Aflatoxins and animal health: 
Case studies from Africa

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PACA workshop 
Engaging the Health and Nutrition Sectors in Aflatoxin Control in Africa
Addis Ababa, March 23 2016
The talk today

• What are the consequences of aflatoxins in animals?
• Some results from our research on livestock
  • Kenya
  • Senegal
• Why do we need to focus research on livestock?
Why bother about aflatoxins and animals?

- Animals are susceptible to aflatoxins: some more, some less

1. Animal suffering - an animal welfare issue
2. Reduced animal productivity
3. Aflatoxins in animal-source foods
Health effects observed

- Liver damage
- Gastrointestinal dysfunction, decreased appetite
- Immunosuppression
- Decreased reproductive function, decreased growth, and decreased production
- Carcinogenicity?

Feeding sheep 1,750 ppb aflatoxins for 3.5 years caused liver/nasal tumours
Highly susceptible: oral LD50 (<1 mg per kg body weight)
   Rabbits, ducks, cats, swine, rainbow trout

Moderately susceptible: oral LD50 (1-2 mg per kg body weight)
   Dogs, horses, calves, turkeys, guinea pigs, sheep, baboon

Relatively resistant: oral LD50 (5-10 mg kg body weight)
   Chickens, rats, macaque monkeys, mouse, hamsters

One teaspoon of aflatoxin is enough to kill 2,500 rabbits
Reduced animal productivity

- Literature review show
  - Little research in Africa
  - Varying results
- Pigs: Increasing 1000 ppb in feed reduced growth gain with $3.9^a$-$16^b\%$
- AFB1 levels impairing production$^c$: 800 ppb in chickens, 700 ppb in geese and quail, 500 ppb in duck and 400 ppb in Turkey


Safe levels?

- ≤50 in young poultry
- ≤100 in adult poultry
- ≤50 in weaned pigs
- ≤200 in finishing pigs
- <100 in calves
- <300 in cattle
- <100 in Nile tilapia

However depending on other factors!
### Interactions

<table>
<thead>
<tr>
<th>Mycotoxin</th>
<th>Main fungi</th>
<th>Impact on animal health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aflatoxins</td>
<td>Aspergillus spp</td>
<td>All livestock susceptible to different degrees. Acute toxicity, hepatotoxic and nephrotoxic. Carcinogenic and mutagenic. Growth impairment. Immunosuppression.</td>
</tr>
<tr>
<td>Ochratoxin A</td>
<td>Aspergillus spp, Penicillium spp</td>
<td>Nephrotoxic Immunosuppression Possibly carcinogenic</td>
</tr>
<tr>
<td>Fumonisins</td>
<td>Fusarium spp</td>
<td>Toxic to liver and central nervous system Possibly carcinogenic</td>
</tr>
<tr>
<td>Zearalenone</td>
<td>Fusarium spp</td>
<td>Swine highly sensitive, cattle less sensitive. Endocrine disruption. Estrogenic effects, reduced reproduction, feminisation, malformations.</td>
</tr>
<tr>
<td>Trichotecenes</td>
<td>Fusarium spp</td>
<td>Gastrointestinal disturbance. Reduced feed intake. Ill-thrift. Immunosuppression.</td>
</tr>
</tbody>
</table>
Standards and policies

FDA limits

<table>
<thead>
<tr>
<th>product or animal</th>
<th>total aflatoxin action level (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>human food</td>
<td>20</td>
</tr>
<tr>
<td>milk</td>
<td>0.5</td>
</tr>
<tr>
<td>beef cattle</td>
<td>300</td>
</tr>
<tr>
<td>swine over 100 lbs</td>
<td>200</td>
</tr>
<tr>
<td>breeding beef cattle, swine, or mature poultry</td>
<td>100</td>
</tr>
<tr>
<td>immature animals</td>
<td>20</td>
</tr>
<tr>
<td>dairy animals</td>
<td>20</td>
</tr>
</tbody>
</table>

Ref: Wu. VOL. 38, NO. 15, 2004 / ENVIRONMENTAL SCIENCE & TECHNOLOGY

<table>
<thead>
<tr>
<th>Species</th>
<th>Range of aflatoxin limits ppb</th>
<th>Average aflatoxin limit ppb</th>
</tr>
</thead>
<tbody>
<tr>
<td>All animals</td>
<td>5-300</td>
<td>48</td>
</tr>
<tr>
<td>Pigs</td>
<td>0-300</td>
<td>40</td>
</tr>
<tr>
<td>Cattle</td>
<td>0-300</td>
<td>41</td>
</tr>
<tr>
<td>Poultry</td>
<td>0-300</td>
<td>33</td>
</tr>
<tr>
<td>Sheep goats</td>
<td>5-75</td>
<td>26</td>
</tr>
<tr>
<td>Dairy</td>
<td>0-75</td>
<td>19</td>
</tr>
<tr>
<td>Duck/turkey/rabbit/trout</td>
<td>10-10</td>
<td>10</td>
</tr>
</tbody>
</table>
Animal source food

- Aflatoxins are transferred to animal products
- 1-7% of aflatoxins in feed is metabolized and transferred to milk
- Some studies show no transfer to eggs, other show low levels (5,000:1 -125,000:1)
- Meat intermediary transfer: around 1000:1?
  - Reduced if stop feeding
Kenya- dairy value chain

• Feed collected from 5 counties¹
  – From farmers: 0.02 ppb to 9,661 ppb and the positive samples ranged from 75% to 100%
  – Milk samples: Up to 6999 ppt, up to 26% of samples
  – Samples exceeding 5 ppb
    • 25% to 100% of the feed in farms
    • 85.7% to 100% of the feed from feed retailers
    • 20% to 100% of the feeds from feed manufacturers
  – Estimate cost of feed discarded if enforced: >20 billion USD
  – Estimated impact of this on lost milk production >30 million USD

¹ Mugangai et al. 2016, submitted
• Milk collected from milk retailers\textsuperscript{a}
  – 58% knew about aflatoxin, but only 6% thought milk was not totally safe after boiling
  – Milk samples: mean AFM1 was 128.7 ppt, up to 1675 ppt. 55% of samples exceeded 50 ppt and 6% 500 ppt

• Child exposure study\textsuperscript{b}
  • 41% of children were stunted
  • 98% of foods contained aflatoxin
  • AFM1 exposure associated with decreased HAZ

\textsuperscript{a} Kiruni et al. 2016, submitted, \textsuperscript{b} Kiarie et al. 2016, submitted
Senegal- dairy value chain

• Feed and milk - under analysis
  – Feed: highest levels in concentrate 305 ppb
Still many questions to answer

Interactions with other mycotoxins?
What are the most effective binders and mitigations?
Do we have the optimal regulations and how do we enforce them?
Objectives of feed standards

1. Protect humans from harmful aflatoxins in animal source foods
   - Milk is the most high risk animal source food because relatively large amounts of aflatoxins are carried over, and milk is consumed especially by infants

2. Safeguard the benefits people derive from livestock and fish by protecting valuable assets that provide multiple benefits
   - These include income, food and nutrition security, draft power, manure and social/cultural benefits

3. Protect value chain actors from fraudulent or defective products

4. Encourage fair trade, competition and economic growth through promoting standards and credibility

5. Safeguard the welfare of animals
Feeding livestock contaminated feed

Aflatoxin contaminated feed given to livestock instead of humans

Livestock produce less because of toxic effects

Animals metabolize toxins

Less aflatoxin contaminated crops reach humans - less crops reach food market

Less animal-source food produced, reduced livelihoods of farmers

A reduced amount of aflatoxins may reach humans through animal-source food
Clays (aluminosilicates)

- Most effective binder but different clays vary in effectiveness

Yeast/bacterial cell wall extracts

- Provide other useful nutrients, but evidence on effectiveness is mixed

Other binders

- Some are promising but less evidence of effectiveness

- Over 100 companies offering AMAs

- In the Brazilian market, where approximately 100 AMAs for poultry and swine were evaluated, only about 30% were effective
Take home message

- Livestock is affected by aflatoxins, and so are animal-sourced food
- Research on full health impacts in animals, and economic consequences
- Livestock feed sector + binders an attractive mechanism to suck contaminated grain out of human food chain
- Potential for aflatoxin regulation to cause harm (burden on agricultural sector, concentrating contaminated among poorest)
Conclusions

There is no silver bullet to eradicate aflatoxins

-A battery of interventions to provide safer food in a world full of food safety hazards!

Animals may be both part of the problem and part of the solution
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better lives through livestock

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