groundnut crop



Earwig infected pod



Sclerotia infected pods



A. niger infected plant

5. Harvest the crop at right maturity (blackening of inside shell layer on opening the pod).

Look for maximum pod maturity in a plant and then uproot. Ignore few immature pods in a plant, if any, at the time of harvest.

6. Over matured pods, which usually remain in the soils due to weak peg strength are the major source of aflatoxin contamination.

Don't

1. Do not grow long duration variety which may be exposed to drought due to early ceasasion of rains, coinciding with pod maturity.
2. Avoid delay in sowing on the onset of monsoon.
3. Do not allow rainwater to go waste and capture moisture for the best use of the crop, particularly at the critical growth stages.
4. Avoid using of disease and pest susceptible variety with poor shelling property.
5. Do not allow diseases and insect pests to develop.
6. Avoid delaying harvesting.

All the pods may not mature at a time – do not wait for the few immature pods, if any, to mature.

7. Never use those collected pods for direct consumption as usually practiced among farm families. Such pods may support even 1000 ppb aflatoxin as against safe limit of 15-20.

(c) At Harvesting and Post-harvesting Level

Do's

1. Set the blade of the digger at right depth to avoid injury to mature pods.

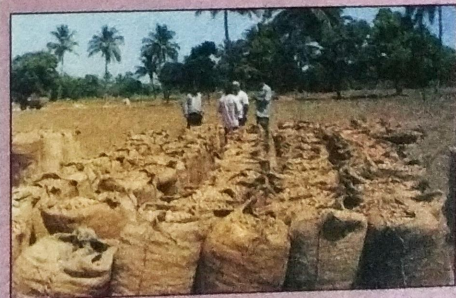


Use of thresher for quick post harvest processing

2. Dry the uprooted plants along with the pod in small heaps up side down. Keep in the field for 6-7 days till the leaf/ peg become brittle.
3. Separate out immature pods as well as pods infested with soil pests after manual stripping.
4. While using mechanical thresher – put appropriate sieve according to the pod size of the variety and ensure effective blowing of lightweight pods.
5. Dry well filled, healthy pod thoroughly and bring down pod moisture below 10%. This can be judged by rattling sound of pods on shaking a handful of pods.
6. Use new /clean gunny bags to store the produce.
7. Produce must be stored in a well-ventilated leak proof room. Store bags on wooden pallet dunnage, maintain 1-meter distance from walls and between stack.

Don't

1. Do not apply Kurfi /spade to harvest groundnut crop.



Well dried pods stored in clean gunny bags



Aflatoxin contaminated seed

2. Do not detach the pods immediately after uprooting. While drying along with vines, the pods should not come in contact with the soil.
3. Do not keep immature and damaged pods along with healthy pods.
4. Do not dry diseased /pest infected pods along with healthy pods. While storing the produce, moisture should not exceed 10%.
5. Do not put freshly harvested plants in the hopper for threshing.
6. Old /damaged bags should not be used as these may be infested with pests.



Sclerotia infected seed



Damage due to pod rot

7. Groundnut should not be stored in hot and humid room. Bags should not be placed directly on the floor.

(d) At the level of shelling /decortications

Do's

1. At house hold level opening of pod is made manually – by hand. Whereas, large scale shelling is done using decorticator – either manually operated or motor driven.

In practice, water is sprayed on the dry pods to reduce split /breakage of kernels.

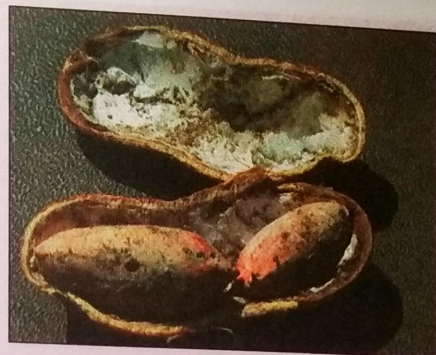
2. Sundry the kernel to bring down its moisture level below 7% at the time of bagging for trade. At this moisture level, the testa can be peeled off with slight rubbing.
3. Remove shriveled, discolored and damaged kernels from the lot including the nuts with broken testa by hand picking or electronic sorting machine or a combination of both and then put them in new gunny bags.



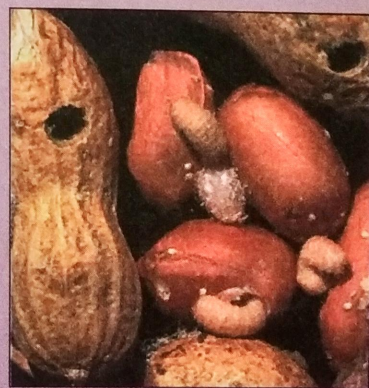
Discolouration of seed from diseased pod

Don't

1. Do not spray water on dry pods – but adjust the space between blade and the sieve according to pod size to reduce breakage.
2. Kernel moisture level, in any case, should not exceed 7%.
3. Do not put discolored and damaged kernels along with intact and healthy nuts. Do not keep processed nuts in old gunny bags /plastic bags.



Immature pod and shrivelled seed contaminated with aflatoxin



Damage of groundnut due to store pest

Success Story

By adopting and integrating the above packages, it has been possible to demonstrate aflatoxin risk free groundnut production (0-15 ppb) through farmers' participatory research at Anantapur district of Andhra Pradesh which is known to be a high risk area for aflatoxin contamination in groundnut.

The UNDP has played a key role in supporting food quality groundnut production programme with no risk of aflatoxin by involving the National Research Centre for Groundnut (NRCG) and Acharya N. G. Ranga Agricultural University (ANGRAU).



Large Scale Adoption

With the breakthrough in groundnut aflatoxin research at pre and post-harvest levels and their integration to reduce the toxin load to as low as '0' ppb b_1 , a pilot project was launched at Nakhatarana (District Bhuj, Gujarat) in about 500 hectare during summer, 2001.

Groundnut farmers under the project area realised 25 quintals dry pod yield per hectare, on an average, with 0-5 ppb aflatoxin b_1 in majority of the cases. This has been an unique example of large scale transfer of farmers' friendly low cost technologies and capacity building of groundnut farmers to address sanitary and phytosanitary problems affecting quality of the produce.

Acknowledgment

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- *The farming community of Anantpur district, Andhra Pradesh, for adopting the aflatoxin management guidelines in groundnut advocated by the UNDP supported sub-programme and for sharing the results and feedback;*
- *Dr. T.Y. Reddy, Principal Scientist, Agricultural Research Station, Acharya N.G. Ranga Agricultural University (ANGRAU), Anantpur;*
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For additional information and copies, please contact:

Dr. M.S. Basu

National Research Centre for Groundnut

Post Box No. 5

Junagadh. 362 001 (Gujarat)

Telephone - PABX: 0285-623041/ 623461 extension 104

Telefax: 0285-651550 (Direct)

Residence: 0285-625831/ 653709

Email: basu@nrcg.guj.nic.in

msbasu@rediffmail.com

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