

Research in Asia: Approach, Methods and Protocols



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Introduction

At the 19th International Congress on Nutrition in Bangkok (in 2009), the United Nations' Standing Committee on Nutrition concluded that "there is an urgent need to provide evidence-based information on food-based strategies and systems in order to make a case for their promotion. A series of scientific articles on food security interventions for nutrition should therefore be published to complement the public health interventions promoted by the Lancet Series [of 2008]. Sustainable food security approaches to nutrition require systemic, multidisciplinary and inter-sectoral approaches taking into account environmental, cultural, social and economic dimensions, and call upon a different set of methodologies."

USAID's Feed the Future Innovation Lab for Collaborative Research on Nutrition (henceforth the 'Nutrition Innovation Lab') responds directly to such demand for sound empirical policy-relevant knowledge.¹ This document lays out the innovative research agenda pursued by the Nutrition Innovation Lab at the intersection of agriculture, health and nutrition. Representing a cluster of investigations, rather than a single study, it seeks to generate globally-relevant findings that will allow national governments and development partners to pursue better-informed investment strategies aimed at leveraging cross-sectoral synergies that can accelerate nutrition impacts among vulnerable populations.

This is a 'living document' in that research questions will continue to be elaborated as national counterparts, USAID missions and research partners contribute to the evolving agenda-setting. While focused on studies conducted in Nepal, the approaches and methods of data collection and analysis presented here are consistent with those applied in other Nutrition Innovation Lab countries, most notably Uganda, but also with other relevant Tufts field study locations in Ethiopia, Timor Leste, and Malawi. Potential future research in Bangladesh, Rwanda, Egypt and Cambodia will also be consistent with the approaches described here and contribute to broadening the empirical base from which policy-relevant conclusions are drawn.

The Research Agenda

The Nutrition Innovation Lab focuses on three major over-arching research questions:

1. In what ways do investments in agriculture achieve significant measurable impacts in nutrition? As a corollary, can pathways to impact be empirically demonstrated?
2. How can large-scale programs best incorporate such knowledge into cost-effective multi-sectoral interventions aimed at improving nutrition?
3. How can policy and program implementation processes be enhanced to support both nutrition-specific and nutrition-sensitive actions?

¹ Until late 2012, the Nutrition Innovation Lab was called the Nutrition Collaborative Research Support Program (CRSP). Additional key partners involved in the capacity-building and technical assistance aspects of the Nutrition Innovation Lab agenda include Tuskegee University and DAI Inc. IFPRI is also a core collaborator in defined countries.

These three overarching questions serve to frame a host of nested studies that will generate concrete evidence that responds to priority developing country concerns while supporting the goals of USAID's Feed the Future initiative. The research is pursued in ways that seek to enhance policymaker understanding of how to overcome constraints in policy and program design and implementation, while also producing global public goods in the form of new scientific knowledge of relevant and diverse settings. Supporting a 'series of impactful scientific articles' as called for by the UN/SCN in 2009 is a key goal of this research.

The three broad research questions are briefly elaborated below, followed in each case by a description of the research design and protocols applied to various study components.

1. ***Understanding Agriculture-Nutrition Linkages:*** In what ways do investments in agriculture achieve significant measurable impacts in nutrition? As a corollary, can pathways to impact be empirically demonstrated?

The belief that "agriculture contributes not just to food production but also to human nutrition and health" (IFPRI 2012) underpins ongoing efforts to "make agricultural policies and programs nutrition-sensitive" (BMGF 2012; Ruel et al. 2013). Yet, despite the considerable rhetoric that agriculture holds the potential to support improved nutrition, there is scant empirical evidence of the kinds of actions in agriculture that achieve significant and measurable human outcomes. Thus, the search for empirical evidence of 'what works' in this arena has been stepped up.

Enhancing agriculture in ways that support improved nutrition is not simply about increasing yields. It is also about reducing costs, enhancing stability in output, strengthening resistance to weeds, pests and diseases, promoting more variety or new crops, stimulation of market and value chain activity, targeting efforts to at-risk regions and populations, securing greater female empowerment (in the agricultural realm and beyond), and promoting demand for a high quality, diverse diet. As a result, agriculture as a broad sector of activity must be unpackaged so that relevant components can be assessed for their relative contributions to nutritional enhancement. This means that pathways linking agriculture and nutrition need to be refined through a focus on plausible biological and other mechanisms over different timeframes, and potential gains need to be understood in net terms through a focus on factors that affect nutrition at the interface among soil, plant and human systems.

Study Components and Research Design

There are four main elements to the research on agriculture-nutrition linkages:

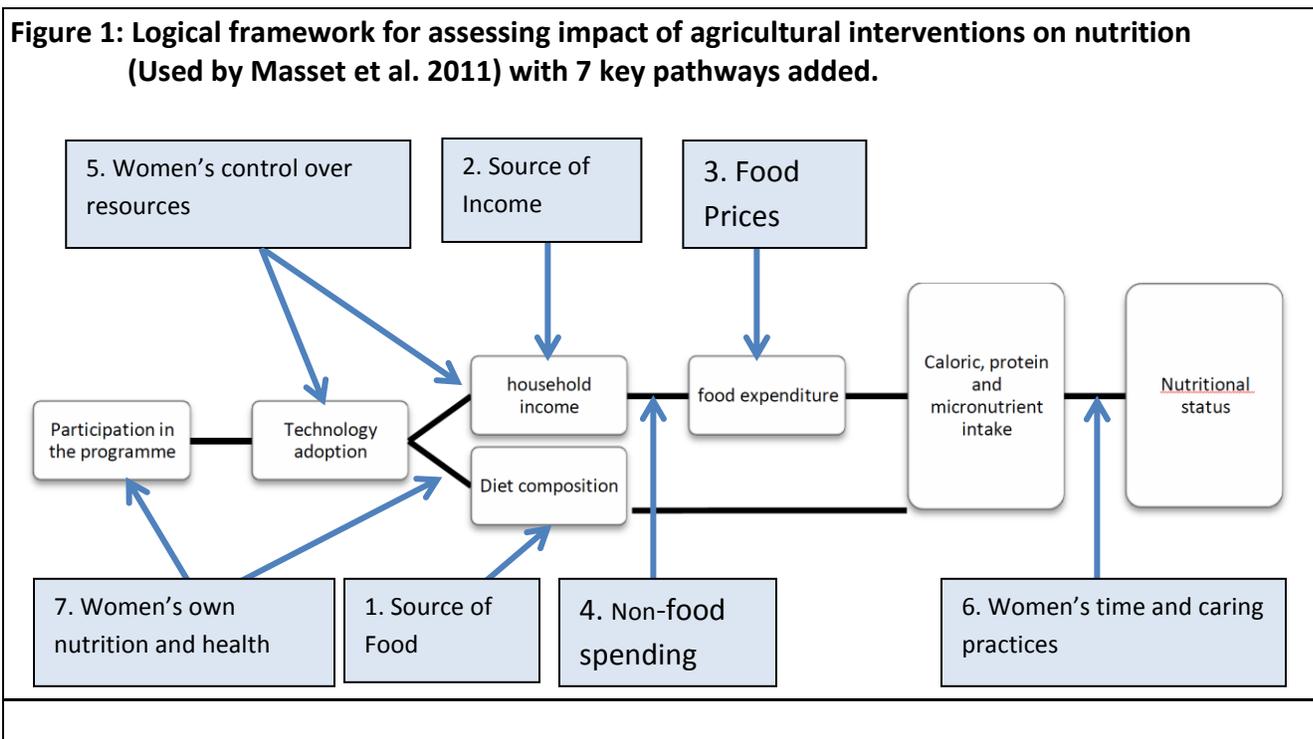
- 1.1 Empirically populating conceptual pathways from agriculture to nutrition outcomes
- 1.2 Exploring neglected biological mechanisms linking food systems, health and nutrition
- 1.3 Testing the validity of various measures of diet quality and nutrition outcomes
- 1.4 Econometric analyses of secondary data linking agro-ecology, agriculture, food systems and nutrition

The research design for these 4 research domains are explained further below.

1.1 Empirically populating conceptual pathways from agriculture to nutrition outcomes

Recognition that “merely producing more food does not ensure food security or improved nutrition” (Herforth et al. 2012) begs questions about when, where and why does it, or does it not ensure food security or improved nutrition? These questions lie at the core of a better understanding of the reality of agriculture-to-nutrition linkages. Much effort has been dedicated to conceptualizing pathways that theoretically allow investments in agriculture to have positive impacts on nutrition. Headey et al. (2011), Gillespie et al. (2012) and USAID (2013) talk of 7 pathways, which include agriculture as a source of food and income, agricultural policy as a driver of prices, and agriculture as an entry-point for enhancing women’s control over resources, knowledge and status. More recently, Ruel et al. (2013) refer to these same pathways, emphasizing that the number of paths is not fixed and that empirical evidence along the posited pathways is stronger for some than for others.

Masset et al. (2011) lay out a chain of connections from agricultural programming through direct and indirect impacts on food and income to nutrition. Figure 1 shows their horizontal framework and identifies where the ‘7 pathways’ apply to that framework.² They used this framework to systematically review literature in their search for evidence of causal associations and/or plausible mechanisms for correlations along the chain. One of their conclusions was that “only few causal links have been successfully explored.” Thus, the immediate problem is that many of the links across most of the major conceptual pathways remain poorly understood.



² The white boxes and dark lines are the original logical framework. The tinted boxes and pale lines represent each of the 7 major impact pathways and where they link to the framework.

The Nutrition Innovation Lab seeks to delve deeper into these questions through carefully designed primary data collection activities. Called the PoSHAN study (Policy and Science for Health, Agriculture and Nutrition), the research in Nepal has multiple elements that are framed around an observational cohort study. The study involves systematic stratified random sampling with 21 randomly selected 3rd level administrative districts (Village Development Committees or VDCs) and 63 wards. Stratification allowed for 7 VDCs to be randomly sampled from each of three agro-ecological zones (Hills, Mountains and Terai). Sampling included listing of districts within each agro-ecological zone contiguously from west to east, with VDCs within districts being listed in alphabetical order based on Nepal VDC profile database.³ Using a random start, the VDCs were selected systematically based on the sample interval. From each selected VDC, 3 wards per VDCs were randomly selected using population proportion to size (PPS) methods. An estimated 4,500 children under 5 years of age will be surveyed in the selected 63 wards (see Table 1), along with their mothers (and/or primary caregivers), and all married women between aged 10 to 30 years (totally roughly 8,000 individuals). Data will be collected from household heads, and at community and ward levels.

As the PoSHAN observational cohort is primarily focused on understanding *how and why* there was an effect (or not) including understanding level of exposure to interventions and the specific agro-ecological nature of Nepal, the sampling strategy focused on ensuring representation of different agro-ecological zones rather than a sampling strategy to detect differences in outcome measures such as stunting. Thus, the PoSHAN cohort will elaborate on the impact assessments (with baseline and endline evaluations) that are already planned within the context of the ongoing programming (primarily focused on USAID programming, but including other government and donor activities to the maximum extent possible).

Table 1: PoSHAN research sample design for children under 5 years of age

Study Area	No. of VDCs	No of Clusters per VDC	No. of Clusters	Est. No. of Children <5 yrs of age
Mountain	7	3	21	798
Hill	7	3	21	1191
Terai	7	3	21	2523
Total	21	3	63	4,512

A preliminary analysis was undertaken to determine the ‘representativeness’ of the randomly selected sample of research sites versus conditions in the rest of rural Nepal (based on DHS

³ VDCs and municipalities were equally considered for random selection.

reporting) to determine potential bias in findings if our survey sites recorded better or worse than average nutrition outcomes. Figure 2 shows that under 5 stunting rates are very similar across all sites, which, given USAID's operational and research focus on stunting, supports the value of the research sites as viable locations for this kind of study.

Where wasting is concerned, the study sites have slightly higher rates of moderate, and slightly lower rates of severe wasting but again the differences are not large. In addition, it is noteworthy that the 21 research sites include 3 of the locations that demonstrated the most marked reduction in stunting nation-wide between 2006 and 2011 (as per DHS rounds), as well as 4 that showed the least reduction in stunting during that period. The three sites included in the 'top ten' districts in terms of reduced stunting are Ramechhap, Argakanchi and Rolpa. The four with the least reduction (rather an increase) in stunting are Taplejung, Terathun, Jumla and Mugu. The wide variation in recent trends across the study locations will be carefully explored in the context of the research given that initial conditions and past trajectories in nutritional status matter immensely to current and future outcomes.

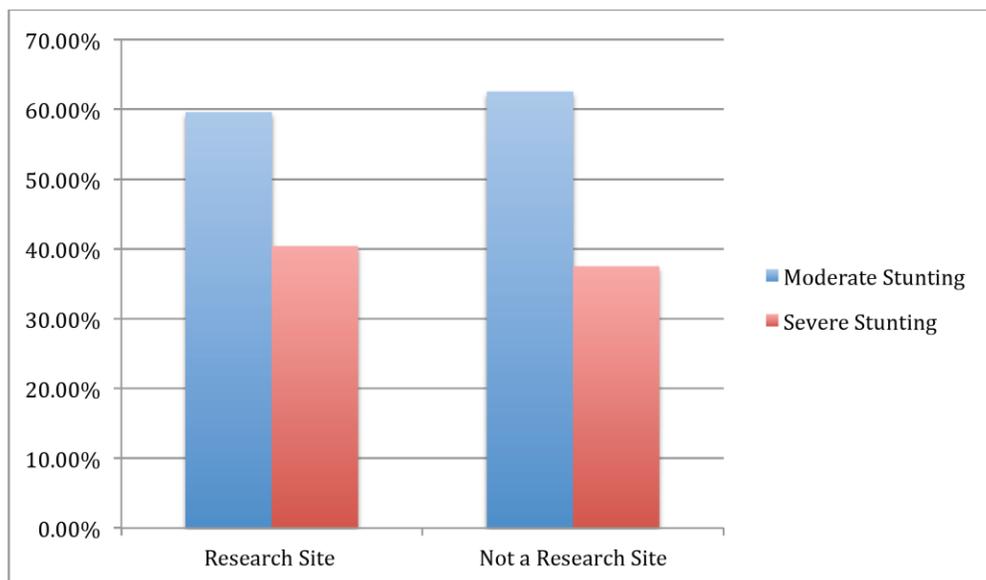
In addition, 3 of the 21 randomly selected VDCs have been chosen to serve as 'sentinel sites' for more in-depth investigations (Figure 3). The selection of the sentinel sites is based on parameters that include a) ease of access and communication, b) agro-ecology (one in each zone), c) roll-out in the VDC of at least the Multi-Sector Nutrition Plan (MSNP) or at least one of USAID's integrated agriculture and nutrition programs. In these locations, study teams are being established in situ to allow for intra-year (seasonal) data collection and more in-depth interaction with both the selected households and with service providers at the local level (which links with the process and implementation research described in section 3 below).

Data collection will include annual surveys in the 21 sites that will be administered at individual, household as well as community-level. Survey instruments include modules dealing with diverse domains, including the following:

- a. Food and nutrition (anthropometry; patterns of food intake/diet quality; dietary inadequacy; household food security indices)
- b. Agricultural practices (assets, productivity, investments and constraints, sales, post-harvest including storage, preservation, processing, and other coping strategies)
- c. Health status (morbidity, mortality, health-seeking behaviors)
- d. Knowledge, attitude and practice of key health behaviors
- e. Total household income and expenditure on food, non-food items and services (including gendered control over income and other decision making authority)
- f. Community markets (food diversity, availability, and prices)
- g. Community/ward/VDC infrastructure in terms of type, number, services
- h. Exposure to, and uptake of, agriculture, nutrition, health resources, services, and other programming components
- i. Contextual factors that confound or modify expected associations between program exposure and outcomes of interest (including status, caste, education, etc.)

Figure 2: Stunting and Wasting at research sites compared with all other non-sampled sites across Nepal (based on DHS 2011 data at district level)

Distribution of Malnutrition (Stunting) in Research versus Non Research Site



Distribution of Malnutrition (Wasting) in Research versus Non Research Site

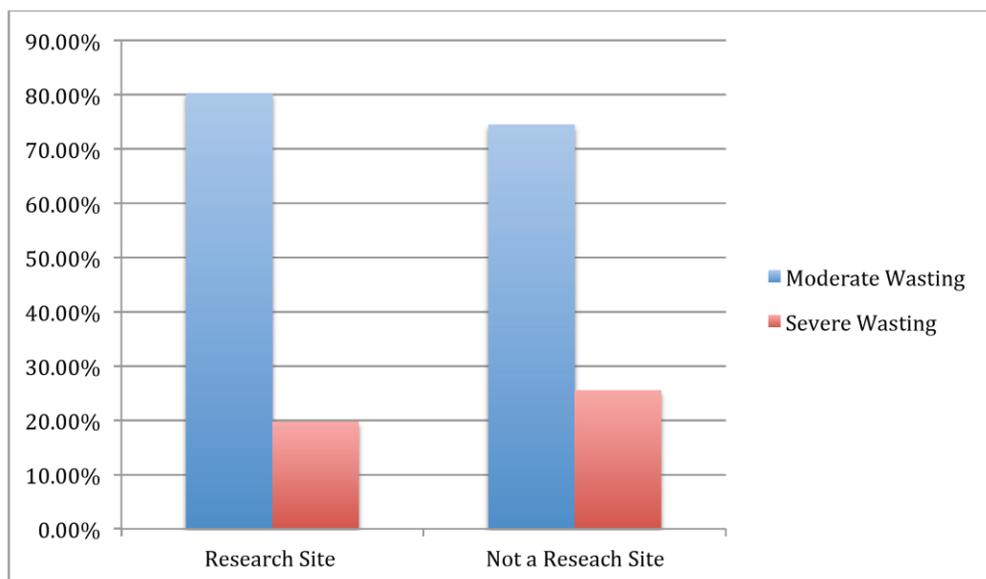
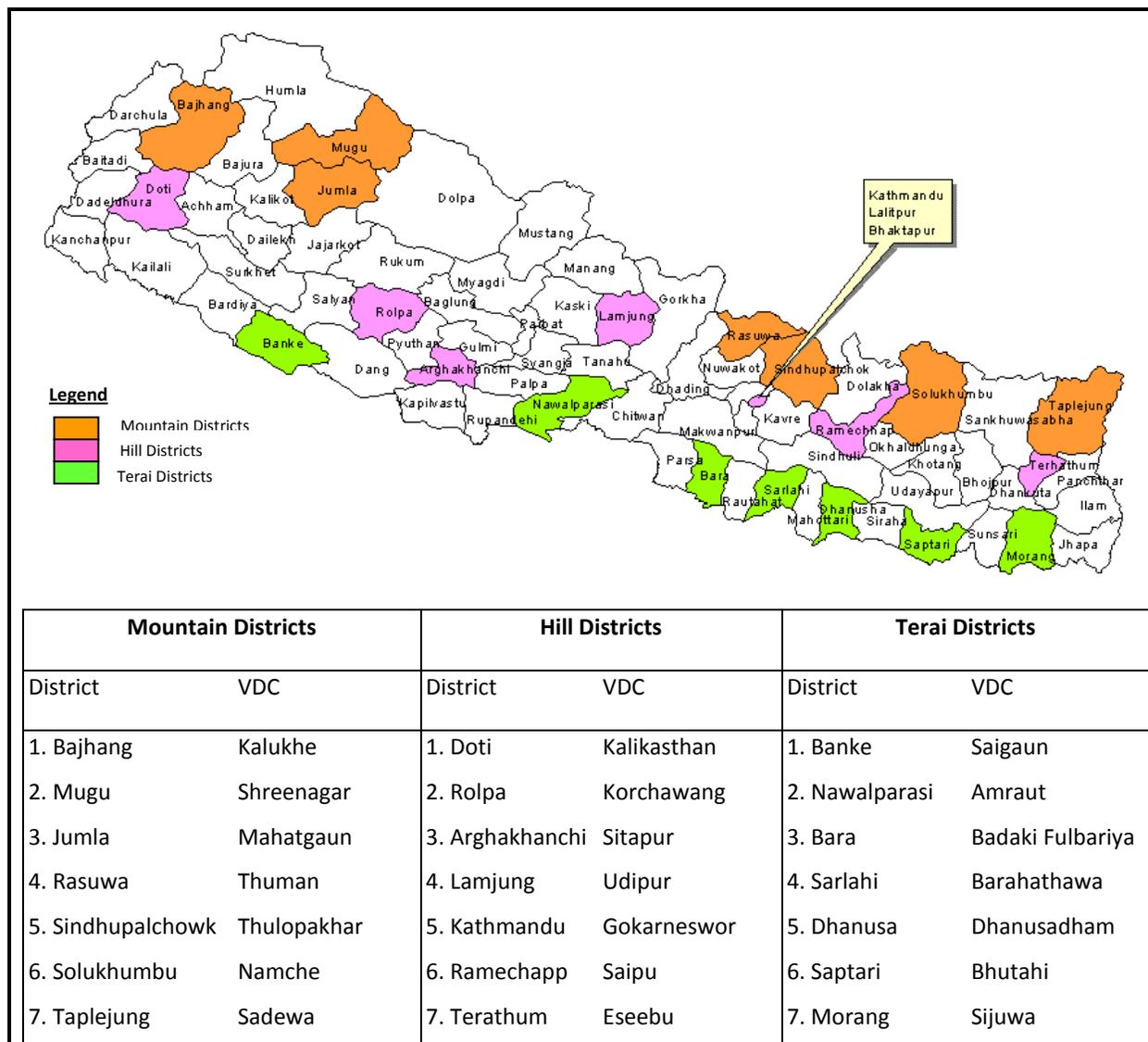


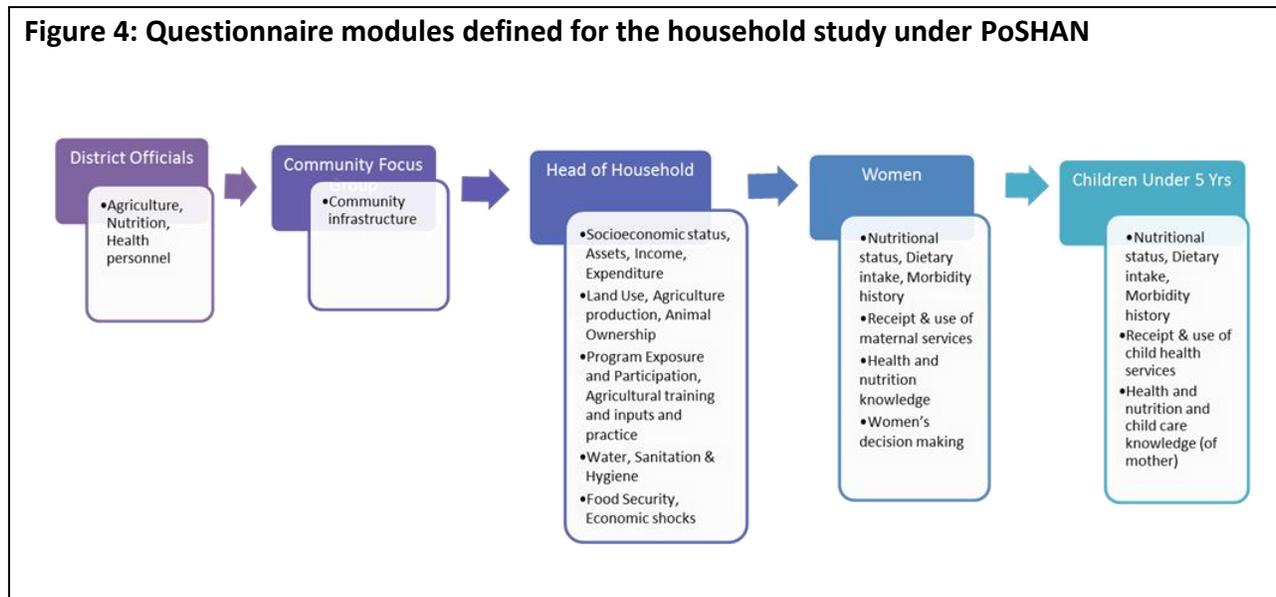
Figure 3: Map of 21 PoSHAN study districts in Nepal, by agro-ecology



These are simply illustrative broad categories of questions. There are 32 questionnaire modules for the PoSHAN household surveys. Data generated will provide a wealth of information and analyses that are needed to understand which pathways are more relevant, how socioeconomic, ethnic and agro-ecological parameters influence the dominance of one or more pathways over others, and, importantly, how different ‘kinds’ of agricultural activity play out in relation to different ‘kinds’ of food consumption nutrition outcomes (e.g. mother’s nutrition versus children’s, children under 5 versus children under 2 (by gender), rates of growth over time, consumption adequacy and dietary quality, etc.) The panel data will permit measuring change over time in the trajectories of human development within and across all the 21 sites.

The survey modules applied in the 21 sites each year will be applied to a variety of respondents within each household, including the household head (adult male or female responsible for financial and other decisions), newly-married women (married within two years of the survey), pregnant and lactating women, and children under 5 (separated out as children 0 to 23m and 24-59m) (Figure 4). Analyses will be conducted on each survey round to consider variability in findings by geography (across the districts), agro-ecology, and across the wealth distribution.

Figure 4: Questionnaire modules defined for the household study under PoSHAN



It is anticipated that most of the commonly conceptualized pathways (see above) will be studied in this research, along with an exploration of the health and nutrition dynamics of populations across agro-ecological zones in relation to agriculture, nutrition and health interventions. Heterogeneity in agro-ecological conditions, market connectedness, non-farm income source availability, migration trends and programming initiatives will allow for diversity and variability of findings across the sites, while the multiyear panel design will allow for deep exploration of linkages--each round of data collection learning from, and building on, the previous round. Multiple years of panel data will also allow for analysis of poverty dynamics, consumption patterns, nutrition and health trends, and change over time in relation to interventions as they happen.

What new will be generated by this aspect of the research? Papers that empirically populate conceptual pathways from agriculture to nutrition. This research, conducted where marginal agricultural productivity, market diversity, food security and nutritional status co-exist with government and NGO programs, offers an opportunity to examine and establish conditional pathways that may help raise the nutritional impact of future agricultural and multisectoral policies and programs. Deeper understanding of key mechanisms playing out across diverse agro-ecologies and socioeconomic settings over time.

1.2 Exploring neglected biological mechanisms linking food systems, health and nutrition

The Nutrition Innovation Lab's cohort study's repeated annual (and some intra-annual) primary data collection at household level on agriculture-nutrition linkages allows for additional priority questions to be appended where appropriate. Some of the key elements largely missing from past consideration of agriculture to nutrition pathway analysis relate to biological, as opposed to economic and cultural or economic mechanisms. In collaboration with other Innovation labs, several important potential contributors to child stunting will be explored:

- 1.2.1 *Water quality*: There are many issues surrounding hygiene and sanitation that need to be accounted for in explaining nutrition and health outcomes, but also in measuring the effectiveness of interventions aimed at improving those outcomes. Within the context of hygiene and sanitation is the issue of open defecation, which is widespread in Nepal. Recent attention to this particular problem as an explanatory factor for stunting in South Asia (Spears 2013) means that it will be crucial to pay close attention to sanitary behaviors at household and district level both through PoSHAN's primary data collection and the analyses of secondary data sets (explained in section 1.4 below). The issue of hygiene and sanitation is of further concern given emerging evidence on the widespread systemic and chronic state of gut inflammation (i.e. environmental enteropathy) and its link to stunting. Equally important will be accounting for the quality of drinking water and the relationship between bacterial contamination of drinking water and stunting. An attempt will be made to assess bacterial contamination across the study sites using field-validated water analysis kits developed by Aquagenx. This will allow for an important potential explanatory factor to be systematically included in household level regression analyses on the determinants of variability in nutrition outcomes.

What's new? Understanding the role of drinking water quality and bacterial contamination of water as an independent determinant of nutrition outcomes (e.g. stunting) measured *at the household level*, over time.

- 1.2.2 *Aflatoxins*: Recent attention to mycotoxin exposure in the food chain as an explanatory factor for child stunting has mushroomed (Roze et al. 2013; Smith et al. 2012). Commonly found in food and feed in the humid tropics of Asia and known to affect growth and reproductive outcomes in animals, concern about aflatoxin levels (AF) has increased recently as it is highly likely that chronic exposure to mold/fungi-related contaminants in the food supply (and potentially even through breast milk) are a major and direct contributor to child stunting. The etiology is poorly understood, but seems to relate to impaired nutrient absorption similar to that of environmental enteropathy and possibly inhibited metabolism of protein and other micronutrients, as well as a more systemic impairment of the child's immune system. Observational and case-control studies from Africa have not been confirmed in Asia. Thus, new information on AF exposure and its effects would be matched by a capacity to do something about it—offering the government a clear way to link investments in agriculture with investments

in nutrition. Two potential approaches to examining this issue in the first phase of the Nutrition Innovation Lab's research are:

1.2.2.1 Assessment in the PoSHAN study sites of the extent of aflatoxin contamination levels using validated field tools (VICAM's AflaCheck™). As with water quality, this would offer additional data points as potential explanatory factors in regression analyses of household determinants of nutrition and health outcomes.

1.2.2.2 Collaborating with AusAID, UNICEF and the University of Jakarta on a nationally representative assessment of aflatoxin levels (AF) in the blood of mothers and children in Timor Leste, and associated nutritional status markers and indices of household food security. A planned nationally representative survey (for 2013-14) provides an opportunity to explore the correlation between anthropometric and biomarker (micronutrient) outcomes, serum AF-albumin adduct levels, and basic food security/consumption data. Since blood samples will be collected from 1,300 women and children to assess micronutrient status, a small amount of the blood would be dedicated to an assessment of aflatoxin exposure led by Tufts University in collaboration with the University of Georgia. If aflatoxin exposure is directly correlated with nutrition outcomes, the impact of these findings would have global significance.

What's new? Potentially ground breaking analyses linking aflatoxin exposure in human subjects, aflatoxin contamination (of field crops, stored crops, food on the plate), water quality and bacterial contamination and nutrition outcomes. Prospective assessment at household level is likely, as well as large-scale cross-sectional assessments that will permit, for the first time, correlations of biomarkers with measures of dietary patterns, food security and nutritional status. This planned research leverages additional resources from UNICEF to support important Nutrition Innovation Lab goals.

1.2.3 *Gut Microbiota and Environmental Enteropathy*: The role of the gut microbiota in determining nutrition outcomes is widely assumed and discussed (Ellis et. al 2013; Smith et al. 2013) but poorly understood empirically. Most enteric pathogens in humans have animal origins. Where humans and domesticated animals live in proximity enteric pathogens can be shared; these can remain subclinical or can result in disease or malnutrition. This dynamic relationship is particularly amenable to study in isolated rural settings to study how changes in the gut microbiome in livestock affect that of their owners' children. Infants are especially sensitive to changes in environmental microbes because their immune systems and gut microbiota are still developing, and therefore more sensitive to pathogens. Zoonotic bacterial diseases prevalent in Nepal include Typhoid (*Salmonella typhi*), brucellosis, verotoxigenic *Escherichia coli* diarrhea, Campylobacteriosis, and shigellosis.

A study is planned in collaboration with Virginia Tech University on the potential for pathogens shared in the gut microbiota of humans and animals as determinants of nutrition outcomes. The objective of the research is to generate data on the human and livestock microbiome from distinct ecological regions of Nepal both in the rainy and dry seasons, and to measure link of the zoonotic disease burden to nutrition outcomes. It is likely that one of the Innovation Lab's field sites would offer a viable platform for this complementary research. The specific aims include:

- Elucidate the fecal microbiome of mothers, infants and livestock to define relationship between the livestock and human microbiome.
- Define the impact of zoonotic infection on the gut microbiome and health of livestock and humans.
- Identify genetic and environmental factors that promote stable gut microbiota in livestock and humans, and factors associated with dysbiosis in the gut microbiota.

This would be a prospective study following roughly 100 mother-infant dyads and their proximate livestock. A team of Virginia Tech investigators will contribute to this research, including a microbiologist, mucosal immunologist, veterinarian, microbial ecologist and food scientist, biostatistician, and glycobiologist. The approach will be based on collection of samples of stool, blood, saliva, and human milk from mothers and their infants. Fecal samples will be collected from livestock (cows, pigs, chickens, goats, and buffalo). Bacterial DNA will be extracted from fecal samples using the QiaAmp Stool kit (QIAGEN California). Samples will be preserved appropriately for subsequent metagenomic analysis and analysis of parameters related to human genetics. Human samples will be collected monthly for 18 months, and disease incidence will be monitored to ensure samples before, during, and after diarrheal episodes of humans and/or their livestock. As with the human samples, livestock stool samples will be evaluated locally for identification of the enteric pathogens that are associated with incidents of disease. Sixteen samples will be collected from each species in each region and pooled together to isolate DNA for microbiome analysis. The samples will be collected once a month for 18 months to identify the seasonal distribution of diarrheal pathogens.

What's new? The characterization of the human and livestock microbiota and their interactions in areas of co-existence. Potentially impactful findings on the extent of shared pathogen contamination across humans and their livestock, with correlates to nutrition and health trends, markers of sanitation, and measures of food security.

- 1.2.4 *Animal source protein in the Asian diet:* Animal-source foods have been a focus of attention in the context of child growth since the work of the first Nutrition CRSP in the 1980s (Murphy and Allen 2003; Ghosh 2013). Type of dietary protein seems to have a specific stimulating effect on weight and length gain. Research in boys under 10 years of age receiving a high milk intake had higher IGF-1 levels compared to boys receiving protein from meat (Hoppe et al., 2004a, Hoppe et al., 2004b, Larnkjaer et al., 2009).

Milk intake is positively associated with serum IGF-I concentrations and height suggesting a stimulating effect of milk on the insulin-like growth factor and subsequently on growth. In contrast, meat consumption has been found to affect cognition (Neumann et al., 2007; Belfort et al. 2013). Nepal has one of the lowest aggregate consumption levels of animal sourced protein in Asia – barely 13 percent of protein derived from animals in the mid-2000s compared with over 30 percent for countries like Pakistan and Myanmar (FAOSTAT).

1.2.4.1 The role of animal protein in the diet will be explored across all households in the PoSHAN study, as well as in the Heifer study sites where promotion of livestock holdings is an explicit aspect of the intervention trials considered.

1.2.4.2 The potential for collaboration with AquaFish and WorldFish is being explored to consider the role of aquatic protein sources in Asian diets and nutrition. The development of pond-based aquaculture in tandem with horticulture promotion and behavior change communication is being considered in certain parts of Nepal, as well as in Bangladesh and Cambodia. Serving as a variant of the homestead gardening model elaborated in these same countries by Helen Keller International over several years, it may be possible to explore how different forms of animal protein contribute to nutrition in various settings, controlling for factors such as income, education and mothers' control of diet choices and related resources. For example, a proposal to work jointly with University of Michigan as well as with Winrock International and the Agriculture and Forestry University in Nepal has recently been submitted to the Aquafish Innovation Lab to assess the impact of household fish pond farming in Nepal on fish consumption and health of women and children; their constraints determined by value chain analysis; and their extension through school ponds and women's fish farming groups.

What's new? New understanding of actual consumption patterns of animal and aquaculture-based protein in food insecure Asian households and its contribution to nutrition outcomes, and the potential impact of animal and aquaculture-focused integrated programming, particularly where combined with other nutrient-rich foods and nutrition education protocols.

1.3 *Exploring links among diet quality and nutrition and cognitive outcomes*

There is much attention to the importance of understanding more than just calorie sufficiency in achieving sound nutrition. USAID already requires the collection by development partners of a variety of in-household measures of dietary 'quality' for mothers and small children. Recent work on datasets across Asia by Skoufias and Tiwari (2013) suggests that different proxies for dietary quality or of nutrition security perform differently within countries and even more across countries. In other words, more attention is needed to how well different measures of dietary consumption relate to nutritional goals across multiple environments (Kennedy et al.

2011; Baumann et al. 2013). The Nutrition Innovation Lab's approach, which incorporates multiple sites for collecting data cutting across multiple disciplines, offers an ideal setting in which to explore the validity (statistical strength and reproducibility) of different indices and other metrics that link nutrition outcomes with diets and food system choices.

1.3.1 *Dietary patterns across Nepal*: On the one hand, the PoSHAN household panel data will be mined over time to examine econometrically how various food group, food frequency and consumption scores (e.g. the Household Food Insecurity Access Scale, Food Consumption Score, dietary diversity scores and other composite metrics) fare as predictors of current and lagged anthropometric outcomes and other measures of dietary quality. This will involve cross-correlation analysis of diverse benchmarks, including the starchy staple index, expenditure share on starchy staples, per capita consumption scores, food share in total per capita consumption, per capita kcal consumption, per capita consumption of key (nutrient rich) food groups, etc., as well as a range of child and adult measures of nutrition. Unconditional quantile regression analysis will also be used to explore if measures perform differently at different points in the income or consumption distribution, across space and over time. Multilevel modeling may also be used to explore the influence of community context on individual nutrition outcomes as per Corsi et al. (2011) in Bangladesh.

What's new? Detailed understanding of the external validity of various metrics of food and nutrition security in relation to health and nutrition trends over time as well as applicability across agro-ecological and socioeconomic contexts.

In addition, three separate discrete studies will be pursued in additional settings:

1.3.2 *Associations between maternal diet and child growth, maternal and child anemia*: A study undertaken by Harvard School of Public Health with Nepal's Institute of Medicine and Bergen University in Norway, explores how patterns of dietary intake and defined food security measures correlate with child and maternal anemia in a peri-urban setting of Bhaktapur district. Key questions explored include: 1) How do indicators based on alternative food or food group classifications compare in explaining nutrient adequacy or status of women and children (controlling for socioeconomic factors)? 2) How does a one-time measure of dietary diversity predict adequacy of nutrients (particularly iron status) compared with multiple measures? 3) What are the benefits of correcting for intra-person variation in dietary diversity in this context? 4) To what extent does a dietary diversity score reflecting maternal consumption in early childhood influence child growth? 5) What is the relationship between consumption of animal source foods and subsequent child growth? These questions are pursued in the context of a cohort study of 500 mother-infant pairs. These pairs were originally surveyed in 2008, but the data were never analyzed or published. The data include information on diet through three 24-hour recalls of lactating women, preserved plasma (not previously analyzed) from lactating women and their children, anthropometry of mothers and infants, infant

feeding practices, morbidity and household locations for follow-up. So far, the preserved plasma has been assessed in relation to iron parameters so that relationships between anemia, iron status, and dietary intake of women and children can be examined. This will deepen understandings of how maternal diet during early childhood influences *subsequent child growth*, and to better understand how changes in overall diet correlate with changes in anemia. The follow-up survey was initiated in late 2012 and 319 of the original mother-infant pairs have been re-identified to date. The follow-up survey also contains substantial information on household food security, dietary intake and socioeconomic variables.

What's new? Unique assessment of diet quality measures in relation to anemia outcomes, child growth and household food security in a panel of mother-infant pairs. Additional resources have been leveraged from the Norwegian government to examine cognitive development in the follow-up surveys.

- 1.3.3 *Dietary diversity, livestock production and nutrition:* A second study, led by the non-governmental organizations Heifer International and the Nepal Technical Assistance Group examines how measures of dietary diversity correlate with child nutrition outcomes. Designed as a randomized control trial, the study explores associations in the context of an intervention trial in three sets of paired communities in Nepal.⁴ Communities were randomly assigned to “control” or “intervention” status. Surveys were completed in 415 randomly selected households at baseline and every 6 months for 2 years (total 5 surveys). Anthropometric data and health information was collected on all children in these households at each survey point. The Nutrition Innovation Lab will facilitate additional rounds of data collection, allowing for a longer timeframe for the longitudinal nutritional data in a large sample of children, in addition to collection of relevant socioeconomic, demographic, and other parameters. The study explores the extent to which interventions framed around animal use and women’s empowerment, a) enhance child dietary quality overall (through direct consumption and/or increased income), and b) animal source food consumption specifically. This study is linked to an additional piece of research focused on multisectoral programming (discussed under section 2.2 below).

What's new? Unique randomized study of the potential for integrated programming centered on livestock to enhance child nutrition outcomes. This study leverages separate resources from Heifer International to supplement Nutrition Innovation Lab funds.

⁴ The interventions include a training program and community support activities focusing on village development, women’s groups, and social empowerment, with enhanced ruminant ownership and management at the heart of the package. Intervention communities received inputs and activities after baseline for a total of 24 months. Control communities received no intervention for 12 months, after which the same activities were introduced.

1.3.4 *Timor Leste dietary diversity and agricultural development*: As a third initiative, the Nutrition Innovation Lab is discussing the possibility of a collaborative opportunity to add dietary diversity scores to a large AusAID-supported survey in Timor Leste (outside of Nepal, but part of the broader Asia mandate of the research). Focused on agricultural practices, the survey will be undertaken in 2013 and in subsequent years as part of the 2011-2016 Seeds of Life program. A 2011 baseline covered 100 administrative units (out of 442) across the country. A total of 1,800 households were randomly surveyed (18 per administrative unit) using a probability proportional to size approach. Questionnaires built on the Population and Housing Census of Timor-Leste 2010, the National Agricultural Sample Survey (2007-2008) and household food security surveys conducted locally by CARE and Oxfam. The possibility of including diet diversity assessments as part of a series of case studies across the country was discussed with the Nutrition Innovation Lab in early 2013. The FANTA tool and FAO methods will be tested in various contexts to determine which works best, and how findings relate to data on agricultural practices, the HFIAS and other measures of household food insecurity.

What's new? An assessment of how measures of household dietary quality/diversity change over time in the context of a national agricultural productivity intervention. This study leverages separate AusAID resources to explore a question of interest to the Nutrition Innovation Lab.

1.4 Econometric analyses of secondary data (linking ecology, food systems, and nutrition)

There exists a wealth of largely untapped data exploring agriculture, dietary patterns and nutrition outcomes relating to Nepal specifically and to global conditions and trends more broadly. The Nutrition Innovation Lab will support initiatives aimed at mining such secondary data sets in ways that respond directly to core questions of relevance to policy and practice.

1.4.1 *Nepal-specific analyses*: There are numerous national-level datasets available for Nepal that can be linked with a view to understanding connections between agricultural capacity, technology adoption, nutrition outcomes, and conditioning factors at levels of aggregation ranging from household to district levels (including climatic/agro-ecological data that cut across districts). The key objective is to develop a data-driven understanding of the overlap between agricultural issues and health/nutrition issues in Nepal, so as to improve the effectiveness of nutrition policy. Led by Purdue University in collaboration with colleagues at NASA and Tufts University, this activity will use multiple rounds of nationally representative datasets: the Nepal Demographic and Health Survey (DHS) and the Nepal Living Standards Survey (NLSS). The goal is to analyze spatial and temporal patterns of nutrition, health and agriculture to identify the magnitude of nutrition impacts resulting from policy-driven changes as well as regional factors that influence nutritional outcomes. By combining the DHS and NLSS data with geographic information system data (such as rainfall layers, NDVI and temperature gradients) localities can be characterized according to their performance on combined agricultural, health and nutrition outcomes (which cannot be done using either the DHS or NLSS data

in isolation). Regression models and other statistical analyses will quantify the connections between agricultural capacity (natural and other assets), market access, nutrition outcomes, and agro-ecological conditioning factors at various levels of aggregation.

What's new? A series of papers rigorously exploring how patterns of climate, ecology and agricultural productivity relate to health and nutrition outcomes over time.

1.4.2 *Global data analyses:* The process of development, including increased income and urbanization, along with associated changes in agricultural and food systems, is inextricably linked with changes in national diet and disease profiles. Research on links between agricultural growth and nutrition outcomes over time (Webb and Block 2012), suggested different trajectories for stunting, wasting and obesity over time with income growth per capita derived from agriculture. That study was restricted to 29 developing countries and did not incorporate explicit attention to foods nationally available over time, and hence dietary pattern links to these trajectories. This research, pursued in collaboration with the Leverhulme Center for International Research on Agriculture and Health (LCIRAH) will investigate the association of national changes in food availability with nutritional and health outcomes for a much larger sample of developing as well as developed countries. The analysis will link global data sources of national food availability and disease profiles collected over the past 30 years and explore potential drivers of change including markers of development and support for agriculture. Questions to be explored include:

- Does increased consumption of fruit and vegetables mitigate the relationship between fat/sugar consumption and increased levels of both under nutrition and NCD risk factors. Countries with higher fruit and vegetable consumption may have lower levels of NCD risk for their stage of development, but due to the low energy density of fruit and vegetables may also have a higher prevalence of stunting and underweight.
- While protection of agriculture during development through policy action mitigates some of the health consequences of development by protecting diets and incomes of the poor, do countries with policy protection for agriculture above a certain threshold of income per capita have lower levels of both stunting and NCD risk factors?
- Are countries with low income inequality protected from increases in NCD risk that accompany development? Is this mirrored by more equitable reduction in stunting?

A linked database will be created to combine indicators from FAOSTAT, databases of World Development Indicators and the Distortions to Agricultural Incentives sets from the World Bank, and the Lancet series of papers investigating worldwide trends in under nutrition, obesity, hypertension and cholesterol. Estimated years for analysis will be 1980-2008, and data on most indicators are available for around 177 countries. Once the database has been populated, links between food and nutrient availability, measures of disease and indicators of development over this time period will be

explored graphically (using scatter plots and line graphs). Mixture modeling of time-series data will explore trajectories in disease risk over time for each country, and assess how these trajectories vary according to food availability composition and development indicators. The year will be level 1 in the model, the country will be level 2 and a third level may represent region or country income level. Models will be fitted using a Markov chain Monte Carlo algorithm with a minimum of 1000 iterations.

What's new? A first large-scale analysis of trends in agriculture, poverty reduction, food patterns and nutrition outcomes over time and space. This study will leverage resources from DFID to support an activity of direct relevance to the Nutrition Innovation Lab.

2. ***Understanding How Complex Multisector Programs Work:*** How can large-scale programs best incorporate knowledge about agriculture's support for nutrition into cost-effective multisectoral interventions aimed at improved nutrition?

The multicountry Scaling Up Nutrition (SUN) movement proposes that “there is a need to incorporate nutrition interventions into smallholder agriculture and rural livelihoods programmes, for example through encouraging home production of foods like fruits and vegetables and animal products that are rich in nutrients.” (SUN 2011) The logic underpinning such a prescription is the widely-accepted idea that “the bulk of the poorest in the world are peasant farmers” (Dalyell 2012; see also HTF 2005), and that actions combining agriculture with targeted health and nutrition activities can both amplify and accelerate gains in nutrition among that target rural population.

The bundling of multi-sectoral components into a linked portfolio of actions is often justified by claimed interaction effects (Ravallion 2013). For example, Timmer et al. (1983) proposed that “integrating the conceptual design of food and nutrition interventions will probably pay high dividends through greater cost-effectiveness of individual programs and greater opportunities to sense and capture program synergies.” They also proposed that “much of the improved performance will come from intersecting targeting, for example, by geographic region at particular times of the year with specific commodities consumed primarily by the poor. Significant synergy might also be expected from programs that intersect.” Similarly, Heaver (2005), focusing on World Bank activities, argued that “multisectoral programs are the most effective way to tackle malnutrition.”

The biggest problem is the lack of clear evidence-based guidance on how to do this, where it makes most sense, and how cost-effective such actions would be at scale compared with any alternative interventions. According to the World Bank (2010), understanding of complex interventions needs to be “enhanced by collecting data on service delivery, demand-side behavioral outcomes, and implementation processes to better understand the causal chain and what part of the chain is weak.” The main challenge for implementing complex programming in

Asia, according to Ved (2009), is that multicomponent models of intervention demand “a high level of quality and performance, coordination and convergence in the face of varying and limited management and technical capacity, poor governance environments, and little experience.” (Ved 2009) In other words, even the best designed programs do not implement themselves, yet need for such interventions is often precisely where capacity to implement is weakest.⁵ This is particularly true for nutrition.

2.1 Understanding multisectoral interventions from the bottom up

The Nutrition Innovation Lab’s research in this domain will focus on seeking to identify which “active ingredients” (Oakley et al. 2006) of multisectoral programming located in various PoSHAN study sites have greater or lesser impact on health and nutrition outcomes, either singly or in combination with others. This represents ‘implementation research’ in that its intent is to investigate and address major bottlenecks (e.g. social, behavioral, economic, management) that impede effective implementation, test new approaches to improve health programming, as well as determine a plausible relationship between the intervention and its impact.⁶ It does not, however, involve any explicit intervention trial or randomized assignment of treatments, because a) the government supports roll-out of multisector programming based on MSNP in a few selected sites only (two of which include PoSHAN study districts), to gain experience and lessons learned prior to expansion across the country; b) new integrated agriculture-nutrition programming supported by USAID, the World Bank, the European Commission and by many NGOs is similarly targeted to different localities around Nepal based on non-random characteristics, and c) none of the large multisector interventions planned for Nepal in the 2012-2015 period has been amenable to randomized research (for a variety of donor-driven resource and timing-related reasons). As such, it was decided by the Nutrition Innovation Lab team to accept the systematic random sampling of study sites described under Section 1 above, and use those sites as living laboratories in which to explore:

- Program fidelity (how well did actual intervention match program design?)
- Reasons for uptake of programmed resources at household level (exposure to ideas, services and assets; decisions to adopt/accept or not adopt/accept new practices or resources; constraints at individual, household, community, program levels)
- Effectiveness of program uptake (process tracing to determine what impact adoption/acceptance had on health and nutrition outcomes)

⁵ More than two decades ago, Petersilia (1990) argued that, “the ideas embodied in innovative social programs are not self-executing”, and that what is needed by planners is an “implementation perspective on innovation—an approach that views post adoption events as crucial and focuses on the actions of those who convert it into practice as the key to success or failure.” Since that time, the call for empirical research that addresses “the multitude of gaps that impede evidence-based interventions from producing optimal health outcomes” (NIH 2013) has been oft repeated but little heeded (Menon et al. 2012).

⁶ According to the US National Institutes of Health, the newly emerging field of implementation science “is the study of methods to promote the integration of research findings and evidence into...policy and practice. It seeks to understand the behavior of...professionals and other stakeholders as a key variable in the sustainable uptake, adoption, and implementation of evidence-based interventions.” (NIH 2013)

- Sustainability of program intent (duration, intensity of adoption/acceptance)
- Equity issues (socioeconomic and geographic distribution of coverage, exposure, adoption/acceptance, and impacts)

Questions and survey instruments are informed by the impact pathways conceptualized under the first broad research domain above. Every effort will be made to ensure that data from program monitoring and evaluation (M&E) systems can be accessed and linked to the research, and that there is mutually-beneficial interaction among researchers and implementing teams. A Memorandum of Understanding has been signed with the Suaahara program of USAID, as well as with Heifer International to promote sharing of, and collaboration on, data and analyses.

The range of multisector programming is quite large. The 21 randomly selected study sites include 7 that are to receive USAID's Suaahara program, 4 more that are targeted by USAID's next generation 'Feed the Future' activity, 2 that are included in the World Bank's targeted voucher scheme for nutrition, 4 involved in the Thousand Golden Days program of the European Commission, and 4 more that did not (in 2013) represent explicit targets for any form of multisector intervention. Of these activities, only the Suaahara program was beginning to be rolled out during early 2013 when the first round of PoSHAN data collection was initiated, and most of the initial Suaahara activity was based on training of trainers and establishing baseline data collection for the program's own impact evaluation (by IFPRI). As such, the PoSHAN sites present 'natural experiments' in which to examine how panel households become aware of new multisector programs, get recruited/exposed to them, decide whether or not to participate in them, how they manage new resources (or not), and what impact participation has on the determinants of child and maternal nutrition.

The 'active ingredients' of these programs will certainly vary by location and donor, but most include elements (combined in various ways) of a) behavior change communication relevant to nutrition, b) promotion of agriculture-based income earning opportunities, and c) promotion of enhanced access to health resources or services. Importantly, PoSHAN will focus on interventions that include nutrition-specific or explicitly nutrition-sensitive activities as defined by Ruel et al. (2013); namely, that they "incorporate specific nutrition goals and actions." In other words, they must expect to have a net positive impact on nutrition outcomes among participant households even if other goals are equally important, such as increasing farm productivity, raising household incomes or improving health.

Given the variety of programs to be implemented across the PoSHAN study localities it will be possible to trace program impact pathways along multiple routes. The over-riding question is to demonstrate if synergies among 'ingredients' and pathways offer 'value added' over individual components. That is, can integrated programs have better impact (faster, greater, more sustained, more cost-effective) than what could have been achieved by pursuing one or other action alone? As Ravallion (2013) puts it, "we need to think creatively about how best to

go about evaluating the portfolio as a whole, allowing for interaction effects amongst its components, as well as amongst economic agents. This is not going to be easy.”

The Nutrition Innovation Lab will explore ‘program exposure and adoption’ among panel households by assessing not just what they know about interventions, but also whether or not they accessed resources offered (and why), and who in the household was involved in what aspects of multisector activities, but also tracing the effect of participation over time on knowledge, household resources use, and outcomes. In this sense, PoSHAN will establish a richly detailed empirical database focused on program fidelity *from the demand side*, which links to the process research (under section 3 below) focused on fidelity from a programmatic ‘supply side’ dimension.⁷ Thus, generation of greater clarity on constraints to program implementation (fidelity) at each layer of operational management -- from central level down to community level -- will be matched with greater clarity on constraints to program uptake by households and their level of ‘devotion’ to the innovations proposed.⁸ Building on the work of Carroll et al. (2007) and Dariotis et al. (2008) the PoSHAN research focuses on 5 groups of fidelity factors with the overall implementation system that together determine program outcomes:

- Implementer characteristics (organizational and human capacities, experience)
- Institutional organization characteristics (efficiency, capacity, collaborative mechanisms)
- Program characteristics (resourcing, coverage, intensity, ‘dose’, duration, etc.)
- Recipient factors (relevant aspects of community, household, individual characteristics)
- Setting or context characteristics

Similarly, there will be attention to potential ‘effect modifiers’ (Marsh et al. 2008), called “moderators” in Hasson’s (2010) framework for assessing program fidelity in Figure 4 below, which go beyond usually-collected socioeconomic characteristics. These include:

- Empowerment issues (gendered control of assets, resources and exposure to information)
- Competition for time and other resources (constraints to adoption)
- Local political, ethnic, and other discrimination
- Negative externalities (trade-offs in resource use, potential impairments to schooling, health, diversity of income sources, diet quality, etc.)

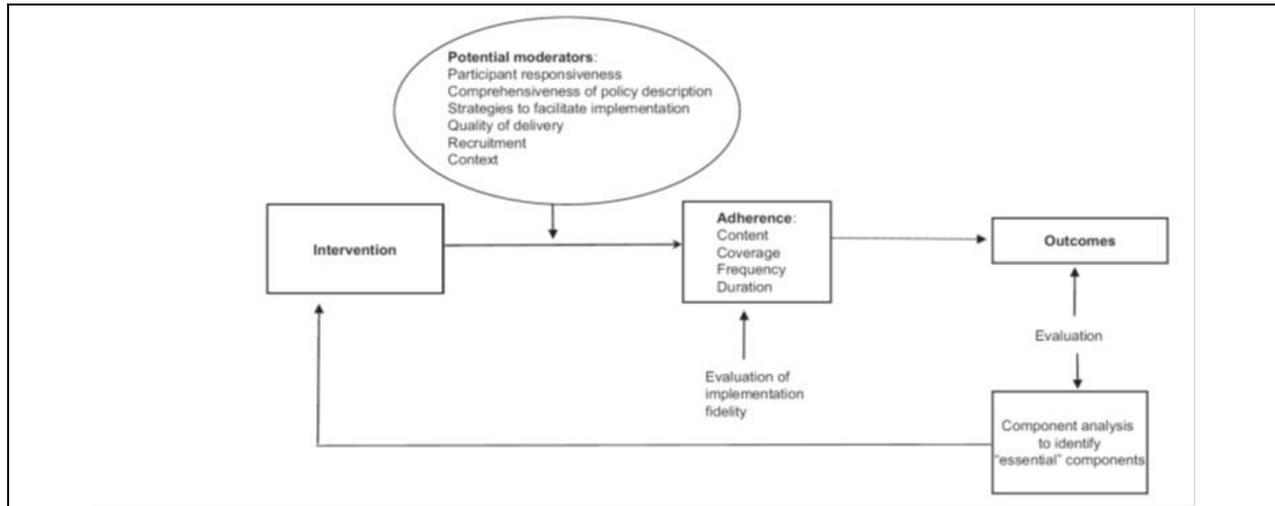
That some eligible beneficiaries of goods and services offered by multi-sectoral programming do *not* take up the offer is an important factor usually ignored in impact evaluation and even in randomized control trials (Ravallion 2013). By considering the behavior, choices and activities of *all* households in

⁷ This conforms with Linnan and Steckler (2002) who make a distinction between dose delivered (intended units of any component actually supplied by a program) and dose received (the extent to which participants in a program “actively engage with, interact with, are receptive to, and/or use materials or recommended resources”).

⁸ Mowbray et al. (2003) defines fidelity as “the extent to which delivery of an intervention adheres to the protocol or program model originally developed.”

a randomly selected study site, not just those actively participating in a defined program, will permit greater depth of understanding of constraints to program fidelity in multiple settings.

Questions asked at household level include information on frequency and timing of interaction with ministry and/or project staff on the ground, services or resources provided through them (linked to agriculture, health, nutrition or other sectors), satisfaction with such interactions, and ultimately use of services and resources, potential alternative sources, reasons for non-adoption or dis-adoption, etc.

Figure 5: Factors to be accounted for in assessing program fidelity

Source: Hasson (2010), based on Carroll et al. (2007)

These ‘demand side’ data will be collected from households annually using questionnaires informed by those used by IFPRI in their Suaahara baseline (and other recent IFPRI modules), the Alive and Thrive surveys in Cambodia and Bangladesh, World Bank project evaluation modules (http://microdata.worldbank.org/index.php/catalog/impact_evaluation), as well as the collective experience of the research teams (which include three Nepali co-principal investigators with agriculture and public health backgrounds). All survey instruments are field tested, adapted and formally approved through relevant ethics review processes at Tufts, Johns Hopkins, Harvard and the Nepal Health Research Council.

Questions are collected from ‘implementers’ of programs (the supply side) at various levels, including program leaders, mid-level and technical managers, and field-based service providers. These interviews also take place annually and are linked to activities specific to the 21 study sites (as elaborated under section 3 below).

Parametric and non-parametric analyses will determine the relative importance of all such factors to program effectiveness and impact. While in most cases there will be pre- and post-intervention data available there is no formal control group for each study location, since the research is not designed as an intervention trial. While there will be study locations ‘without’ interventions to act as comparators, the real world situation examined here is one in which lessons are drawn from actual practice (an ‘intent-to-treat’ approach) which allows for household and community ‘matching-by-analysis’ econometric techniques, careful costing of intervention components and exploration of implementation dynamics on an on-going basis. There is no ‘bias’ in sample selection in that sites were randomly selected and attention will be paid to all forms of integrated programming affecting the study households that have explicit nutrition intent (not one program versus another).

The challenges (and there are many) to empirical assessment of the fidelity of multi-component models relate to the fact that different components tend to be delivered by different actors based in sector-defined institutions (such as line ministries or specialized NGOs), different beneficiaries can be exposed to multiple levels of ‘treatment’, and different outcomes are likely to be seen according to levels of that exposure which are determined by many dimensions of program fidelity, including coverage, synchronicity of delivery by different sectors, intensity of treatment, etc. (Imbens and Wooldridge 2009). Thus, while Mowbrey et al. (2003) highlighted the long-standing controversy between “maximizing fidelity in contrast to the desirability or even the necessity of adaptation”, there is no expectation here that all program elements will be fully, simultaneously and exactly implemented as planned. Research on program fidelity has to be able to accommodate such fluidity by seeking to document where and when changes to protocol were made (by choice or by happenstance).

One analytical approach to be explored in this context is multiple hypothesis testing which is increasingly used in the context of investigations of program impacts through sub-group heterogeneity analysis. That is, in addition to seeking out the most relevant ‘active ingredients’ of packaged or integrated interventions, multiple outcomes can be grouped such that the overall impact of ‘treatment’ can be determined in relation to what McKenzie (2012) calls “a family of outcomes.” If, for example, a household or grouping of households exceeds a given threshold of ‘benefit’ across, say, 6 out of 10 possible benefits linked to a multicomponent intervention, then such a collective outcome can be assessed as being different from zero rather than each outcome individually (Andersen 2008).

What’s new? Rigorous operations research that links supply and demand side issues to understand programming effectiveness for nutrition.

2.2 Assessing impacts of adding a nutrition-specific component to a nutrition-sensitive program

An additional study will be supported by the Nutrition Innovation Lab outside of the PoSHAN sites since it offers a window of opportunity to assess the ‘layering’ approach of some multicomponent models (where the addition of one more element to an existing program can have a disproportionately significant gain). The location is the district of Nawalparasi in the Terai, where Heifer International has added a new component to the intervention trial described under 1.3.3 above.

The original RCT represented a package of interventions that were expected to improve child nutrition, but appear to have done so only to a limited extent (based on preliminary analyses). The experiment was therefore extended to determine if the inclusion of a specific nutrition intervention (based on behavior change communication) would significantly improve the nutrition outcomes. A nutrition education curriculum was developed and field tested by Heifer and linked to other activities around animal husbandry training, provision of livestock, and community development. The study will assess the value-added effects of the nutrition curriculum on child growth using matched communities in Heifer working areas. Communities

will be randomly assigned to receive: 1) Heifer activities plus the nutrition curriculum, 2) training in child nutrition and animal husbandry, and provision of livestock, without social capital activities, or 3) no interventions. After a baseline survey, households will be followed up every 6 months for 2 years (total 5 surveys). Anthropometric measurements will be obtained on all household children at each survey time, along with indicators of child health.

What's new? Understanding the specific value-added role of nutrition education (BCC) added to integrated programming in agriculture, using an RCT approach.

3. Understanding Policy and Programming Processes: How can policy and program implementation *processes* be enhanced to support nutrition-specific and -sensitive actions?

According to Lobb and Colditz (2013), implementation science has evolved as a direct response to policymaker demands for evidence on, a) the cost-effectiveness of complex national-scale initiatives, and b) how to best implement large multicomponent programs. In both cases, greater attention is required to how initiatives are managed and implemented, not just to what is done.⁹ Interventions do not operate in a vacuum. They are implemented in a context that has spatial, temporal, political, economic and other characteristics.

That said, there is little clarity on the most appropriate methodologies for process tracing or implementation research. According to Garrett et al. (2011), “an explicit, well-developed theory of working multisectorally does not exist, certainly not for nutrition.” A systematic review of the literature published between 1994 and 2007 on public health in developing countries concluded that analysis of how policies are implemented is “still in its infancy.” (Gilson and Raphaely 2008). The authors of that review argued that much more understanding is needed “on implementation, and specifically, the challenges of implementing equity-oriented policies, as well as more examination of successful policy change experiences.”

The Nutrition Innovation Lab’s approach to process research builds on the work of policy analysts such as Walt et al. (2008), Garrett and Natalicchio (2011) and Pelletier et al. (2012). Each has proposed and tested ways through which to pursue concurrent or prospective analyses of policy processes by capturing “the views of multiple stakeholders and tracing the influence of each organization’s practices and culture upon the policy process.” (Exworthy et al. 2008) All such approaches are based on sets of interviews with individuals who are, or were at some point, part of the process.

There are many such individuals where multi-sectoral government or multi-agency actions are concerned, and also multiple layers of decision-making. In seeking to define policy

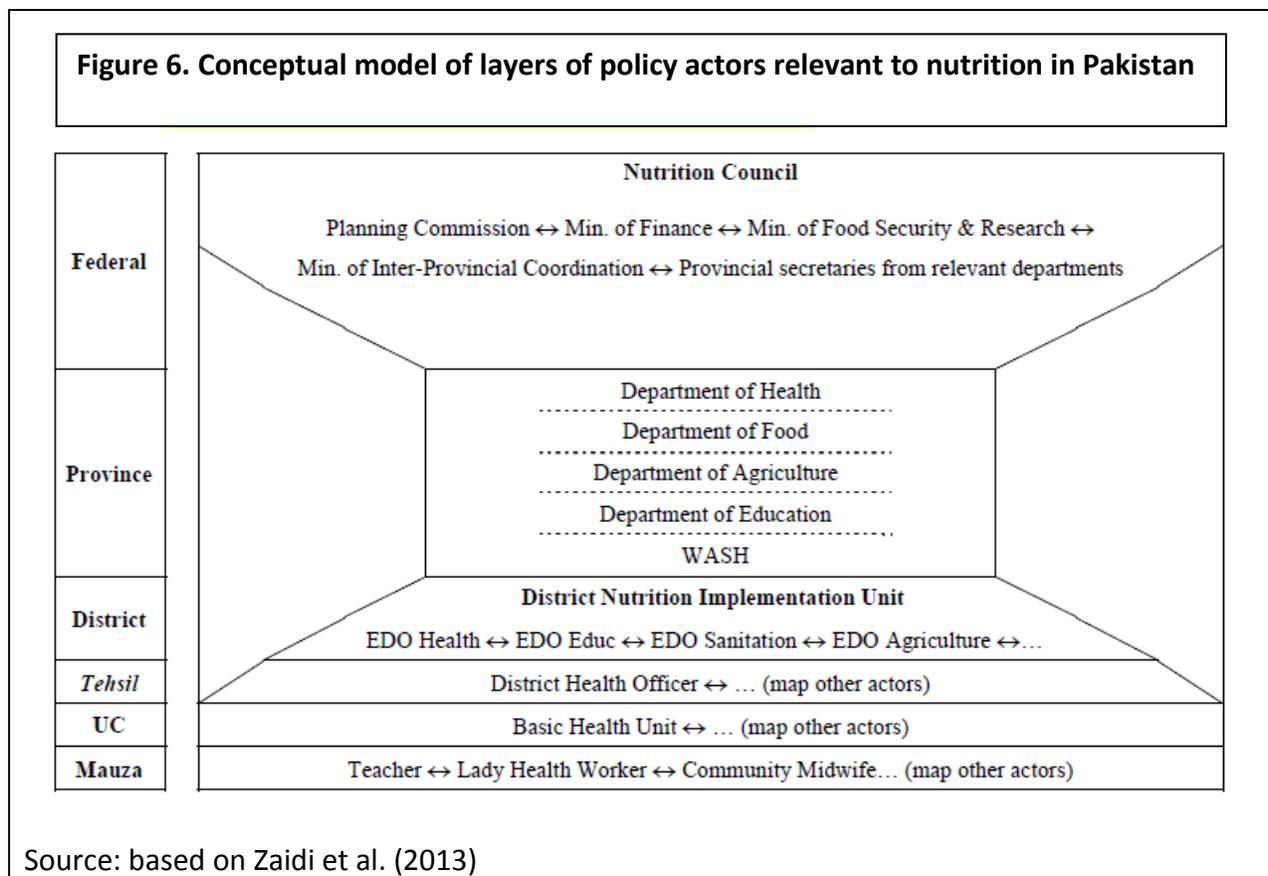
⁹ For Deaton (2002), “policy cannot be intelligently conducted without an understanding of mechanisms; correlations are not enough.”

“mechanisms at work” (White and Phillips 2012) one has to accept that “decisions ‘emerge’ rather than taking place at a single point in time” (Walt et al. 2008). Determining the most appropriate way to specify how those decisions emerge, where in the system, and when, remains an inexact science (Menon et al. 2012).¹⁰ Fixsen, et al. (2005) emphasized the multi-level influences on implementation, including what they call external influencers to organizational procedures, which themselves include the role of the individuals who manage practitioners and practitioners themselves all along a chain of authority and responsibility.

The importance of individuals and institutions at different levels of authority guided Zaidi et al. (2013) in their assessment of constraints to actions on nutrition in Pakistan (Figure 5). While the titles and functions of the ‘players’ identified in Pakistan are different in Nepal, the picture is remarkably similar. There are key stakeholders at the macro (federal) level who ‘manage’ people and resources at the meso level (regions, districts, ilakas), and they manage people and resources in the same line ministries, agencies or NGOs at the micro level (VDCs and wards). At each level, the key is to ascertain “the dynamic interplay between individuals and the organization within which they work and how that interplay influences individual or organizational behavior [in relation to multisector policies].” (Damschroder et al. 2009) At the macro policy level, Pelletier et al. (2011) suggest that there are 5 clusters of factors that affect the evolution of *national* nutrition agendas and policies; namely, i) societal conditions (events and processes that persist for many years); ii) catalytic events (programs and policies defined in relation to nutrition); iii) structural factors (the institutional arrangements for promoting and coordinating multisectoral approaches); iv) points of contention (disagreements over strategies and interventions complicated by politics among stakeholders); and v) the behaviors, strategies, and tactics of federal-level actors (issues of leadership, capacity and willingness to collaborate).

Below them, at the meso level, there are many of the same factors at play, but greater attention needs to be paid to actual versus planned resource flows, management effectiveness, and de facto rather than de jure elements of policy or program implementation. According to a review of the policy process in Bangladesh, Bolivia, Guatemala, Peru and Vietnam, Pelletier et al. (2012) found that “mid-level actors from ministries and external partners had great difficulty translating political windows of opportunity for nutrition into concrete operational plans, due to capacity constraints, differing professional views of undernutrition and disagreements over interventions, ownership, roles and responsibilities.”

¹⁰ As Walt et al. (2008) point out, “processes of ‘making’ policy are not necessarily overt or clearly bounded.” At the same time, decision-making processes are typically opaque, decisions usually emerge over time rather than appear fully formed as discrete ‘events’, and there are many hurdles to “accessing the many different, geographically widespread actors, individuals, groups and networks involved in policy processes.”



At the local or micro level, policies and program implementation requires “well-trained and motivated staff that are provided with adequate support and incentives to take pride in their work and deliver the best possible services.” (Olney et. al. 2010) Here, special attention must be paid to individual capabilities, knowledge and how individuals practice their defined responsibilities. The actions and attitudes of fieldworkers (project NGO staff as well as extension agents, community health workers and social mobilizers) as they interface with households is key: how do they reach out to households, how effective are their interactions, are they responsive to expressed need, how do they interact with the other service providers, what constraints do they face in working more collaboratively?

At each of these broad ‘layers’ of the implementation process, empirical information is needed on the key individuals and institutions involved. In this regard, the literature broadly agrees on the importance of the following 4 dimensions:

- a) Position (ministry (or other) function, responsibility, reporting channels)
- b) Power (authority, resource control, charisma)
- c) Players (stakeholder gender, education, experience, politics)
- d) Perceptions (knowledge, ideas, attitudes and practices of the individual)

Centering research attention on how the four ‘Ps’ play out in policy processes builds on several bodies of literature, including Kingdon’s (1984) theory of ‘multiple policy streams’ (where intensified attention to nutrition would need to be understood in its relation to other national priorities), the so-called punctuated equilibrium theory promoted by Baumgartner and Jones (1993) and Shiffman (2002) (where the promotion of national policies and strategies on nutrition represent disruptive bursts of agenda-setting after a long period of inertia). It also relates to ‘implementation theory’ (Sabatier 1999) which posits that decision making on social goods tends to be top-down rather than responding to expressed demand from the bottom, and organized accordingly. And it is consistent with the theoretical work of Walt et al. (2008), Buse (2008) and Pelletier et al. (2010), all of which have informed survey techniques and approaches promoted by IFPRI (Menon et al. 2012), including participant observation, review of official documents and triangulated interviews (both structured and open-ended).

3.1 *Assessing policy process effectiveness as a determinant of nutrition outcomes*

The study goal is to link measures of institutional and individual capacity to link work across sectors at national and district government levels (multiple line ministries), with measures of program fidelity at local (sub-district and community) levels and human outcomes across 21 field sites. The capture of insights from stakeholders along the entire chain from central (government) level down to the beneficiary (household) represents a survey-based in-depth longitudinal prospective study of events as they unfold. The study uses semi-structured questionnaires as data collection tools. Interview content will be kept confidential, but answers are coded and aggregated in ways that de-identify individual respondents.

Key research questions include:

- a. What is the evidence base used by stakeholders in developing multi-sectoral policy and integrated activities in Nepal?
- b. How are ‘new’ nutrition goals and actions aligned or added to other activities?
- c. What collaborations pre-exist across sectors and how are they affected by proposed multisector policies and interventions?
- d. What barriers/facilitators/constraints affect collaboration, resource flows and implementation of proposed policies and program elements?
- e. What effect do organizational culture, institutional resourcing and individual capabilities have on effective implementation and level of ‘readiness to change’ from a management perspective?
- f. How do differing levels of autonomy and responsibility affect collaboration?
- g. Does employment stability (length of stay in a position/experience) affect individuals’ knowledge, attitudes and practices in their job?
- h. What incentives and dis-incentives for collaboration exist at various organizational levels and across ministries and agencies?
- i. What resources can be accessed at different levels (financial, social, intellectual) to support collaboration, learning, innovation and effective implementation?

The study is based on interviews with stakeholders defined at the national, sub-national, district, Ilaka, VDC and ward (field level service provision) levels (see Table 2). There is no 'representative' universe of stakeholders from which to draw a sample for such research. The approach taken instead was to define the core organizational entities that are directly involved in either the national Multi-Sector Nutrition Plan and/or at least one of the various multisectoral programs planned or newly launched in Nepal. From a government perspective, that meant conducting interviews with relevant office-holders in 10 ministries or coordinating bodies at the central level, 8 at the meso-level (the main line ministries having some role to play in managing resources and activities that feed down to the relevant districts), and 3 at the micro level (implementers of government services at the community level).

From a non-government perspective, a range of key donor and NGO organizations were identified as 'players' in the appropriate policy and programming arenas (for example, as core members of the National Nutrition Group, having had a role in the NAGA (2009) assessment, and/or active engagement with donor-funded integrated programs) as well as academics directly involved in advisory, consulting or other collaborative capacities. At the meso and micro levels, relatively fewer institutional players are involved from the donor and academic perspective, so data collection focuses on line ministry and implementing NGO stakeholders.

At the national level, interviews with policymakers and senior program staff are conducted by Tufts researchers in association with Nepali collaborators. At the other levels, a local survey firm conducts the interviews. In addition to ministry staff, additional interviews are pursued with select officials from government coordination bodies (e.g. the National Planning Council and the Nepal Nutrition Group) as well as with select staff from donor agencies, UN agencies and international and domestic NGOs. The stakeholders from the government include representation from multiple sectors/activities, including planning, finance, agriculture, nutrition, health, social welfare, local development, education, water and sanitation. Additionally, thought leaders from key local academic institutions are also included, including the Institute of Medicine/Tribhuvan University, Padma Kanya Campus, Tribhuvan University, Patan Academy of Medical Sciences, the Institute for Integrated Development Studies), and UN and donor agencies (such as UNICEF, World Bank, WFP, USAID, DFID etc.)

Table 2. Sample frame for process research interviews in Nepal

Central/national	Institutions/Individuals	Interviews per site	Number of sites	Total interviewed
Government	NPC and Line ministries	10	1	10
NGO/UN/Bilateral	INGOs, UN, USAID, World Bank, National Nutrition Group, DFID	10	1	10
Academic	Tribhuvan University, Patan University, Padma Kanya University	5	1	5
District level				
Government	Agriculture, health, nutrition, water supply, sanitation, local development officers, other officials	8	21	168
NGO	Main implementing LNGO, NTAG and Local Chapter of NGO Association	3	21	63
Ilaka Level				
Government		8	21	168
VDC Level				
Government	From 21 VDC health facility posts, agricultural offices, social mobilizer	3	21	63
Ward Level				
Government	Health Worker, Agricultural Extension worker and Social Mobilizer in selected wards	3	63	189
Total Sample				676

According to Walt et al. (2008), “capturing and measuring levels of resources, values, beliefs and power of diverse actors is difficult.” Every effort is therefore made to generate answers to rigorously framed questions in such a way that comparability and replicability are possible across study locations, across levels of enquiry and across years of surveys. The ‘interview triad’ approach of Brownhill and Hickey (2012) suggests the value of triangulating ideas and attitudes on key issues across multiple informants in standardized ways. The analytical approach involves careful coding of interview responses in a standardized way that allows the creation of a dataset with unique identifiers by study location, function of respondent, level of function and year. These data can then be analyzed in five main ways to understand:

- i) **Vertical coherence** in the policy process. Do individuals in the chain of authority from central to local levels (in government or in implementing agencies) share a common understanding of defined policy agendas, problems to be tackled, priority technical or strategic issues, capacity needs and constraints, collaborator weaknesses and strengths, knowledge and experience.
- ii) **Horizontal coherence** in the policy process. Do individuals with similar levels of authority (working in the same layer of the process but in different institutional entities) share a common understanding of defined policy agendas, problems to be tackled, priority technical or strategic issues, capacity needs and constraints, collaborator weaknesses and strengths, knowledge and experience.
- iii) **Collaboration dynamics** in the policy process. Who works with whom and why? Does this change over time in the context of planned multisectoral action? What are the key determinants of effective collaboration (level of authority, individual training and experience, gender of individual, scale of resources, etc.)? Does the knowledge, attitudes and practices of individuals in relation to collaboration, complex programming and nutrition goals change over time, and does this enhance their effectiveness?
- iv) **Policy and Program Fidelity as an outcome of vertical and horizontal coherence.** Is the effective roll out of policies and implementation of complex programs determined by measures of coherence in different administrative settings?
- v) **Policy and Program Fidelity as a determinant of nutrition outcomes.** To what extent do measures of process coherence serve to enhance understanding of the determinants of nutrition and health outcomes?

Annual process surveys are tied to the 21 PoSHAN household survey sites, which allows for ‘process’ variables to be included in econometric analysis of the determinants of both programming effectiveness and human outcomes. On the one hand, the approach permits a pooling of data across sites to generate statistical power and a degree of national representativeness of findings. On the other hand, the approach allows for disaggregation by broad categories of study sites (for example, by the country’s major agro ecologies of the country), as well as for multiple in-depth ‘case studies’ based around the sentinel sites or on different kinds of intervention sets. The use of case studies explicitly acknowledges the importance of variability of context, and because they help in answering ‘how’ or ‘why’ questions through detailed examination of complex phenomena (Wells et al. 2012).

What’s new? A first ever analysis of individual and institutional processes at multiple levels of governance as potential determinants of programming effectiveness and nutrition outcomes at local and household levels.

3.2 Effectiveness of training-of-trainers ‘cascade’ approaches for the delivery of health and nutrition messages in integrated programming.

The fidelity of program implementation has increasing significance within the context of evaluation, treatment effectiveness research and service administration (Mowbray et al. 2003) and there is increasing emphasis on the need to gain insight into the “black box” of interventions (Hulscher et al. 2003, Hasson 2010). Within the context of impact pathways, program fidelity measurements allow determining if the achievement of the expected outcomes is due to the success or failure to implement the program model as intended (Mowbray et al. 2003).

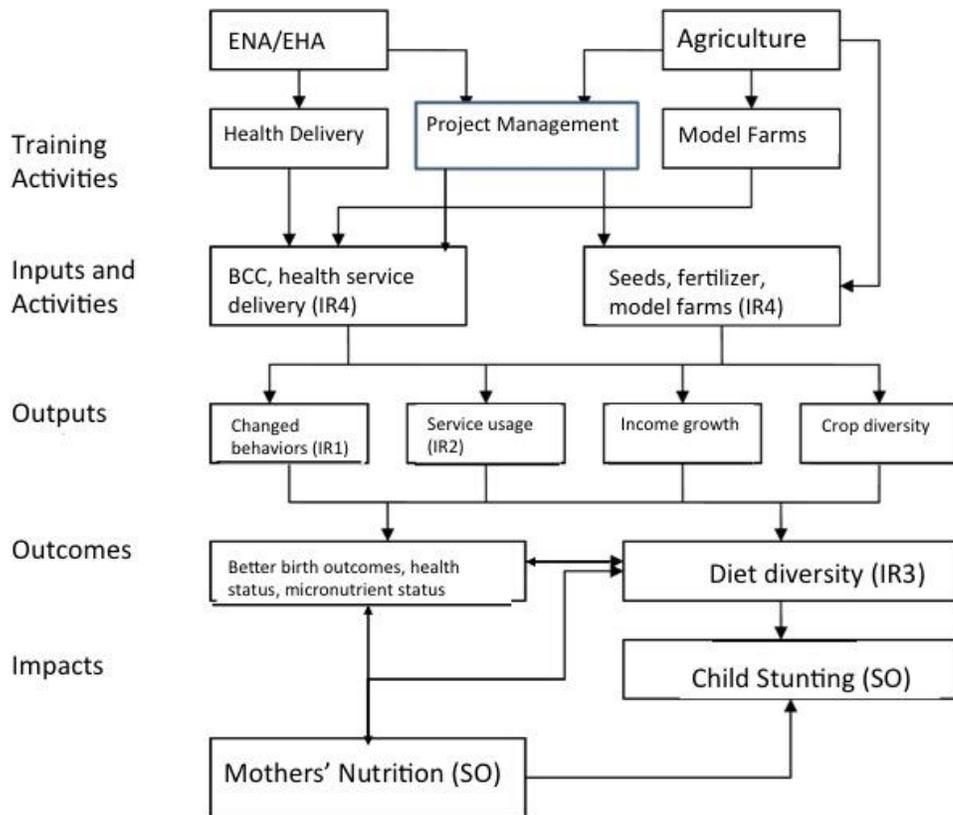
In-service training is a significant component of integrated programs targeting nutrition and health outcomes. Outcomes depend greatly on the quality of teaching, not just the content (Morgan and Deustchmann 2003). While it can take many forms, a low resource intensive form of in-service training that is often used by programs is the “training of trainers cascade approach” where central core or master trainers are trained who are then expected to train others. In this approach, a cascade of training is initiated in which master-trainers teach knowledge, intervention techniques, activities or skills to trainees who in turn become trainers and transfer knowledge gained (and training skills) to others down the cascade (Baron 2006). The cascade approach can also allow for the spread of information at a remarkable speed which could be problematic if the information transferred is inaccurate, culturally insensitive or not relevant (Baron 2006).

The cascade approach of training takes four forms, hierarchical, process, employee role and project. Within development and integrated programming, the cascade approach is usually implemented in the hierarchical form where training starts at the upper management or master level and moves downwards through the system up to the frontline workers (Rafi 2010, Morgan and Deustchmann 2003). Rafi (2010) reports cascade approaches to be an effective training tool for transferring education around human rights and law to front line volunteers in Bangladesh but others caution the use of these approaches and indicate that these have often failed due to the inability to guarantee the training quality and the lack of fidelity in knowledge transfer (Morgan and Deustchmann 2003). Success or failure is dependent on the quality of training as well as the length of the cascade where a shortened cascade that is implemented by external in partnership with local trainers (the latter whose capacity has been developed by the former) is likely to be a possible solution (Morgan and Deutschmann 2003).

USAID programs with a behavior change or messaging component (BCC) have consistently used the training of trainers cascade approach, especially in the realms of malaria diagnostics and girl’s education. Within the Nutrition Innovation Lab research agenda, there is a unique opportunity to explore the effectiveness of a specific “training of trainers” cascade approach in relation to the quality of the training, adherence to protocol of training, fidelity of messaging and leakage of messaging. Specific examples of programs in Nepal that are implementing a training of trainers cascade approach to transfer messages of essential nutrition and health

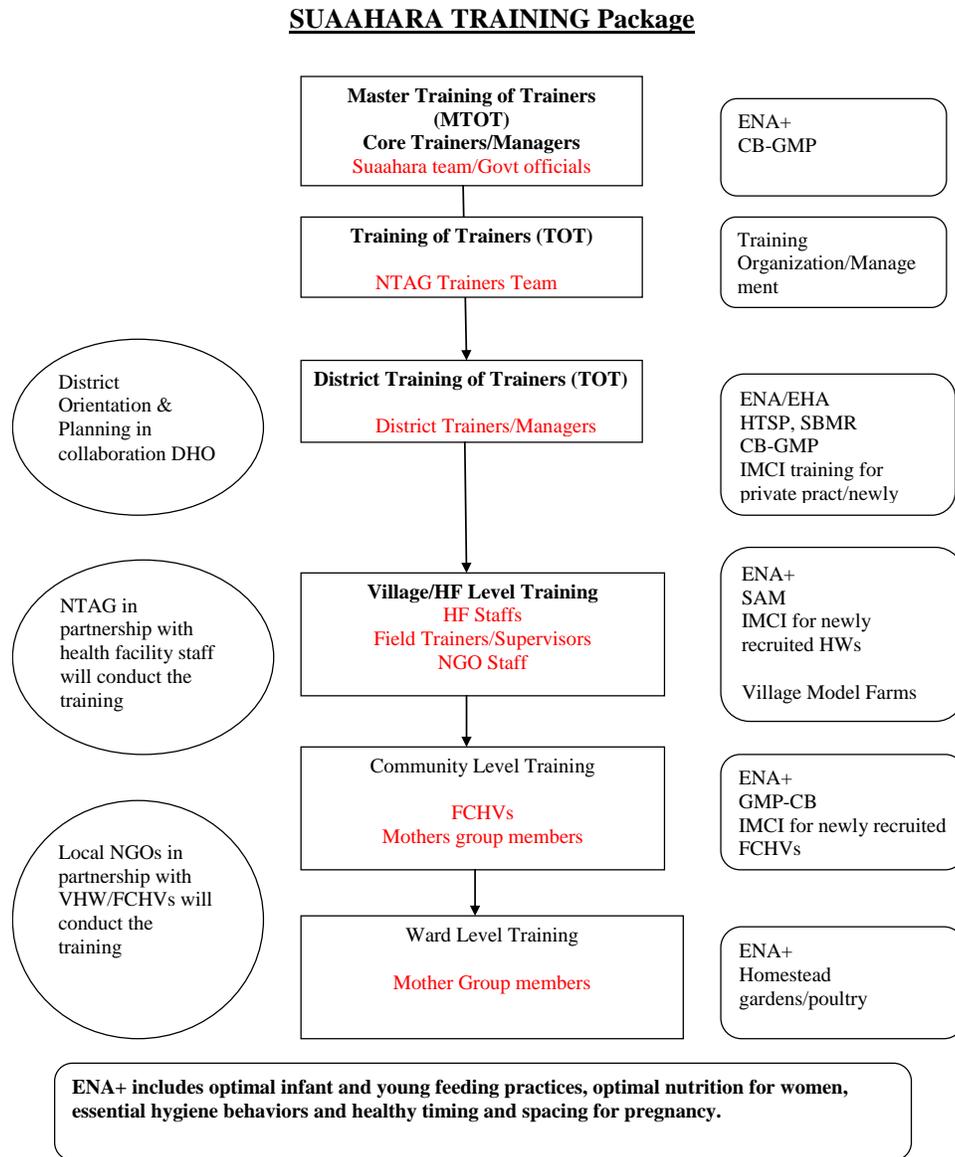
actions (ENA/EHA) include the Suaahara program. It is also likely that the Kisan (USAID Feed the Future program) would implement such an approach. Figure 6 provides a simplified program impact pathway for the USAID Suaahara program, an integrated nutrition and health program currently being implemented across Nepal.

Figure 7: Program Impact Pathway of USAID SAAHARA



The cascade training approach within the Suaahara program (Figure 7), seeks to improve the knowledge and skill base of service providers. It involves the training of a cadre of master trainers-of-trainers (MTOTs) at the national level. ENA/ EHA experts conduct these trainings over a period of 5 days. The expectation is that the training at the MTOT level will translate into trainings at the district and health facility level (organized by Suaahara). Once district, health facility and partner NGO staff are trained, these in turn become trainers for frontline workers (FCHVs) at the community level. The MTOTs play a supervisory role at these lower levels. The frontline workers interact with target groups at the household level to raise awareness about program components that aim to improve knowledge and skills to help mothers/caregivers optimally feed their infants and young children, and to care for their own nutritional needs.

Figure 8: Training Cascade Approach of USAID SAAHARA



The training approach is based on the principles of behavior change communication of small doable actions, and the widely acknowledged theory that adults learn best by reflecting on their experience. Attempts have been made to make the training sessions relevant to the needs of participants and their communities. The participatory training approach uses the experiential learning cycle method and prepares participants for hands-on performance of skills. Existing in-country social behavior change communication materials and other available infant and young child feeding visuals are being used. The course employs a variety of training methods:

demonstrations, practice, discussions, case studies, group discussion, and role-plays. Participants also act as resource persons for each other. Participants benefit from community practice, working directly with breastfeeding mothers, pregnant women, and mothers or caregivers who have young children. Respect for individual trainees is central to the training, and sharing of experiences is encouraged throughout the training. At the end of training, participants complete non-written pre and post training assessment questionnaires and discuss the results to review answers at the end of each module. There is also a written training evaluation administered on the training objectives, methods, materials used, and open ended questions on what trainees found most useful and ways to improve training.

The training cascade is therefore key to the success of the Suaahara program. The proposed study seeks to understand the fidelity of transfer of messages across the Suaahara training cascade and examine the fidelity of the program intervention through the delivery and uptake of these messages. The key objective of this study is to examine the fidelity of the training cascade and the fidelity of the program intervention and its impact pathway, which relies heavily on the transfer of knowledge and messages via the training cascade. The study will also assess if training methods and goals of the training have been maintained through the various levels of the training cascade and if FCHV retain knowledge imparted during the training.

Specifically, the research questions associated with this study include:

1. Is fidelity of the training cascade maintained so that goals of the training at the national level are consistent at the community level?
2. Do FCHVs retain messages/information taught during training and applied in their practices?
3. Do FCHVs transfer the messages received during training to others?
4. What are the barriers to uptake and retention of training messages by FCHVs?
5. What are the barriers to onward transfer of information received by FCHVs?

The proposed study will use a mixed methods approach to administer pre/post evaluation tests in the Suaahara training cascade workshops to MTOTs and trainees at the different levels of the training cascade, including FCHVs trained in the seven PoSHAN districts that are *also* Suaahara districts – Bajhang, Rasuwa, Sindhupalchowk, Solukhumbu, Taplejung, Lamjung, and Nawalparasi. In addition, institutional questionnaires used in the district, ilaka, VDC and ward PoSHAN studies will also be administered in order to understand the knowledge, attitudes and practices of trainers and field practitioners.

What's new? An understanding of training fidelity where nutrition and health knowledge and communication of that knowledge is intended to cascade through multiple programmatic and organizational levels and have impact on outcomes at the household level. What is the fidelity of the training cascade? How much information is retained (leaked) at each level? What are the determinants of effective training in BCC for nutrition?

This summary of the current (November 2013) range of research activities undertaken or planned by the Nutrition Innovation Lab will be periodically updated as required. Comments and questions on any of the content can be sent to Patrick Webb (Patrick.webb@tufts.edu) and/or Shibani Ghosh (Shibani.ghosh@tufts.edu).

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