FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Innovation Lab for Nutrition

Annual Report

October 1st, 2016 - September 30th, 2017

Building the evidence base for policies that leverage agriculture for nutrition

Award
#AID-OAA-L-10-00006

Feed the Future Innovation Lab for Nutrition

U.S. Government Partners

Feed the Future Innovation Lab for Nutrition's Global and Local Partners

Feed the Future Innovation Lab for Nutrition
Annual Report
Fiscal Year 2017 (Year 7)

Management Entity Information

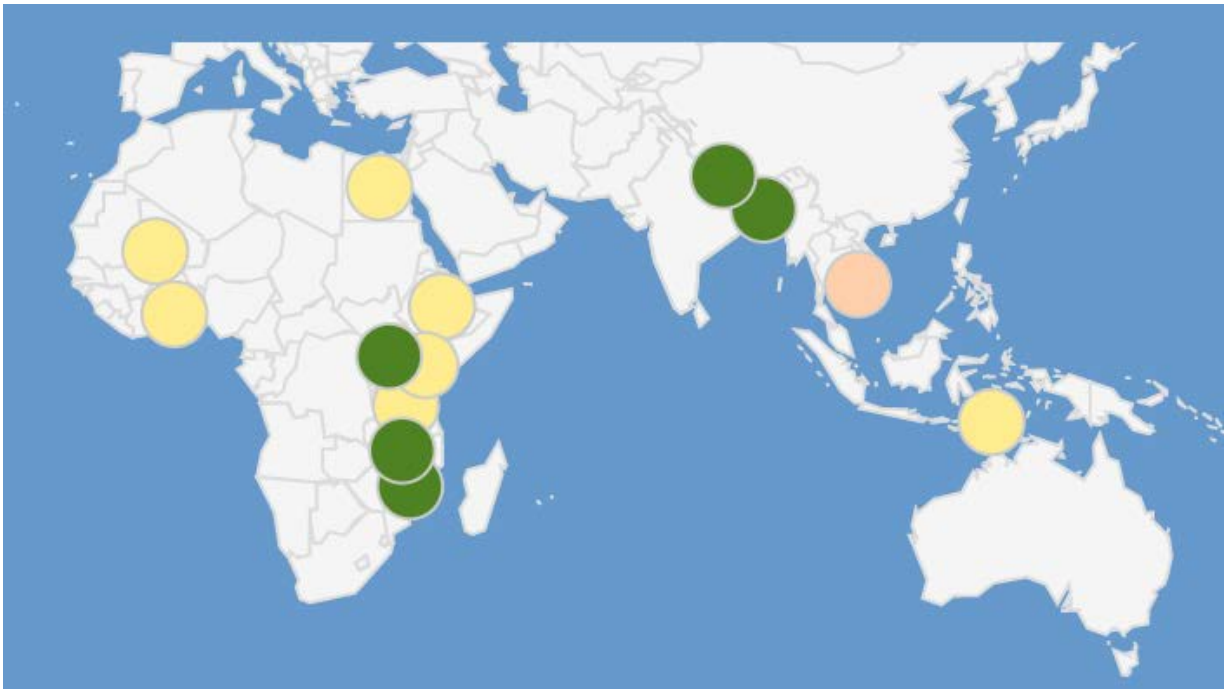
Tufts University's Friedman School of Nutrition Science and Policy is the Management Entity (ME) for the Feed the Future Innovation Lab for Nutrition (hereafter called the Nutrition Innovation Lab). The Nutrition Innovation Lab's core activities are funded under cooperative agreement AID-OAA-L-10-00006 from the United States Agency for International Development (USAID). Additional work is funded through USAID mission Associate Awards or Buy-Ins and with funding from other donors.

Core Management Team	Position	Email Address
Patrick Webb	Program Director	Patrick.Webb@tufts.edu
Shibani Ghosh	Associate Director	Shibani.Ghosh@tufts.edu
Eileen Kennedy	Program Investigator	Eileen.Kennedy@tufts.edu
Robin Shrestha	Regional Coordinator	Robin.Shrestha@tufts.edu
Elizabeth Marino-Costello	Senior Program Manager	Elizabeth.Marino_Costello@tufts.edu

Global Technical Advisory Committee Information

Members	Position	Institution	Email Address
Shakuntala Thilsted	External Advisor	Research Program Leader, WorldFish Center, Bangladesh	sht@life.ku.dk
Richard Deckelbaum	External Advisor	Director, Institute of Human Nutrition, Columbia University	rjd20@columbia.edu
Ram Shrestha	External Advisor	Founder and Executive Director, Nepal Technical Advisory Group (NTAG)	ramntag@gmail.com
Stephen Vosti	External Advisor	Faculty, University of California at Davis	svosti@ucd.edu
Ahmed Kablan	Agreement Officer Representative	International Nutrition and Public Health Advisor, USAID BFS	akablan@usaid.gov

Map of Focus Countries



Country Index

- Countries with Ongoing Research: Bangladesh, Malawi, Mozambique, Nepal, Uganda
- Countries with Supported Research: Egypt, Ethiopia, Ghana, Kenya, Mali, Tanzania, Timor Leste
- Exploring Research in: Cambodia

List of Partners

US Consortium Partners	Johns Hopkins University
	Harvard T.H. Chan School of Public Health
	Boston Children's Hospital
	Purdue University
	Tuskegee University
Other US Partners	Baylor College of Medicine
	Georgia State University
	Feed the Future Innovation Lab for Peanut Productivity and Mycotoxins (University of Georgia)
	Feed the Future Innovation Lab for Horticulture Innovation Lab (University of California, Davis)
	Feed the Future Innovation Lab for Livestock Systems, University of Florida
	Feed the Future Innovation Lab for Aquaculture and Fisheries (Oregon State University)
	Feed the Future Innovation Lab for Post Harvest Loss (Kansas State University)
	Feed the Future Innovation Lab for Soybean
Nepal-Based Partners	Child Health Division, Ministry of Health and Population
	National Planning Commission
	Tribhuvan University/Institute of Medicine (IOM)
	Patan Academy of Health Sciences (PAHS)
	Nepali Technical Assistance Group (NTAG)
	Helen Keller International (HKI/Nepal)
	Save the Children/Nepal
	Center for Molecular Dynamics Nepal (CMDN)
	National Agricultural Research Council (NARC)
	Heifer/Nepal
	Valley Research Group (VaRG)
Bangladesh-Based Partners	WorldFish (Bangladesh)
	Dhaka University (Bangladesh)
	Helen Keller International (HKI/Bangladesh)
	CSISA-Cereal Systems Initiative of South Asia (CIMMYT/Bangladesh)

Cambodia-Based Partners*	World Vegetable Center
	WorldFish (Cambodia)
	Royal Agriculture University (Cambodia)
	CESAIN (Kansas State and Royal Agriculture University initiative)
Malawi-Based Partners	Lilongwe University of Agriculture and Natural Resources (LUANAR)
	University of Malawi, College of Medicine (COM)
	South African Medical Research Council (SAMRC)
	Food and Nutrition Technical Assistance (FANTA)
	Ministry of Health (MoH)
	University of Cape Town (UCT)
Mozambique-Based Partners	Institute of Public Health (Ministry of Health,
	University of Lurio, Nampula
	IITA (International Institute of Tropical Agriculture)
	ANSA
Egypt-Based Partners	El Zanaty & Associates
	GOTHI, Viral Hepatitis Research Laboratory (VHRL)
Other International Partners	World Bank
	Leverhulme Centre for Integrative Research on Agriculture and Health-University of London (LCIRAH)
	London School of Hygiene and Tropical Medicine
	UNICEF
	Save the Children (SAVE)
	Heifer International
	Australian Department of Foreign Affairs and Trade (DFAT)
	University of Indonesia-Jakarta
	St. John's Research Institute (Bangalore, India)
	SPRING (USAID program)

Acronyms

AAEA	Agricultural & Applied Economics Association
BBNC	Bangalore Boston Nutrition Collaborative
BIFAD	Bureau for International Food, Agriculture and Development
CSISA	Cereal Systems Initiative of South Asia
CIMMYT	International Maize and Wheat Improvement Center
FTF	Feed the Future
GAIN	Global Alliance for Improved Nutrition
HKI	Helen Keller International
IFPRI	International Food Policy Research Institute
INGO	International Non-Governmental Organization
IOM	Institute of Medicine (Nepal)
JHBSP	Johns Hopkins Bloomberg School of Public Health
LCIRAH	Leverhulme Centre for Integrated Research on Agriculture and Health
LSHTM	London School of Hygiene and Tropical Medicine
NGO	Non-Governmental Organization (or private voluntary organization)
NASA	National Aeronautics and Space Agency
NTAG	Nepali Technical Assistance Group
PAHS	Patan Academy of Health Sciences (Nepal)
PoSHAN	Policy and Science for Health, Agriculture and Nutrition
SDG2	Sustainable Development Goals 2
UNICEF	United Nations Organization for Children
UNSCN	United Nations Standing Committee on Nutrition
VaRG	Valley Research Group (Nepal)
KSU	Kansas State University

Table of Contents

I) Executive Summary

The Nutrition Innovation Lab pursues research on: i) how agriculture can be leveraged to achieve improved nutrition; ii) how multiple sectors of policy and program activity can be more effectively integrated to achieve improvements in maternal and child nutrition at scale; and, iii) what role is played by neglected biological mechanisms (such as exposure to dietary aflatoxins or to open defecation) in impairing nutrition. In FY 2017, the Innovation Lab continued to emphasize activities that were innovative on both the research and capacity building fronts. New partnerships were established with other Innovation Labs (e.g. the Feed the Future Innovation Lab for Livestock Systems and the Feed the Future Innovation Lab for Post-Harvest Loss) and with other USAID projects (e.g. CSISA in Bangladesh). The Management Entity (ME) also leveraged support from the UK (Department for International Development- DFID and the London School of Hygiene and Tropical Medicine- LSHTM) for a global symposium in Nepal.

During FY 2017, the Nutrition Innovation Lab has continued a series of field studies in several challenging contexts in sub-Saharan Africa and South Asia. The Nutrition Lab initiated a study on Environmental Enteropathy in Uganda, and continued the BAHNR and Aflacohort study in Bangladesh and Nepal respectively. Additional support for the Aflacohort study was sought from the Mission (in process). The third Uganda panel survey was wrapped up and analysis of the 3-panel data set has commenced. New research was initiated in Mozambique in FY2017, through a new award/buy in. Data management and analyses for all other activities has continued at a rapid pace, allowing for numerous presentations to be made and high quality papers to be produced. Abstracts were submitted for important international meetings, including the Micronutrient Forum, Experimental Biology, the International Congress on Nutrition and the 5th Annual National Symposium in Nepal, which was held in collaboration with the 2nd Agriculture Nutrition Health Academy.

A total of 56 presentations were made during FY 2017, of which 34 were peer reviewed oral or poster presentations at conferences and 22 were invited presentations (key notes and seminars). A total of 26 peer-reviewed papers were published in FY 2017 in a range of impactful scientific journals. Of the oral and poster presentations, 47 were taken from peer-reviewed abstracts and 17 presentations were by invitation.

Three students were supported for graduate-level studies, but more emphasis was placed this year on shorter-term training. In Nepal, 1,014 individuals received short-term skills training (including 540 women and 474 men), while in Uganda, 118 individuals received various forms of skills training (including 49 women and 69 men). In Bangladesh, 285 individuals were trained. The 5th Annual Scientific Symposium was held in Nepal in July 2017 with funding from the USAID/Nepal mission, attracting approximately 430 participants over five days.

II) Program Activities and Highlights

The Nutrition Innovation Lab's research generates programmatically-relevant findings aimed at donors, governments, operational agencies and academic partners. In FY 2017, the Nutrition Lab continued its focus on innovative activities in terms of research and capacity building.

The research in FY 2017 included:

1. *Agriculture-to-nutrition pathways (including research on policy governance, multisector programming, analyses of secondary data relating to climate and prices, and assessment of household engagement in agriculture-based livelihoods).* This work includes a nested set of studies, such as the multi-year PoSHAN community studies panel and policy survey analyses, analysis of data from Uganda longitudinal birth cohort study and panel surveys, implementation of the final panel survey in Uganda, planning a new survey in Cambodia[1], completion of a randomized controlled trial in the Banke district implemented by Heifer.
2. *Neglected biological mechanisms*: Research activities included the continued implementation of the Aflacohort study in Banke Nepal, processing of samples in the Uganda birth cohort study, conducting a new study to assess the extent of EED (environmental enteric dysfunction) in the Uganda birth cohort infants as well a study on the relationship of EED and aflatoxin exposure in pregnancy and their effect on birth outcomes in Uganda. Development of a new study in Mozambique was accomplished.
3. *Resilience to environmental climate/seismic shocks and price volatility*: A new addition to the research portfolio in FY17, several studies have sought to understand resilience post-earthquake in Nepal, and to examine resilience in dietary patterns over time, as well as recovery from wasting linked to agricultural commercialization

Capacity building activities in FY 2017 focused on:

1. Long term training (support for post doctoral fellowships and graduate level work)
2. Short term training (training courses, organization of the 5th Annual Scientific Symposium on Agriculture, Nutrition, and Health, organization of seminars and learning labs to build technical capacity of partners, support attendance of the Boston Bangalore Nutrition Collaborative (BBNC)

In FY 2017, 26 papers were published in peer-reviewed journals. In addition, 33 peer-reviewed (conference) oral or poster presentations and 22 invited presentations.

Developing partnerships and collaborations is a key emphasis for Innovation Labs and in FY 2017, the Nutrition Innovation Lab sought new partnerships and collaborations with other Innovation Labs (e.g. the Feed the Future Innovation Lab for Horticulture, Aquaculture and Fisheries, Livestock Systems, for Post Harvest Loss and for Soybean) and other USAID projects (e.g. CSISA in Bangladesh) as well as leveraging existing USAID resources to garner support from the UK (Department for International Development- DFID and the London School of Hygiene and Tropical Medicine) for the 5th symposium in Nepal.

[1] While we planned and prepared for the survey, budgetary constraints prevented us from implementing this survey.

III) Key Accomplishments (FY 2017)

Research Accomplishments

Agriculture-to-nutrition pathways: The Nutrition Innovation Lab has now completed:

- The cleaning and processing of the full data set of the 4th Nepal PoSHAN panel community and policy surveys. Several papers were drafted using the combined as well as pooled datasets for more in-depth complex analyses. Discussion and preliminary work on longitudinal analyses utilizing three panel datasets from the Terai region is advancing. Several presentations were made at the Nepal symposium. The first panel survey (2013) data have been released to USAID DDL and are being reviewed
- Three rounds of data collection in Bangladesh focused on integrated aquaculture and horticulture programming on diets and nutrition (of producers and market-based consumers). Data analysis is currently ongoing. Each round data set had 3060 male and female respondents respectively. Data will be analyzed in FY 2018. One poster presentation was made at the Nepal symposium
- An RCT (randomized controlled trial) that examined the role of nutrition sensitive interventions in improving infant and young child growth and development was completed. Two papers have been drafted and submitted, one oral presentation and one poster presentation at the Nepal symposium.
- The third and final round of data collection of the Uganda panel survey. Data analysis and writing of the evaluation report is currently underway. One poster was presented at the Nepal Nutrition symposium.
- A qualitative survey to evaluate sustainability of a home garden, poultry, and nutrition education intervention in three program districts of western Nepal. Data cleaning has been completed along with coding and compilation process. Data analysis is ongoing.

Neglected Biological Mechanisms: The Nutrition Lab completed:

- Processing of blood samples in Uganda and transported samples to Boston.
- The mid-point data collection on the Aflacohort study in Banke district in Nepal. Completed the analysis of maternal serum samples with about 70% of infant samples being analyzed. Supported the analysis of dried blood spots as part of a validation study. Analyzed maternal data and presented findings in an oral presentation at the Nepal Symposium
- Final data collection in approximately 400 infants from the birth cohort study on EED using the lactulose mannitol test.
- Initiated a study on the association of EED and aflatoxin exposure in pregnancy to birth outcomes in the Mukono district, Uganda (n=285 pregnant women)
- Finalized a study on aflatoxin exposure in children under five in Nampula province, Mozambique that will be implemented in FY 2018.

Dissemination of research findings:

- 56 oral or poster presentations (22 invited, 34 peer reviewed), the total (aggregate) audience participating in these presentations was more than 15,976 people.
- 26 peer-reviewed articles published.

Capacity Building (Human and Institutional) Accomplishments

- One Ugandan received support for graduate studies; one Nepali finished her PhD; one US post-doctoral fellow, two Nepali (one male, one female) and two Ugandan candidates were supported to the BBNC (one woman and one man).
- 1,417 individuals received short-term training in Asia and Africa in FY 2017. A total of 118 individuals in Africa (69 men, 49 women) and 1014 in Asia (474 men and 540 women).
- A total of 430 attendees at the 5th symposium with 21 learning labs, 59 oral presentations and 68 poster presentations.
- Continued promotion of local partner engagement through the support of the IOM Masters in Public Health Nutrition (10 students). Worked closely with IOM faculty on the delivery of lectures, seminars and journal clubs for the 2017-18 academic year.
- Nine Nepal and 6 Uganda based institutions gained enhanced capacity to engage with and undertake policy-relevant research linking agriculture to nutrition.
- Coordinated and facilitated lecture sessions on 1) Nutritional Assessment methods and 2) Electronic data collection methods in Ag-Nutrition research.
- Support to the Nepal Health Research Council (NHRC) through a presentation and sharing of relevant documents and guidelines.

IV) Research Program Overview and Structure

The Nutrition Innovation Lab constitutes a research platform, which provides numerous opportunities for cutting-edge research on agriculture, diets and nutrition in developing countries. Such research has an applied focus (operations or "delivery science" research or field based research rather than "bench science"), it is country-owned (supporting research which includes national stakeholders and informs locally-defined priorities in food and nutrition) and it allocates resources to few grants at larger scale, rather than many small grants supporting studies of experimental or pilot activities. The research is pursued in ways which seek to enhance global and national understanding of how to overcome constraints in policy and program design and implementation, while also producing global public goods in the form of new scientific knowledge of relevant and diverse settings.

Following these principles, the Nutrition Lab is framed by the following over-arching research questions, namely: 1) How can investments in agriculture achieve measurable impacts in nutrition (and can pathways to impact be empirically demonstrated)?; This includes how multisector programs and policies (and the enabling environment) can support nutrition-specific and nutrition-sensitive actions and how sustainable are these actions; 2) What role is played in nutrition by biological mechanisms which have been relatively overlooked or ignored in past research (including aflatoxins, water quality, chemical contamination, etc.)? and 3) What type of resilience (household and community) exists to environment, climate, seismic or price volatility shocks and what is the potential for recovery?

Tufts University's Friedman School of Nutrition Science and Policy serves as the Management Entity (ME). The Friedman School implements the program of work in partnership with several US university partners–Tuskegee, Purdue, Johns Hopkins and Harvard. The Nutrition Lab partners with many additional universities, Feed the Future Innovation Labs and research organizations, including the University of Georgia, University of Florida, University of California-Davis, International Food Policy Research Institute; European universities (University of Bergen, Norway, the London School of Hygiene and Tropical Medicine and the Leverhulme Centre for Integrative Research on Agriculture and Health in London); and host country institutions, such as the Nepal Agricultural Research Council (NARC), the Child Health Division of the Ministry of Health and Population of Nepal (CHD) and the National Planning Commission, the Nepal Valley Research Group (VaRG), the Nepali Technical Assistance Group (NTAG), Tribhuvan University (Institute of Medicine), Patan Academy of Health Sciences (PAHS), St. John's Research Institute in Bangalore, Makerere University, Gulu University, Institute of Public Health, Mozambique, University of Malawi, the Lilongwe University of Agriculture and Natural Resources, the Medical Council of Malawi, the South African Medical Research Council (SAMRC) and the Ugandan Office of the Prime Minister and Ministry of Health); as well as international non-governmental organizations like Heifer International, Heifer Nepal, Helen Keller International (Bangladesh, Nepal, Cambodia), FHI 360, FANTA, SPRING, Save the Children, CIMMYT, IITA and WorldFish.

V) Research Project Reports

Objective 1: Understanding Agriculture to Nutrition Pathways

a) PoSHAN Community Panel Survey and analysis

i) A panel of approximately 4,300 households (5,400 children under five years of age and 4,500 mothers) is conducted annually in 21 research sites by Johns Hopkins University with New Era, NTAG and NARC. In FY 2017, while no new data was collected, the Innovation Lab worked on processing and analyzing prior panels.

ii) *Location:* 21 districts in Nepal; Taplejung, Terhathum, Morang, Solukhumbhu, Saptari, Ramechhap, Dhanusha, Sarlahi, Bara, Sindhupalchowk, Rasuwa, Kathmandu, Lamjung, Nawalparasi, Arghakhachi, Rolpa, Banke, Jumla, Mugu, Bajhang, and Doti

iii) *Collaborators:* Johns Hopkins, NARC, NTAG, IOM, New Era, Purdue and Tufts University

iv) *Achievements*: The fourth round of data collection completed in September 2016 and data cleaning in July 2017. A total of 5,163 households (5522 women and 6647 children under 5 years of age) were interviewed. Preliminary descriptives from Panel 2 and Panel 3 were shared with collaborators, partners and stakeholders. A total of 7 papers were published. Two papers have been published on the PoSHAN community studies panel, one examining individual, household and community level risk factors of stunting in children younger than 5 years and another assessing the cost of improving household diets and one examined the pre-earthquake patterns of under nutrition and food security. There were another three papers not derived from this data which focused on micronutrient status of breast-fed infants, development and cognitive functioning of Nepali infants. In addition, the first panel survey (2013) data have been released to USAID DDL and are currently under review.

Initial findings show a statistically significant association between cropping and livestock diversity (the range of items produced) and dietary diversity of children in Nepal. This offers some of the first empirical evidence of a direct link between agriculture and diet quality measured as a minimum number of food groups consumed. However, the effects hold most strongly for poorer households that are reliant on own production for their food (rather than the market), and the effect disappears for younger children and infants; that is, the agriculture to nutrition route via own production consumed works for children older than 5 years. Expecting an impact during the first 1000 Days may therefore be misplaced and require other complementary targeted nutrition interventions.

The study of earthquake resilience suggests that even if household investments in agriculture are not major drivers of poverty reduction and nutrition for many less poor and less remote households, agricultural activity does serve as a buffer against shocks. That is, while many businesses and livelihoods were damaged by the earthquake and had not recovered in the aftermath, farm activities were able to pick up and continue despite some losses. This safety net function of agriculture offers support for poorest households in risky environments – something to be bolstered through careful investments by development agents.

v) *Capacity building*: Significant efforts have been put into training partners, collaborators and students to undertake rigorous research and data collection.

vi) *Lessons learned*: Demand has been steadily growing for findings from this research activity. Insufficient level of effort had initially been dedicated to responding to such demand with publications as outputs. The ME rectified this in mid-FY 2016 so that analyses underway led to several publications in FY 2017 with more upcoming in FY 2018.

vii) *Presentations and Publications:*

Presentations

1. **Dorsey J, Manohar S**, Neupane S, Shrestha B, **Thorne-Lyman A, Webb P**, et al. 2017. *A multi-level risk factor assessment for stunting: Evidence from a national sample in Nepal*. The FASEB Journal 31 (1 Supplement), 639.17-639.17 (Peer reviewed, Poster).
2. Thorne-Lyman AL, Rashid M, Wu L, Schulzel K, Christian P, Labrique AB, Ali H, Mehra S, Shaikh S, Klemm RDW, West KP Jr. Prevalence and Risk Factors for Infantile Bleeding and Mortality in Rural Bangladesh: Is Vitamin K Deficiency a Cause? Experimental Biology, Chicago IL, April 2017 (Peer reviewed, Poster)
3. **Mulmi P**, Masters WA, Webb P, Block SA, Ghosh S, Namirembe G, Manohar S, Klemm R, West K. Household food production is associated with dietary diversity for poorer households and older children: Results from a nationally- representative survey in Nepal. 5th Annual Agriculture to Nutrition Scientific Symposium, Kathmandu, Nepal, July 2017 (Peer reviewed, oral)
4. Moucheraud C, **Chandyo R**, Henjum S, Strand TA, Ulak M, Fawzi WW, Locks LM, Shrestha PS, Webb P, Thorne-Lyman AL. Engagement in agriculture protects against food insecurity and adverse child nutritional outcomes in a peri-urban population in Nepal. 5th Annual Agriculture to Nutrition Scientific Symposium, Kathmandu, Nepal, July 2017 (Peer reviewed, Oral)
5. Lyman-Thorne A. Nutritional resilience following the 2015 earthquake in Nepal. 5th Annual Agriculture to Nutrition Scientific Symposium, Kathmandu, Nepal, July 2017 (Peer reviewed, Oral)
6. Broaddus E, **Manohar S**, Thorne-Lyman AL, Nonyane A, Winch P, West K. Seasonality of consumption of non-staple micronutrient-rich foods among young children in three geographically diverse Nepali communities. 5th Annual Agriculture to Nutrition Scientific Symposium, Kathmandu, Nepal, July 2017 (Peer reviewed, Oral)
7. **West K**. Vitamin A interventions to reduce child mortality, blindness and hearing loss in Nepal, 5th Annual Scientific Symposium, Kathmandu, Nepal, July 2017 (Invited Key note)
8. **Gauchan D**, Sthapit B, Sthapit S, Joshi BK, Jarvis D. Exploring linkages of production diversity with household nutrition and management of crop biodiversity in the rural remote mountains of Nepal. 5th Annual Agriculture to Nutrition Scientific Symposium, Kathmandu, Nepal, July 2017 (Peer reviewed, Oral).

Publications

1. **Dorsey J, Manohar S**, Neupane S, Shrestha B, **Klemm R, West K**. 2017; *Individual, household, and community level risk factors of stunting in children younger than 5 years: Findings from a national surveillance system in Nepal;* Maternal and Child Nutrition; e1243; doi**:** 10.1111/mcn.12434 (Peer reviewed)

2. Haugen J, Ulak M, Chandyo RK, Henjum S, **Thorne-Lyman A**, Ueland PM, et al. 2016. *Low prevalence of vitamin D insufficiency and deficiency among breastfed infants despite a high prevalence among their mothers in Nepal.* Nutrients. doi: 10.3390/nu8120825 (Peer Reviewed)
3. Kvestad I, Hysing M, Shrestha M, Ulak M, **Thorne-Lyman AL**, Henjum S, et al. 2017. *Vitamin B12 status in infancy predicts development and cognitive functioning five years later in Nepalese children.* American Journal of Clinical Nutrition. doi: 10.3945/ajcn.116.144931. (Peer reviewed)
4. **Biehl E, Klemm RD, Manohar S, Webb P, Gauchan D, West KP JR**. 2016. *What Does It Cost to Improve Household Diets in Nepal? Using the Cost of the Diet Method to Model Lowest Cost Dietary Changes.* Food and Nutrition Bulletin 37.3 (2016): 247-260. (Peer reviewed)
5. Henjum S, Lie O, Ulak M, **Thorne-Lyman A**, Chandyo R, Shrestha P, et al; 2017; *Erythrocyte fatty acid composition of Nepal breast-fed infants,* European Journal of Nutrition; doi: 10.1007/s00394-017-1384-4 (Peer reviewed)
6. Shrestha S, **Thorne-Lyman AL, Manohar S**, Shrestha B, Neupane S, Rajbhandry R, Shrestha R, **Klemm RDW**, Nonyane BAS, Adhikari RK, **Webb P, West Jr KP**. 2017. *Pre-earthquake national patterns of preschool child undernutrition and household food insecurity in Nepal in 2013 and 2014.* Asia Pac J Clin Nutr. 2018;27(4) doi: 27(4) 2017-0052 (Peer reviewed)

b) PoSHAN Policy Panel Survey and analysis

i) *An empirical study of the extent to which knowledge, attitudes and practices of individuals charged with cross-sectoral collaboration for nutrition actually influence program and policy fidelity, as well as household-level outcomes observed on the ground.* During FY 2017, while no new data were collected, the fourth panel survey was processed and multiple analyses were conducted leading to the publication of five papers.

ii) *Location:* 21 districts; Taplejung, Terhathum, Morang, Solukhumbhu, Saptari, Ramechhap, Dhanusha, Sarlahi, Bara, Sindhupalchowk, Rasuwa, Kathmandu, Lamjung, Nawalparasi, Arghakhachi, Rolpa, Banke, Jumla, Mugu, Bajhang, and Doti

iii) *Collaborators:* PAHS, HKI, VaRG and Tufts University

iv) *Achievements*: Completion of the fourth panel in Oct 2016 (n=520) and data cleaning in December 2016. Analyses of two rounds (Round 2 and 4) was presented at the 5th Annual Scientific Symposium 2017 held in Kathmandu, Nepal. Papers using Rounds 1 (2014), 2 (2015) and 3 (2016) were published as a special issue in the Food and Nutrition Bulletin. The results of two full panel rounds demonstrated that national investments in training and awareness-building among civil servants across sectors and across the country has been paying off: the demand for technical information about how to address nutrition in multisector ways has grown, discussion among colleagues about nutrition problems and solutions has also grown, and there is a clear commitment beyond the Ministry of Health to achieving the government's ambitious national nutrition agenda. This work has also confirmed that a simple tool can work to quantitively assess change over time in individuals' commitment to, and capacity for, more effectively nutrition-sensitive actions.

v) *Capacity building*: Numerous policymakers in the NPC and CHD have requested personal interactions with Nutrition Innovation Lab researchers to learn more about the approach and instruments used in the governance study.

vi) *Lessons learned*: The findings of early analysis suggest that such data can be very important for documenting strengths and weaknesses in governance processes for nutrition. The positive external reviews of the articles and a subsequent highlight of the Food and Nutrition Bulletin articles in an online network (ENN Online) confirmed strong global research interest in this innovation domain of study and the credibility of the data.

vii) *Presentations and Publications:*
Presentations

1. **Shrestha R.** Overview of Nutrition Innovation Lab activities in Nepal, HKI Nepal, November 2016 (Invited)
2. **Shrestha R.** Feed the Future Innovation Lab for Nutrition- Orientation to USAID funded projects in Nepal, Ministry of Health, Child Health Division, November 2016 (Invited)
3. **Ghosh S.** Understanding the relationships of nutrition-agriculture research in Nepal: Findings of the Nutrition Innovation Lab. National Seminar Nutrition, Government of Nepal, January 2017, Pokhara, Nepal (Invited)
4. **Ghosh S.** Evidence base for the prevention of stunting Helen Keller International and USAID Suaahara Seminar, January 2017- Kathmandu, Nepal (Invited)
5. **Webb P.** Food systems and diets: facing the challenges of the 21st century. Key note lecture at the 5th Annual Scientific Symposium, July 2017 (Invited Keynote)
6. **Neupane S, Baral K, Davis D, Namirembe G, Shrestha R, Ghosh S, Webb P.** Measuring nutrition governance in Nepal: A multiyear assessment of institutional and individual collaboration, capability and commitment at sub-national levels in Nepal. 5th Annual Agriculture to Nutrition Scientific Symposium, Kathmandu, Nepal, July 2017 Poster presentation (Peer reviewed)

Publications*:* Four papers were published as a special issue in the Food & Nutrition Bulletin on nutrition governance in Nepal. The appearance of this special issue demonstrated close collaboration with another USAID project – SPRING. One of the papers, on measuring nutrition governance, was used as a desk review for the Theory of Change workshop in Nepal by facilitators from the Government of Nepal, Multi-Sector Nutrition Policy and UNICEF.

1. **Kennedy E**, Fekadu H, **Ghosh S**, Baral K, Davis D, Sapkota D, **Webb P**; 2016; *Implementing Multisector Nutrition Programs in Ethiopia and Nepal: Challenges and Opportunities From a Stakeholder Perspective;* Food & Nutrition Bulletin 37: S115-S123 doi:10.1177/0379572116674552 (Peer reviewed).
2. Pomeroy-Stevens A, Shrestha MB, Biradavolu M, Hachhethu K, Houston R, Sharma I, Wun J; 2016; *Prioritizing and Funding Nepal's Multisector Nutrition Plan;* Food & Nutrition Bulletin 37: S151-S169 doi:10.1177/0379572116674555 (Peer reviewed).
3. **Webb P, Ghosh S, Shrestha R, Namirembe G, Gurung S**, Sapkota D, et al; 2016; *Measuring Nutrition Governance: An Analysis of Commitment, Capability, and Collaboration in Nepal.* Food & Nutr Bull 37: S170-S182 doi:10.1177/0379572116674856 (Peer reviewed).

4. Marasini MK, Mugenyi S; 2016; *Overcoming the Limits of Evidence on Effective Multisectoral Nutrition Policy;* Food & Nutrition Bulletin 37:S183-S184 doi:10.1177/0379572116676120 (Peer reviewed).
5. Lamstein S, Pomeroy-Stevens A, **Webb P, Kennedy E**; 2016; *Optimizing the Multisectoral Nutrition Policy Cycle: A Systems Perspective;* Food & Nutrition Bulletin 37: S107-S114 doi:10.1177/0379572116675994 (Peer reviewed).

c) Birth Cohort Study in Uganda

i) *Livelihood and nutrition interventions to improve maternal and child nutrition in Uganda:* The study enrolled 5,044 women and followed pregnancy outcomes and child growth in districts targeted by USAID's Community Connector Project (CCP) versus those in non-targeted districts. It also supported assessment of the role of aflatoxins, detected in the blood of mothers and infants, in determining nutrition outcomes. The cohort study ended in FY 2017, all data are clean and shared with all the partner organizations. A recent graduate from the Harvard TH Chan School of Public Health is working as a post doctoral fellow on this project.

ii) *Location:* Sub-counties; Atanga, Aduku, Ayer, Agweng, Apac, Atyaka, Agoro, Bugangari, Buyanja, Bwizi, Kibito, Kebisoni, Nyamweru, Parombo, Ruhija, Rugyeyo

ii) *Collaborators:* Makerere University, Harvard University, University of Georgia, Children's Hospital, and Tufts University

iii) *Accomplishments:* All serum samples were transported to Boston in February/March 2017. Lab technicians in Boston verified all samples determining the exact number of samples per visit and linking it to the visit data set. Aliquoting of samples was started. Data on birth outcomes and infant mortality was collated and confirmed with field supervisors and enumerators. Matching mother-infant pairs for aliquoting prior to shipping to UGA has been unexpectedly time-consuming. The first full analyses of these data will begin in the Spring of 2018.

iv) *Capacity building*: Multiple sessions have been held with our Ugandan colleagues regarding the review of data management practices.

v) *Lessons Learned:* Significant challenges were reported in FY 2016. In FY 2017, the ME put considerable efforts to ensure that data are clean and all samples are linked to collected data.

vi) Presentation and Publications:

Presentations

1. **Smith ER**, Manji K, McDonald CM, et al. Early Breastfeeding Initiation, Prelacteal Feeding, and Infant Feeding Are Associated with Biomarkers of Environmental Enteric Dysfunction. The FASEB Journal 2017;31(1 Supplement):959.13. (Peer reviewed, Poster)
2. **Liu E**, Manji KP, McDonald CM, et al. Preterm Birth and Biomarkers of Environmental Enteric Dysfunction among Infants in Tanzania. The FASEB Journal 2017;31(1 Supplement):649.7 (Peer reviewed, Poster)

Publications

1. **Locks L,** Mwiru R, Mtisi E, Manji KP, McDonald CM, Liu E… **Fawzi WW**, **Duggan CP**. 2017. *Infant Nutritional Status and Markers of Environmental Enteric Dysfunction are Associated*

with Midchildhood Anthropometry and Blood Pressure in Tanzania. Journal of Pediatrics,187: 225-233. e1, ISSN 0022-3476, http://dx.doi.org/10.1016/j.jpeds.2017.04.005 (Peer reviewed).

d) Uganda Panel Survey

i) Assessing the linkage between agriculture, food security, nutrition and health among women and children in rural Ugandan households: A repeated panel survey (baseline, midline and endline assessment) was conducted to determine if the USAID Uganda Community Connector project (UCCP) improved production practices, incomes and nutrition. The midline assessment showed no change in key program indicators over baseline. While not a traditional impact evaluation design, the design of this study provides a snapshot of Community Connector implementation and the potential for integrated programs to affect change.

ii) *Location:* Kisoro, Dokolo, Agago, Lira, Kole and Kamwenge districts in Uganda

iii) Collaborators: Makerere University, Harvard and IFPRI take the lead, collaborating with Tufts.

iv) Accomplishments: The third panel was successfully collected. All datasets are cleaned, collated and being analyzed. One hundred fifty community focus group discussions (FGDs) were conducted in 116 parishes to better understand the potential effect of UCCP and non-UCCP interventions. In addition, information was gathered and inputted on the exact type of services available at the parish level. Four abstracts using the first two panels (2012-2014) were submitted to the International Congress for Nutrition to be held in Buenos Aires, Argentina in October 2017. Three are accepted as posters, one as an oral presentation. Preliminary findings on anemia in households owning livestock, despite higher availability of animal source foods, have been confirmed through further analysis. A plausible link with malaria vectors has also been convincingly reiterated. A revised paper on this outcome has been re-submitted to a high impact journal for review. If confirmed, this suggests a need for livestock promotion programs to carefully consider context and to plan for remedial action against mosquitoes, as well as behavior change communication relating to use of meat and dairy in young children's diets.

v) Capacity building: During the last panel, Dr. Kabunga trained enumerators and supervisors.

vi) Lessons learned: There was a delay in the start of the panel survey due to a faculty strike at the major partner university in Kampala. Fortunately, this has not affected the survey timeline.

vii) Presentations and Publications:

Presentations *(Orals or Posters)*

1. **Ghosh S., Liang L., Kabunga N., Agaba E., Griffiths JK., Duggan C. Bashaasha B and Webb P**. Ugandan women with higher dietary diversity scores are more likely to belong to higher than lower BMI quantiles: Findings from rural north and south west Uganda. Poster presentation at the 5th Annual Scientific Symposium, July 2017, Kathmandu, Nepal (Peer-reviewed, Poster)

Publications

1. Pomeroy-Stevens A, D'Agostino A, Adero N, Foehringer Merchant H, Muzoora A, Mupere E, **Agaba E**, Du L; 2016, *Prioritizing and Funding the Uganda Nutrition Action Plan;* Food & Nutrition Bulletin 37:S124-S141 doi:10.1177/0379572116674554 (Peer Reviewed).
2. **Agaba E**, Pomeroy-Stevens A, **Ghosh S, Griffiths JK**; 2016; *Assessing Progress in Implementing Uganda's Nutrition Action Plan: District-Level Insights;* Food & Nutrition Bulletin 37:S142-S150 doi:10.1177/0379572116674553 (Peer Reviewed).

e) Econometric Analyses of Secondary Data - Linking Ecology, Food Systems and Nutrition

i) *Measuring links among environmental factors, agriculture and nutrition outcomes:* Over the past seven years, Purdue and Tufts have worked on large data sets that *allowed us to test the linkages of agriculture to nutrition through innovative, globally relevant analyses. Several publications have been published.* In FY 2017, continued substantial progress was made in several analytical work streams, publishing of the analysis infrastructure (including roads and bridges) and its relationship to nutrition outcomes.

ii) *Location*: Focus on Nepal and Uganda (national level analysis).

iii) *Collaborators:* Purdue, Tufts

iv) *Achievements*: Innovation multi-level modeling using large datasets has opened up an exciting realm of policy-relevant research opportunities. As a result, governments are keen to understand the interactions among proximate and distal determinants of undernutrition as well as the effectiveness of large-scale program interventions. A paper and presentation on the role played by infrastructure for helping nutrition in Nepal (via reduced transaction costs for the marketing of foods) was widely discussed by policymakers. The World Food Programme of the United Nations subsequently requested Nutrition Innovation Lab's partner Purdue to be involved in planning a new strategy for nutrition-sensitive road-building in Nepal. The findings, which are being further developed, have important implications for national governments beyond Nepal regarding priority infrastructure investments through a

v) *Capacity building*: Not applicable

vi) *Lessons learned*: Collaboration among numerous academic institutions can yield powerful data capacity with unique findings on environmental links to child nutrition. Protecting 'turf' has not been a problem in this regard.

vii) *Presentations and Publications:*

<u>Presentations</u>

1. **Harding K, Webb P,** Aguayo V. *Low birth weight and poor child feeding practices are determinants of child wasting, severe wasting, and of the co-occurrence of wasting and stunting in South Asia* (MCN). 5th Annual Agriculture to Nutrition Scientific Symposium, Kathmandu, Nepal, July 2017 (Peer reviewed, Poster)

2. **Harding K, Webb P,** Aguayo V. *Factors associated with wasting among children under five years old in South Asia: Implications for action* (PlosOne). 5th Annual Agriculture to Nutrition Scientific Symposium, Kathmandu, Nepal, July 2017. (Peer reviewed, Poster)
3. **Masters W,** Hall A, Martinez EM, Shi P, Singh G, **Webb P,** Mozaffarian D. The nutrition transition and agricultural transformation: a Preston curve approach. USAID/ BFS/ ARP Seminar & SAIS Global Agriculture Seminar (Invited)
4. Larsen AF, Headey DD, **Masters W**. Misreporting month of birth: Implications for nutrition research. Agricultural and Applied Economics Association (Peer reviewed, Oral)
5. Omiat G, **Shively G.** Assessing the rainfall-agriculture and rainfall-health nutrition pathways in Uganda. 5th Annual Agriculture to Nutrition Scientific Symposium, Kathmandu, Nepal, July 2017. (Peer reviewed Oral)
6. **Masters W**. Nutritional content of packaged infant foods in developing countries, Clark University Seminar November 2016 (Invited)
7. **Masters W.** Structural change in agriculture, food and nutrition, FAO, Rome November 2016. (Invited)
8. **Masters W.** Evidence review for impacts of agricultural research on poverty, nutrition and resilience. Agrilinks Webinar video Washington DC April 2017 (Invited)
9. **Mulmi P, Masters WA,** Block SA, **Webb P.** Farm production, child dietary intake and household wealth: Results from a nationally-representative survey in Nepal. Agricultural and Applied Economics Association, Chicago, IL. (Peer reviewed, Oral)
10. Pray CE, **Masters WA**, Ayoub S. Impacts of Agricultural Research on Poverty, Malnutrition and Resilience. USAID Bureau for Food Security, Office of Agriculture, Research and Policy (USAID/BFS/ARP) Agricultural and Applied Economics Association Annual Meeting, Chicago, IL, August 2017 (Peer reviewed, Oral)
11. **Masters WA**, Spielman K, **Heneveld KM**, Theys NC, Coates J. Level and variation of diet quality in rural Ethiopia: Does consumption smoothing maintain household dietary diversity during lean seasons? Agricultural and Applied Economics Association, Chicago, IL. (Peer reviewed, Oral)
12. **Masters W and Shively G.** Introduction to Economics for Agri-Health researchers. Learning Lab at the 5th Annual Scientific Symposium, Kathmandu Nepal (Invited)
13. **Masters W, Ghosh S** and Bell W. Indicators of malnutrition and food security. Learning Lab at the 5th Annual Scientific Symposium Kathmandu Nepal (Invited)
14. Kadiyala S and **Masters W**. Innovative methods and metrics for agriculture and nutrition (IMMANA). Learning Lab at the 5th Annual Scientific Symposium, Kathmandu Nepal (Invited)
15. **Shrestha B and Amatya A.** Lightning session: analysis framework for social determinants and their influence on food intake by women. Learning Lab at the 5th Annual Scientific Symposium, Kathmandu, Nepal (Invited)
16. **Ghosh S.,** Strutt N., Otoo GE., Suri D.J., Addison J.C., Chui K., Tano-Debrah K., and Uauy R. Effect of a macro and micronutrient fortified complementary food supplement (KokoPlus) on linear growth of children 18 months of age in Ghana. Experimental Biology 2017, Chicago IL, April 2017 (Peer reviewed, Oral)
17. **Ghosh S.** Role of protein and amino acids in IYCN and relationship to growth. Hidden Hunger Conference, Stuttgart, Germany, March 2017 (Invited)

Publications

1. **Shively G**. 2016. *Infrastructure mitigates the sensitivity of child growth to local agriculture and rainfall in Nepal and Uganda.* Proceedings of the National Academy of Sciences of the United States. doi:10.1073/pnas.15244821l4 (Peer reviewed)
2. **Omiat G, Shively G**. 2017. Charting the cost of nutritionally-adequate diets in Uganda, 2000-2011. African Journal of Food, Agriculture, Nutrition and Development 17(1): 11571-11591. doi:10.18697/ajfand.77.16340 (Peer reviewed)
3. **Masters W,** Nene M, Bell W. 2016. Nutrient composition of premixed and packaged complementary foods for sale in low- and middle- income countries: Lack of standards threatens infant growth. Maternal & Child Nutrition e12421. Doi:10.1111/mcn.12421
4. **Thapa G, Shively G**. 2017. Child nutrition and local food prices in Nepal. Nepalese Journal of Agricultural Economics, volume 3. (Peer reviewed)
5. **Mulmi P, Block S, Shively G, Masters W**; 2016; *Climatic conditions and child height: Sex-specific vulnerability and the protective effects of sanitation and food markets in Nepal;* Economics & Human Biology, 23: 63-75, doi:10.1016/j.ehb.2016.07.002 (Peer reviewed)
6. **Masters WA**, Hall A, EM, Shi P, Singh G, et al; 2016; *The nutrition transition and agricultural transformation: a Preston curve approach*; Agricultural Economics 47 (2016) supplement 97–114, doi: 10.1111/agec.12303 (Peer reviewed)
7. Darrouzet-Nardi AF, **Masters WA**; 2017; *Nutrition Smoothing: Can Proximity to Towns and Cities Protect Rural Children against Seasonal Variation in Agroclimatic Conditions at Birth?* PLoS ONE 12(1): e0168759. doi:10.1371/journal.pone.0168759 (Peer reviewed)
8. Sharma R, Gaffey MF, Alderman H, Bassani DG, Bogard K... **Webb P**, et al. 2017. *Prioritizing research for integrated implementation of early childhood development and maternal, newborn, child and adolescent health and nutrition platforms.* Journal of Global Health. (Peer reviewed)
9. **Shively G, Thapa G**; 2016; *Markets, transportation infrastructure and food prices in Nepal*; American Journal of Agriculture, doi: 10.1093/ajae/aaw086 (Peer reviewed)
10. Sharma R, Gaffey MF, Alderman H, Bassani DG, Bogard K... **Webb P**, et al. 2017. *Prioritizing research for integrated implementation of early childhood development and maternal, newborn, child and adolescent health and nutrition platforms.* Journal of Global Health. doi: 0.7189/jogh.07.011002 (Peer reviewed)
11. **Harding KL**, Aguayo VM, **Namirembe G, Webb P. 2017**. *Determinants of anemia among women and children in Nepal and Pakistan: An analysis of recent national survey data.* Maternal & Child Nutrition 2017; e12478. DOI: 10.1111/mcn.12478 (Peer reviewed).

f) Impact on Nutrition of Specific Behavior Change Communication (BCC) Layered over a Livestock Training Intervention

i) This activity is implemented by Heifer and focuses on answering the question: "*What is the value-added for nutrition of BCC beyond enhanced agricultural practices associated with livestock management?*" Initiated in FY 2014, it investigates child nutrition in communities randomized to receive one of three interventions: 1) Heifer/Nepal's community development activities and livestock training, supplemented by specific training (BCC) in child nutrition; 2) livestock training and BCC alone; or 3) no activities (control). A baseline survey was undertaken in mid-

2013. A total of 960 households were enrolled in the study across the three arms, including roughly 1,300 children. A fourth round of panel data collection took place in 2016.

ii) *Location: Banke district in Nepal*

iii) *Collaborators:* Heifer/Nepal, Nepal Agricultural Research Council, Nepal Technical Advisory Group, Tufts University and Valley Research Group

iv) *Achievements*: Data collection for this activity has been completed. Several oral and poster presentations have been given during this fiscal year. Data analysis is ongoing, so there are no specific results to report.

v) *Capacity building*: a) Heifer/Nepal's office and field staff, as well as the Valley Research Group team, received training in Ethics of Human Subjects Research prior to each round of field work; b) Heifer/Nepal and Valley Research Group teams received mentoring in conduct of longitudinal research; c) Heifer/Nepal and Valley Research Group teams received mentoring in statistical methods; and d) Nepali dieticians were mentored in developing training curricula.

vi) *Lessons learned*: Studies such as these, in remote regions of low-income countries, require flexibility. Unforeseen events, like natural disasters, caused significant delays. Nevertheless, the study has not been compromised; 4 rounds of data are in-hand and follow-up rounds are planned.

vii) *Presentations and Publications:*
Presentations

1. **Thorne-Lyman A**. Herding Livestock Programs towards nutrition. November 2016, Center for Strategic and International Studies (Washington DC). (Invited)
2. **Miller LC**, Joshi N, Lohani M, Rogers BL, Mahato S, Neupane S, **Neupane S, Ghosh S** and **Webb P.** Improvements in child growth and diet quality after a holistic community development intervention than after nutrition training alone. Oral presentation at 5th Annual Nutrition Innovation Lab Symposium, Kathmandu, July 2017 (Peer reviewed, Oral).
3. **Thorne-Lyman AL, Shrestha M, Fawzi WW, Joshi N, Lohani M, Rogers BL, Mahato S, Strand T, Kvestad I, Hysing M and Miller LC.** Animal source food consumption during early childhood is associated with reduced risk of poorer child development outcomes in rural Nepal. Poster presentation at 5th Annual Nutrition Innovation Lab Symposium, Kathmandu, July 2017 (Peer reviewed, Poster).

g) Livestock Programs in Nepal: Effects on Health and Nutrition 4 Years Post-Intervention

i) *How do interventions framed around animal use and women's empowerment: a) enhance child dietary quality overall (through consumption and/or increased income); and b) animal source food consumption specifically? How long does it take for such effects to be measurable?* Led by Heifer/Nepal and the Nepali Technical Assistance Group, this study represents a follow-up survey of a group of 415 households previously enrolled in a two-year randomized control trial which ran from 2009 through 2011. The households reside in communities, which were randomly assigned to participate in a livestock-centered community level intervention or to be

controls (the communities are in Districts Nawalparasi, Chitwan and Nuwakot). The Nutrition Lab supported additional rounds of data collection in FY 2013 and FY 2014, focused on impacts on child nutrition and health, diets and incomes several years post-intervention.

ii) *Location:* Nawalparasi, Chitwan and Nuwakot

iii) *Collaborators:* Heifer/Nepal, Nepal Agricultural Research Council, NTAG, Harvard University and Tufts University

iv) *Achievements*: The implementation of an RCT in Nepal despite the effects of natural disasters and political unrest has been challenging but ultimately rewarding. Two papers have now been published from this work, with several more in preparation. The findings tend to confirm that interventions that include livestock promotion within a package of other benefits that include behavior change communication can demonstrate important benefits for health and nutrition. These take time to manifest, however, so outcomes should be assessed against duration of exposure to program activities. A minimum of 4 years of engagement is likely to be necessary for effective changes in diets and on child nutrition outcomes. This has implications for the design (duration) of integrated program elements of USAID-funded Feed the Future activities.

v) *Capacity building*: a) Tufts has supported the analytical work of Heifer/Nepal and NTAG, taking the methodological approaches used to a higher level than had been originally planned; b) Heifer/Nepal mentored NTAG staff in the conduct of longitudinal research project over four years; c) important research skills were developed for key staff at Heifer/Nepal office as well as among field staff; and, d) Heifer/Nepal staff and NTAG staff received training in Ethics of Human Subjects Research.

vi) *Lessons learned*: A single, well-designed study has the potential to address multiple questions which go beyond the one specific research question posed in an RCT. Impacts of community-level interventions can take more than two years to be measurable.

vii) *Presentations and Publications:*
Presentations
1. Darrouzet-Nardi AF, **Miller LC,** Joshi N, Mahato SN, Lohani M, Rogers BL. A livestock-based community development intervention contributes to more equitable intra-household allocation of foods for children in rural Nepal. Poster presentation at 5th Annual Nutrition Innovation Lab Symposium, Kathmandu, July 2017 (Peer reviewed).

Publications
1. Darrouzet-Nardi AF, **Miller LC**, Joshi N, Lohani M, Rogers BL, Singh P, Mahato S. 2016. *Child dietary quality in rural Nepal: Effectiveness of a community-level development intervention.* Food Policy 61:185–197. (Peer reviewed)

h) Frontline Worker (FLW) study

i) *What are the perceptions of FLWs of priority nutrition problems, solutions and worker capacities?*
This study represents an in-depth assessment of the knowledge, attitudes and practices of the

network of individuals who work in different sectors at Village Development Committee (VDC) and ward level–interacting with households. The study is linked to front line worker survey conducted in late 2015 to determine the effectiveness of the USAID's *Suaahara Project's* approach to building the knowledge and skills of the FLWs, with a view to disseminating key program messages to the community. The latter study was conducted only in a sample of *Suaahara* sites; the present survey adopted the instruments used and applied them to PoSHAN sites surveyed in 2015, plus the five "expansion" districts where *Suaahara* began to operate from 2015 onward. The data will be compared with those collected by Suaahara, with a joint publication in view.

ii) *Location:* 13 districts; Jumla, Arghakhanchi, Doti, Dadeldhura, Baitadi, Achham, Banke, Nawalparasi, Morang, Saptari, Dhanusa, Sarlahi and Bara

iii) *Collaborators:* Save the Children, IFPRI, Patan Academy of Health Sciences, Hellen Keller International, Valley Research Group and Tufts University.

iv) *Achievements*: Data collection was completed in most of the intended sites, despite the logistical challenges posed by the April 2015 earthquake. Preliminary descriptive analyses have shown most FLWs in the surveyed districts received trainings within their own sectors, but were less likely to have trainings across sectors. Awareness of longer-term consequences of malnutrition and benefits of acting early within the first 1000 days of child's life was evident. There were, however, gaps in knowledge around potential benefits of nutrition-sensitive' actions. Further discussion on potential collaboration between Nutrition Innovation Lab FLW study and Suaahara program FLW study took place during the fiscal year. Analyses and papers have been subsequently discussed and planned for the FY 2018. No results to report at this time.

v) *Capacity building*: Engagement with key staff of the Suaahara Project on the design of a FLW study and discussions on joint analysis and writing, have supported advances in scientific understanding among Suaahara collaborators.

vi) *Lessons learned*: There is considerable scope to use the research platform established in Nepal by the Nutrition Innovation Lab-Asia for linking with other partners and adding additional (relevant) questions to the research agenda.

vii) *Presentations and Publications:* In progress.

i) Action Against Malnutrition through Agriculture (AAMA)

i) Description: An evaluation of the sustained activities of a combined home garden, poultry, and nutrition education intervention in Kailali, Baitadi, and Bajura districts of far western Nepal. The AAMA program was carried out from 2009 through 2012 with the period of implementation being the longest in Kailali followed by Baitadi and Bajura districts. All three districts were exposed to at least one program that included elements of homestead food gardening. The study collected qualitative data using focus group discussions and in-depth interview methods from a total of 114 AAMA program implementers and beneficiaries across three intervention districts of Nepal. The Nutrition Innovation Lab AAMA evaluation study rolled out in January

2017 and was completed in February 2017.

ii) Location: 3 Districts; Kailali, Baitadi, and Bajhang

iii) Collaborators: Government of Nepal Ministry of Health Child Health Division, Tribhuvan University Institute of Medicine, Patan Academy of Health Sciences, Helen Keller International Nepal, Valley Research Group and Tufts University

iv) Achievements: The qualitative arm of the study was successfully completed by February 2017 as planned. A total of 19 focus groups and 9 in-depth interviews were conducted over a month's time that covered 114 AAMA program implementers and beneficiaries. Data translations and transcription was completed in July 2017.

Preliminary findings suggest that AAMA was implemented in very different ways in each of the 3 districts targeted. Some locations had very intensive and extended interaction with participating households, while others had much less. The former tended to happen where multiple inputs were provided, model farmers were already well trained, and some of the model farmers were also female health volunteers (and hence had a status and trust in the community before AAMA arrived). In other cases, model farmers and health volunteers were different individuals, and they interacted very little. These differences will have important implications for the design of survey instruments in a planned quantitative follow-up in FY 2018.

i) Capacity Building: In December 2016, 12 personnel were trained that included 1 quality assurance consultant (female), 2 research coordinators (male), enumerators and supervisors (8 males and 1 female).

ii) Lessons Learned: There was a delay in the roll out of the study because of the delay in the issuance of the district entry letter from the Ministry of Health, Child Health Division. However, the new Director and Nutrition Chief at the Child Health Division were very supportive and eventually assisted in issuing the required documentation. Nevertheless, the study was completed on time as planned.

iii) Presentations and Publications: In progress.

j) Bangladesh Aquaculture and Horticulture for Nutrition Study

i) Description: The Nutrition Innovation Lab, collaborating with the Horticulture Innovation Lab, the AquaFish Innovation Lab, and other partners in Bangladesh, is studying the population-level effects of exposure to one or more agricultural interventions (specifically horticulture and aquaculture) and post-harvest technologies on diets and nutrition.

ii) *Location*: 111 unions from three divisions: Dhaka, Barisal and Khulna

iii) *Collaborators*: HKI/Bangladesh, DATA Company, Tufts University, Horticulture Innovation Lab, WorldFish, AquaFish Innovation Lab, Dhaka University, Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING).

iv) *Achievements*: Three rounds of data collection have been completed with the third round completed in May 2017. Data cleaning of rounds 2 and 3 datasets is ongoing. Each round dataset has 3060 male and 3060 female respondents. As part of testing innovative horticulture technologies to improve household food consumption, the Horticulture Innovation Lab has constructed and implemented 36 floating gardens, 4 chimney dryers and 3 Coolbot Coolrooms. Study tools for a qualitative process mapping and quantitative cost effectiveness survey of innovative technologies have been finalized. The research will utilize qualitative and quantitative methods to traces processes starting from the introduction, adoption, and use of each technology in order to determine feasibility and potential for scale up of said technologies.

Early results suggest that the technologies can indeed be cost-effective and feasibly implemented as planned, depending on location (distance to market and local produce prices being determining factors). However, the investment cost of these technologies (start-up costs) remain prohibitive for scaling up. That is, farm-level cost-effectiveness is only possible if the initial capital investments are excluded from the calculus; if the start-up can be covered by development agents, then households can afford to maintain and extend the impact of such technologies. But, households are still too poor to make the initial investments themselves.

More broadly, it is becoming clear that USAID and other donor investments in aquaculture and horticulture development in the Zone of Influence have had significant impacts over time. Those households most engaged in one or both of these activities produce more (of all nutrient-rich foods), sell more, but also consume more and have a higher quality diet in terms of food groups consumed. Value chain development is also happening, with more of the higher-priced (nutrient rich) commodities being sold not at the farmgate, but in more distant markets and towns where higher prices can be had. Analysis of these multi-round data continues.

v) *Capacity Building*: In November 2016, 29 farmers from Lebukhali and Kalapara were trained on Coolbot Coolroom management. Between January-February, 2017, 72 enumerators and phlebotomists were trained on data collection.

vi) *Lessons Learned*: There were delays in implementation of the cool rooms due to lack of electrical connection. A key lesson learned is that often electricity is not available – further, if it is available the supply is low. The study teams have been working with the government officials of the Rural Electricity Board to resolve this issue. In case of the floating gardens, there are clearly issues during the monsoons with torrential rains stagnating the growing media. This was resolved by planting seeds and saplings in small containers under shelters and later transferring them into the floating garden.

vii) *Presentations and Publications*:

Presentations

1. **Ghosh S.** Update presentation to USAID- preliminary findings of Panel 1. January 2017 (Invited)
2. **Gurung S.** Nutrition Innovation Lab and Horticulture Innovation Lab in Bangladesh, HKI Bangladesh Knowledge Sharing Workshop update. February 2017 (Invited)
3. **Gurung S.** Update presentation to USAID (Nutrition Innovation Lab and Horticulture Innovation Lab activities). March 2017 (Invited)
4. **Ghosh S, Gurung S, Shrestha R, Heneveld K, Namirembe G and Webb P.**

Anemia in women of reproductive age, household food insecurity, food consumption and household food production practices in southwestern Bangladesh. Poster presentation at the 5th Annual Scientific Symposium in Nepal, July 2017 (Peer reviewed)

Objective 2: Study Neglected Biological Mechanisms and Pathways

a) Aflacohort Study, Nepal

i) Description: This study considers the impact of mycotoxin exposure (maternal and infant) on birth outcomes and length-for-age. The study also seeks to validate the use of low cost data collection methods (e.g. dried blood spots versus venous blood) for mycotoxin analysis.

ii) Location: Banke district, Nepal

iii) Collaborators: Helen Keller International, Nepal, Patan Academy of Health Sciences, Child Health Division, Ministry of Health, Kanti Hospital, Nepalgunj Medical College

iv) Achievements: As of September 2016, we had completed study recruitment with the last birth occurring in February 2017. A total of 1675 women were followed up with successful visits 2 and 3. Data collection on visits 4, 5 and 6 is still ongoing with a total of 1463, 1354 and 833 women being followed up as of September 2017. Seven hundred eighty five participant households (46.9 %) have successfully completed all study time point visits. In total, only 197 participant households (11.8 % of those enrolled) have ended participation and are no longer part of the study. The data management team conducts frequent data quality checks for consistency and accuracy of the birth cohort data. Regular (weekly) feedback is provided to the field team and errors corrected accordingly. All maternal blood samples have been tested for aflatoxin B1 at the University of Georgia. Findings for the complete sample were presented in January at a national policy seminar and subsequently at two conferences.

Exposure of aflatoxin is widespread (94%) among the pregnant women; the exposure of infants and young children is currently being assessed. In January 2017, the first infant serum samples (1,025 three-month, 372 six-month and 49 twelve-month old infant samples) were shipped to the University of Georgia for aflatoxin analysis. 320 matching dried blood spots were sent along with the serum samples for aflatoxin analysis. The Aflacohort team wrote and submitted 9 abstracts to various outlets: 3 were submitted to the International Congress for Nutrition, 2 were submitted to the Environmental Biology Conference, and 4 were submitted and presented at the 5th Symposium.

Preliminary findings show a positive association between peanut consumption and aflatoxin levels is emerging in this population, particularly in the context of a strong association with seasonality. Highest levels are found in the pre-winter and winter seasons. It has also be possible to demonstrate a statistically significant independent effect of aflatoxin exposure during pregnancy on rates of low birth weight. While more analysis is needed on the full sample and on infant outcomes, these findings show that health and agriculture sectors must work more closely together to raise awareness of the threats posed by aflatoxins in the diet, and to promote best practices in food management decisions.

v) Capacity Building: In October 2016 a new research coordinator, based in Katmandu, was trained on the study protocol. During the fall of 2016, the research team decided the study needed a full-time data manager in order to ensure robust data collection quality. Therefore, a full-time data manager was hired in December 2016. At the same time, a new nurse was hired to replace an outgoing nurse, plus an additional new nurse position was created to address the high blood collection volume. In March 2017, one enumerator was promoted to supervisor and two field guides were promoted to enumerators. Lastly, two new field guides were hired for the remaining duration of the study.

vi) Lessons Learned: There has been some recent turnover of staff during the study. In the fall of 2016 the research team decided the study needed a full-time Data Manager in order to ensure robust data collection quality. Therefore, a full-time Data Manager was hired in December 2016. At the same time, a new nurse was hired to replace an outgoing nurse, plus a new nurse position was created to address the high blood collection volume.

vii) Presentations and Publications:

Presentations

1. **Ghosh S, Andrews-Trevino JY, Davis D, Shrestha R,** Bhattarai A**, Anushree KC, ... Webb P**. 2017. *Factors associated with mid upper arm circumference in pregnant women in Banke, Nepal.* The FASEB Journal 31 (1 Supplement), 960.10-960.10. (Peer reviewed)
2. **Ghosh S, Andrews-Trevino JY, Davis D, Shrestha R**, Bhattarai A, **Anushree KC, ... Webb P.** 2017. *Factors associated with anemia in pregnant women in Banke, Nepal.* The FASEB Journal 31 (1 Supplement), 788.32-788.32. (Peer reviewed)
3. **Andrews-Trevino JY, Ghosh S, Davis D, Shrestha R,** KC A, **Pokharel A,** Paudel M, Dulal B, **Acharya S, Lamichhane A, Shively G,** Paudel, K, **Baral K, Wang JS, Webb P**. Examining the Relationships Among Maternal Exposure to Aflatoxins, Birth Outcomes and Stunting in Nepalese Infants: Protocol for the AflaCohort Birth Cohort Study. 5th Annual Agriculture to Nutrition Scientific Symposium, Kathmandu, Nepal, July 2017 (Peer reviewed)
4. **Andrews-Trevino JY, Ghosh S, Davis D, Shrestha R,** KC A, **Pokharel A,** Paudel M, Dulal B, **Acharya S, Lamichhane A, Shively G, Paudel, K, Baral K, Wang JS, Webb P**. Prevalence of aflatoxin exposure, and factors associated with serum aflatoxin levels, among pregnant women in Banke district of Nepal. 5th Annual Agriculture to Nutrition Scientific Symposium, Kathmandu, Nepal, July 2017 (Peer reviewed)
5. **Lamichhane A, Pokharel A, Acharya S, Shrestha R, Andrews-Trevino JY, Davis D, Paudel K, Baral K, Webb P, Ghosh S**. Reported food restrictions in pregnancy and lactation are associated with ethnicity, education and wealth among pregnant women in Banke district. 5th Annual Agriculture to Nutrition Scientific Symposium, Kathmandu, Nepal, July 2017 (Peer reviewed)
6. **Andrews-Trevino JY, Ghosh S, Rogers BL, Shively G, Davis D, Baral K, Webb P**. Exploring maize and peanut consumption and aflatoxin exposure in pregnant women living in Banke, Nepal. Future of Food and Nutrition Conference, Boston, MA, March 2017 (Peer reviewed)
7. **Ghosh S., Andrews-Trevino JY, Kablan A and Webb P.** Biological mechanisms linking agriculture to nutrition. 5th Scientific Symposium Learning Lab, July 2017 (Peer reviewed).

m) Aflatoxin Levels in Women and Infants: Birth Cohort Study, Uganda

i) *What is the relationship and subsequent impact of aflatoxin exposure on linear growth in a prospective longitudinal study design?* Data from this study are obtained from the birth cohort study, which enrolled 5,044 women in 12 districts since November 2014. The birth cohort study follows pregnant women through 24 months post-partum to assess differences in pregnancy outcomes and child growth in districts targeted by USAID's Community Connector Project (CCP). This will permit an assessment of the potential effects on nutrition of combined CCP activities relating to agriculture, livelihood development, health promotion and market development.

ii) *Collaborators:* Makerere University, University of Georgia and Harvard T. H. Chan School of Public Health

iii) *Achievements:* A total of thirty thousand frozen serum samples were shipped from Kampala to Tufts as of March 2017. Currently, lab technicians are verifying sample tube labels against field spreadsheets. No results to report yet

iv) *Capacity building:* Enumerators and phlebotomists underwent retraining particularly on clinical practices and blood draws. This data is presented in Section VI.

v) *Lessons learned:* The study is ongoing with samples being processed in Boston. Given the large volume of samples collected, one key lesson learned is that this type of study requires larger and longer term staff support. We will examine the takeaways closely and actively take them in account to benefit future projects.

vi) *Presentations and Publications:* None to date

n) Assessment of Environmental Enteropathy in Uganda

i) Nutritional Consequences of Environmental Enteric Dysfunction (EED) in Uganda: This study explores possible risks of exposure to enteropathogens and enterotoxins in undernutrition. The goal is to understand the environmental contributors of EED. Two studies are being undertaken within this study. One study is to examine the EED levels in the birth cohort infants (n=400) and relate it to their growth pattern. Another study will focus on examining levels of EED in pregnant women (n=350) and examine the relation with birth weight of their newborns.

ii) *Location:* Birth cohort study follow up in the districts of Kabale, Kamwenge, Kabarole and Rukungiri and pregnancy study is in the Mukono district, Uganda

iii) Collaborators: Tufts, Makerere University, Harvard TH Chan School of Public Health, Mengo Health Center and Hospital in Kampala, Uganda

iv) Accomplishments: Fourteen enumerators were trained on the proper procedures for conducting lactulose: mannitol tests in the field. In total, 385 lactulose:mannitol tests were successfully conducted in seven sub-counties in Southwest Uganda, The L: M tests involved the administering of a solution containing 5 grams of lactulose and 2 grams of mannitol and a timed

urine collection for a minimum of 4 hours. The urine samples were preserved with drops of thimerosal, aliquoted into 1.5 ml. cryovials, and frozen at a minimum of -20 degrees Celsius prior to analysis. Data on urine volume was collected in order to measure percent lactulose and mannitol recovery in addition to the L: M ratio. Furthermore, a survey on livestock interactions was administered during the course of the L: M test as the literature indicates a possible link between exposure and poor L: M scores. The urine samples were analyzed at Baylor College of Medicine and the data is currently being analyzed.

Using this data, an abstract has been submitted to IUNS 2017 on assessing the relationship between household water quality and EED in young children in Uganda. Building off this study, a follow up study is nearing completion ("Examining the presence of Environmental Enteric Dysfunction (EED) in pregnant women and its association with birth outcomes in Mukono, Uganda") which explored the role of EED in birth outcomes in Mukono, about 20 miles outside of Kampala. Enrollment for this study, which enrolled 258 pregnant women, finished in mid-May 2017. At the time of enrollment, women receive an ultrasound, a blood draw, a hemoglobin check, and a questionnaire. Within a week following enrollment an L: M test is administered by trained enumerators who also worked on the previous EED study. All births are expected to take place by the end of October 2017.

Results from a sub-sample of the 385 children suggest a link between high EED and households which permit livestock (poultry and small ruminants) to wander freely inside human dwellings. In other words, there is a statistically significant association between poor gut function and poor sanitation within the household. This suggests a need for development programs to focus on changing behaviors relating to the living environment in which babies and infants are expected to grow – complementing the USAID-funded SHINE study in Zimbabwe.

v) Capacity building: Fifteen participants were trained to conduct EED and pregnancy study.

vi) Lessons learned: N/A

vii) Presentations and Publications:

1. **Lauer J, Duggan C, Ausman L, Griffiths J, Webb P, Ghosh, S**. Risk factors associated with environmental enteric dysfunction in rural southwestern Uganda. Friedman Fellows Symposium, Chicago, Illinois, April 2017. (Peer reviewed)

o) Food and Security, Maternal Nutritional Security Status and Psychosocial Health Outcomes Among HIV Infected and Uninfected Pregnant Women in Uganda (PRENAPs): East Africa Gulu Cohort, Uganda

i) *Effects of exposure to mycotoxins on the growth of HIV-exposed and unexposed infants:* This study involves secondary analysis of blood samples from a now-concluded study in Gulu.

ii) Location: Gulu district, northern Uganda.

iii) *Collaborators:* Gulu University, Cornell University and Harvard TH Chan School of Public Health.

iv) *Achievements:* The laboratory analyses were completed at the University of Georgia. Barnabas Natamba, the PI in Uganda has also completed the analysis on aflatoxin levels in relation to infant birth weights and growth. Manuscripts are being developed. No results to report yet.

v) *Capacity building*: None

vi) *Lessons learned:* N/A

vii) *Publications and Presentations:*
Publication

1. Widen E, Collins S, Khan H, Biribawa C, Acidri D, Achoko W, Achola H, **Ghosh S**, **Griffiths J**, Young S. 2017. *Food insecurity, but not HIV-infection status, is associated with adverse changes in body composition during lactation in Ugandan women of mixed HIV status;* American Journal of Clinical Nutrition 116.142513v1105/2/361; doi: 10.3945/ ajcn.116.142513 (Peer reviewed).

p) East Africa Associate Award: DELFIA

i) Use of the DELFIA kit for estimating aflatoxin levels in biological samples: This project seeks to develop a sensitive, low-cost evaluation system for aflatoxin detection in blood. The aim is to develop a system using small volumes of blood–obtained by a finger prick, not by venipuncture—enhancing acceptability. The cost per test could theoretically be much less than the current cost of approximately $100-$300 per test using current methods (the DELFIA GTP-binding kit).

ii) Achievements: A large number of assays were conducted over the last year and results are now being reviewed by collaborators in the Medical School's Department of Public Health at Tufts. At the end of March 2017, the ME has requested a report from Medical School detailing the achievements and a final outcome for the DELFIA activity.

v) *Capacity building:* None
vi) *Lessons learned:* N/A
vii) *Publications and Presentations:* None so far.

q) Mozambique Aflatoxin Survey

i) Assessing Aflatoxin levels in Children under five years of age in Nampula province: This project aims to assess the aflatoxin levels in children under five years of age in Nampula province, Mozambique as well as enumerate the association with stunting/height for age in the children. The project is being conducted through buy-in support from the USAID mission in Mozambique.

ii) *Location*: 10 districts in Nampula province

iii*) Collaborators*: Institute of Health (INS), University of Lurio, IITA, ANSA

iv) Achievements: The Nutrition Innovation Lab finalized the concept note and budget for the study and conducted a scoping visit in May 2017. Subsequently the concept note and budget have been approved by the Mission. The protocol and questionnaire tools have been developed

and partnership discussions have commenced with the Institute of Health (INS), IITA and University of Lurio. No results to report yet.

v) *Capacity building:* N/A

vi) *Lessons learned:* N/A

vii) *Publications and Presentations:*
Ghosh S. Assessing the relationship of aflatoxin exposure and stunting in 10 districts of Nampula province, Mozambique. Oral presentation at the USAID Mission, Maputo, Mozambique. May 2017 (Invited)

Objective 3: Household and Community Resilience to Shocks

a) Understanding Household Resilience to Shocks

i) Understanding the Effects of Environmental Shocks in Nepal: PoSHAN Panel Study: The focus of this research is on issues of household risk, price volatility, and environmental and other shocks for agricultural development and program implementation.

ii) Accomplishments: As noted under Objective I, the 4th round included questionnaires that included inquiries about the loss and recovery since the April 2015 earthquake. An analysis of PoSHAN community data was undertaken at Johns Hopkins in collaboration with Tufts, and a paper is being prepared on the impacts of the earthquake (measure in the 2016 round of data collection). In addition, the ME had meetings with Feinstein International Center at Tufts and the Flowminder Company, a data analysis firm, to explore the use of mobile phone data as a proxy indicator for household food insecurity.

In a separate study, the ME has used Round I (2014) and 2 (2015) PoSHAN data, to compare household mobile data information with validated Household Food Insecurity Access Scale (HFIAS). Preliminary results suggest that mobile phone data may have the potential to predict food security when incorporated with additional community level indicators. High phone ownership and usage is strongly correlated with higher household food security, but that relationship is enhanced (statistically) in locations where public sector services (health, agricultural extension, education) are most used. In other words, it appears that the combination of services and individual use of phone-mediated information has a strong effect on food security, independent of income level and home farm production. One abstract has been submitted for the Nepal Symposium. Further analysis will be done using Round 4 (2016) data.

v) *Capacity building:* None

vi) *Lessons learned:* N/A

vii) *Publications and Presentations:*
Presentations
Thorne-Lyman AL, Manohar S, Shrestha B, Neupane S, Nonyane B, ... **Webb P**. 2017. *Nutritional Resilience Following the 2015 Earthquake in Nepal*. The FASEB Journal 31 (Supplement), 639.20-639.20 (Peer reviewed).

Other Project Reports

a) Nutrition capacity development to meet National priorities - Malawi

i) The Nutrition Innovation Lab is collaborating with the partners noted below to develop and implement a postgraduate competency based curriculum in dietetics, a food composition database and identify opportunities to include nutrition into the medical school curriculum. The course design complies with international training standards and will be subject to external review and examination.

ii) *Collaborators:* Lilongwe University of Agriculture and Natural Resources, University of Malawi, College of Medicine, South African Medical Research Council, Food and Nutrition Technical Assistance and the Ministry of Health

iv) Achievements: Supervising Dietitian, Molly Uebele, gave two presentations in February. One presentation was given to the Malawi Ministry of Health informing them of the benefits of the new Dietetics Program to the Malawian Health Care System. The other, also detailing the benefits of dietetics, was a lecture given to the first year nursing students (over 130) at the Kamuzu College of Nursing. Two new staff, a supervising dietitian replacing the current supervisor, and a new clinical coordinator to oversee the medical rotations and spearhead the medical curriculum review activity were hired and trained. The outgoing and incoming dietitians overlapped for one month, which made the transition seamless. A data manager has been trained to work on the food composition project, which is moving ahead as planned. An abstract was submitted to the International Food Data Conference to be held in Argentina in October 2017. At present, there is now a Malawian database with 118 items in it. Currently work is going on for the final testing of the items. Development of a coding system and gathering of recipes is being done over the next quarter.

iv) Capacity building: All three activities mentioned above are capacity-building initiatives.

v) Lessons learned: Our partners' capacity to carry out the full dietetics program is compromised and hence we have needed to fill the labor gaps with additional staff. This requires additional funding and begs the question of sustainability. We have also learned that we need better direct communication to avoid unnecessary delays caused by unanswered questions from our partners. There is a direct impact on activity progress due to poor internet and phone communication.

vi) *Presentations and Publications:* A variety of presentations on all three activities progress have been undertaken at the Mission, Ministries and local partner venues. In addition, regular presentations occur hosted by all ME staff to build faculty and dietitian teaching and clinical nutrition knowledge through live presentations and journal clubs.

Presentations

1. **Uebele M.** Dietetics: Past, Present and Future. Lecture to 1st Year Nursing Students, February 2017 (Invited)
2. **Uebele M**. Improving Health Service Delivery in Malawi: Introducing Dietitians, Informational Lecture on the Dietetics Program, Malawi Ministry of Health, February 2017 (Invited)

b) Research on Causes and Solutions to Address Stunting in Egypt

i) The Nutrition Innovation Lab collaborated with the partners noted below to understand the causes and examine potential solutions to address stunting in Egypt. Activities included an in-depth literature review, analysis of secondary data to examine associations between stunting and explanatory factors including individual, household and community factors and the development of study which would examine the relationship of stunting, overweight and exposure to aflatoxins. Work through FY 2017 included submitting an abstract to Experimental Biology on the findings of the secondary analysis.

ii) *Collaborators:* GOTHI (Ministry of Health), El Zanaty & Associates, University of Georgia.

iii) *Achievements:* Submission of abstract for poster presentation at Experimental Biology

iv) Capacity building: N/A

v) Lessons learned: N/A

vi) *Publications and Presentations:*

Presentations

1. **Ghosh S, Namirembe G, Moaz M, Pokharel A, Marino-Costello E, ... Webb P**. 2017. *Relationship of Stunting and Overweight in Egyptian children under five years of age: Trends and associated risk factors.* The FASEB Journal 31 (1 Supplement), 649.13-649.13. (Peer reviewed, Poster)

VI) Human and Institutional Capacity Development

a) Long term training

Long-term Training: Africa - 2 (2 Male and 0 Female)
Uganda

Name (first, last)	Sex	University	Degree	Major	Program End Date[2] (month/year)	Degree Granted [3] (yes / no)	Home Country
Nassul Kabunga	M	Tufts University	Post-doctoral	Agricultural Economics		Yes	Uganda
George Omiat	M	Purdue University	PhD	Agricultural Economics	12/30/2016	Yes	Uganda

[2] Anticipated graduation date or end of program support
[3] Indicate if program support resulted in a degree

Long-tern training: Asia – 1 (0 male and 1 Female)
Nepal

Name (first, last)	Sex	University	Degree	Major	Program End Date[4] (month/year)	Degree Granted [5] (yes / no)	Home Country
Prajula Mulmi	F	Tufts University	PhD	FPAN	2/11/2017	Yes	Nepal

b) Short term training

Asia: Short-term Training: 887 (463 Male and 424 Female)
India/Nepal

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained M	F	Total
India	BBNC 1/1/2016	Civil	1	2	2
Nepal	AAMA Program Activities	Civil	10	2	12
Nepal	5th Annual Symposium	Government, Civil and Private Sectors	218	212	430
Nepal	Learning Lab Day 1	Government, Civil and Private Sectors	108	101	209
Nepal	Learning Lab Day 2	Government, Civil and Private Sectors	110	100	210
Nepal	IOM training - Overview of Nutritional Assessment Methods	Civil	8	6	14
Nepal	IOM training - Nutritional Analysis and Electronic Data Collection	Civil	8	2	10

[4] Anticipated graduation date or end of program support
[5] Indicate if program support resulted in a degree

Short-term Training: Asia - 285 (193 Male and 92 Female)
Bangladesh

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained M	F	Total
Bangladesh	Farmers training on Coolbot equipped cool storage management (Lebukhali, Patuakhali)	Civil Sector	10	4	14
Bangladesh	Farmers training on Coolbot equipped cool storage management (Kalapara, Patuakhali)	Civil Sector	15	0	15
Bangladesh	Refresher training (CoolBot Beneficiaries)	Civil Sector	9	9	18
Bangladesh	Refresher training (baghar, Gournadi) (Chimney Dryer beneficiaries)	Civil Sector	4	11	15
Bangladesh	Refresher training (Dumki, Shrirampu) (Chimney Dryer beneficiaries)	Civil Sector	12	2	14
Bangladesh	Refresher training (Chimney Dryer beneficiaries)	Civil Sector	15	0	15
Bangladesh	Refresher training (Floating garden beneficiaries)	Civil Sector	50	22	72
Bangladesh	Refresher training (Coolbot beneficiaries)	Civil Sector	40	10	50
Bangladesh	BAHNR 3rd round survey training (DATA Office Dhaka) (Enumerators and Phlebotomists)	Civil Sector	38	34	72

Aflatoxin Award: Asia 127 (11 Male and 116 Female)
Nepal

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained M	F	Total
Nepal	Research Coordinator	Civil Sector	1	0	1
Nepal	Data Manager	Civil Sector	0	1	1
Nepal	Nurses	Civil Sector	0	2	2
Nepal	Refresher Training enumerators/Supervisors	Civil Sector	2	27	29
Nepal	Supervisor Training	Civil Sector	0	1	1
Nepal	Enumerator Training	Civil Sector	0	2	2
Nepal	Field Guide Training	Civil Sector	0	2	2
Nepal	Refresher Training Enumerators/Supervisors	Civil Sector	2	27	29
Nepal	Maternal infant and young child nutrition (MIYCN)Training	Civil Sector	3	27	30
Nepal	Lab Technologist	Civil Sector	1	0	1
Nepal	Refresher Training Enumerators/Supervisors	Civil Sector	2	27	29

Africa: Short-term Training: 118 (69 Male and 49 Female)
India/Uganda

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained M	F	Total
India	BBNC 1/1/2016	Civil Sector	0	2	2
Uganda	Environmental Enteric Dysfunction (EED) and Pregnancy Study	Civil Sector	4	4	8
Uganda	Supervisor Training: How to successfully manage complex field survey activities including field staff, materials and data	Civil Sector	5	1	6
Uganda	Enumerator Training: How to collect household survey data, collect biomarker samples, manage and transmit data using ODK forms loaded on Samsung Tablets	Civil Sector	54	36	90
Uganda	EED and Pregnancy Outcomes study-mid study refresher	Civil Sector	4	3	7
USA	Lab Technicians training	Civil Sector	2	3	5

c) Institutional Capacity Building and Support

i) Support to the Institute of Medicine, Tribhuvan University, Nepal

A Memorandum of Understanding between the Institute of Medicine and the Friedman School was renewed in February 2017. This reflects mutual satisfaction with the range of collaborative efforts over the past 5 years and anticipation of further productive engagement going forward. The ME has been instrumental in helping the IOM to design and launch its MPH specialization in public nutrition. The partners are exploring ways to offer more support to IOM-based faculty in securing resources and teaching for that course. The ME worked closely with IOM to plan the 2017 Scientific Symposium, which was a global event over 5 days, including learning labs (training workshops), which were of immense benefit to Nepali students and faculty alike. Dr. Webb continues to serve on the international editorial board of the Journal of the Institute of Medicine.

ii) Nepal Advanced Research Methods Course

The Nutrition Innovation Lab continues working with the Patan Academy of Health Sciences in the development of an intensive advanced research methods training for Nepali public health and agriculture researchers. Other collaborators include the Institute of Medicine, Harvard University, and St. John's Research Institute (Bangalore).

iii) The 5th Nepal Annual Scientific Symposium

For the first time the Nutrition Innovation Lab partnered with the agriculture, Nutrition & Health (ANH) Academy to co-host the 5th Annual Scientific symposium in July 2017, which was held in conjunction with Academy Week. The ANH Academy Week and the Scientific Symposium are similar in their missions and agendas. The purpose of the symposium is to enhance local capacity to propose, maintain and present high-quality research. The Symposium is organized by Nutrition Innovation Lab partner Johns Hopkins University in collaboration with NARC, Tufts, IOM and Nepalese Technical Advisory Group (NTAG).

iv) Support to Ugandan institutions

In FY 2017, we continued support to different Ugandan institutions. We supported a nutritionist from Mulago Hospital (government-run hospital) and an agricultural engineer from the National Agricultural Research center. We held regular training and retraining of team members/graduate students and staff from Makerere University. Dr. Wamani from the School of Public Health at Makerere University continues to implement the hybrid online course whose development was supported by the Innovation Lab. Our panel survey team members including Dr. Kabunga and Mr. Agaba disseminated data and findings on nutrition and food security at the district level which support future planning at the local level.

VII) Information Dissemination

The Nutrition Innovation Lab focused on several different national and international conferences. All the abstracts and presentations made in FY 2017 are enumerated under each research report. In addition, the ME and partners also utilized all possible opportunities to present findings at different academic conferences and policy events/fora. The Innovation Lab maintained and updated the website and extensively used Twitter for transferring information and new findings.

Presentations:

1. **Ghosh S.** Stunting and Malnutrition in the Developing World (Findings of the Nutrition Innovation lab). Annual Meeting of the Feed the Future Innovation Lab for Livestock systems. University of Florida, March 2017 (Invited Speaker)
2. **Webb P.** Grow more food= Better nutrition? Simmons College, May 2017
3. **Webb P and Ghosh S.** Contributing to the Global Food Security Strategy: Feed the Future Innovation Lab for Nutrition. June 2017. Advancing the Global Food Security Strategy: Insights from three Innovation Labs on food security, gender and nutrition
4. **Webb P and Ghosh S.** New directions in nutrition. June 2017. Advancing the Global Food Security Strategy: Insights from three Innovation Labs on food security, gender and nutrition
5. **Ghosh S.** Gender and Food Security: Innovation Lab findings from Bangladesh, Nepal and Uganda. June 2017. Advancing the Global Food Security Strategy: Insights from three Innovation Labs on food security, gender and nutrition
6. **Webb P.** Ethics Seminar. NHRC, Kathmandu Nepal, July 2017
7. **Webb P.** Understanding Research from the Feed the Future Innovation Lab for Nutrition. Agrilinks Webinar, online, July 2017
8. **Webb P.** Feed the Future: Overview of the Friedman School's role in USAID's research on global agriculture, food and nutrition. Friedman School Seminar series, Boston, MA, September 2017

VIII) Governance of the Nutrition Innovation Lab

The Nutrition Lab interacted with its partners on a monthly basis hosting monthly PI meetings on Skype and WebEx and ensured a quarterly interaction with partners. While the Innovation Lab was not able to host a board meeting (physically), significant discussions were held through the monthly meetings.

IX) Innovation Transfer and Scaling Partnerships

Unlike other Innovations Labs, which focus on generating new varieties of seeds, techniques for pest control or tools for market analyses, the Nutrition Innovation Labs' (Asia and Africa) main intellectual property relates to dissemination of research findings which directly impact policy and program design and the methods of implementing both. The one technology transfer which may represent an important step forward in research in Nepal is the programming and use of electronic tablets for implementing surveys in the field. While this has already been done in the

context of Demographic and Health Surveys, it has not been extensively used in: a) the context of interviews relating to policy processes at all levels of governance; and b) the remotest parts of the country, including the Western Mountains. Documenting the process, cost and time-savings involved in tablet-based data collection will represent an important upgrading of local research capabilities in-country.

X) Environmental Management and Mitigation Plan (EMMP)

As per USAID regulations, an Institutional Environmental Evaluation (IEE) was submitted and approved. Based on the approved IEE conditions, an Environmental Monitoring and Mitigation Plan (EMMP) was developed by the Nutrition Innovation Lab ME. An EMMP format was prepared and shared by the Tufts ME with its partners. The EMMP was formed after reviewing the governing IEE/EA and conditions, which apply to the project were then translated into specific mitigation actions. Monitoring measures, timelines and responsible parties were specified. Institutions responsible include UCDavis' Horticulture Innovation Lab (Bangladesh), Patan Academy of Health Sciences (Nepal), Makerere University (Uganda) and Kohalpur Medical and Teaching Hospital (Nepal).

A review of EMMP monitoring and mitigation activities was conducted and information for each IEE condition was compiled. An Excel file with all country activities with IEE conditions is attached. Also attached are reports and certificates for the Aflatoxin Lab at the University of Georgia.

XI) Open Data Management Plan

In October 2015, the Nutrition Innovation Lab developed its data management plan (DMP), which was approved by the USAID. The Nutrition Innovation Lab will generate a series of diverse data sets which range from longitudinal household panel data, including: agriculture, food security, household consumption and expenditure, water, hygiene, sanitation, water quality, longitudinal individual data on nutrition, diet, health, biomarkers (i.e., serum aflatoxins, micronutrients, gut microbiome, environmental enteropathy) and anthropometry, as well as longitudinal policy level data on nutrition and governance. Institutions, which are responsible and/or involved in this effort, include Tufts University, Johns Hopkins Bloomberg School of Public Health, Harvard TH Chan School of Public Health, Makerere University and Purdue University.

In FY 2016, the Innovation Lab worked with Tufts Technology Services in developing a platform for data sharing (Lab Archives). Currently, the platform hosted by Tufts University allows sharing of data across all the Innovation Lab partner institutions. Per the DMP, data will be also released to public access on this platform. Significant amount of work is still needed particularly on developing the metadata and procedures as well as coding manuals for the different studies (listed in the DMP). However the first panel of PoSHAN Community studies (Johns Hopkins) has been submitted to the USAID DDL and is currently under review. In FY 2017, the Innovation Lab reviewed the DMP and no changes were made to the DMP.

XII) Project Management Activity

The ME, in FY2017, shifted priorities and postponed expansion plans for new activities in additional countries due to approximately $100,000 funding decrease in this last year compared to the budget submitted. Commitments to expand work in Cambodia, Nepal PoSHAN panel, Nepal Nutrition Collaborative, fellowship announcements, and Ugandan Annual Symposium kick-off all were delayed. Researchers were focused this year on dissemination of the preliminary findings from all of the research programs to date with the hopes of obtaining additional funding in the coming year. Even given the decreased funding, the ME continued to support all the ongoing research with at least 35-40% of the funds awarded to partner institutions. ME staffing remained consistent for the last two years. The ME focused then on ensuring that researchers at Tufts and in our partner institutions submitted abstracts to conferences and tried to increase the productivity around publications.

XIII) Other Topics (Impact Assessment, Gender Initiatives)

Not applicable

XIV) Issues and how they are being addressed (Financial, Management, Regulatory)

This year's budget fully supported all existing research however due to budget cuts, we were unable to conduct the activity in Cambodia despite the protocol and survey tools being completely ready for submission to the IRB. We were also unable to support a cross sectional follow up on Travel included multiple trips to Washington, DC made mostly by the Program Director as he was invited by USAID to participate in a number of FTF activities. Most of the effort for the Africa program consisted of sorting out and reconciling survey data and managing the serum samples preparing them for analysis. The ME will seriously consider funding a snapshot investigation of Ugandan children beyond six months of age to take place in the next year as funding permits.

XV) Future Directions

The Innovation Lab is working with the Kansas State University researchers to develop a project in Cambodia that will allow us to leverage some of our resources with theirs and that of the Horticulture Innovation Lab to study the efficiency of integrating crop (horticulture) and livestock (pig) systems in select FTF areas in Cambodia. We are also working with the Post Harvest Loss Innovation Lab on leveraging their activities on aflatoxin assessment in four districts in Nepal with ours. Our Aflacohort activities are likely to be extended (pending support from the Mission) that will allow us to examine the relationship of other mycotoxins to growth in the infants.

Appendix: Three Success stories

Success Story 1: The 5th Annual Scientific Symposium: A Global Event

The Feed the Future Innovation Lab for Nutrition successfully organized the 5th Annual Scientific Symposium entitled **"Agriculture, Nutrition and Health"** in Kathmandu, Nepal from July 9-13, 2017. The symposium was hosted jointly with the Agriculture Nutrition and Health (ANH) Academy, which allowed for more global representation of distinguished researchers, attendees and participants. The symposium focused on national (Nepali) and global issues linked to agriculture food security, health and nutrition. The Honorable Member of the Nepal National Planning Commission, Dr. GB Joshi, inaugurated the symposium.

The five-day event kicked-off with two days of Learning Labs (21 labs), which covered a range of topics from agricultural economics to biological mechanisms linking nutrition and agriculture. The symposium was attended by 430 young researchers, program implementers and students from 86 institutions (24 countries). The conference featured keynote addresses, panel discussions, oral and poster presentations. Experts from Nepal, Uganda, Timor Leste, Bangladesh, Pakistan, England, Ethiopia, India, and the United States presented their research on technology, metrics and methods. A total 59 oral and 68 mini-poster presentation sessions were spread out over two days. Six Innovation Lab PhD students and two graduates presented findings of studies supported by the Innovation Lab. One of the mini-posters highlighting the findings was awarded best poster in this year's symposium.

Several learning labs and panel discussions were organized by the Innovation Lab and Lab researchers actively engaged in the sessions. Drs. William Masters and Gerald Shively organized a session providing an introduction to agricultural economics while Drs. William Masters, Shibani Ghosh and Ms. Winnie Bell presented a session on indicators of malnutrition and food security. In addition, Dr. Ahmed Kablan of the Bureau of Food Security, Drs. Shibani Ghosh and Patrick Webb along with junior researcher and PhD candidate Ms. Johanna Andrews-Trevino organized a learning lab on food safety and biological mechanisms linking agriculture to nutrition. Emphasis was placed on highlighting the importance of publishing in a panel discussion by Drs. Keith West, William Masters, Andrew Thorne-Lyman and Gerald Shively while Ms. Swetha Manohar, PhD candidate and research associate from Johns Hopkins facilitated a panel discussion of early researchers and the potential for inter- disciplinary approaches.

Significant emphasis was placed on ensuring that symposium highlights were shared on Twitter and other forms of social media. All oral presentations were recorded so as to be available for viewing by academics and researchers that were unable to attend. The symposium was prominently highlighted on the UN SCN website. The success of the symposium would not have been possible without the engagement of our in-country symposium partners who took on significantly more responsibility in engaging local policy makers, government representatives and students and successfully organized a learning lab session on social determinants and their influence on food intake by women. Where the Nutrition Innovation Lab once led the way, local partners are gradually taking over leadership thus fulfilling a key aim of the Feed the Future initiative, that is to build lasting capacity in the area of nutrition and agriculture.

Figure 1: Participants of the symposium

Figure 2: Nutrition Innovation Lab PIs from Tufts University, Johns Hopkins and Purdue with Institute of Medicine, Nepal

Photo Credits: Johns Hopkins and Robin Shrestha

Success Story 2: AflaCohort Birth Cohort Study- Nepal

The Feed the Future Innovation Lab for Nutrition launched the AflaCohort study in December 2015. The study which runs through 2018, aims to gain a better understanding of the relationship between past and current aflatoxin exposure (maternal and infant), birth outcomes and length-for-age in Nepali infants and young children. It also seeks to validate the use of low cost data collection methods (e.g. dried blood spots versus venous blood samples) for aflatoxin analysis. It is being conducted in 17 sites in Banke district, Nepal.

Tufts University's Friedman School of Nutrition Science and Policy leads the study in collaboration with the Patan Academy of Health Sciences, Helen Keller International, Purdue University, Nepalgunj Medical College and the Government of Nepal. The study is generously supported by the United States Agency for International Development, Bureau of Food Security and USAID Mission in Nepal.


Photo Credit: Aflacohort study team and Johanna Andrews-Trevino

This unique study follows women through their pregnancy and their infants through 12 months of age. It collects anthropometric measurements every 3 months thus providing a valuable resource to understand growth patterns. Unique and sensitive measures being collected include infant birth weight collected within 72 hours of birth and recumbent birth length, knee heel length and head circumference.

Data collection includes drawing a venous blood sample from mothers and their infants. Study nurses trained locally have successfully collected samples from 99% of the pregnant women, and 85% of participating 3 and 6 month olds. About 94% of the maternal samples had detectable aflatoxin and analyses indicate that there is no difference in exposure by site, socio-economic status, education and other factors thus implying universal contamination. Seasonal variation may play a role with the highest levels seen in the winter months. Analysis is also showing an association between maternal aflatoxin and low birth weight prevalence.

While the study is ongoing, researchers involved have started dissemination at the national level in Nepal as well as in global conferences. Findings related to dietary source of aflatoxin and related agricultural prevention and control practices were presented at the Future of Food and Nutrition Conference in Boston and Experimentation Biology Conference in Chicago, respectively. Preliminary multivariate findings on dietary determinants of maternal aflatoxin levels and the association between maternal aflatoxin levels and low birth weight were presented at the 5th Annual FTF Innovation Lab for Nutrition Scientific Symposium in Kathmandu, Nepal in July 2017.

During the symposium Johanna Andrews Trevino, a PhD Candidate and Assistant Researcher at the Innovation Lab presented a methodology poster, which was selected as runner-up for the Best Poster Prize. Three posters, on anemia, on maternal nutritional status and food restrictions during pregnancy and lactation were also presented. The Innovation lab will present two posters at the upcoming IUNS 21st ICN International Congress of Nutrition in Buenos Aires, Argentina in October 2017, one on maternal aflatoxin levels and low birth weight and another on validity of different measures for estimating gestational age.

Success Story 3: Investigating the Causes and Consequences of Environmental Enteric Dysfunction (EED) in Uganda

In 2016-2017, the Feed the Future Innovation Lab for Nutrition conducted two studies on environmental enteric dysfunction (EED) in Uganda. EED is a subclinical disorder of the small intestine that is likely the result of living in poor water, hygiene and sanitation (WASH) conditions and is significant due to its postulated association with poor growth outcomes, particularly stunting in young children. As environmental enteric dysfunction (EED) is highly prevalent in developing countries like Uganda, having a clear understanding of its causes and consequences is vital.

The first study, a cross-sectional, cohort study, examined the environmental causes and nutritional consequences of EED in southwestern Uganda using a population of children (n=385) from the Uganda Birth Cohort Study. Children between 12 and 16 months of age were enrolled from seven sub-counties in the southwest of the country. Intestinal health or severity/extent of EED was assessed in the study using the lactulose: mannitol (L:M) dual sugar absorption test. This test is able to evaluate both the absorptive capacity and permeability of the intestine. Using background data and anthropometry collected in the Uganda Birth Cohort study, we were able to determine several key WASH-related risk factors for EED as well as draw conclusions about EED's association with growth outcomes. Some of these results will be presented by PhD candidate, Jacqueline Lauer at the IUNS in Buenos Aires, Argentina in October 2017.

The second study, a prospective cohort study, examined environmental enteric dysfunction (EED) in pregnant women and its association with negative birth outcomes in their children, including low birth weight, low birth length, and premature delivery. Two hundred and forty seven pregnant women living in Mukono District in the Central Region of Uganda were enrolled in the study and administered an L:M test. In addition to the L:M test, the study is also unique in that it will examine the potential for new markers of EED that are likely to be sensitive- including serum anti flagellin and serum lipopolysaccharide. The study will also aim to assess the aflatoxin levels and examine the relationship of EED, aflatoxin and poor birth outcomes. The study is current ongoing with data collection being completed by the end of October 2017. To our knowledge, this is the first study to examine this association and our results will hopefully pave the way for future studies in this area.

Photo Credit: Jacqueline Lauer