Incorporating Nutrition into Feed the future Research Programs

Speakers
Ahmed Kablan, USAID Bureau for Food Security
Jeffrey Griffiths, Tufts University
Patrick Webb, Tufts University
Maura Mack, USAID Bureau for Food Security

Facilitator
Julie MacCartee, USAID Bureau for Food Security

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Ahmed Kablan
USAID Bureau for Food Security

Ahmed Kablan is a Pharmacologist with a biotechnology and drug discovery background. He has over 12 years of postdoctoral research and science policy and regulatory experience. He is a member of USAID working groups that are tasked with writing the USAID Nutrition Strategy and the research policy, helped in drafting the Feed the Future nutrition action paper, and provided a topline and in depth summary of the 2013 lancet series on maternal and child nutrition and health. Kablan is the activity manager for the Feed the Future Soybean Innovation Lab and the Feed the Future Nutrition Innovation Labs for Africa and Asia.
Jeffrey Griffiths
Tufts University

Jeffrey K. Griffiths is the Director of the Feed the Future Nutrition Innovation Lab for Africa and has worked at the intersection of health and nutrition for 30 years. By training he is a pediatrician, internist, and infectious diseases physician with expertise in infectious diseases and the influence of the environment on health. For many years he has been involved in US water policy and has thrice testified before the US Senate. He is the immediate past Chair of the Drinking Water Committee of the US EPA’s Science Advisory Board, and was a founding member of the interdisciplinary Water: Systems, Science and Society (WSSS) program at Tufts University.
Patrick Webb
Tufts University

Patrick Webb is Dean for Academic Affairs at the Friedman School of Nutrition Science and Policy at Tufts University in Boston. He is currently Program Director for the Feed the Future Nutrition Innovation Lab for Asia, as well as Principal Investigator for the Food Aid Quality Review supported by the Office of Food for Peace. Until 2005, he worked for the United Nations World Food Programme in Rome as Chief of Nutrition. During that time he was part of the Millennium Development Goals Hunger Task Force. He currently researches the design of food security interventions, national policies supportive of agriculture, and food aid formulation and policy issues.
Maura Mack
USAID Bureau for Food Security

Maura D. Mack is a Nutrition Advisor with the USAID Bureau for Food Security/Office of Agricultural Research and Policy. She has served 13 years with USAID on long-term assignments in the Philippines, Afghanistan, and at headquarters, and short-term assignments in Ethiopia, Ecuador, and West Africa. Maura also has 15 years of US domestic experience working on public health issues, primarily in the US-Mexico border region. She has an MPH in Nutrition from UC-Berkeley and an interdisciplinary PhD in nutrition, agriculture, and agricultural economics from the University of Arizona.
Nutrition & Agriculture Linkages

An overview and global context

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International Nutrition and Health Adviser
Bureau of Food Security/Agriculture Research and Policy
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Malnutrition

Undernutrition
- Stunting, Underweight, Wasting

Overnutrition
- Overweight, Obesity

Micronutrient deficiency
Multi-sectoral impacts of malnutrition:

- **Health** → contributes to 45% of <5 death (3.1 million child deaths)

- **Education** → lower IQ and school performance

- **Economic growth** → loss of 3-6% in annual GDP

- **Poverty** → wages that are half as high in adulthood in children who were undernourished in early life

- **Infectious disease treatment** → e.g. hastens HIV progression; worsens malaria and diarrheal infections

- **Higher risk of nutrition related NCDS** → e.g. CVDs, T2D
- Underlying cause of ~45% of all <5 deaths (3.1 million child deaths each year)
  - 1 in 5 Children is stunted (165 million)
  - Small birth weight contributes to 3.3% of total child deaths

*Shaded area indicates contribution of undernutrition to each cause of death*

Malnutrition is a result of insufficient intake consumption of health nutritious food, inadequate care and infectious diseases. It includes:

<table>
<thead>
<tr>
<th>Malnutrition Type</th>
<th>Chronic – Inadequate intake of nutrients over time</th>
<th>E.g. Poor cognitive function, lower lifetime earnings, greater risk of NCDs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stunting (short for age)</td>
<td>Acute (immediate) – inadequate intake of calories</td>
<td>Increased risk of morbidity &amp; mortality</td>
</tr>
<tr>
<td>Wasting (thin for height)</td>
<td>Both chronic and acute</td>
<td>Associated with increased risk of morbidity &amp; mortality</td>
</tr>
<tr>
<td>Underweight (low weight for age)</td>
<td>Both Chronic and acute over consumption of calories</td>
<td>Poor cognition, High risk of NCDs (T2D, CVDs, HT), Lower lifetime earning</td>
</tr>
<tr>
<td>Overweight/Obesity (high weight for age)</td>
<td>Inadequate intake of one or more vitamins/minerals</td>
<td>E.g. Anemia, goiter, blindness, stunting</td>
</tr>
<tr>
<td>Micronutrient deficiencies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEFINITION</td>
<td>INDEX or MEASURE</td>
<td>MODERATE</td>
</tr>
<tr>
<td>------------------------------------</td>
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</tr>
<tr>
<td><strong>Stunting</strong> reflects chronic malnutrition</td>
<td>Inadequate length or height* relative to age</td>
<td>HFA</td>
</tr>
<tr>
<td><strong>Underweight</strong> reflects both chronic malnutrition and acute malnutrition</td>
<td>Inadequate weight relative to age</td>
<td>WFA</td>
</tr>
<tr>
<td><strong>Wasting</strong> reflects acute malnutrition</td>
<td>Inadequate weight relative to length or height*</td>
<td>WFH</td>
</tr>
<tr>
<td></td>
<td>Inadequate muscle tissue and fat stores in the body</td>
<td>MUAC (6–59 months)</td>
</tr>
<tr>
<td></td>
<td>MUAC-for-age (3–59 months)</td>
<td></td>
</tr>
<tr>
<td><strong>Bilateral Pitting Edema</strong> reflects severe acute malnutrition</td>
<td>An accumulation of fluid that starts in both feet and that can progress to other parts of the body</td>
<td></td>
</tr>
<tr>
<td><strong>Overnutrition</strong></td>
<td>Excessive fat accumulation that presents a risk to health</td>
<td>WFH BMI-for-age</td>
</tr>
</tbody>
</table>
### Nutritional status of Feed the Future countries

<table>
<thead>
<tr>
<th>Country</th>
<th>% children underweight</th>
<th>% children stunted</th>
<th>% children wasted</th>
<th>% women BMI &lt;18.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>36</td>
<td>41</td>
<td>16</td>
<td>33</td>
</tr>
<tr>
<td>Cambodia</td>
<td>28</td>
<td>40</td>
<td>11</td>
<td>19</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>29</td>
<td>44</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>Ghana</td>
<td>14</td>
<td>28</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Guatemala</td>
<td>13</td>
<td>50</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Haiti</td>
<td>18</td>
<td>29</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Kenya</td>
<td>16</td>
<td>35</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>Liberia</td>
<td>19</td>
<td>39</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Malawi</td>
<td>13</td>
<td>47</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Mali</td>
<td>30</td>
<td>43</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>Mozambique</td>
<td>15</td>
<td>43</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Nepal</td>
<td>29</td>
<td>41</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td>Rwanda</td>
<td>11</td>
<td>44</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Senegal</td>
<td>18</td>
<td>29</td>
<td>10</td>
<td>22</td>
</tr>
<tr>
<td>Tanzania</td>
<td>16</td>
<td>42</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Uganda</td>
<td>14</td>
<td>33</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Zambia</td>
<td>15</td>
<td>45</td>
<td>5</td>
<td>10</td>
</tr>
</tbody>
</table>
Causes of malnutrition

Determinants of child nutrition and examples of interventions to address them

Interventions
- Breastfeeding
- Complementary feeding
- Vitamin A supplementation
- Zinc supplementation
- Hygiene & sanitation
- Immunization
- Salt iodization
- Agriculture
- Poverty reduction
- Income generation
- Education
- Health systems strengthening
- Women's empowerment

Immediate causes
- Food/nutrient intake
- Health

Underlying causes at household/family level
- Food security
- Care resources
- Health, water/sanitation services

Basic causes at societal level
- Institutions
- Political & ideological framework
- Economic structure
- Resources environment, technology, people

1. It is the period of most vulnerability

2. Interventions after this period are not likely to have impact

3. Interventions in this period have immediate and long term consequences

Nutrition programs now focus on pregnant women and young children under 2 years of age.
<table>
<thead>
<tr>
<th>Preconception through pregnancy</th>
<th>0-6 mo: Exclusive breastfeeding</th>
<th>6-24 mo: Complementary feeding</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="Image1" alt="Image 1" /></td>
<td><img src="Image2" alt="Image 2" /></td>
<td><img src="Image3" alt="Image 3" /></td>
</tr>
</tbody>
</table>

Infant and Young Child Feeding (IYCF)
Key Points – Nutrition Basics

Mortality

- Malnutrition is an underlying cause of ~45% of all child deaths

3 underlying causes of malnutrition

- Food Security
- Caring Practices
- Health

Critical window to prevent malnutrition

- First 1,000 days of a child’s life – improving nutrition from pregnancy to 2 yrs of age
A 10% increase in GDP/PC leads to a 6% reduction in stunting.
A 10% increase in GDP/PC leads to a 7% increase in overweight and obesity in women.

Prevalence of women overweight or obese (BMI > 25) and GDP per person, for low-income and middle-income countries.

Source: Ruel and Alderman; Lancet 2013
Improving nutrition requires a multisectoral approach.

**Agriculture**
- Production for household’s own consumption
- Income-oriented production for sale in markets
- Reduction in real food prices
- Nutrition-sensitive value chains

**Social Protection**
- Meet basic consumption needs and reduce fluctuations in consumption (seasonality, shocks)
- Enable savings and investments through reduction in risk and income variation
- Build, diversify, and enhance use of assets

**Social and Behavioral**
- Intra-family food consumption
- Empowerment of women as instrumental to household food security and health outcomes
- Improved nutrition practices in the 1,000 day window

**Improved Nutrition**

**Health**
- Access to health care services
- Treatment of acute undernutrition
- Family planning and reproductive health
- Safe water, and good sanitation and hygiene practices
Thank you!!!!
Unexpectedly Important Nutrition and Health Linkages to Mycotoxins and Sanitation

Jeffrey K. Griffiths, MD MPH&TM
Professor of Public Health & Medicine
Director, USAID Innovation Lab for Nutrition - Africa
Tufts University School of Medicine
Learning Objectives

• Learn about important new (and unexpected) data on the roles of the gut microbiome, aflatoxins, and sanitation in health and nutrition for low-income countries.
• Understand new integrative paradigms about how health and growth are affected by nutrition and environmental factors.
Focus of this talk

• Malnutrition and under-nutrition remain major global health issues, even as obesity and over-nutrition are on the rise.

• An operating paradigm has been that it is the lack of foods that is the key issue.

• This turns out to be too simple – new data is showing major influences of the external, and internal (microbiome), environments.
Simple Idea – Not Enough Food Leads to Malnutrition

- Stunting
- Wasting
- Small for Gestational Age/Low Birth Weight
- Micronutrient Deficiency (Fe, Zn, vitamin A, Iodine)
Stunting – low height for age

CDC Children with Kwashiorkor – Stunting, protein deficiency
Wasting – low weight for age

This slide dates to a famine in South Asia
Acute Shortage of Food

CDC
Simple Idea – Not Enough Food
Leads to Malnutrition

...so the fix should be – more food
The global response has been – help poor farmers grow more food.
Supposition:

\[ \text{↑food} = \text{↑income} \& \text{↑nutrition} \]

and thus to better health

\[ \text{Higher Income} = \text{Can afford more food, more diverse/healthier diet} \]

\[ \text{Higher production of food} = \text{more food available in household} \]
World Bank data – underweight versus GNP

Why isn’t the Relationship a Straight line if More $$$ = Better Nutrition??
Global economic data

Here – more $$$ leads to better nutrition. Especially ↓ WASTING

Here higher income only leads to modest improvement.
From presentation by Will Masters: note steep rate of decline in poverty versus very modest rate of decline in undernutrition -

Poverty and child undernutrition in Uganda, 1989-2009

• 800,000 neonatal / 3.1 million childhood deaths per year. 165 million stunted children.

• If top 10 nutrition interventions targeted to 34 countries with 90% of childhood deaths …

• Reduce deaths by 15%, stunting by 20%, acute wasting by 61%. (For < $10 billion per year).
Bad News: Lancet review (2013) of how much “food would fix”: not much (20%).

Adolescent, preconception, gestational, and maternal nutrition adequate calories (proteins, fats, carbs) in all life stages diversity of micronutrients, vitamins, high quality proteins optimal breastfeeding, responsive feeding practices, stimulation good complementary feeding 6-23 months, dietary diversity wealth, education – [be sure to choose your parents well] Others.....
It’s not just what you eat...
It’s your external and internal environment
And how they are linked (water and sanitation)

**MYCOTOXINS**: FUNGAL FOOD TOXINS WHICH IMPAIR GROWTH AND IMMUNITY

**ENVIRONMENTAL ENTEROPATHY**: INFLAMED, LEAKY, DYSFUNCTIONAL INTESTINES

**THE GUT** **MICROBIOME** - **GUT BACTERIA GONE BAD**

Griffiths Innovation Lab for Nutrition
MYCOTOXINS IN FOOD

HUMAN AND ANIMAL PATHOGENS

MICRO- AND MACRO-NUTRIENTS

PERMEABLE ("LEAKY") AND INFLAMMED GUT

UNHEALTHY INTESTINAL MICROBIOME
Agriculture in Urban Nairobi: Sewage
Left: broken sewage main in field. Right: lush fields.

Farmers work in contaminated fields; crops contaminated with human pathogens; go home to families carrying tools & wearing boots that have been in sewage...
Water needed for crop productivity, vegetable kitchen gardens and dietary diversity (animal meat protein is good), to promote income, keep farmers hydrated and fit for work, .... Promote gender equality .... Irrigation, reservoir construction help address climate change .... What else does the water carry?
<table>
<thead>
<tr>
<th>ORGANISM</th>
<th>TYPICAL SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROTAVIRUS</td>
<td>HUMANS; PERHAPS ANIMALS</td>
</tr>
<tr>
<td>HEPATITIS A</td>
<td>HUMANS</td>
</tr>
<tr>
<td>HEPATITIS E</td>
<td>HUMANS, <strong>SWINE</strong></td>
</tr>
<tr>
<td><em>E. coli</em> (bacteria)</td>
<td><strong>CATTLE, HUMANS</strong></td>
</tr>
<tr>
<td><em>Shigella</em> species</td>
<td>HUMANS</td>
</tr>
<tr>
<td><em>Salmonella enterica</em> (bacteria)</td>
<td><strong>CATTLE, POULTRY, SWINE, HUMANS</strong></td>
</tr>
<tr>
<td><em>Campylobacter jejuni</em> (bacteria)</td>
<td><strong>POULTRY</strong></td>
</tr>
<tr>
<td><em>Cryptosporidium</em> (protozoan)</td>
<td><strong>CATTLE, HUMANS, OTHER FARM ANIMALS</strong></td>
</tr>
<tr>
<td><em>Microsporidia</em> (fungus)</td>
<td><strong>FARM AND DOMESTIC ANIMALS, HUMANS</strong></td>
</tr>
</tbody>
</table>

*Causes chronic diarrhea, wasting, malnutrition in people with HIV/AIDS

*Cryptosporidium* – a leading cause of diarrhea children < 24 months; known to cause stunting; and children have x 4 risk of death in next year

Pathogens in Rural and Agricultural Water and Watersheds. USDA 2010
Poor Sanitation / Hygiene. Fecal Contamination of Domestic Environment

Fecal Ingestion Infants/Children and Enteric Infections

(1) Increased gut permeability (2) Bacteria (and gut contents) leak into body (3) Intestinal Inflammation

ENVIRONMENTAL ENTEROPATHY

In studies dating to 1993, 43% of stunting explained by increased gut permeability
ENVIRONMENTAL ENTEROPATHY (EE)

People living in contaminated environments have leaky, chronically inflamed intestines.

EE - Short blunted villi, tissue is infiltrated with inflammatory cells. 15% less protein and 5% less carbohydrate is absorbed.

↑ nutritional needs, bacteria leak into body, leads to anemia.

Bad bacteria are likely cause.

Korpe & Petri, Trends in Molecular Medicine June 2012, Vol. 18, No. 6
Handwashing is “necessary but not sufficient”

Original Research Article
Hand-Washing, Subclinical Infections, and Growth: A Longitudinal Evaluation of an Intervention in Nepali Slums

REBECCA LANGFORD,1* PETER LUNN,2 AND CATHERINE PANTER-BRICK3
1School of Social and Community Medicine, University of Bristol, Canynge Hall, Bristol, BS8 2PS, United Kingdom
2Department of Biological Anthropology, University of Cambridge, Cambridge, CB2 3DZ, United Kingdom
3Jackson Institute for Global Affairs and Department of Anthropology, Yale University, New Haven, Connecticut


- 1st longitudinal study to assess hand-washing and enteropathy. 45 intervention, 43 control
- ↑mucosal damage = ↓ growth (p<0.01 HAZ, WAZ)
- Handwashing led to 41% ↓ diarrhea morbidity
- No change in markers of mucosal damage
- HW alone doesn’t address chronic subclinical infxn
Ingest Dietary Pathogens

Δ living in contaminated environment
Δ ingest human and animal pathogens

Small Intestine Mucosal Damage

Villus Atrophy

Barrier Function Compromised

Loss of Mucosal Enzymes

Translocation of Antigens, Bacteria

Maldigestion & Malabsorption

Mucosal Inflammation and Immune Reaction; Systemic Immune Response

Growth Faltering

From: Lunn, PG. 2000 Proceedings of the Nutrition Society 59:147
Has Diarrhea
Treat To Prevent
Death, Morbidity
ALL HAVE ENVIRONMENTAL ENTEROPATHY

Without any overt signs of ‘clinical’ illness
Ok, so you have a leaky, inflamed gut. What lives in it?
• 317 Malawian twins studied first 3 years of life
• 50% both well nourished; 43% discordant (one well, one malnourished); 7% both were malnourished.
• Both twins in discordant pairs received RUTF, a therapeutic food. Gut microbiomes (MB) studied: RUTF → transient MB improvement.

Science 339:548-554. 1 February 2013

Improve        Don’t Improve
Gnotobiotic (sterile gut) mice – given either Normal or Kwashiorkor MB

Mice given normal MB – maintained weight

Mice given kwashiorkor MB bacteria – lost 1/3 of their weight
Major adverse changes in amino acid and other gut metabolites

Decoupled TCA cycle intermediates (↑ succinate) – mitochondrial metabolites – ↓ energy metabolism
Kwashiorkor microbiota + Malawi diet = abnormal sulfur metabolism (methionine, cysteine; protein metabolism)
Poor populations:
- > 99% will have environmental enteropathy in the absence of good water/sanitation.
- Lacking WASH and barriers to fecal contamination, they will have a different spectrum of gut bacteria (the gut microbiome) than people with good WASH
- Next: Aflatoxins
**INSIDE YOUR GUT**

Microbiome modulates your immune system

Could malnourished children benefit from being given a new microbiome?

Malnourished Child Microbiome Includes More Pathogens and Actively Promotes Weight Loss in Malnourished Children

Microbiome of 1000-1150 species produces amino acids, short-chain fatty acids, and others which feed intestinal cells and shift your metabolic stance

Microbiome Actively Promotes Obesity and Insulin Resistance

Fecal Transplant: Better Insulin Sensitivity and ↑ gut butyrate

Less Diverse Microbiome

Diverse Microbiome

Less Diverse Microbiome

**UNDER-nourished INEFFICIENT**

**NORMAL BMI [MB energy harvesting]**

**OVER-nourished HYPER-EFFICIENT**
Malnourished Child Microbiome Includes More Pathogens and Actively Promotes Weight Loss in Malnourished Children

Microbiome modulates your immune system

Could malnourished children benefit from being given a new microbiome?

Microbiome Actively Promotes Obesity and Insulin Resistance

Microbiome of 1000-1150 species produces amino acids, short-chain fatty acids, and others which feed intestinal cells and shift your metabolic stance

Fecal Transplant: Recurrent Clostridium difficile disease

Diverse Microbiome

Less Diverse Microbiome

Less Diverse Microbiome

Malnourished Child Microbiome

Diverse Microbiome

NORMAL BMI [MB energy harvesting]
Environmental Enteropathy occurs when people live in contaminated environments. It is reversible. For example, US Peace Corps volunteers develop EE when they live in rural African villages. When they return to the US, their EE goes away.

The absence of fecal material – be it human or animal – in the environment both prevents and “treats” EE.

**Water/sanitation is critical to this separation.**

- Dean Spears has looked at open defecation as a marker of sanitation using 140 DHS data sets from 60 countries.

How much stunting is due to poor sanitation (and possibly EE?)

---

How much international variation in child height can sanitation explain?

Dean Spears*

First circulated: 10 December 2012
This version: 17 January 2013
Key findings Spear’s analysis of 140 DHS from 65 ‘developing’ countries

• Open defecation (certainly a marker of a “contaminated environment”) is linked to a **1.24 S.D. decrease** in the height of children.

• **Sanitation alone** accounts for **54%** of the between-country height variation (next slide).

• Open defecation and a lack of sanitation in an household, along with country GDP, predict child height **more than** mother’s height or education; governance; or infrastructure.
Open defecation means the environment *for everyone* has got fecal bacteria in it.

So even if your household has a latrine and you wash your hands, when you or your children visit the neighbors, you are exposed to their sanitary environment.
Note going from > 80% without sanitation (far right) to 0% without sanitation moves the HAZ score from under -2 to just under -1. This “from the real world” DHS data analysis suggests a clean environment does lead to decreased stunting.

Figure 1: Open defecation predicts child height, across DHS survey round country-years
Solid OLS regression lines weight by country population; dashed lines are unweighted.
Econometric analyses Spears 2013

• Sanitation predicts stunting even when income is controlled. “...The difference between Nigeria’s 26% open defecation rate and India’s 55% is associated with an increase in child height approximately equivalent to quadrupling GDP per capita.” **Point: India would have to quadruple national income to make up for its poor sanitation as compared to Nigeria.**

• Sanitation and population density interact, open defecation harms human capital. Open defecation (no sanitation) explains **65%** of global height. **The policy case for sanitation as a public good is immense.**
Mortality Rises with Bad Sanitation

(a) infant mortality

infant mortality rate (per 1,000)

village-level open defecation

- regional means
- pooled: India & Africa
- India
- five African countries
Aflatoxins and other mycotoxins
Drying Cassava, Kamwenge Uganda: note green/yellow fungal discoloration

Photo: J K Griffiths  Uganda December 2012
Aflatoxins (Aflatoxins are mycotoxins)

- Produced by *Aspergillus* fungus
- Known – hepatoxic & cause liver cancer in people
- Known in mammals to cause growth faltering and ↓ *in utero* growth (e.g. low birth weight)
- Associated* with lower birth weight, growth, stunting, and wasting in children
- Associated* with lower CD4 and higher viral loads (e.g. worse immunity) in people with HIV
- Widespread exposure in sub-Saharan Africa, SE Asia; maize, peanuts, many other crops.

*Some criticize these studies for only being “associative” - but it is *unethical* to give aflatoxins to people. Prospective studies of exposure and outcomes are needed to show “causation.”*
Gong et al (BMJ, 2002) showed that **stunting** and weight for age was inversely related to blood aflatoxin levels in Gambia (p < 0.001, $R^2 =0.37$).

Jolly *et al* have shown the same in Ghana.
CONTAMINATED WATER / POOR HYGIENE (PATHOGENS, OTHER STUFF IN WATER)

ENVIRONMENTAL ENTEROPATHY & STUNTING

AFLATOXIN (MYCOTOXIN) INGESTION (FUNGI NEED WATER/MOISTURE TO GROW)
Aflatoxins II

- Contamination occurs in the field; promoted by poor (too humid) post-harvest storage.
- Passed *in utero* and in breast milk to children
- Complementary food (e.g. porridge made from maize) is frequently contaminated – as are milk, eggs, chickens, animal meats...
- Prevention: storage without moisture/oxygen; dispersal of natural variant *Aspergillus* which lacks toxin; test and condemn crops/foods
Aflatoxin is in breast milk – could this have an impact on disease transmission? No one knows.
P. Turner et al showed (Lancet 2005) these 5 methods reduced blood aflatoxins by 60%:
1. Sun dry thoroughly on mats, not ground;
2. hand sort and discard moldy nuts;
3. use fiber (not plastic) sacks for storage;
4. store storage sacks on pallets, above the ground;
5. spray insecticide on ground under the pallets to reduce insect damage.

**Post-Harvest Handling Can Decrease Aflatoxins in Those Who Eat the Groundnuts**
World Food Prize 2013
for Aflatoxin advocacy

“Dr. Charity Mutegi helped train more than 300 agricultural extension specialists in Kenya and worked with thousands of farmers, maize traders and millers to increase their awareness of aflatoxin. She sparked Kenya’s parliament to establish a committee to study sources of contaminated grain and to invest in training maize farmers. She also has documented the extent of aflatoxin contamination in peanuts.”

Read more: http://iipdigital.usembassy.gov/st/english/article/2013/09/20130906282333.html#ixzz2iSKu6nqr
Poor populations:
- Often have monotonous, non-diverse diets lacking key nutrients
- Will likely eat aflatoxins in foods.
> 99% will have environmental enteropathy in the absence of good water/sanitation.
- Lacking WASH and barriers to fecal contamination, they will have a different spectrum of gut bacteria (the gut microbiome) than people with good WASH
Dietary insufficiency which worsens Malnutrition Infection which worsens Environmental factor: water (vehicle)
Malnutrition

Dietary Insufficiency (can grow more with water)

which worsens

Updated

Social Practices & Beliefs

which worsens

Environmental factor: aflatoxin (water, drying practices)

Environmental factor: Dirty Water (pathogens) (Farm hygiene)

Enteropathy
Maize, groundnuts  
Key staple crops

**Aspergillus** spp. + moisture + warm temperature = Aflatoxin formation

Aflatoxin ingestion, duodenal uptake - Metabolites bind to DNA, proteins – can measure in blood, urine, tissues

**Immunosuppression**

**Agricultural interventions**

**Enteropathy** – permeable intestine with documented increased nutrient needs, state of chronic inflammation

**Microbiome** – less diverse, abnormal nutrient utilization by flora

**Leaky Inflamed Intestine (EE)**

**WASH interventions**

**Clinical Manifestations:**  
Cycle of repeated infections  
Worsening nutritional status – stunting, underweight, IUGR

**Nutrition interventions**

**Diet, Societal Conditions**  
**Diet:** poor diversity, inadequate caloric & micronutrient intake, leading to **immunosuppression**

**Pathogen** exposure: Widespread food, water, environment contamination
Take-Home: healthy growth requires:

✓ Adequate, varied nutrition with enough calories, micronutrients, and vitamins
✓ The absence of environmental toxins such as aflatoxin – immunosuppression, poor intra-uterine and post-natal growth, liver toxicity
✓ A clean environment which prevents environmental enteropathy, with its chronic inflammation and higher nutritional needs
✓ A normal gut microbiome which does not starve its host of nutrients and promote weight loss
Thanks, and let me turn this over...

Nile River, upper Uganda, 2011
J.K. Griffiths
Incorporating Nutrition into Feed the Future Research Programs

Agriculture sector approaches to addressing malnutrition

Patrick Webb

USAID
Feed the Future Webinar
February 2014
Take-away messages

- Continued ‘conventional’ research in agriculture is essential.

- Many ways for Innovation Labs to impact nutrition. Value-added potential is huge.

- Doing so matters to FTF goals, post-MDG goals, to all development agendas, purposes, sustained, healthy people.

- But to achieve nutrition impact, it has to be by design, well-documented, and at scale.
>160 million children <5y are stunted today. (US <5 population in 2013 = 20.2 million.

- Stunting underpins almost 20% child deaths globally
- Severely stunted child c.5 times more likely to die of diarrhoea
- Maternal stunting is risk factor for small births
- One fifth of stunting may have origins in fetal period

- c. 80% of all stunted children live in 34 developing countries
- Stunting is an equity issue, with poorest children 2.5 times more likely to be stunted than richest children in those countries

- At present trend, still 127 million stunted children in 2025...
The Feed the Future Guide describes the strategic approach and implementation structures of Feed the Future (FTF), the U.S. global hunger and food security initiative. It is intended to inform partners and stakeholders about the development of FTF and how we translate our principles into actions on the ground. This guide is a living document. As we continue to consult with partners and learn lessons, we will update this guide to reflect the evolution of Feed the Future.
Lancet 2013

- 10 targeted interventions implemented at 90% coverage cuts stunting by 20%, mortality by 15%.

- But…“coverage rates for [many] interventions are either poor or non-existent.”

- Cost: US$9.6 billion per annum.

- Even at 90% coverage, 80% of stunting remains!!!
"Higher calorie intake has improved nutrition and health."


- "Merely producing more food does not ensure food security or improved nutrition." (Herforth (2012) World Bank)

- "Agriculture interventions do not always contribute to positive nutritional outcomes.” (FAO 2012)
Role of ‘nutrition sensitive’ interventions

- Agriculture interventions
- Conditional cash transfers (linked to nutrition-specific interventions)
- Education focused interventions
- WASH interventions
- Social safety nets/transfers

... if they address the underlying determinants of nutrition — and incorporate specific nutrition goals and actions.
New crop technology

Higher productivity

Higher income, sales, and consumption

Women and children eat more

Net return/day of labor x3

Net rise in real income = 10% rise in income

Net gain in calories = 47% rise in calories

10% rise in income = 4.8% rise in undernutrition

2.4% fall in undernutrition

Child nutrition improved...a little!

Agriculture and Livelihoods

Tradeoffs; opportunity costs of time

Empowerment, income control

Diet quality (animal source foods, whole diet)

Diet composition

Participation in the programme

Technology adoption

Food expenditure

Food safety (mycotoxins; environmental enteropathy (gut microbiota; shared pathogens))

Nutritional status

Do no harm (malaria, bird flu, pesticides)

Nutrition and Health

Empowerment, income control

Diet quality (animal source foods, whole diet)

Diet composition

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Nutritional status

Do no harm (malaria, bird flu, pesticides)
Innovations

1. Genetic advances
   - Drought resistant seeds
   - Biofortified staples
   - Vaccines for livestock, poultry

2. Programming innovations
   - Integrated health/nutrition/agriculture packages
   - Aquaculture/vegetable/homestead models
   - Agriculture platforms for nutrition BCC

3. Process innovation
   - Cross-training of field level workers
   - Enhanced evidence-capture
   - Innovative empowerment/entitlement components
Conclusions

- Many ways for ALL innovation labs to impact nutrition. Value-added potential is huge.

- Agriculture’s contribution to nutrition outcomes has yet to be convincingly documented. Rigorous evidence from actual programming needed. Anecdotes and ‘numbers fed’ not enough.

- Many innovations, successes out there. But, replication requires effective documentation of best practices, data on cost-effectiveness, focus on scaling. **Collaboration is key!**
USAID’s Focus on Nutrition

Maura D. Mack, PhD, MPH
Nutrition Advisor
USAID Bureau for Food Security

Nutrition Webinar for Feed the Future Innovation Labs
February 11, 2014
USAID Nutrition History

• USAID created in 1961 during the Kennedy Administration.

• Began to address nutrition in 1965 in India

• Since the 1980s, nutrition-related research has been one of the key foci of USAID.
USAID Nutrition History

• Human Nutrition Collaborative Research Support Program (CRSP) during the 1980s

• Nutrition in Agriculture CRSP during the 1980s-early 1990s

• Global Nutrition CRSP/Nutrition Innovation Labs since 2010
USAID Nutrition Today

• Presently, nutrition is getting a huge amount of attention within USAID.

• USAID Nutrition Strategy near completion

• Whole-of-US Government Nutrition Strategy under development

• Big push for integrating nutrition in all Feed the Future programs throughout their zones of influence
Feed the Future Food Security Innovation Center

- Seven interlinked research, policy, and capacity programs aimed at sustainably transforming agricultural production systems
- Nutritious and Safe Food Program
Nutritious and Safe Foods Program

- Nutrition Innovation Labs (Africa and Asia)
- CRP 4 – Agriculture for Nutrition and Health
- Horticulture Innovation Lab
- World Vegetable Center-AVRDC
- USDA/NBCRI/Aflatoxin
- Post Harvest Loss Research
Nutritious and Safe Foods Program

- Adapting Livestock to Climate Change Innovation Lab
- AquaFish Innovation Lab
- CRP 3.7 – Meat, Milk, and Fish
- Golden Rice – IRRI
- HarvestPlus
Promoting Cross-Sectoral Collaboration to Address Nutrition

- Nutrition is a key focus of collaboration

- Nutrition review of innovation labs’ research programs underway

- Nutrition Innovation Labs: resource for consultation and collaboration
For more information

Please contact:

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Thank you!
Incorporating Nutrition into Feed the Future Research Programs

Nutrition Innovation Labs
Overview and Opportunities for Collaboration

Patrick Webb
USAID webinar Feb 2014
Deep dive research focused on agriculture’s contributions to nutrition: panel data, prospective cohorts, sentinel sites, blood/serum assessment.

- Neglected biological mechanisms (aflatoxins, water, gut microbiome)
- Programming performance, costs, scaling
- Policy and governance effectiveness for nutrition
Mountain sites
Hill sites
Valley (Terai) sites
Nutrition Innovation Lab offers opportunity for complementary/synergistic research (platform).

Validating innovative metrics for assessing agriculture-nutrition linkages.

Capacity building in nutrition (partner training, local curriculum development, survey design)

Peer reviewing nutrition-specificity of instruments, RFAs, strategic plans, etc.

Building regional collaborations, evidence base, with partners beyond agriculture.
Many collaborators (Asia and Africa):
Thank you for joining us!

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You can visit the [event page](#) to post comments & questions.

Stay In Touch
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- OR
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Upcoming Events
- #AskAg Twitter Chat
  Empowering Farmers with Open Ag Data | Feb 18
- February Ag Sector Council | Drought Tolerant Rice | Feb 26

Agrilinks and the Agriculture Sector Council Seminar Series are products of the USAID Bureau for Food Security under the Knowledge-Driven Microenterprise Development (KDMD) project.