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Emerging Evidence on Health and Food Safety and Effects on the Growth and Development of Infants and Young Children

Looking Beyond a Decade of Accomplishments in Nutrition
NIL Legacy Event | September 17th, 2021

Christopher Duggan | Jacqueline Lauer | Akriti Singh | Johanna Andrews-Trevino | Saiful Islam

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Environmental Enteric Dysfunction and Undernutrition: New Insights and Ongoing Challenges

Jacqueline M. Lauer, PhD, MPH

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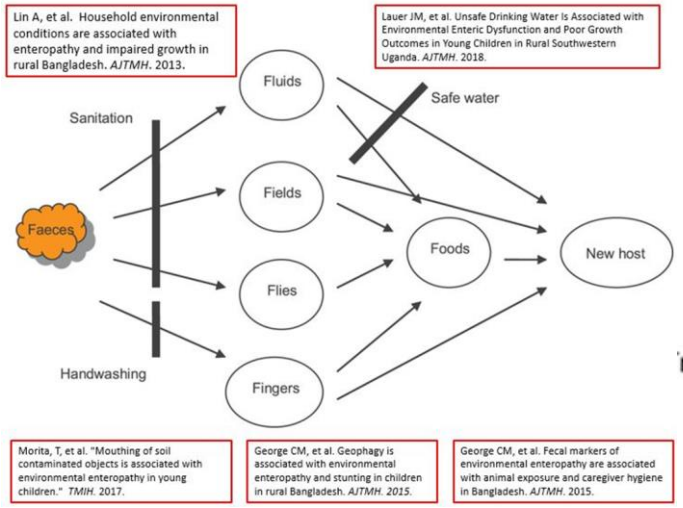
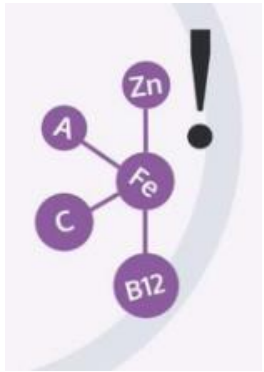
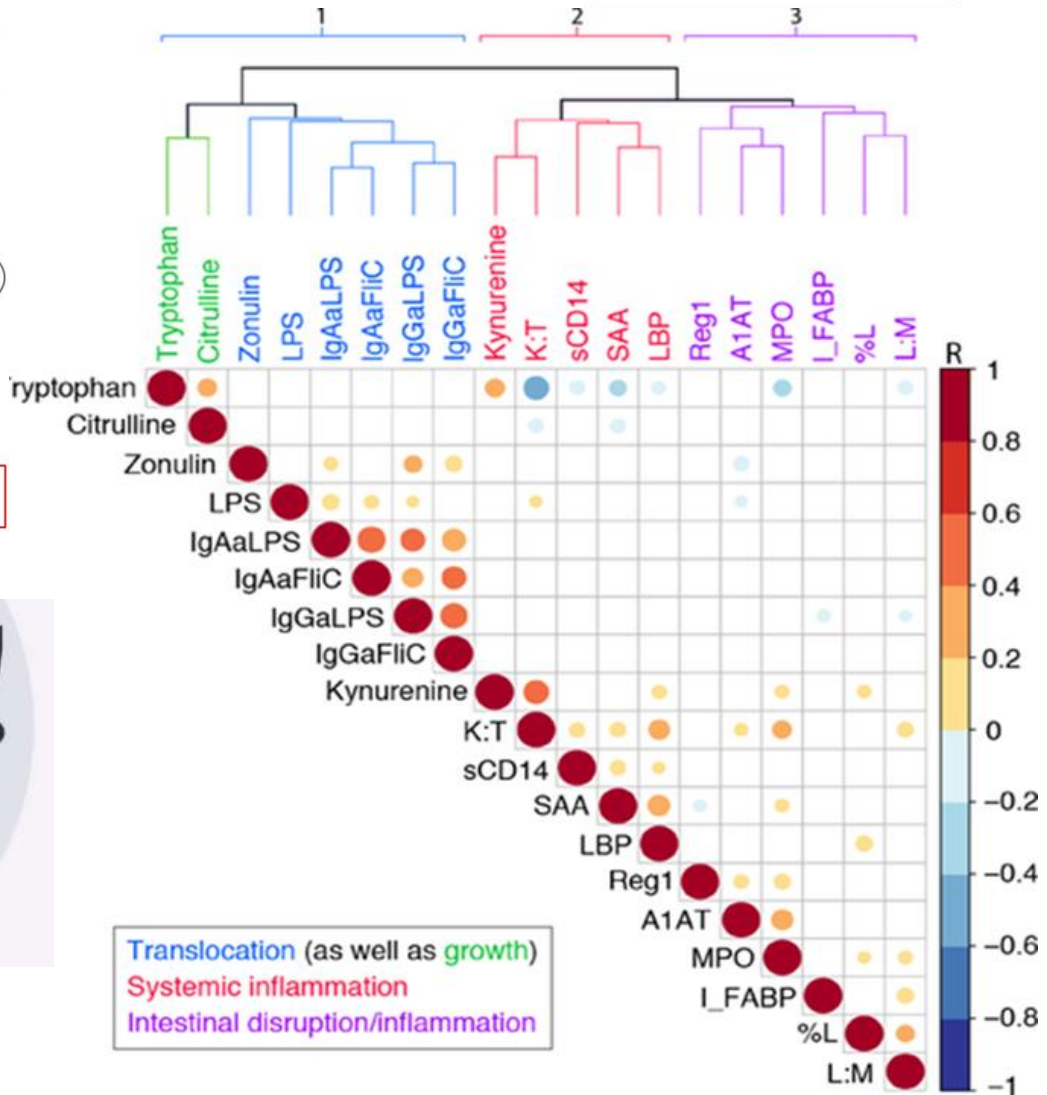
ENVIRONMENTAL ENTERIC DYSFUNCTION

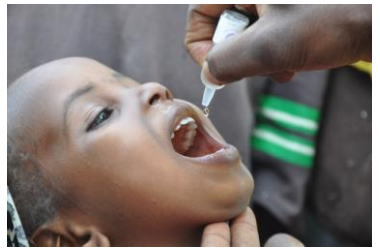


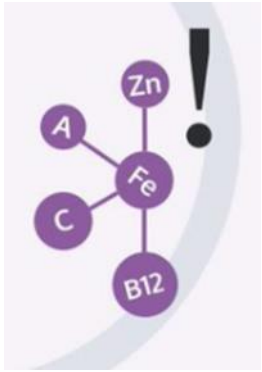




Translocation (as well as growth)
Systemic inflammation
Intestinal disruption/inflammation

- Nutrient Malabsorption
- Increased Nutrient Requirements
- Growth Hormone Resistance





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Volume 108, Issue 4

Biomarkers of maternal environmental enteric dysfunction are associated with shorter gestation and reduced length in newborn infants in Uganda

Jacqueline M Lauer, Christopher P Duggan, Lynne M Ausman, Jeffrey K Griffiths, Patrick Webb, Edgar Agaba, Nathan Nshakira, Hao Q Tran, Andrew T Gewirtz, Shibani Ghosh

EED INTERVENTIONS

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MICRONUTRIENT POWDER

Food fortification of complementary foods for children and vulnerable populations to address anaemia and vitamin & mineral deficiencies.

Used for children 6 months to 12 years of age

CITATIONS

- Lauer JM, Duggan CP, Ausman LM, Griffiths JK, Webb P, Bashaasha B, Agaba E, Turyashemererwa FM, Ghosh S. Unsafe drinking water is associated with environmental enteric dysfunction and poor growth outcomes in young children in rural southwestern Uganda. The American journal of tropical medicine and hygiene. 2018 Dec;99(6):1606.
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Emerging Biomarkers of Environmental Enteric Dysfunction (EED)

Akriti Singh, PhD, MPH

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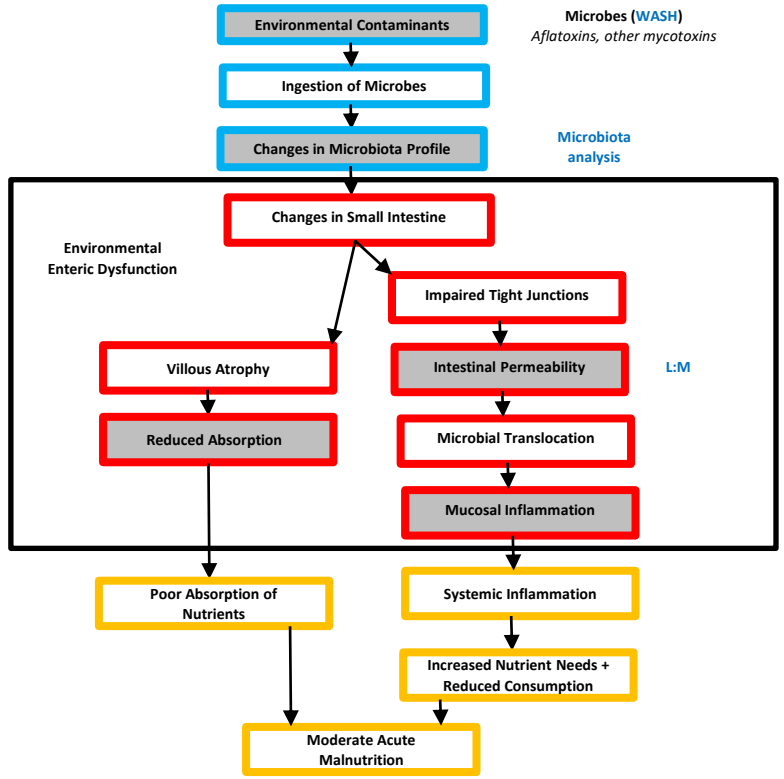
MEASURING EED

- Several emerging biomarkers
  - Host fecal mRNA transcripts
  - Fecal proteins
  - Microbiota

- EED and MAM
  - Growth
  - Treatment outcomes
  - Household WASH conditions



Adapted from Prendergast et al. 2015

NIL-SUPPORTED STUDIES

- EED and growth
  - mRNA-based score (inflammation) inversely associated with LAZ and WLZ

- EED and recovery from MAM
  - mRNA-based score (gut defense) directly associated with recovery
  - Protein AAT (permeability) inversely associated with recovery

Original Research Communications

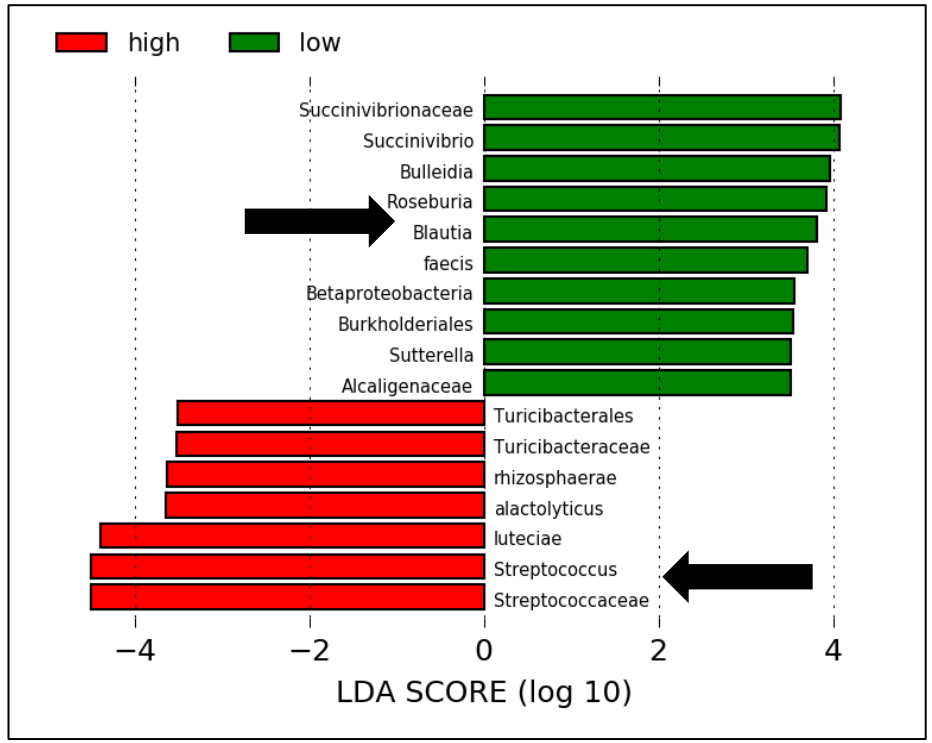
Biomarkers of environmental enteric dysfunction are differently associated with recovery and growth among children with moderate acute malnutrition in Sierra Leone

Akriti Singh,[1] Shibani Ghosh,[1] Honorine Ward,[2] Mark J Manary,[3] Beatrice L Rogers,[1] and Irwin H Rosenberg[1]

[1]Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA, USA; [2]Tufts Medical Center and Tufts University School of Medicine, Boston, MA, USA; and [3]Department of Pediatrics, Washington University, St Louis, MO, USA

NIL-SUPPORTED STUDIES

- EED and Microbiota
  - High mRNA-based score (inflammation) enriched in inflammogenic taxa
- EED and household WASH conditions
  - Improved drinking water source directly associated with lower intestinal permeability (mRNA-based score, LMER, AAT)



Source: Singh 2020

CITATIONS

- Prendergast AJ, Humphrey JH, Mutasa K, Majo FD, Rukobo S, Govha M, et al. Assessment of Environmental Enteric Dysfunction in the SHINE Trial: Methods and Challenges. *Clin Infect Dis*. 2015;61 Suppl 7:S726-32.
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Exposure to Multiple Mycotoxins, Environmental Enteric Dysfunction and Child Growth in Banke, Nepal

Johanna Andrews Trevino, PhD, MSc

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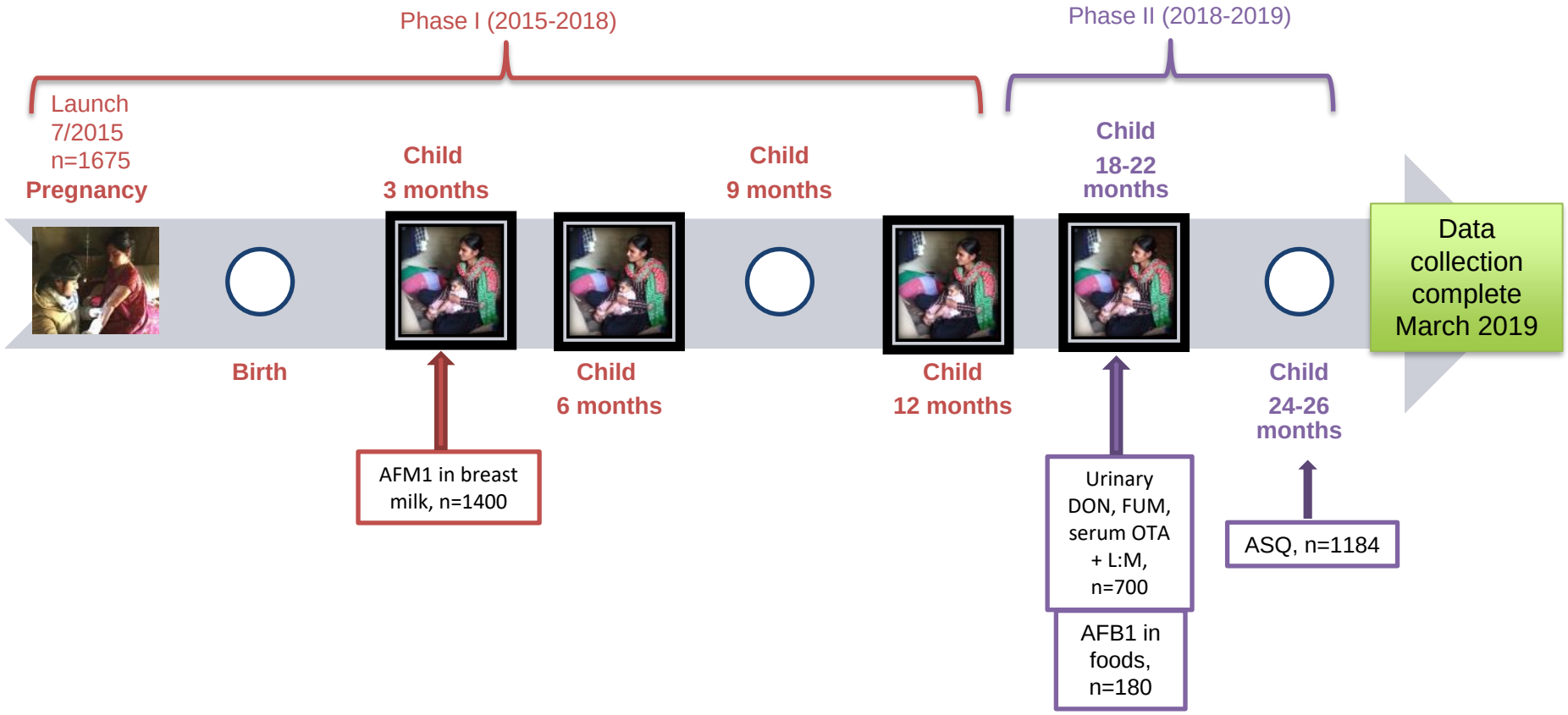
AflaCohort Study, Banke, Nepal (2015-2019)



Main objective: Understand the relationship of *in utero* and early life exposure to aflatoxin and linear growth in the first 24 months of life, controlling for other potential explanatory factors.

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SURVEY DATA & BIOMARKER COLLECTION

SERUM AFLATOXIN CONCENTRATIONS

	n	Detectable Aflatoxin B1 (%)	Mean ± SD AFB1 (pg/mg alb)	Min	Max
Pregnancy	1652	94.3	3.4 ± 8.5	0.4	147.3
Child 3 mo	1363	80.5	1.0 ± 1.1	0.4	24.7
Child 6 mo	1294	75.3	1.2 ± 2.1	0.4	41.6
Child 12 mo	1329	81.1	2.0 ± 4.6	0.4	84.6
Child 18-22 mo	699	85.1	2.4 ± 7.9	0.4	128.1

High occurrence of aflatoxin exposure during pregnancy.

High occurrence of aflatoxin exposure in the first 2 years of life.

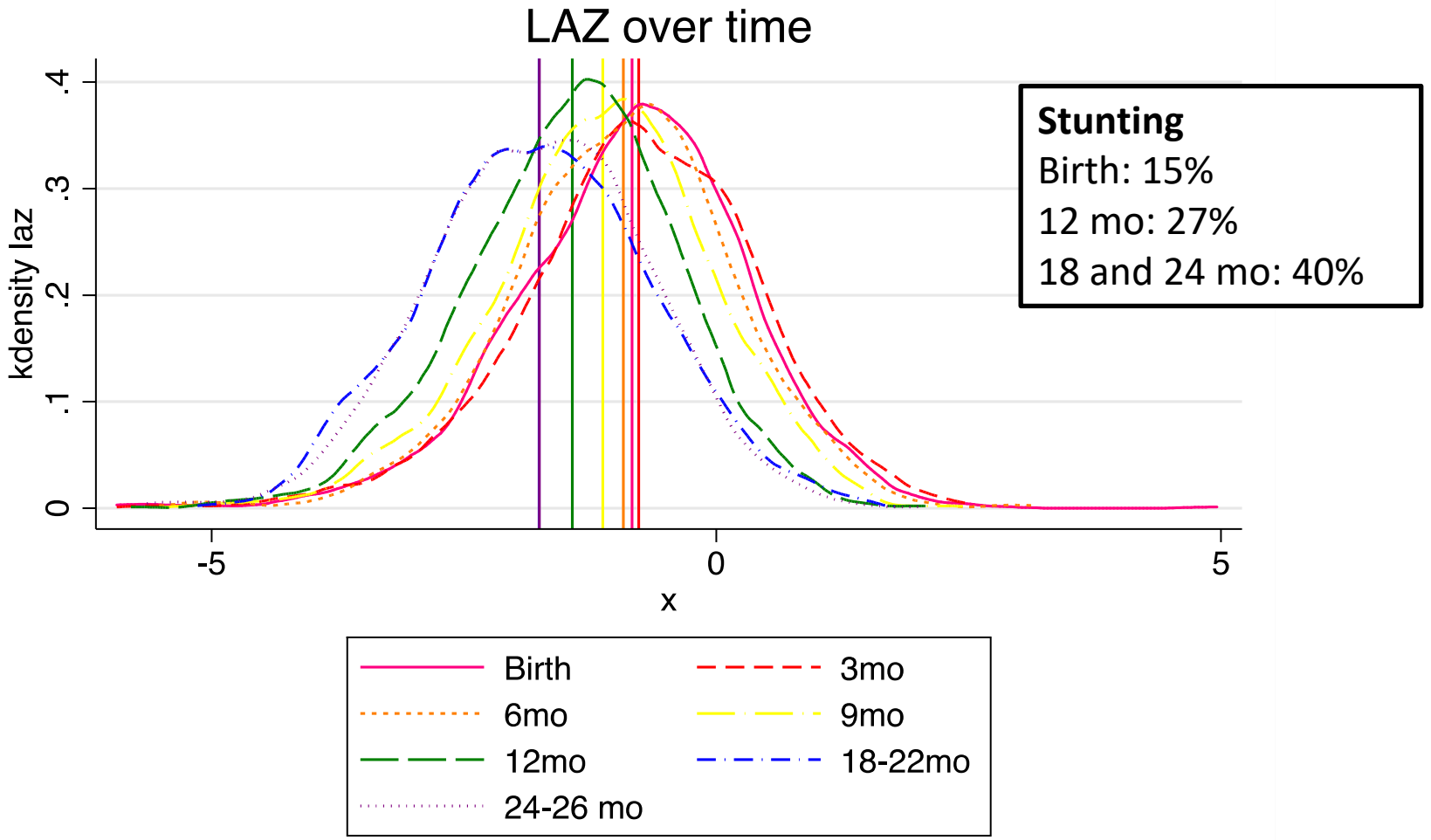
The Journal of Nutrition
Community and International Nutrition

Relatively Low Maternal Aflatoxin Exposure Is Associated with Small-for-Gestational-Age but Not with Other Birth Outcomes in a Prospective Birth Cohort Study of Nepalese Infants

Johanna Y Andrews-Trevino,[1] Patrick Webb,[1] Gerald Shively,[2] Beatrice L Rogers,[1] Kedar Baral,[3] Dale Davis,[4] Krishna Paudel,[5] Ashish Pokharel,[4] Robin Shrestha,[1] Jia-Sheng Wang,[6] and Shibani Ghosh[1]

[1]Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA, USA; [2]Department of Agricultural Economics, Purdue University, West Lafayette, IN, USA; [3]Department of Community Health Sciences, Patan Academy of Health Sciences, Lalitpur, Nepal; [4]Helen Keller International-Nepal, Kathmandu, Nepal; [5]Kanti Children's Hospital, Kathmandu, Nepal; and [6]Department of Environmental Health Science, University of Georgia, Athens, GA, USA

20% low birth weight
38% small-for-gestational age
16% Stunting at birth



Source: Mycotoxin Birth Cohort Study / Banke, Nepal / 2015-2019

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AFLATOXINS & GROWTH OUTCOMES

Aflatoxin exposure and child nutrition: measuring anthropometric and long-bone growth over time in Nepal

Johanna Y Andrews-Trevino, Patrick Webb, Gerald Shively, Ahmed Kablan, Kedar Baral, Dale Davis, Krishna Paudel, Robin Shrestha, Ashish Pokharel, Sudikshya Acharya, Jia-Sheng Wang, Kathy S Xue, and Shibani Ghosh

	Length (cm)			LAZ			Stunting			Knee-heel length (cm)		
	β	95% CI	P	β	95% CI	P	OR	95% CI	P	β	95% CI	P
AFB_1	-0.19	-0.29, -0.10	<0.001	-0.05	-0.09, -0.02	0.003	1.18	1.05, 1.32	0.005	-0.09	-0.13, -0.05	<0.001
AFB_1/weight (kg)	-0.26	-0.33, -0.18	<0.001	-0.08	-0.11, -0.05	<0.001	1.22	1.12, 1.32	<0.001	-0.08	-0.11, -0.04	<0.001

Changes in child AFB1-lysine adduct concentrations were significantly associated with changes in LAZ, length, and knee-heel length.

Serum aflatoxin concentrations were associated with higher odds of stunting.

MYCOTOXIN CONCENTRATIONS

	n	n (%) detectable
Ochratoxin A, ng/mL	699	699 (100)
Fumonisin B1, pg/mg creatinine	683	683 (100)
Deoxynivalenol, ng/mg creatinine	689	596 (87)

High occurrence of mycotoxin exposure at 18-22 months of age.

MYCOTOXINS, EED & GROWTH OUTCOMES

	Length, cm	Weight, kg	Head circumference, cm	Stunting, %	Underweight, %
Aflatoxin B1, pg/mg albumin	-0.29 (-0.53, -0.05) p=0.022	-0.11 (-0.18, -0.03) p=0.007	-0.08 (-0.15, -0.004) p=0.040	1.29 (1.10, 1.50) p=0.002	1.20 (1.03, 1.40) p=0.018
Ochratoxin A, ng/mL	0.15 (-0.23, 0.54)	0.10 (-0.05, 0.25)	0.04 (-0.08, 0.16)	0.98 (0.80, 1.19)	0.88 (0.67, 1.15)
Fumonisin B1, pg/mg creatinine	-0.07 (-0.22, 0.09)	-0.02 (-0.07, 0.03)	0.03 (-0.02, 0.08)	1.05 (0.94, 1.18)	1.09 (1.00, 1.18) p=0.043
Deoxynivalenol, ng/mg creatinine	0.11 (-0.03, 0.26)	0.05 (-0.02, 0.11)	-0.05 (-0.10, -0.002) p=0.044	0.95 (0.84, 1.06)	0.95 (0.84, 1.08)
L:M ratio	-0.33 (-0.63, -0.03) p=0.031	-0.11 (-0.21, -0.02) p=0.022	-0.04 (-0.15, 0.07)	1.19 (0.92, 1.55)	1.02 (0.78, 1.33)

While exposure to multiple mycotoxins is common, we found a more consistent relationship between higher AFB1-lysine adduct levels and child growth outcomes.

KEY TAKEAWAYS

- We found widespread exposure to mycotoxins in the first 1000 days.
- Findings add to the body of evidence hypothesizing that aflatoxin may be a contributor to poor child growth. Interventions to reduce dietary exposure to aflatoxin may have positive effects on child growth in LMICs.
- Weight (and age)-varying effects are an emerging priority issue requiring deeper research-based understanding.
- Food systems approach to food safety – exposure comes from a variety of sources. There are various exposure channels to consider beyond the household (e.g. markets, trade, exchanges) [data not shown].
- Effective research requires a rigorous design and partnerships rooted in mutual respect and good communication.

COLLABORATORS AND TEAM

- USAID Bureau of Resilience and Food Security and USAID Nepal
- Child Health Division, Department of Health Services, MOHP
- Nepal Health Research Council (NHRC) and Tufts IRB
- Patan Academy of Health Sciences (PAHS)
- Helen Keller International (HKI) - Nepal
- Purdue University
- University of Georgia/FTF Innovation Lab on Peanuts and Mycotoxins
- Kansas State/FTF Innovation Lab for the Reduction of Post-Harvest Loss
- Banke District Public Health Office
- Banke VDC and Ward Health Posts, FCHVs
- Nepalgunj Medical College
- AflaCohort Field team and participants

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Unpacking the Determinants of Food Safety and Quality Concern Dynamics: Evidence Using Panel Data from Rural Bangladesh

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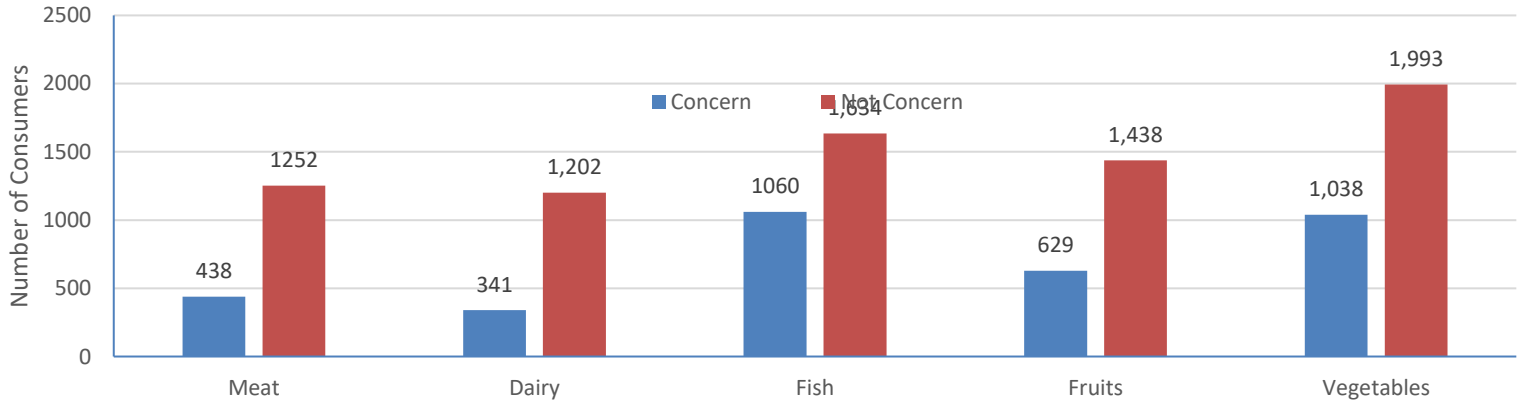
BACKGROUND

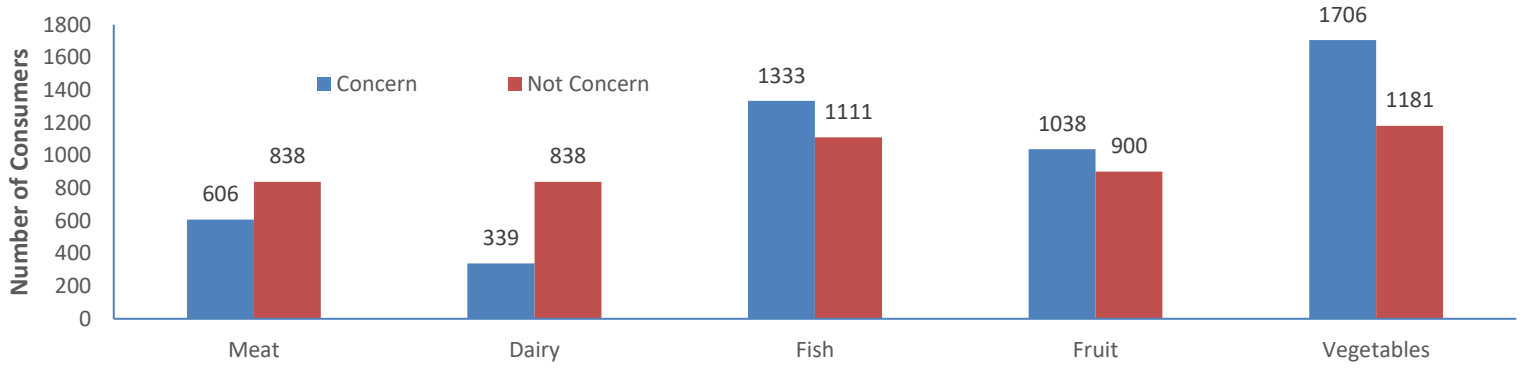
- With the change in:
  - agri-food system;
  - increase in income and;
  - improvement of living standards,
- Consumers have become increasingly concerned about food quality and safety, nutrition, health and wellbeing (Botonaki et al., 2006; WHO, 2015).

Consumers concern on food safety and quality in two rounds

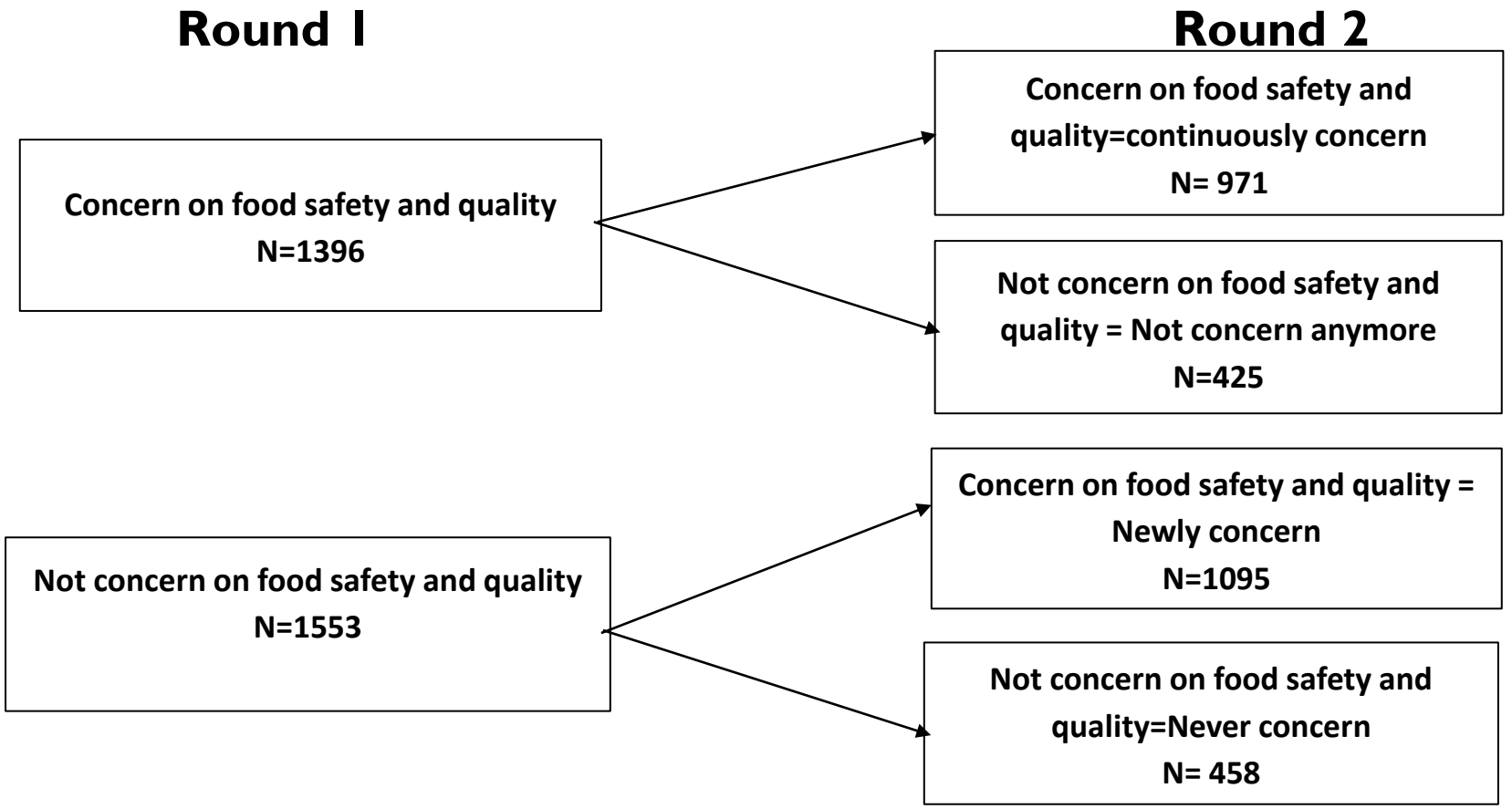
Round 1



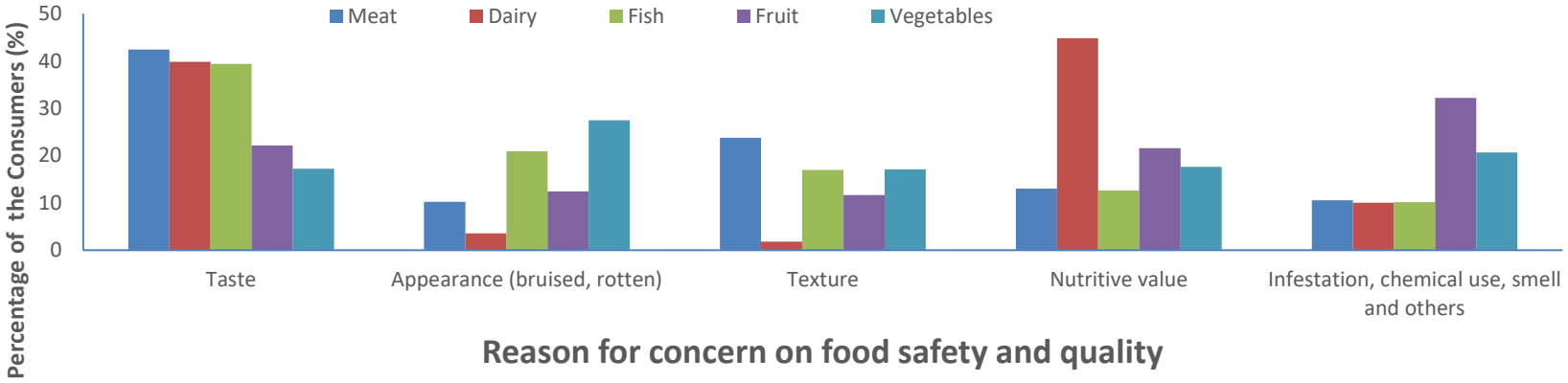
Round 2



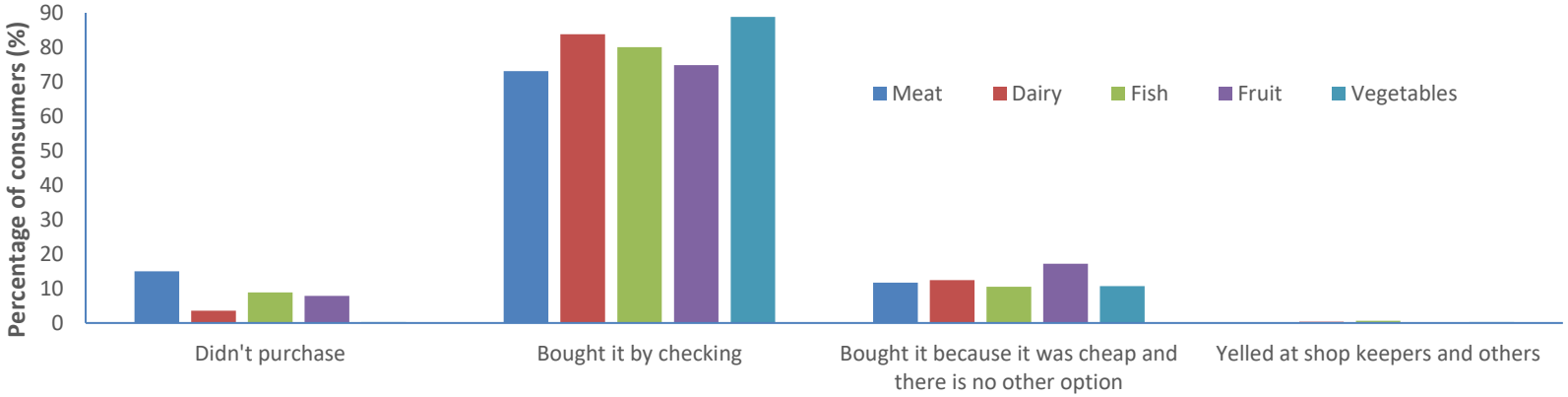
Dynamics of consumers' food safety and quality concern behavior



Reason for concerns and coping strategies against concerns



Reason for concern on food safety and quality



Coping strategies against food safety and quality

Determinants of Food Safety and Quality Concern

Concern about food safety and quality are more among:

- ✓ **male** headed; higher **educated**;
- ✓ Comparatively **richer**;
- ✓ who have **access to electricity**;
- ✓ located **long distant from the market**; and
- ✓ who **purchased more number** of food items.

❑ **Temporal** (location) and **spatial** (round/season) disparities exist.

❖ **Own production of high value foods** particularly fish and fruit production **reduces** worry about food safety and quality.

CONCLUSIONS

- Consumers **are not confident** about the safety and quality of foods items they purchased for various reasons.
- Food safety and quality in the developing countries **not only an exports phenomenon.**
- **Own production diversity reduces** food safety and quality concern.
- Finally, better management of insect, pest and diseases and chemical inputs and promoting alternative safe measures such as **integrated pest management (IPM), and overall food environment improvement** would substantially reduce consumers' worries about food safety and quality.

Q&A

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