



Linking Agriculture, Nutrition, and Health: Updates from the Feed the Future Nutrition Innovation Labs

Presentation Transcript

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Jeffrey Griffiths, Tufts University
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Zachary Baquet:

Welcome everyone. Good afternoon. My name is Zachary Baquet. I'm the Knowledge Management Specialist for the Bureau for Food Security. Thank you for joining us today as we're talking about linking AG Nutrition and Health updates from the Feed the Future Nutrition and Innovation Labs. It's my pleasure to MC this today. We're going to start out just with some orders of business. Please put cell phones on mute or vibrate so that we're not interrupting.

We have some people joining us on a phone line. If you're on that phone line please mute your line. Also please save – Slightly different from our AG Sector Council format we're going to allow for two clarifying questions for the particular speaker after their presentations. And then at the end we'll also have a broader Q&A. And we're going to alternate between in person and online for that as well. So please save your clarifying questions for those. If you have broader questions save them until the end.

And also when asking a question please identify yourself and your organization before asking a question. And for those of you online I think the last one was about 25 people who are joining us today online. Forty-three? Okay that jumped really quickly. Welcome and also when you're asking your question please state where you're joining us from. That's always good to hear. This presentation is also sponsored by the USAID's Bureau for Food Security. And we're also getting help from IRG/Engility who is providing technical services and bringing you the webinar today.

So with that I'm going to pass it over to Rob Bertram, Director of the Office of Agricultural Research and Policy for the Bureau for Food Security. Rob?

Rob Bertram:

Thank you Zachary. Wow I have to say flipping around on – what is today? August 6th? – and seeing a full house crowd in a seminar in Washington at this time of year really tells you just how much interest there is. It's great. I see a lot of faces that are involved. Some people I know who have been involved in this area for years and some who are involved now. I think it's all a signal of how much the community is embracing what was the core of Feed the Future when we started out – this idea that nutrition and agriculture have to come together to get the kinds of human well-being impacts that we're looking for from all our investments.

This is real testimony to that. Thank you all for coming. We have a great lineup in Maura Mack who is the manager of the Nutrition

Innovation Labs is going to introduce our speakers. But I just wanted to say that the Innovation Lab, led by Tufts in partnership with Perdue, Emory, Johns Hopkins, and Harvard is quite a – DAI – right. It's a great team but we're very grateful for the leadership that Tufts is providing. The other point that I think is emerging; this Innovation Lab was formerly a CRSP that was designed to focus on just two countries originally.

Partly because we really wanted to do the deep dive, have enough resources to really get into the details of what it would take to get the kinds of outcomes we're interested from our agriculture investments. But now, given how important this topic is across all our focused countries and beyond, we're dealing with the very good kind of problem, which is how to respond to this groundswell of interest from our missions overseas because everybody really wants the insights and value that your programs are bringing. We'll be thinking about how to do that going forward. And we look forward to doing that with you.

Let me turn it over now to Maura to say a bit more about our speakers. We look forward to their presentations and the discussion that ensues. Thanks.

Maura Mack:

Good afternoon. My name is Maura Mack. I'm Nutrition Advisor with the Office of Agricultural Research and Policy in the Bureau for Food Security. Welcome and thanks to all of you who are here today participating with us. It is my honor to introduce our distinguished colleagues and speakers. First Patrick Webb, Director of the Nutrition Innovation Lab – Asia and Dean for Academic Affairs in the Friedman School of Nutrition Science and Policy at Tufts University.

Next Eileen Kennedy, Co-Principal Investigator with the Nutrition Innovation Labs – Africa and Asia, and Professor in the Friedman School at Tufts University. Shibani Ghosh, Associate Director of the Nutrition Innovation Labs – African and Asia, Adjunct Assistant Professor in the Friedman School at Tufts and also Senior Scientist with the International Nutrition Foundation.

Jeff Griffiths, Director of the Nutrition Innovation Lab – Africa and Professor of Public Health, Professor of Medicine, and Director of Global Health in the Department of Public Health and Community Medicine at Tufts University. And Gerry Shively, Professor, and Associate Head of the Department of Agriculture Economics at Purdue University. Purdue is one of the core US-based collaborators with the Nutrition Innovation Labs.

A special thanks to our speakers for being with us here today. Now I'd like to turn the program over to Patrick.

Patrick Webb:

Great. Thank you Maura. Thank you Rob and everyone for being here. Apologies; I have a sore throat so if you can't hear please let me know. You probably all know what speed dating is as a concept. You're introduced to someone briefly. They share a few ideas, see if there's any chemistry, take a few notes, and then move on to the next one. Well this morning you're going to have some intellectual speed dating, exposed to a bunch of ideas, maybe see if there's some chemistry, maybe engage with some of those ideas, and then move on.

There's a lot of material we're going to be sharing, a mix of plans as well as preliminary findings. And really just a sprinkle of the wide range of issues that we're trying to address under Feed the Future with the Nutrition Innovation Lab. Just a brief, brief overview: we're halfway through the first phase. The focus is on delivery, science, trying to understand policy and programming realities on the ground. How do we better connect agriculture and nutrition?

A lot of human and institutional capacity building, and importantly an ability to serve as a platform to link a network with other innovation labs and other researchers around the world on a range of different issues. It is as Rob said focused on the core issues. How do we demonstrate empirically the best way forward in terms of policy and program design and implementation to achieve the goals of nutrition by leveraging agriculture? The evidence there is weak. It's partial. Everyone has an understanding of the various seven pathways that people have been proposing for achieving this.

But a lot of these pathways, as you'll hear from Dr. Kennedy, are still conceptual and often empirically underpinned. And we need to do a better job of populating those pathways. You'll hear from Dr. Kennedy on a lot of the theory linking agriculture to nutrition. You'll hear from Dr. Ghosh on some of the new findings around nutrients – specific nutrient contributions to nutrition outcomes. I'm going to very briefly talk a little bit about some of the policy drivers or the implementation drivers.

You'll hear from Dr. Shively around some of the more macro levels; some of the opportunities that exist for linking primary _____ data collection with secondary data analysis. And from Dr. Griffiths on emerging and cutting edge domains that are

downstream in our understanding of agriculture, nutrition, and health linkages. And I'm going to skip through a bunch of slides to make sure this works. Now I'm going to focus quickly now on the process issues. Why? Because there's very little evidence.

There's a lot of talk, a lot of demand for how do we do this better? What is it – not just in a program design or a policy design? How do some things work better than others? And it's hard. There's very little empirical evidence relating to the implementation of delivery science, partly because decisions are complex and _____ involve lots of players, lots of actors. Now just to frame this – I follow this very useful blog from the World Bank.

In July there was a blog about how do you pick the right respondents in a household to answer a particular survey question? And they were focused on a study in Tanzania that actually demonstrated that who responds to certain questions within a household ends up with actually often quite different, sometimes competing responses. And I can see lots of nodding heads. It's actually quite obvious when you think about because people have different experiences even within the same household, different realms of responsibility.

I was involved in some work in Bangladesh some years ago. When you talked about personal things it was easy enough to parse out what men said, what women said in the same household. But when you talk about family – household level activities – there were lots of areas of discordance, which meant that the man said yes and the woman said no, or the man said no and the woman said yes. And this is just at a household level relating to domains of food security and nutrition outcomes.

Interestingly if the household was very food insecure the level of concordance was higher, let's say, than medium and high food secure households. It was actually a U-shaped curve, but let's not get too much into the details. The bottom line here is that it matters who you ask certain questions in food security. Now take that as an analogy to institutions and whole government. Then who do you ask about implementation of policy and process?

This is a diagram from **Bhutta** for Pakistan, and obviously from federal levels and through districts down to the field level service providers, there are countless agents, countless Ministries, countless individuals, as well as institutions engaged in multisectoral policy implementation and multisectoral program design and implementation. How do we find out what works and

what doesn't work? Can we figure out many of the theoretical pathways to failure? There's plenty of theoretical constructs about what works or what doesn't work relating to structures and lack of coordination and human resources and capacity and so on.

But how do you empirically populate these theories and figure out is a determinant? It matters because many USAID programs have coordination among actors as a defined goal. This is just one particular program in Nepal. If that is an outcome to be desired then we need some way of trying to encourage that it'll happen. For example in Nepal the research has been framed by these 21 randomly selected study sites covering hills, mountains terrain. In each of these locations there's going to be a range of actors affecting what actually happens on the ground.

And that's going to be the same at all 21 sites. But the actors, their power, their background, their experience, their resource management capabilities, their willingness to understand and coordinate, is going to be different at different places. At the bottom level extension agents, women's health community volunteers, sector coordination across different line Ministries, down at the district and provincial level, across Ministry coordination both across Ministries and other development tangents, and then donor coordination as well as ministerial and body coordination across all of the sites.

The outcomes, household level, individual level, nutrition, agriculture, health outcomes that we'll be assessing in these panel sites over time we can try and figure out are any of the determinants of those outcomes framed by effective coordination and effective implementation of policies and programs in those locations? The question is how? This is a whole new world. This is actually cutting age research in the sense that a lot of process empirically – process work in the past – has been done with very few stakeholder interviews – 22 in Vietnam, several staff members here, 18 respondents, 6 respondents.

These are all the big names _____ [*sounds like Pelatia*] and others, Shiffman, who've been doing this kind of work in the past. It's very insightful, but very limited amount of information. How much is enough? We don't know. What is the sample universe or something like that? We don't really know. But just in Nepal (we'll be doing the same in Uganda and in other countries) we're going to be assessing – we have already collected data at each of those different layers, those different levels, relating to what goes on on the ground in the 21 sites.

We're talking about 700 interviews, not 17 interviews. And the goal is to understand vertical coherence, collaboration, understanding, implementation, capacity, you name it. Vertically does what happened on the ground; can it be related through regression of determinants? And then a common understanding of policy agendas, problems, needs, and constraints and so on. Can you vertically identify what's going on? Horizontal coherence? These are terms used in the latest Lancet Series by the way on enabling governments.

Horizontal coherence: is there coherence across the layers.
Collaboration dynamics: what determines effective collaboration, not just within a program but among program stakeholders and beyond the program? And can these outcomes be used to increase the R^2 if you'd like in understanding the determinants and outcomes right down to the field level? This is an ambitious agenda but it is taking us much further than it has ever gone before in trying to understand the delivery part of delivery science.

It's not a luxury. If we are ever – and we keep saying we want to learn how things happen, not just what happens or why they happen. If we really want to understand how they happen or didn't happen then we've got to go much deeper into understanding individual and institutional roles in allowing those things to happen. We have to understand the real costs. We have to understand when assessing programs, what are the enabling environmental costs that allowed programs to work or not work, that are not typically factored in.

And this requires really paying more attention up stream. We'll be going down stream later, but upstream in the AG to nutrition pathways. The role of individuals in households matter immensely. The role of individuals in institutions and as policy makers matter immensely. So let's try and find out if we can measure that and if we can tease that out as a determinant that will allow us to do better in the future. But this does require us to pay very careful attention to methods – the actual appropriate research methods.

What is the sample frame? What are the analytical tools that allow us to do this? Can we frame experiments at all? This is not something you can randomize? You can't randomize a control of national policy making – or not easily anyway. So we need to figure out what our thresholds of appropriate evidence are and how can findings of this level, this kind of level, be linked into the

things we're more familiar with, which is agricultural productivity, income, poverty reduction, nutritional outcomes, right down at the household level. I'll stop there. *[Applause]*

Zachary Baquet: We're opening it up for clarifying questions for Patrick Webb. Any in person?

Timothy Reuter: I'm Timothy Reuter with the Office of the Deputy Coordinator for Feed the Future. You can decide whether this is a clarification question or something that can be taken on later. But I'd be interested to hear how this fits in with what the Lancet has been doing. We've been hearing a lot of requests from our Civil Society partners to round out the gaps that were in the Lancet studies, which they were very forthcoming about. I'd love to hear how this fills in those gaps and how that might feed into a broader agenda. Thank you.

Patrick Webb: Thanks. Yeah everyone has avidly read the Lancet Series I'm sure. How does it fit in squarely? It's informed by – I was personally and very much involved in the whole Lancet Series and I'm co-author on the paper too. It's designed to be responding to these known gaps. And essentially what the Lancet Series did – It's not magic what they came up with. They have simply framed a consensus position on what do we think collectively are priority questions that need to be addressed? All of the research you're going to hear about response to that express need.

Zachary Baquet: We have clarifying questions? Hold on.

Kathleen Kurz: Good morning. Kathleen Kurz of DAI. Hi Patrick. Just more a clarifying comment that I think the delivery science is really important but I think it should have both qualitative and quantitative. And I think the process notes are particularly amenable to qualitative research which we don't do as much as we do quantitative. So then on the number of interviews, if it's qualitative then its purpose of sampling, and then it's just as many as you need to get no new information. Then it's not usually relevant to talk about how many – You can do it like a sample size calculation.

Patrick Webb: Totally correct. This is designed – The sampling for this was designed in terms of capturing each line Ministry and each organization at each layer that has an explicit role in multisector policy and planning for nutrition. It's not until you get no new answers. It's actually designed to capture a voice from each institutional player at each level. That's how that number plays

out. And of course the numbers are different as you go down. But absolutely your point is taken on that – on the qualitative.

Zachary Baquet: Okay we're going to keep moving and pass it along to our next speaker.

Eileen Kennedy: Let's see if standing here works. Thank you for inviting me. There we go – unraveling the puzzle. And I was talking a little bit earlier to Bobby Van Heffden and what struck me is what's in this next slide. Agriculture and nutrition linkages are not a new concept. Howie Bouis and I worked together on a briefing paper that was used at the International Conference of Nutrition back in 1992. To keep it light a lot of people talked about speed dating, Patrick maybe leads into marriage. But when you talk about agriculture and nutrition it's a marriage of agriculture and nutrition to promote better health.

Twenty plus years later maybe the marriage needs some help. And if you look at the Lancet Series one of the schemas in paper two; there are two broad tracks that are emphasize for optimal fetal and child nutrition and development. One track is the direct nutrition interventions. And the second track is the nutrition sensitive policies and programs. Coincidentally I was in Ethiopia the day after the Lancet Series was release. And some of my meetings were with very senior level people in many Ministries.

But I want to hone in on comments I got from senior officials in the Ministry of Health. I can't say, Patrick, they looked at the whole Lancet Series, but what they did hone in on is numbers. How much is this going to cost? And again this was health. The reaction from some of the suggestions; for example there's evidence of effectiveness of balanced energy, protein supplementation during pregnancy, small for gestational age can be reduced by 34 percent – so all good.

But the dominant reaction was, "We could never spend \$972.00 per pregnant woman per year for this particular strategy." And so we very quickly – and again this was health – got into a discussion of this next track which is nutrition sensitive policies and programs given a lot of visibility by Feed the Future, by scaling up nutrition, and really looking at producing the same effect: improved fetal and child nutrition. Or are there ways of doing it at lower cost through nutrition sensitive development? We will see schemas. This one is Leroy and _____ [*sounds like Fungelo*], endpoint nutritional status.

Patrick already showed the Gillespie one. Again outcomes, child nutrition, maternal nutrition. And the brief that Patrick and I did for Feed the Future came to the conclusion last year that the current state of empirical evidence impacts on nutrition ascribe to agricultural interventions is weak and mixed at best. We can talk about that more. We have been doing key informant interviews in Nepal and Ethiopia. We will be doing some in Uganda. And the recurring theme that keeps coming up is how can agriculture help improve nutrition?

And I'm being asked for specifics; specifics not on pathways; specifics on process and mechanisms. And I'm not being facetious on the title of this slide. For people who are out there trying to implement I can't tell you how many times I've heard no more pathways. What they want is – It doesn't matter if they mind or not. What works? And what are the assumptions in unpacking those links of what works? Now I won't read the slide but basically there's some evidence on Vitamin A impact.

But really we need more rigor in the work we're doing in demonstrating the effects of various kinds of agricultural innovations on nutrition. So when I talk about unpacking nutrition I'm really looking at what are the mechanisms, and biological plausibility. One predictor of improved fetal outcome is birth weight. When you increase birth rate neonatal health improves, mortality goes down, etc. What's crystal clear when you're talking about pregnancy is there's no ambiguity on timeframe.

I think I can say conclusively that either you're pregnant or you're not. Are there other options? Either you're pregnant or you're not and it's generally nine months. So timing is important. What is the process of improving birthrate and dose response: how long during pregnancy? How much of the intervention did you get? As it happens both in Nepal in their multisectoral nutrition plan which was launched September of last year (2012) and Ethiopia which has just revised it's National Nutrition Program there is a very pronounced emphasis on what I call homestead production.

In Nepal, Helen Keller International has been involved in something called Action Against Malnutrition through Agriculture. I was hoping we'd have the 2012 report. It's not out yet. But it's a combination of homestead production plus essential nutrition actions. It's micronutrient rich foods. It's poultry. It's animal source of protein which Shibani will talk a little bit more about and increasing women's income. Then it's combined with behavior

change, again targeted to pregnant women and children under the age of two.

Now this is the kind of (I don't put a particular reference here) sloppy analysis that has gone on. You want to improve birth weight. And the way to do it is increasing maternal weight gain, particularly in underweight women. You don't see an effect of agriculture strategies, whatever they are. So the erroneous conclusion that some people cling to is that agriculture nutrition is ineffective. Now what we are doing in our work is looking at what is a determinant of birth weight?

One of the determinants of birth weight is maternal weight gain. How do you get there? Well you can get there through income, knowledge, diet diversity; and again when you unpackage it means different things. It can be increased calories, increased micronutrient foods, animal protein. What's the evidence? Here's dietary diversity leading to maternal weight gain birth weight. Then you add increased knowledge. And let's look at the 2012 AMMA Helen Keller International work.

And what you find from that report: positives mean that you see a positive effect. So income increases in the homestead production. Income increases leading to dietary diversity. Based on the way they measured knowledge that also increased. That leads to diet diversity. And we see from the data presented effects of diet diversity on caloric intake, animal protein intake, and micronutrient rich foods.

What we don't know is the level of effect of each of those positive. We don't know whether that led to maternal weight gain. And we therefore don't know whether there's any effect on birth weight. With all the caveats of the reviews we've talked about, small sample sizes, and the treatment area I think the number of pregnant women was 12 and the comparison area number of pregnant women was 9. So we're beginning to get some clues. But we need to fill in level of effect.

And when we talk about agriculture improving nutrition is it enough that we're getting an increase in diet diversity. Do you need these other links in the short-term? And what do we know is happening in the longer term? When a woman in this particular intervention goes into a subsequent pregnancy is there long-term effect because of this intervention? For us next steps are we really do need to get beyond statements in the whole nutrition sensitive development that information is lacking.

And a part of what we're doing (this has been going on for the last two years) is agreement on guidelines that are feasible; guidelines for research designs and metrics for complex interventions. We had a workshop this past April which was very well-received. We're not submitting for experimental biology next year (2014) to have a much larger session. We're actually not simply looking at the theoretical but out of our combined country and subnational research looking at what are the plausible mechanisms producing or not some of these effects?

And how does it help us think about modifying policies and programs? Can this marriage be saved? We think so. But we also think it needs a bit of counseling. Thank you. *[Applause]*

Zachary Baquet: We have time for clarifying questions for Eileen Kennedy. Any in person? Any from the online audience? No?

Kitty Cardwell: Eileen I'm Kitty Cardwell, USDA. I just wonder if you're taking into account anti-nutritional factors that come through agriculture – toxins, etc. as part of it?

Eileen Kennedy: Sure and we are going to be hearing about this from Jeff later on. But absolutely.

Kitty Cardwell: *[inaudible comment]*

Eileen Kennedy: Oh no. Yep, absolutely. Are you talking about the pregnancy birth cohort? Yes. *[laughter]* But this was to illustrate one linkage between a) maternal variable and birth outcome. And then you could have schemas that go on for pages and pages. But trying to identify the high potential mechanisms so that we can hone in on that.

Zachary Baquet: Presentations and the like will be up on Agrilinks for those who are interested. We'll go to our next speaker.

Shibani Ghosh: No actually I don't. I'm a little data driven when it comes to – And _____ structured, sorry. I didn't mean it that way. *[laughter]* This is the first time I'm giving a presentation at such a level so excuse me if I make any mistakes. I'm going to talk about a very specific issue and I want to sort of put a disclaimer out here that this is not the only causation or causality or association to stuntings. This is one specific area that the Nutrition Innovation Lab is looking into which is the role of animal source foods and its linkage with linear growth.

In this specific presentation I'm going to be presenting some data on looking specifically at animal source protein. What I'm going to do is look at some analysis that was done at an ecological level and looking at the link between protein quality and standing, then look at some data at what we're seeing in terms of protein sources in Nepal. It's quite interesting. It's very national level data but it's quite startling in the way things have evolved in Nepal. And then we'll look at some very primary data, very preliminary findings around protein sources in Uganda and how it's linking to stunting.

This is the **AGS** to just give you an overview of what's going on in the _____ [*sounds like throme*] and what we plan to do next. For the data sources I've used FAOSTAT through balance sheet data, which is very much at the country level food consumption data that has been collected for weight. We have done an analysis looking at the per capita food availability of 116 commodities in 214 countries and regions over a period of 45 years from 1961 to 2005. So for this presentation I've extracted some data from that analysis and linked to some UNICEF data on prevalence of stunting.

And then we're always looking at specific FAOSTAT data for Nepal and, as I said the baseline for Uganda which is our first panel survey that we conducted from October to December of 2012. I'm using the data on dietary pattern. It's a 24 qualitative recall which is trying to understand the types of foods that are introduced to children – infants actually – that are 6 to 24 months of age and correlated to the anthropometric data that was collected on these kids in terms of weights and heights.

Just before I go into the specific of Nepal and Uganda I just want to share a few findings at the global level. These are basically sources of protein from 2005. And what we have here is the level of animal source foods in these different regions of the world. Oceania tops it and I think this is because (I looked it up) it's primarily Australia that is part of Oceania that has a very high consumption of animal source foods. As you can see as you go down, here's where the world average is, which is about 40 percent.

And Asia and Africa are way down here with Africa being pretty dismal at 20 percent. Now I have a red line here which is essentially some analysis that was done (it's very old and from the 1990's) in which they said, "What combination of animal protein and legume protein would be needed to meet your amino acid needs (which is a measure of quality)?" And they had come up

with a figure of approximately 40 percent. And you can see that even if you were take the yellow, which is the legumes and pulses for Asia and Africa, for Africa you definitely would meet the cut off of 40 percent combined animal source and legume source proteins.

The next thing that we did was we basically converted all the total protein and grams per capita into utilizable protein. This is a measure of protein quality where we collect the total protein value. Let's say you have 65 grams of protein in your diet but only a certain percentage of it comes from high quality protein. We basically do calculations estimating the amino acid levels, estimating the digestibility of the diet, and calculate what is called the utilizable protein.

And what you're seeing is this is going from east in Southern Africa up to North America. And this is for 115 countries. This is sort of a distal version because we needed to regress it with the problems of stunting. And you see that there is an increase in utilizable protein as you have an increase in the animal source foods from the previous slide. And then there's simultaneously a decrease in the prevalence of stunting. This is specifically data that is originating from 2005.

When we did correlation coefficients we looked at the HOOK protein per capita in relation to energy. And of course there are a few who have been in the realm of nutrition; there is a very strong link between energy and protein. So you see the correlation. It's about the same when you look at it from a utilizable protein perspective. And not surprisingly there is a negative correlation with stunting prevalence. So those countries which have higher levels of energy availability have a lower prevalence of stunting.

What is very interesting is that the stunting prevalence is negatively correlated – not only the total protein, but when you correct it the negative correlation increases. The correlation coefficient is higher. So there's something to be said about the quality of the protein that is being consumed. We then did a regression analysis and what you see here – I forgot to put the times in here – this is basically the dependent variable which is whether there was stunting present in the country or not.

This is 115 countries we're looking at. And what you see – obviously – you have a strong interaction with energy. You have an interaction with protein and your _____ protein. Now given the connection between energy and protein as soon as you put

energy and protein together in the model you find that protein becomes insignificant. But as soon as you regress it with actual utilizable protein – so here you have corrected it for the quality – both energy and protein are significant.

This is really pointing out this age old argument that we've had about energy or protein or energy and protein, or all of the above. The message from this very ecological analysis is we really have to start thinking not about total protein but the quality of the protein that is in the diet. I'm going to shift over to Nepal and this is the plot of the types of protein sources. This is total protein in Nepal and you can see it has gone up. As I said earlier it's very interesting that what has gone up is the cereal protein in the diet.

And there's a flat line when it comes to total protein from animal sources and total protein from legume sources. The two types of protein that you would imagine would improve the quality of the diet actually flat lined in Nepal for the past 45 years. By the way it's grams per capita of protein and it's both types of protein. It's less than 10 grams per day. And then we did a comparison of the different food groups and different countries in South Asia. We used Myanmar, Pakistan, Sri Lanka, Bangladesh, India, and Nepal.

And what you can see (and I've just used that 40 percent cut off) and here I managed to put the animals and legumes together. You can see Myanmar is the only country in South Asia in 2005 that was actually able to meet that combined total of 40 percent of total protein coming from animal and legume sources. India and Nepal are very low down there, just about 20 percent – 27 percent – of total protein. This figure – I told you I was going to explain something massive here but what this is showing is 1990 to 2005 there's absolutely been no change in the profile of protein in Nepal.

It's predominantly cereal. It's almost 75 percent of cereal and it's gone down a little bit in 2005 but it's essentially remained the same. That quality of protein is not very good. Now the next step that we'd like to do in Nepal is actually regress this with some of the stunting figures. That's some of the work that is ongoing. We actually don't have the data and results to present right now but that's going to be the next step. But what we do have is primary data on Uganda where we've actually been able to do some of the analysis, the correlations, and associations.

In this slide what I'm presenting is data on 1,300 index children age 6 to 24 months of age whose mothers are primary care givers reported what they had consumed in the past 24 hours. And what

you see here is only 12 percent of kids in any form have consumed some form of animal source food in the past 24 hours of the survey with most of them consuming cow's milk and the maybe some fish and seafood and meat, which includes poultry. Only 12 percent of these kids have actually had some form of high quality protein the day before.

And then we plot the growth pattern of these same kids. This is 1,900 kids because I realized we put in all the breastfeeding all these _____ under six months of age. But what you see is the green is the height for age. These _____ are reflective of the linear growth pattern. And you can see that the kids at three months of age are already starting the 0 Z score which means that they've already started the process of being stunted. And they're actually steadily going down by 24 months of age where they're coming to -2 Z scores.

This is the mean value. You can see the range of kids. Some of them go down to almost -3 which is basically a form of cereal stunting. What we did was we did one of these analysis and we tried to see what different foods. I'm presenting only the animal source foods because those were the ones that could've _____ out to ours. We did it for all the beans and legumes and everything. What we found 1) there was there relationship between being stunting and having consumed milk in the past 24 hours.

And here's basically the graph that we are presenting data by percent of stunting. This is the percent of kids that were stunted in that sample of 1,300. And the much higher percentage of stunted if they've not had cow's milk or white _____. Almost 30 percent of kids who were stunted had not consumed cow's milk and about 20 percent who were stunted had consumed cow's milk. And that different is actually statistically significant. So they were 38 percent less likely to be stunted if they were in this group basically.

And if we do this analysis using these scores we find a very similar and very strong t-test result actually. We did this for meat as well. What was very interesting is we find the same _____ when we used whether the child is stunted or not. And it's almost 50 percent less likelihood of being stunted. But we don't seem to see the difference in _____ scores. We want to keep track of this. We're going to be collecting data in the next panel year to find out what exactly is going on. There might be some noise in this data that is not allowing us to see this.

The other thing that we looked at was to see if the household has livestock. And this is very relevant from the perspective of linking nutrition to agriculture. What we find is there a 13 percent lower risk in poor households if they have livestock of the child being stunted. And this risk reduced incredibly to about 46 percent if it's a norm for a household that has livestock. There is an effect of income that really needs to be explored in this data.

As I said when I started this it's a preliminary analysis and we're continuing to work on it from the perspective of looking at AG production, productivity, and livestock, and its relation to income of these households. I'm just going to quickly skip through this. One of the things that has been talked about in terms of the type of protein or the type of food that is linked to linear growth that is of animal origin is its relationship which is other than providing high quality protein. And in terms of cow's milk basically the idea is that it is factors in cow's milk – other potential bioactive compounds – that could possibly have improved linear growth.

But they're also known to be linked to non-communicable diseases. One of the things that has to be looked at is the serum insulin growth factor levels of these children which is one of the things that we are exploring in Uganda in a cohort study that is going to be undertaken in the next few months. I'm going to skip over this slide and in conclusion say that we really are finding something interesting when it comes to the relationship of quality of protein – not total protein – and linear growth.

And it does really matter what type of protein source one has. Animal source foods are also a highly bioavailable form of micronutrients, not just macronutrients. The takeaway message is not about we need to get everybody animal source protein. But we really need to explore their link of animal source foods itself with linear growth. And from an agricultural perspective understanding what's happening in households where there is livestock production and access and utilization of these livestock products and its relationship to growth and cognition. Thank you very much. *[Applause]*

Zachary Baquet: Do we have clarifying questions for Shibani Ghosh?

Jean Capps: My name is Jean Capps and I am a consultant both in maternal and child health and in nutrition. A couple of question. I think you covered the fact that you did take into account breastfeeding in your Uganda work. I was wondering when you looked at cow's

milk consumption and non-consumption this was children six months to two years of age?

Shibani Ghosh: Correct.

Jean Capps: Okay, unless it's changed cow's milk is not recommended for children under the age of 12 months for reasons other than preventing stunting. I'm sort of leaping ahead to the problematic implications of the study and whether that has changed. Because for other reasons it can introduce allergies to milk and other things that you're not supposed to do – unless it's changes. So that would be one consideration and I was wondering if you looked at that. And did you look at goat's milk?

Shibani Ghosh: Right. With respect to your first question it was 6 to 24 months. It was a 24 hour recall as to what the mother has provided the infant, not as to what we would expect – what we wanted them to provide. That's one thing. I understand the whole cow's milk under 12 months of age but again this is in the situation of Uganda. What you have is basically the household has cows and the cow's milk in the house that has been consumed. So briefly when it comes to the takeaway – *[audio cuts out]*

Female: . . .how long the children had regular access to the cow's milk.

Shibani Ghosh: This is a 24 hour recall. It's a survey.

Jeff Griffiths: Thanks very much. Thank you all for being here and thank you for the kind introductions. What I'd like to talk about today – I've entitled this talk "Why Isn't Food Enough?" And I'm bringing in some things. Now if you want to call this direct nutrition or nutrition sensitive, this may kind of blow those

[0:48:49 to 0:51:59 - audio cuts out]

. . .associations in people with lower birth weight, growth faltering, wasting in children, decreased immunity. There was a publication that came out last week linking aflatoxins to worse immunity in people with HIV. This fungal contamination is extremely widespread. If you look at the globe and you go 26 degrees (that's what people have said in prior times) north or south of the equator then basically any crop you have is very likely to be contaminated with aflatoxins if it's not dried well.

This is some data. There's tons of data about this but I just want to show – This is a paper from _____ *[sounds like Gongadol]* –

and this was from West Africa – showing that as nutritional status in terms of height for age or weight for age got worse that there was a higher level of aflatoxin found in the blood. Now the R^2 on this was 37 percent. That means that 30 percent of the stunting and the low weight for age were attributable to aflatoxins. Remember the Lancet Series talked about 20 percent was nutrition series? This is 37 percent.

This would suggest that that's something we have to pay attention to. I've mentioned that this contamination occurs globally and the aflatoxins gets onto foodstuff in the field itself or after it's harvested it could in fact infect and contaminate something which is being dried. You have to get it down to seven or eight percent moisture for the fungus not to be able to grow on it. These are scary compounds because it turns out they're even found in breast milk. If a mom eats this stuff it's in the breast milk. You can detect aflatoxins in kids who are still on the breast. And therefore it's getting to them because of their mom.

Complementary foods once children are weaned they're frequently contaminated. Most kids get kind of a crappy – excuse me – a poor quality porridge and that will contain aflatoxins often also if it's something with maize or sorghum or something like that. Unfortunately often many of the animal source foods are actually also contaminated with aflatoxins. So in terms of prevention you want it not to get infected in the field and you'd like it also not to grow once it's been harvested. I'm not going to go into detail about that.

And there is a market solution to this in the sense that if people valued crops without aflatoxins then they would pay extra for it and therefore the farmers would be rewarded for it. That's what happens in Europe and that's what happens in the United States. You can play this game where you think about aflatoxins and you start looking at things like this. It turns out when aflatoxins are ingested by people it causes them to have a leaky intestine. I'm going to talk about this more. And you think about how is HIV transmitted after a child is born?

That child has not been infected by a mother, then it's through the breast milk. And if you have a leaking intestine does that mean there's a higher rate of HIV infection? No one's looked at that. But once you start thinking about the aflatoxins issue you can really go all sorts of places with that. Just to follow up on this in terms of leaky intestines and so forth let me talk a little bit about environmental enteropathy. This is a photo I took in Ethiopia last

year. This would be common for many parts of the world where people and their animals have a very intimate living relationship.

They care for their animals and their animals live close to them. And therefore that means that they are going to live in a place where the feces of the animal in the humans may be something which contaminates their environment. Sorry about that. Here's my one pathway. For people who live in a contaminated environment they're going to be eating the fecal contaminates that are there from both animals and humans. This leads to these bacteria living inside of them. And it turns out that you get three things that happen to your intestine.

One is that your gut becomes leaky. There's something called permeability. Bacteria and fecal contents leak into your body because it's leaky and that sets up a state of chronic inflammation around your intestine. This is called environmental enteropathy. Now people have looked at this also and it turns out to be one of the most important predictors of stunting. And in studies that were done in West Africa it predicted 43 percent of the stunting. So we've talked about two things now: 37 percent and 43 percent in those specific locations.

This is a graphic picture of this. These are what your intestine looks like if it's healthy. Think about your fingers and absorbing nutrients. And if you have environmental enteropathy you don't have those fingers sticking up anymore. They are all inflamed. And these little dots you see in this particular pictograph from a pathological specimen are inflammatory cells and they're fighting off the infection. What happens to people is they can't absorb food as well and it looks like they absorb about one percent protein and five percent less of the carbohydrates.

So they have higher nutritional needs. If you live in a contaminated environment you need more to get by as well as someone else and you could understand then how this could lead to stunting. What independent evidence exists that this is a problem globally? Well it turns out people haven't been going around checking people's intestinal permeability, which turns out to be a tough test to do, in studies for the last 30 or 40 years. We don't know that. But Dean Spears did an analysis recently where he looked at sanitation.

And there are DHS surveys from around the world looking at sanitation. And what is interesting about this is because if we're talking about open defecation that means there's more exposure to

feces. So we know the people who have poor sanitation in terms of defecation with feces out there are going to be at one end of the spectrum. And the places without it will be a different one. And when he looked at 140 different surveys from 65 countries it was linked to about 1.25 standard deviations in the height of a child in terms of a Z score.

So this is a huge amount. Remember a child who is normal is usually given a Z score of 0. And a child that is stunted is -2. So 1.25 or one and a quarter of that 2 he could ascribe to living in an area with open defecation. And he came up with an analysis showing it's about 50 percent between country height. This was more important than any other factor that was in there. This is just one of the graphs from his analysis. And this is the difference. This is a place with lots of open defecation. Average height for age score is -2. That's stunted. And over here it's about -1. You can see that there's a huge difference between this.

So there is evidence. And even from a different direction, a different econometric ecological kind of analysis – not the one we usually do with a controlled trial and so forth. But this is important. The third thing that I would point out is that poor populations also have a different spectrum of bacteria living in their intestine. This is because they're living with animals – remember agricultural nutrition and so forth. And these bacteria that live inside your intestine are called the microbiome.

Now in your ideal person it turns out that this person has an ideal BMI and has a really good diverse microbiome. What does the microbiome – all these bacteria in your intestine – do? It turns out they ferment the leftover food inside your intestine and they feed the cells of your intestine. They produce these short-chained fatty acids and some of these amino acids and they feed your intestine. What happens is really interesting. In people with malnutrition; they have a less diverse microbiome.

And they're particular spectrum of bacteria are nasty ones. They have pathogens in them. They have all those salmonella and things like that in them whereas people who are obese as it turns out also have a less diverse microbiome. And just like people who are malnourished; they have a leaky intestine also. It's really very cool that there's this spot like this and then it goes like that. In terms of the studies that we do now we have to worry about what kind of bacteria people have and why they have it and sanitation and how does this affect all this stuff?

And you might say, "Who cares? I understand that your gut gets more inflamed and you need more calories but what other kind of data can you provide that this is something to be paying attention to?" This is a study that was just published in the *Journal of Science* in February. This particular group looked at twins in Malawi. One twin was normal in terms of anthropometrics. And one child was stunted. They gave both kids – 'cause that way they wouldn't have to share – Both kids got this stuff called ready-to-use therapeutic food which is going to make them all better.

Well what turned out was that the kids who were normal, when they got this RUTF their biome matured as you would expect a child's microbiome would do. And that happened over the period of time when they were fed with this stuff as well as afterwards. But in the children who were malnourished they got some temporary improvement while they were on this jazzed up food and then it went back towards this immature type which is not what you want to have in your intestine.

So you might say, "Well that's weird, but so what." Here's the so what. It turns out that when you took those bacteria and you put them into mice who didn't have any bacteria in them to start with – they were germ-free mice. The ones who got the bacteria from the normal kids they're fine. They were happy. But if you put the microbiome from the malnourished kids in the mice they lost a third of their body weight in 18 days. The bacteria in their intestine caused the mice to lose weight.

So when we think about these bacteria these are from malnourished kids. You put them in the mice and the mice go down the tubes. Well those are the bacteria that are living in kids who are malnourished. That's the point. They have bad bacteria living in there and they promote weight loss. This references in the slide set so I'll let you guys go ahead and find that. It's a really interesting study. You have enteropathy because you're exposed to this dirty environment. And then the bacteria themselves are actively causing you to lose weight and not be able to put on the weight and growth that you should have.

Here we have a big picture. I'm not going to call this a pathway. You can figure out which ones are important and which ones are not. But I just want to point out that then in this kind of environmental approach to what we're looking at you can see aflatoxins can contaminate crops and that they then cause injury and stunting. It looks like they cause a leaky, inflamed intestine. Well that turns out to be very similar to what is seen when people

live in an environment where there is bacteria such as salmonella or campylobacter or those kinds of bad things from their animals. That also leads to this leaky, inflamed intestine and environmental enteropathy.

And then let's throw on to that actually an inadequate diet which is bad. And it may have aflatoxins, etc. in it. That's my concluding slide I think. Here are my take home messages. We obviously do need good nutrition but we also need to live in an environment where we don't have environmental toxins like the aflatoxins. We want to live in an environment where we don't coexist with our animals so well that in fact their bacteria live in us. We don't want to have environment enteropathy. But we also want to have a microbiome which does not starve us. We want not to have that.

Now we don't know necessarily how to affect all of these. We know nutrition is important. We need food safety, processing of agricultural products is going to be important. And water and sanitation is going to be very important to this. And on that note, thanks very much. *[Applause]*

Zachary Baquet: Clarifying questions for Jeffrey Griffiths?

Male: That was an incredibly compelling presentation. Sort of the way you showed the impact of what's going on in this area versus what the Lancet is talking about really struck me. I guess this is a clarifying comment which may be a little annoying. But the thing that would really take it to the next level for me is showing me the money. This is something that came out of the Lancet Series where they talked about how much would it cost to do all these things? And I would love to see something similar. How much would it cost to eliminate aflatoxins, or at least significantly reduce it from people's diets, to separate people from the animals?

And I just think the next level of this research that would make it more policy relevant is cost. You can start doing cost benefit analyses and then that would just be so powerful in the way that we encourage governments to invest their monies in these countries and in deciding how we spend our own money. Just a request.

Jeff Griffiths: Well if I can make a comment about your clarifying comment, I think you're right on the money in terms of that. That wasn't an intentional pun. I think one of things is we already have probably some surrogates. We have some idea about what does it cost to introduce hand washing or sanitation or things like that. We have

some idea about what the things would be that would actually be the measures. We also have some data about how much it costs, for example, to store a certain crop in such a way so that it's not going to be having aflatoxins grow on it.

We have some of that – if you want to call it – maybe more proximate information about those pieces. Because one of the things that I hope comes out of this is there are ways to prevent these things from happening by cleaning up your environment or (I'm going to use this term) cleaning up the crops that you eat. If you've got something like that then we already I think have some idea about at least what some of those pieces would be. But I don't think anybody's looked at this in kind of a holistic way to say which one of these should be prioritizing, etc.? We may not have the data for that yet.

Zachary Baquet: Is it from online?

Maura Mack: Yes and first I wanted to mention that we do have 70 participants joining on the webinar.

Zachary Baquet: Wow.

Maura Mack: Quite a lot – very exciting. Mandy Willig from the University of Alabama at Birmingham asked can you improve gut function without first wiping out the gut bacteria in children exposed to aflatoxins.

Jeff Griffiths: We don't know. That would be the bottom line. We don't know the answer to that question but I have to say in response to this particular question people are now wondering if malnourished kids could be given new bacteria. So wipe out what's there and then you give them this or something like that. It's been shown that in obese people if you give them a fecal transplant, e.g. bacteria from normal people, it turns out that their symptoms of diabetes get better. Their insulin resistance goes down and some other things that happen.

So the question is if that works in that direction what would happen if we went the other direction? No one really has an answer about that. This is really brand new science. This stuff is really opening all sorts of questions for us. And it brings up the whole issue also of antibiotic resistance and do we really want to be giving people antibiotics around the world? I don't think that's necessarily the direction we want to go.

Zachary Baquet: We're going to move on to our last speaker, Gerald Shively.

Gerald Shively: Great. And I know there are still some questions about Jeff's presentation and I think we'll have plenty of time to come back to that. Let me apologize in advance just a little bit because I'm going to give you a very data intensive presentation. I don't want to draw any strong conclusions but I want to give you a sense of the kinds of activities that my team is involved in, primarily trying to amass secondary sources of data and mobilize those to learn some things about the linkages between agriculture and nutrition.

Just to make sure everyone's on the same page, this is a graph of Z scores. You've heard discussion earlier today about Z scores. This is a graph from the DHS survey for Nepal in 2006; three lines just showing three different agro-ecological zones in Nepal. But the key point here is that for a normal population the distribution of Z scores would be centered at 0. And for Nepalese children it's centered much closer to -2. And about 50 percent of the mass of that distribution is below 2, indicating very high levels of stunting in that population.

I show you this because I'm going to be coming back to Z scores repeatedly. We're primarily looking at Z scores or prevalence of stunting as left-hand side variables in analysis that we're doing. Some of you are familiar with DHS data. I'm going to be talking about using DHS data. If one approaches the task of explaining Z scores in a kind of regression framework I just want to show you a very simple regression output here and draw your attention to five things. First of all most of time if we use DHS survey data to try to explain variation of Z score or prevalence of stunting, in an overall sense we do a pretty poor job of explaining total variation.

So the R^2 on this regression is .16 as Jeff indicated. This echoes other things that you've heard today. Just observing things about children, their mothers, and the household often helps us explain some of the variation in Z scores, but a very small percentage of it. In the case of something like stunting, again consistent with Shibani's presentation, as children get older prevalence of stunting increases. For those interested in education a very robust finding across most DHS datasets is that the education of the mother and the education of the father both matter to child growth outcomes.

And typically educating moms provides a higher benefit cost ratio than educating fathers. In this case the marginal impact of education is about four or five times greater for mothers than for fathers. And then to echo some of the things that Jeff has just

talked about if you look at indicators of hand washing or indicators of open defecation they're strongly correlated with Z score outcomes. Hand washing of course increasing Z scores; open defecation reducing Z scores or increasing probability of stunting. This is what we know from using datasets like the DHS surveys.

Part of the motivation for our study is to try to figure out if there are ways that we can combine information from the agricultural sector to improve our understanding of these child growth outcomes using the kinds of DHS surveys some of you are familiar with. I just want to underscore here that Uganda and Nepal, the countries that we're focusing on as part of the Nutrition Innovation Lab work, are key target countries for this kind of thing primarily because agriculture is a very large proportion of GDP in these countries, employment in agriculture is very high in these countries. So if you're looking for places where there may be a strong link between agriculture and nutrition it makes sense to look at countries like Uganda and Nepal.

The idea here is that if one just focuses on DHS data we can learn a lot about children and child growth outcomes but the DHS data, for those who are familiar with it, is very silent on the topic of agriculture. The DHS datasets are very rich in details for children, mothers, and the immediate family – household environment – health indicators but contains virtually no information about what's going on agriculturally. Some of you are familiar with large scale national surveys that are promoted by the World Bank, the Living Standards Measurement Surveys.

One of the primary activities of my team is to take the LSMS datasets and try to combine them with DHS datasets to measure things about agricultural capacity, agricultural characteristics, market access, market participation, and things like that. Another member of the team, or a collaborator of mine, is Molly Brown at NASA at the Goddard Space Flight Center. We're using satellite remote sensed data to also understand something about growing conditions where children are living. I'll say a little bit about that in a minute.

For those who are not familiar with NASA's work they have satellites that orbit the earth. Some of these satellites have sensors that on a daily basis are taking pictures of the earth and these sensors can be used to give us a picture of how green an area is at any given time. This is a picture of a launch. This is a picture of the sensor. For those who want to look at it later there's a little movie here, provided by NASA that tells you something about

NDVIs. The NDVI is a Normalized Difference of Vegetation Index which just gives us a number that tells us at a particular place, at a particular time, as viewed by the satellite, how green is the environment?

These things have been used. Some of you are familiar with HughesNet. In semi-arid environment the NDVI have been used as a way of providing early warning about growing conditions on the ground. If you look at NDVI data for Nepal and Uganda this is what it looks like, seasonal fluctuations, peaks, and valleys. The orange lines are Nepal. The green lines are Uganda. On average Uganda is a much greener place than Nepal. And so on average those data are a little bit higher on the index.

One particular good use of the NDVI data is to detect droughts. Here are data that are expressed in terms of anomalies. In other words how far is the NDVI value that we observe at a particular point in time from something that would be considered normal? The NDVI data are fairly good at picking up this draught that occurred in 2008 in Nepal, somewhat less good at picking up a draught that occurred in 2006. So for those who have particular hope about the use of satellite data to understanding something about growing conditions, my caution is that in extreme environments, semi-arid environments, the signal that the satellite data provides us is a very strong signal.

In places that are less arid like Nepal, like Uganda, the signal is less distinct. There's a little bit more effort required to try to pull the signal out of the noise. One of the ways that we're doing this is to try to match the satellite remotely sensed information to growing conditions in the area surrounding where a child is observed in the DHS data. So you can think about the following fraud experiment. Imagine that a five-year-old child is measured in 2011 in the DHS survey. We might look backward in time and ask what was the relevant period in which that child might have been malnourished leading to a short-term nutrition outcome like wasting?

And we can ask what the satellite tells us about growing conditions during this period. And we can even ask questions like if we look backward in time, perhaps to the time when the child was born, or even when the child was in utero, what does the satellite tell us about growing conditions where that child was about to be born, for example? That's one of the things we're trying to do. I'm not going to give you any strong take home conclusions about that at this point but I want to give you a sense of what some of our work is aiming at.

Here's a graph from Uganda. On the X-axis here I simply have a measure of greenness – this index that the satellite imagery gives us. And we're looking at the greenness at a crop specific period of time. During the growing season, for a crop that was important where the child was living, what was the measure of greenness? And then on the left-hand side we have a measure of wasting: weight for height Z score. And what the data kind of illustrate in this case is that there's this range of responsiveness where if you move from the least green areas to the most green areas or conditions there's a gain in Z scores of about .64 percent.

That's an unconditional difference that's observed in the data and it just simply indicates that what the satellite is telling us about greenness may in fact correlate with growing conditions and child growth health. Now if we back up just a little bit and step away from the satellite data for a second and think about agricultural data in the neighborhood of the child I want to draw your attention – and I apologize to those in the back of the room who probably can't see the bottom of the board – to three variables that we've used to characterize agriculture in the area where a child is living to ask questions about what agricultural performance might be telling us is important for child growth outcomes.

Three variables: crop yield – so in other words on average what were yields in the neighborhood of the child that we observed; market participation – in other words how commercialized is agriculture in the area around that child; and then third, use of purchased inputs: purchased seed, purchased fertilizer. How intensively are purchased inputs used in the vicinity of a child. The take home message from this is that if you think about all of the normal DHS health/child/mother variables they're all very robust to the inclusion of these other factors.

So if you put agricultural variables in the regression all of the other things remain fairly important and in some cases the importance even is strengthened a bit. But in terms of the actual relationship here there are some surprises and some reasons that we might want to be concerned and dig down a little bit deeper into the data. First of all we find in Uganda a somewhat small but statistically significant negative correlation between yields and child growth. In other words in places where agriculture is performing a little bit better we find that children are doing less well.

We could think about some stories that might be consistent with that. One might be that in areas where an emphasis is being placed

on agriculture that labor is being diverted from other uses, that cash income is being diverted from other uses. It could have something to do with the types of crops that are being grown. This raises questions rather than answers questions. Second, in terms of market participation we find that greater rates of commercialization are related to less favorable child growth outcomes.

Again this is not news. Researchers at IFPRI, including Eileen, were pointing at this as a potential problem a decade or more ago. Commercialization may be bad for kids. Again this is not a definitive conclusion here but definitely something to be thinking about. And then the third, somewhat more optimistically, use of purchased inputs positively correlated with child growth outcomes. In other words where people have access to better seeds, perhaps fertilizer there's at least some correlation in the data with child growth outcomes.

Now to go back to the satellite imagery if we think about including all of those normal kinds of factors that we're interested in, they're all very robust to the inclusion of what the satellite is telling us. And we find some positive correlation between how green it was in the most recent growing season and child growth outcomes. Switch over here for just a minute to data from Nepal. In Nepal we have a slightly different set of variables that we're interested in. But let me focus on some of the agricultural variables.

In the case of yield and crop diversity we find positive correlations between both agricultural yields and the diversity of agriculture and child growth outcomes – in this case stunting outcomes. And we find particularly strong and significant relationships between household production of fruits, household production of vegetables, and household production of animal protein in child growth outcomes. So again in a very large nationally representative survey the patterns are quite strong and robust.

This is my last slide except for a summary slide. I just want to point to changes in Nepal between 2006 and 2011. I have on each side of the screen here distributions of Z scores. On the left weight for height, on the right height for age, and the shift in the lines are very small but statistically significant movements in the distributions between 2006 and 2011. These have been much celebrated in Nepal with good cause. Moving those distributions to the right is what we want to do.

The thing that I would like to point out is that if we actually try to understand what factors explain that movement to the right some of those are things that are obvious: factors related to mothers, factors related to children. Some of them are factors that are related to what's going on agriculturally and some things that are going on with respect to weather or climate: some things that may be under our control; some things that may be less under our control.

Just three takeaway messages for you: first the standard explanations of child growth outcomes are very robust to the inclusion of these other kinds of things. If we start to add agriculture, weather, climate into the analysis the other things remain important. They may not account for all of the improvements over time however. Second the connection between agricultural performance and nutritional outcomes is not always clear. Getting closer to the household improves our analysis but there are definitely some cautionary signals in the data with respect to what's happening in agriculture.

And then the third thing that I'd like to point out is that climate may matter but it may not matter as much as we think. And in particular if we move outside Nepal and Uganda to areas that are extremely extreme in the sense that there are climate signals that are very strong – for example semi-arid environments where draughts are very important – climate may be a much more important variable. But in places like Uganda and Nepal I don't think there are big correlations hiding in the data that we haven't yet seen.

I think that gives us some reason to be optimistic that things are within our control in terms of moving those distributions father to the right. Thank you. *[Applause]*

Zachary Baquet: So in the interest of fairness have we got any clarifying questions?

Anu Narayan: Just a quick question. My name is Anu Narayan. I'm with the SPRING Project. Just a quick question about did you not test the same three – the crop yield, market participation – for Nepal as well. That would've been interesting to see.

Gerry Shively: I wanted to highlight for you just some indicators of crop diversity in Nepal which were available in Nepal and not so available in Uganda. We can talk later about what different layers of analysis we have and I'd be happy to share some of those with you. I

wanted to highlight something that was available in Nepal and not available in Uganda.

Zachary Baquet: Any clarifying questions from online?

Shana Gillette: Hi I'm Shana Gillette. I'm with Livestock Innovation Lab and we work in Nepal and in Africa. So I just had two questions for clarification on mobility patterns. Can you look back on childhood nutrition if a child has perhaps moved every two years? We also work with pastoralists. They're moving all the time. That's one question. And then connected to that the connection between climate and conflict; we're seeing the impact of that on nutrition in Western Africa. And there is a connection in climate and crop reduction in Nepal as far as the **green** onset of the monsoon season and microclimates.

Gerry Shively: Thanks for both of those questions. On the issue of mobility it's a little bit frustrating at times working with the DHS data. I would say that for the longer term indicators like height for age we're stepping a little bit into a gray zone because we don't always know where the child was at the time of birth. That information is typically not collected in the DHS. It is in some cases not necessarily a speculation but an assumption on our part that where the child was measured was where the child was born.

And so to the extent that that's not true we're probably incorrect in our use of the data. With more near-term indicators like weight for height Z where we're looking at what's been happening over the last 12 months I feel more confident about the alignment of the data. But you point out a shortcoming that I clearly acknowledge. On the second point, climate and conflict, there's been some recent work very much in the headlines about temperature and conflict and certainly in both Uganda and Nepal there's the potential for climate to trigger conflict and for that conflict to have negative repercussions for child nutrition.

Certainly something that we can pick up partially through the use of geographic indicators, but I think there's probably much more work to be done to improve our understanding of how climate connects to conflict in local areas, perhaps over competition for resources to the detriment of children and mothers.

Zachary Baquet: With that we're going to open it up to questions for the whole panel. You can shift your chairs. Here's an extra mic to share between you. All right we have a question from online.

Female: This is a question from Aaron Buchsbaum with the SPRING Project in D.C. For Patrick Webb: are you intending to look at project level differences in agricultural nutrition implementation across Nepal? Some of the districts you highlighted are under the Feed the Future zone and some are not. I imagine the project designs are different across those districts.

Patrick Webb: Yes. The approach we took in Nepal, and slightly different in Uganda, was not to bind ourselves only to Feed the Future intervention sites. There was a lot of discussion with IFPRI as a colleague and with the mission. We decided to go a different route by random selection of study sites partly because there are so many different kinds of multisector activities going on across the country. We wanted to be open to capturing diversity of experience. Roughly four of the districts are Suaahara sites.

Another three or four are in the next Feed the Future program, which is a different multisector program that will also be capturing World Bank, European Union, and other kinds of multisector programing. So it allows us to assess, in a similar standardized way, the experiences of a variety of different approaches to link agriculture and nutrition.

Veronique Lagrange: Thank you. A question for Dr. Ghosh. My name is Veronique Lagrange. I'm with the US Dairy Export. Of course I would like to congratulate you for your story that shows the efficacy of dairy. But a question, going forward: we do fund research around the world and would it be possible to go back to your data and see if there is a dose effect with a quality protein in that country you should consider in future studies?

Shibani Ghosh: Data of the dose effective quality protein: yes and in fact actually the data that is currently available for us for Uganda is actually qualitative so we can't actually convert it to understanding what the total quality protein available is. We are looking at other datasets in Kenya and Bangladesh and we're seeing very variable results when it comes to quality protein and it's linkage to linear growth. But that's really underway right now. That would be something. If we can actually collect quantitative data which will allow us to estimate what is the total protein and then convert to utilizable protein we can definitely look at the dose effect.

Zachary Baquet: Question from online.

Female: I have a question from Michael Keytober who is joining from USAID in Ghana for Dr. Griffiths. For single household farmers

with half an acre plot (as an example) how much does a treatment of aflatoxin cost – ballpark? And then he wonders is it available in Ghana and how often would the treatment be applied?

Jeff Griffiths:

All right. Well it turns out that there is a commercial product called aflasafe™. It is approved for use in Ghana. My understanding is it costs approximately \$7.00 per acre for use. The way that this is done is that you get some biomass, some sorghum, or something like that, that's been infected with a fungus, that's an aspergillous fungus but it's one that does not make the toxin. And then you take this stuff and you throw it in your field and it out-competes because you're putting so much of it on the field – what might be there naturally.

And this aspergillous, by the way, that you're throwing out there that does not make the aflatoxin is naturally found. It's not genetically modified or anything like that. My understanding is from data I believe actually acquired from Nigeria. But it's about \$7.00 per acre for treatment. I think the issue is availability and then secondly how is a farmer going to be recognized for having produced a better crop without aflatoxin in it? Was there another aspect to the question? I think that's what it was the – Yeah, okay thank you. Well there's data that I've seen from the United States and some data from West Africa that one treatment will last not only a calendar year but will persist in the soil, that aspergillous that does not make the toxin, for two years. I can't say with certainty what that data all looks like, but I have seen data saying that.

Patrick Webb:

Can I just follow up? To get real answers to that would require some intervention study and we're not funded at that level. I mean we are seeking additional funds that would allow us to test a variety of different ways for addressing this; ideally preventing it through improved management on the farm is one technique. There are certain types of hermetic-sealed bags that if you store the crop in it it kills the mold and when you open it you have a clean outcome. These things need to be tested both in terms of efficacy and in terms of cost-effectiveness.

At the same time we are doing a lot of exploration in this area. We're collaborating with the Australian government for example, not in terms of an intervention trial. We're trying to understand through a cross-sectional, nationally representative sample of mothers and children in East Timor where they are doing a national nutrition survey, also collecting blood samples to assess on 1,300 individuals, to assess micronutrient status. We have been

asked to assess the aflatoxin exposure in that same blood sample. Then that will become one of the first large-scale samples that allow us to try and determine levels of association and dose response.

There are different avenues we're exploring to try and tease out these questions. But it does require partners and more resources.

Ahmed Kablan:

Ahmed Kablan, USAID Bureau for Food Security with a question for Jeff. I know you mentioned about the work of the gut microbiome and the microbiota and there is a lot of really exciting studies coming out every day from different well-distinguished labs. The question is do you see in the future that the result will bring us to identify a kind of bacteria that is missing in stunted children or is missing in an obese person and what we need to replace it with and how that can be approached?

I know that another ____ experiment would be fecal transplant that results in the _____ result and the mice study. And the other comment regarding your comment about replacing the microbiota or the microbiome of the stunted child to help them in order to get over the negative effect of the bacteria. What about stepping back and helping or replacing the microbiota in the mother because she's pregnant or at preconception because the first inoculation of the infant have been _____ through the anal and vaginal secretions during birth.

And at the same time some studies that recur or go to conclude that the bacteria population of the human being is determined in the first year, year and a half – essentially the first 1,000 days. And some studies that give the pregnant woman the probiotic urine _____ over the last six months. This should be a positive effect in terms of the health outcome.

Jeff Griffiths:

Thanks very much Ahmed. This is very stimulating, very provoking information that we have available to us. And to be honest we really don't know how this is going to work out. But I think that certainly it's reasonable to have as one's paradigm that it may be possible to ameliorate some of the effects of having a very bad microbiome by some kind of either a specific food that you eat that actually promotes the growth of a particular class of bacteria, or it could even be that just like people are eating probiotic yogurt in the United States that we actually come up with something that has some real science behind it in terms of doing that.

There are exquisitely wonderful studies that have been done looking at the proportion of different large classes of bacteria in people who are stunted or people who are obese, and people living with different kinds of diets, etc. And it's very clear that there are immense shifts in the bacteria. Someone who's a carnivore eating fast food in the United States has a very, very different microbiome than someone who's a vegan. And in fact sometimes a person who is simply eating a non-meat diet may actually have a microbiome which is reminiscent of that found in certain other animals besides humans.

Because the bacteria are going to live on whatever you are eating. I think there's tremendous potential there. We don't really know where that's going to end up. But I think it's very exciting to think about. And I think that we have an opportunity with the platforms that we've got. I just want to have a call out to our colleagues at Livestock for Climate Change Innovation Laboratory because we're collaborating with them to actually characterize the microbiomes in children and in livestock in both Nepal and Uganda.

They are providing the funding for this and they've selected the researcher for that. We're providing a site which is well-characterized. I think that's an approach where we can collection information which will help answer those questions. My guess is that in ten years we're going to be beginning to address some of your questions about this, but it's very exciting stuff.

Julie Connor Wattan: Julie Connor Wattan from Food for Peace, probably Jeff but maybe some others. When thinking about the gut and the infants and at certain all the theoretical studies we have on breast milk – I remember a question Lars Hanson raised about 25 years ago that those exclusive breastfeeding actually exist anywhere. We know that a lot of prelacteal are introduced to the child that can have an effect on the gut. First other thing besides breast milk that kids seem to get in most cases aside from prelacteal is water, which is probably usually contaminated.

We also know from some of the research that's going on related to HIV the dramatic drop in the incidence of HIV when kids are exclusively or almost exclusively breastfed. Are you looking at that sort of behavior change type interventions that would need to happen at a community level and at the household level to be able to enable exclusive breastfeeding in the first six months and whether that would have an effect on children's nutritional status? The other thing I guess is the aflatoxin levels in breast milk and

types of aflatoxins that are in breast milk are different and we see the sharp rise once other foods are introduced.

All of those things seem to speak to that we need to do something to fix breastfeeding.

Shibani Ghosh:

In fact what we are trying to do in Nepal is actually focus on understanding how the fidelity of behavior change communication messaging. One of the programs that we're looking at is through _____ what is called a training cascade where they're transferring essential nutrition actions and essential health actions through a training cascade where master trainers or trainers are trained to then deliver the knowledge to the lower levels, down up to the ward and the frontline worker with his the FCHV in Nepal.

What we're hoping to do is basically understand the delivery of the messages and the fidelity of those messages and see how that then relates to the outcomes that are collected at the ward through the survey that is done by Johns Hopkins. To answer your question what we are hoping for by doing this study we'll be able to relate not just the fidelity of messaging but the messaging itself relative to the outcomes of child growth and anemia and practices of exclusive breastfeeding. I should've just said yes, right?

Eileen Kennedy:

That's an excellent question. In the formative research both in Nepal and Ethiopia on the Essential Nutrition Actions it was very clear that when people were using the term exclusive breastfeeding that for a lot of moms they were not including water. In the development of the materials really that work was essential. I think it was Kathy Kurz who said both qualitative and quantitative information is needed. And in the formative research – absolutely.

Jeff Griffiths:

I don't think I have anything else to add to those. Our perspective birth cohort that we're going to be starting in Uganda soon I think we'll have an opportunity to look at fidelity of message and get some idea about what over time is working with pregnant women who are in these households being served by a specific program, and in the case of Uganda, and see how that changes over time and whether or not the program does so the same way over time as different mothers are enrolled in the program and so forth.

So I think we'll be addressing some of those questions you had, at least about that kind of messaging. There is other messaging that'll go on about behavior change besides that of breastfeeding. It

could be that there are different kinds of uptake of that kind of information too.

Zachary Baquet: We've got a question from online.

Female: Edwin **Theomi** who is joining us from Malawi today has a question for Shibani. Was there any relation between cow keeping and milk consumption as it relates to stunting? For example here in Malawi we see a lot of people keeping cows and consuming milk, and yet their children are stunted. What could be happening in this case?

Shibani Ghosh: Thanks Edwin. Edwin is one of our collaborators from Malawi. It's great to have this question. So in fact yes the slide that I showed you in which we found that if a household, even if a poor household had livestock. And unfortunately I don't have the disaggregate data but there are predominantly cows in some parts of Uganda so there is a relationship in presence of livestock in the household and cow's milk consumption and stunting. We're going to have to disaggregate the data and look at specifically if it stands up only on cows versus if it's other livestock.

I didn't get his other question. What was it in Malawi?

Female: Just mentioning that in Malawi he sees a lot of people keeping cows and keeping milk, yet their children are stunted. So what could be happening in that case?

Shibani Ghosh: Right so I think this sort of comes down to the fact that there are possibly issues around behavior that need to be addressed. That is being addressed in many of the programs which are trying to target behavior change through communications for mass media. And I think it sort of comes down to what we're trying to do so if I'm jumping over Nepal it's that in fact the whole idea of behavior change is not new. It's not novel. We're using novel methods and techniques to try to translate messages into behavior and change and behavior.

So I think the key thing is going to be really to understand how we can target behavior and what's really going wrong in our interventions of trying to change behavior.

Jeff Griffiths: I just want to tag onto what Shibani just mentioned there. I think that when you look at a household it's a complex organism if you want to think of it that way. There could be something which is nutrition promoting such as the ingestion of milk, if we want to think of that paradigm that let's say there is a benefit of drinking

milk: it's high quality protein in it, and things like that. However there may be other things in the house. There may be bad sanitation. Or it could be that the kids are ill with one kind of an illness or another that they're acquiring from other people or their animals, etc.

These kids may be drinking milk but it may turn out that their microbiome is such that they really can't get 100 percent out of it. I think that when we look at these kinds of interventions because we're scientists we tend to look at this thing. We want to control for it. And what I think we have to be challenged to do is look at the whole mixture of different circumstances and come to some understanding of integrated agriculture, nutrition, and health interventions and how they all play with one another.

And when do they really work well by themselves? When do they really work best when they're combined?

Dennis Amigradi: Dennis Amigradi from **OTT**. I would like to follow the question from by Judy. In all of your stories we look for the outcome of the children growth. Have we looked for the quality of the breast milk under all these variables that you have studied?

Jeff Griffiths: I'm just going to say that we usually don't look at the quality of the breast milk, but we look at the fidelity of whether or not it's exclusive breast feeding and contaminated and that's a different issue.

Shibani Ghosh: Actually that's a really excellent questions and I think this is one of the areas that really needs to be addressed. I know there's research out there when you're looking at quality of breast milk and that different micronutrients and macronutrients behave differently when it comes to breast milk composition. But I don't think there's enough of data that's going to allow us to understand at country level, whether it's Uganda moms versus Nepali moms how their breast milk composition varies. But it's a very, very good point you've made.

Zachary Baquet: I'm just going to pass one last question to wrap it up to Robert.

Rob Bertram: Thanks Zachary. I was just cruising right along until we hit that big speed bump with Gerald saying that market participation and yields were actually negatively correlated with the outcomes that we're seeking in terms of height and stunting. Then the third point Gerald was that input use was positively so. And yet those seem

internally inconsistent because you'd think that with inputs you would be getting both higher market participation and higher yields. So I wondered if you could say a bit more about this. Was this a tiny subset of people who are using inputs? How do you explain what seems to be really kind of diametrically opposite suggestions?

Gerry Shively:

Good. I certainly want to be provocative without provoking. *[laughter]* There are a lot of things going on in the data. There's choice about crops. There is intensity of labor use, a lot of things that perhaps these variables are serving as proxies for that we're going to have to drill a little bit more deeply into. I think perhaps the point that I want to make is that we shouldn't just rush blindly to the conclusion that if we boost yields that somehow that's going to be the magic bullet.

In fact the data seem to suggest, at least in the context of Uganda, where the crop mix may be very heavily dominated by bananas and there may be issues related to that that the correlation is perhaps something that we should think about and that the data is something we should dig more deeply into. Patrick.

Patrick Webb:

I think that's why you focused on it – to be provocative. Really I think that's where we would all sum up. What we're trying to communicate is that we're trying to connect the dots. We're trying to link different kinds of approaches and data sources and topic areas that are often typically kept separate. We're really dealing with the microbiome. We're dealing with NASA. We're dealing with health and agriculture. We're dealing with secondary data as well as primary data. And really trying to integrate and tease out what is relevant and what can inform policy and programming choices.

That's really – And we've only presented a snapshot and a partial snapshot of the kinds of studies and the kinds of work that different partners, including DAI on certain technology approaches and different value chain work. All of this matters. We have to set limits to what matters but the questions we're exploring we're ensuring that we look at from these different perspectives and triangulate different sources of information to come up with something hopefully synergistic and new that allows us to go forward so that we don't five years from now say, "Yeah the evidence is weak." We want to come out with some strong evidence.

Shibani Ghosh:

I just wanted to add actually (and I haven't had a chance to talk to Gerry) that we presented this in the Ghana meeting that we did find in the primary data that technology adoption was very low in the surveyed population. Those households that had adopted some improved seeds or any other types of inputs had children who were less likely to be stunted. Again we've not gotten into market participation and crop yield. That kind of data is still being analyzed. But I think there's something there that's going on that needs to be dug into. Jeff I'm going to hand it to you.

Jeff Griffiths:

You know I think that at the superficial level increased market participation could mean that you sell off the good crop and that your kids don't get it. So it could be as simple for these kinds of things. It may not be that the explanation is that deep. Then obviously there are huge policy implications if that's the case because with something that's looking at development of income by increasing the yield of something needs to be coupled with something where there's some information about nutrition that household is going to have available to them so they can make good choices. And –

Eileen Kennedy:

Yes but my take on that Gerry – And I don't think the takeaway message is increasing yields are not good. I think again one of the mechanisms when we're looking at selected outcomes – In this case you were looking at height for age. Depending on countries a lot of the work that Patrick and I did years ago, control of income, was very important. And at a set level of income the data were clear that in a number of our countries female headed households had a set level of income had better nutritional outcomes for their children.

So it's income, control of income, and uses of income where there are explanations for that. And without getting so complex – the spaghetti diagrams – but at least understanding where we need to focus. Unfortunately people do look at those Gerry and say, "Well increasing yields are not important. That's the wrong message."

Zachary Baquet:

Okay, with that I'd like to thank our speakers for joining us today. *[Applause]* We will be putting up the PowerPoint presentations and the recording up on Agrilinks on the events page. Look for it there. For those of you online and in person we do have a survey. There's a link for those online. For those of you in person there's a sheet that was on your chair. If you could please fill those out we are greatly appreciative and we try to improve. With that have an excellent afternoon and rest of the day. Bye.

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