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What have we learned and where to next?

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Presentation and Poster Abstract Booklet

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Day 1: June 3rd, 2015
Presentations & Posters

Keynote Presentation:

Agnes Quisumbing, *Senior Research Fellow*- International Food Policy Research Institute (IFPRI)

LOOKING BACK TO MOVE FORWARD: GENDER INAGRICULTURE, HEALTH, AND NUTRITION RESEARCH

Biography:

Agnes Quisumbing, PhD is a Senior Research Fellow in the Poverty, Health, and Nutrition Division of the International Food Policy Research Institute, Washington DC. She co-leads a research program that examines how closing the gap between men's and women's ownership and control of assets may lead to better development outcomes. Her past work at IFPRI analyzed the factors that enable individuals, households, and communities to move out of poverty over the long term, and on how resource allocation within households and families affects the design and outcome of development policies. She has undertaken studies on intrahousehold resource allocation in Bangladesh, Ghana, Ethiopia, Guatemala, the Philippines, Sumatra, and South Africa. She has recently completed the first phase of the Gender, Agriculture, and Assets Project (GAAP), a large research program that worked with implementers of agricultural development programs, to evaluate their impacts on gender asset inequality, in South Asia and Sub-Saharan Africa. Her 20 years of research experience on gender, agriculture, and nutrition issues includes studies of the long-run impact of agricultural development interventions on poverty, and impact evaluations of food and cash transfer programs, emergency assistance, dairy value chain projects, and asset transfer programs. She is also one of the researchers who developed the Women's Empowerment in Agriculture Index. A citizen of the Philippines, Quisumbing joined IFPRI in 1995. She received her Ph.D. and M.A. in economics from the University of the Philippines, Quezon City, and her A.B. in economics from De La Salle University in Manila. She was a Fulbright-Hays Fellow at the Massachusetts Institute of Technology and a Visiting Fellow at the Economic Growth Center, Yale University. Before joining IFPRI, Dr. Quisumbing worked at the University of the Philippines, Diliman and Los Baños; the World Bank; and the International Rice Research Institute. She publishes regularly in peer-reviewed journals and books and is co-editor of a book that has been recently published by Springer on *Gender in Agriculture: Closing the Knowledge Gap*.

Day 1: June 3rd, 2015
Presentation Abstracts

Session 1: Women & child health outcomes

Kenda Cunningham[1], G. Ploubidis[2], E. Ferguson[1], R. Uauy[1, 3], P. Menon[4], S. Kadiyala[1], M.Ruel[5]

WOMEN'S EMPOWERMENT IN AGRICULURE AND STUNTING OF CHILDREN UNDER TWO IN RURAL NEPAL: DO CARE PRACTICES MEDIATE THE ASSOCIATION?

[1]*London School of Hygiene and Tropical Medicine, UK;*
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Introduction: Despite improvements in the past decade, child (<5y) under-nutrition remains as a public health burden in Nepal, with 41% stunting. Women's disempowerment and low social status contribute to persistent child under-nutrition in South Asia, given maternal role as a primary caregiver. In Nepal, 80% of the population resides rurally and nearly all, rural women are engaged in agricultural labour.

In previous analyses using the same data set, we found a positive significant association between several dimensions of women's empowerment in agriculture – autonomy in production decisions, satisfaction with time available for leisure, and access to and decision-making on credit – and child (<2y) LAZ. In this study we formally test whether two care practices – child feeding and household water, sanitation, and hygiene (WASH) facilities and behaviours – mediate which these associations for children 6 to 24 months of age.

Methods: We used data from a cross-sectional baseline survey of an evaluation of a large-scale USAID-funded multi-sectoral nutrition program in Nepal, Suaahara. Household data (n=4080) was collected in 16 intervention and comparison districts in 2012 covering all three agro-ecological zones. For this study we limited the sample to those households with a child 6 to 23 completed months of age (n=1402), given the window of opportunity up until the age of two years but that we are only interested in complementary feeding practices for children at least 6 months of age. Multivariate regression analyses were used to test the associations between various aspects of women's empowerment in agriculture including decision-making around household production, access to resources, control of income, leadership in the community, and time devoted to work and leisure activities and child LAZ. Regression models adjusted for district-level clustering and controlled for child, maternal and household characteristics. For those associations found to be statistically significant, we then created a priori conceptual frameworks to empirically test whether child feeding and/or WASH facilities and practices mediate the associations. We then used a linear structural equation model to formally test each of these two potential mediating paths, controlling for child, maternal, and household characteristics that would potentially confound the relationship.

Findings and interpretations: Women's empowerment in agriculture was positively associated with LAZ (β=0.24, P<0.05). The three of ten specific domains of women's empowerment in agriculture driving the association with LAZ included: satisfaction with time available for leisure activities (β=0.34, P<0.001); autonomy in production decisions (β=0.195, P<0.05); and access to and decision-making on credit (β=0.17, P<0.05). In addition, both of the mediating variables – child dietary diversity and household WASH facilities and practices) had statistically significant positive associations with child LAZ. However, the two indirect pathways were not statistically significant. Thus, in this population, women's empowerment in agriculture does not influence child (6-24 m) via improvements in child dietary diversity or household WASH facilities and practices.

In conclusion, in the context of rural Nepal, women's empowerment in agriculture is a contributor to child LAZ, and infant and young child feeding practices along with water, sanitation, and hygiene are also key contributors. Thurs, addressing under-nutrition in Nepal, particularly during the most vulnerable growth-faltering period of the first two years will likely require nutrition programs and policies that prioritise women's empowerment within agricultural households, along with traditional approaches such as IYCF behaviour change programs. In sum, a combination of nutrition-specific and nutrition-sensitive approaches will be necessary if further reductions in stunting are to be seen among rural Nepali children.

Monica Jain[1], Manfred Zeller[2]

DO MOTHERS NOT HAVE THE TIME TO FEED THE CHILDREN PROPERLY IN BANGLADESH?

[1]Associate Research Fellow Women's time, child diet, gender, International Food Policy Research Institute, USA

Introduction: The complementary child feeding practices are poor in Bangladesh and they have improved minimally over time, especially for children 6-23 months (Jain (2014)). While there could be several reasons for poor complementary feeding practices, one of the hypothesis regularly proposed is the lack of time mothers have to prepare age appropriate food and feed it to the children with the required frequency. We test this hypothesis using a unique panel data on time use of women and food intake of children (based on 24 hour recall) in Bangladesh collected in the period 1996-97 in three different agricultural seasons.

Methods: We use non-experimental survey data. So it is possible that the women from richer households spend more time on household chores, like cooking, and their children also eat more and better. Therefore, to identify the effect of women's time allocation on the child's food consumption, we need to control for observables like income. We do this by controlling for various observable characteristics of children, mothers and household in the **pooled OLS regression**. However, there also might be some unobserved factors (unobserved heterogeneity), or measurable but non-surveyed factors. For example, the more motivated or more informed women may spend more time cooking and their children may also eat more nutritiously balanced diets. Or the women are living in communities where social norms encourage that women spend more time on household chores like cooking, and feed their children more and better food. In such cases, the OLS regression probably suffers from omitted variable bias. To control for such unobservables that do not change over time, we exploit the change in time use of mothers across agricultural seasons to identify its effect on food intake of children using the **child fixed effects** model.

Findings and interpretations: We find that in the higher intensity agricultural seasons majority of women reduce their cooking time. They spend around two hours on exclusive child care time, which does not vary significantly by income, education or agricultural season, and even the poor and illiterate women do not compromise on it. However, there is gender discrimination in child care time in favor of boys. Women also multi-task child care with their other work for more than two hours every day and it does not differ by education or gender composition of children. It does differ by season, but with no clear pattern. The women's cooking time does not effect the food consumption of their children either 6-23 or 24-59 months old, but there is some evidence of discrimination in favor of boys. The exclusive child care time has no effect on food consumption of children 6-23 months old, but there is some evidence of negative effect on food consumption of children 24-59 months and on girls. Multi-tasking child care time has no consistent effect on food intake of children either by age or gender. The work time of women has a positive effect on their own and somewhat on their sons' food consumption.

Maria Christina Jolejole-Foreman, Guenther Fink

HUNGRY AND PREGNANT: ASSOCIATION BETWEEN FOOD SCARCITY DURING PREGNANCY AND CHILDREN'S SURVIVAL AND HEALTH OUTCOMES

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Introduction: In Zambia, subsistence agriculture is predominant. Most farmers cultivate less than 2 hectares of land with low levels of productivity [1]. But even in years of good harvests, many households are unable to meet their basic nutritional needs. In average years, 60 percent of farmers face a hungry season of several months, which is particularly acute during November, December, January and February [3]. On the other hand, Zambia is one of the twenty-two countries in Africa with highest burden of undernutrition in children under five [4]. There is a growing literature suggesting that in utero exposure to hunger can have consequences on child's health later in life1. In this paper we assess the extent to which food reserves among small-scale farms affect maternal nutrition and birth outcomes.

Methods: We link data from Zambia's post-harvest surveys (PHS), which track food reserves at the household level over time, to child health outcomes captured in the Demographic Health Survey (DHS). Month and year of harvests from PHS were matched with month and year of birthdates of children from the DHS. We construct food reserve availability index variable (*FRAI*) based on the question on when the households ran out of stocks in the PHS survey.
We analyze the impacts of food scarcity during gestation, measured using FRAI, on survival, birth size, weight-for-age (WAZ), height-for-age (HAZ) and weight-for-height (WHZ) Z-scores. In addition, we differentiate the exposure across gestational stage. We estimate the following multi-variable model:

$$Outcome_i = \propto + FRAI_1\beta_1 + FRAI_2\beta_2 + FRAI_3\beta_3 + X_i\gamma + R_i\theta + M_i\delta + \varepsilon_i \quad (1)$$

Where $Outcome_i$ is the health outcome measure (i.e. child survival, birth size, WAZ, HAZ, WHZ) observed for child I during the DHS interview. X_i is a vector of other characteristics. And R_i and M_i are region and month indicators, respectively. $FRAI_i$ is the average of food reserve availability index in the first, second, third trimesters.

Findings and interpretations: This study expands on a limited body of research examining the links between agriculture and nutrition and health outcomes. In summary, we find that the effect on children's physical growth measures is predominantly when the mother is exposed to food scarcity in early gestation. We find consistent results for physical growth measures for both the degree and type of exposure to food scarcity. On the other hand, chance of survival decreases when mothers were exposed to food scarcity during the second trimester. Exposure during the first trimester yielded the opposite result. A plausible reason is selection. If the mother is really malnourished, pregnancy will not just live and might result to early miscarriage. Pregnancy selection is tough and children who survive will do better on. Because agricultural production is seasonal, it also follows that post-harvest food availability depends on the size of production. Farmers who produce less tend to exhaust their supplies early, forcing them to seek work elsewhere, sell assets, or take loans to survive. Thus, the constraints for household food supply which occur before the harvest when stocks from previous year's harvest are nearly exhausted contributes to nutritional deficits of household members. Our estimates speculate that policies aimed at reducing vulnerability to food scarcity may result into improved children's health. The results also suggest proper timing of food aid and government programs to aid in proper food storage to secure food reserves.

Happy Magoha[1, 2], Martin Kimanya[3], Bruno De Meulenaer[1], Dominique Roberfroid[4], Carl Lachat[1,4], and Patrick Kolsteren[1,4]

EXPOSURE LEVELS AND EFFECTS OF AFLATOXIN AND FUMONISIN THROUGH BREASTFEEDING IN INFANTS UNDER SIX MONTHS OF AGE IN ROMBO, TANZANIA

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Introduction: Among the main causes of child growth retardation are poor complementary feeding and breastfeeding practices. Recently, it was shown that the dietary exposure to mycotoxins has profound effects on growth of children. Infants breastfeeding from mothers consuming mycotoxin contaminated foods may be exposed to aflatoxin M_1 (a metabolite of aflatoxin B_1) and fumonisin excreted in breast milk. The level of exposure from breast milk can impair their growth. This study examined the exposure to aflatoxin and fumonisin through breast-feeding in infants under six months of age and their associated effects.

Methods: A total of 143 infants were progressively recruited and three follow up visits were made at the 1st, 3rd and 5th month of age. A 24-hour dietary recall for the infants was conducted and anthropometric measurement recorded in each visit. 'Weight-for-height Z-score' (WHZ), 'Weight for age Z-score' (WAZ) and 'Height-for-age Z-score' (HAZ) were computed in reference to the WHO 2006 growth standards. Breast milk samples were collected in each visit during the morning by self-expression and were kept at 4°C and frozen within one day, at -20°C, until analysis. Aflatoxin M_1 (AFM_1) were cleaned-up by immuno-affinity clean up columns (AFLAPREP) and quantification was done using High performance liquid chromatograph (HPLC). Clean up of fumonisin B_1 (FB_1) involved the use of SAX columns and quantification was also done by HPLC. Exposure assessments of AFM_1 or FB_1 from breast milk were done using deterministic approach. Deterministically, contamination of aflatoxin M1 or fumonisin B1 was combined with breast milk intakes documented by the United States Environmental Protection Agency (US. EPA, 2011). Mixed-effect linear regression models were used to determine the association between mycotoxin exposure levels and the growth indicators i.e. WAZ, HAZ and WHZ.

Findings and interpretations: This is the first time FB_1 in breast milk is reported. Above 40% of samples contained FB_1 at levels ranging from 5.6 – 471.1 ng/ml, with 10% and 2% containing FB_1 above the EU limit of 200 ng/ml for fumonisin in infants' food in lactation stages of month 1 and 5, respectively. All the breast milk samples were contaminated by AFM_1 at the level ranging from 0.01 to 0.55 ng/ml. More than 90% of samples exceeded the AFM_1 EU limit of 0.025ng/ml for infants' foods while over 76% exceeded the EU limit of 0.05ng/ml for dairy milk and milk products. Exposure levels for AFM_1 and FB_1 from breast milk ranged from 1.13 – 66.79 ng/kg bw/day and 0.60 – 64.93 µg/kg bw/day, respectively. FB_1 exposure levels exceeded the provisional maximum tolerable daily intake of 2µg/kg bw/day in 29% and 35% of the infants during month 1 and 5, respectively. Inverse association ($p<0.05$) was observed between AFM_1 exposure levels and WAZ or HAZ and FB_1 with WAZ and WHZ. This calls for urgent measures to reduce contamination of these toxins in food with a view to prevent their exposure to lactating mothers and their infants, hence, improve their nutrition status.

Session 2: Behaviour change/ Consumer acceptance

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DEVELOPING COUNTRY CONSUMERS' ACCEPTANCE OF BIOFORTIFIED FOODS: A SYNTHESIS

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Introduction: One in three people in the world suffer from hidden hunger, caused by lack of minerals and vitamins in their diets, which leads to negative health consequences. Biofortification, the process of breeding and delivering staple crops with higher micronutrient content provides a comparatively cost-effective means for increasing the daily adequacy of micronutrient intake and for combating micronutrient deficiency in many developing countries. In order to contribute to the goal of improving nutritional status in developing countries, biofortified crops must be accepted and consumed by target populations.

Methods: In the past eight years, several studies were undertaken to understand consumers' acceptance of foods made with biofortified staple crops. This paper reviews and brings together evidence on consumer acceptance of 5 biofortified crops across 7 countries in Africa, Asia and Latin America. Consumer acceptance is measured in terms of their willingness to pay (WTP) for biofortified staple crop varieties relative to the local varieties. These studies apply various preference elicitation methods (including experimental auctions, revealed choice experiments, and stated choice experiments) adopted from experimental economics literature. Field experiments were used to also test the impact of various levers on consumers' valuation for biofortified foods. These levers (or treatments) include (i) nutrition information and the media through which such information is conveyed; (ii) the frequency of convening such information, (iii) the length and content of nutrition information; (iii) different branding options; (iv) the nature (national or international) of the branding/certification agency that is endorsing the biofortified staple food; and (iv) the nature (national or international) of the agency that is delivering the biofortified staple food. These studies provide methodological contributions in the areas of loss aversion, endowment, participation fees, hypothetical bias and payment effects, as well as external validity of real choice experiment versus experimental auction techniques.

Findings and interpretations: For crops with visible biofortification traits (i.e., those crops enriched with vitamin A and hence change colour), even in the absence of information, consumers are willing to pay as much as (e.g., orange sweet potato in Uganda and vitamin A orange maize in Zambia), if not more (e.g., vitamin A yellow cassava in Oyo state, Nigeria) than their conventional counterparts. Across all studies for vitamin A enriched crops, nutrition information results in consumers willing to pay a significant price premium for biofortified crops, ranging from 8% to as high as 50%, depending on the study. For crops with invisible biofortification traits (i.e., those crops enriched with minerals such as iron and don't change colour), the premium is generally lower. For iron pearl millet, consumers are willing to pay a price premium of about 6% and up to 32% depending on the treatment. In Guatemala, consumer WTP doesn't significantly differ between iron and conventional beans even in the presence of information. In Rwanda, regardless of the treatment consumers prefer deep red iron bean variety more than white iron bean variety. Overall these studies revealed that there are no obstacles to the acceptance of biofortified foods. These results are expected to inform the development of biofortified crops that consumers like, and of appropriate marketing campaigns to encourage the consumption of biofortified foods.

Christine Hotz[1], Gretel Pelto[2], Margaret Armar-Klemesu[3], Elaine Ferguson[4], Peter Chege[5], Enock Musinguzi[6]

A QUALITATIVE AND QUANTITATIVE RESEARCH APPROACH TO APPROPRIATELY DESIGN INTEGRATED AGRICULTURE AND NUTRITION INTERVENTIONS FOR IMPROVED INFANT AND YOUNG CHILD NUTRITION IN RURAL KENYA

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Introduction: Several interventions can be used to address nutrient intake adequacy among infants and young children (IYC) in resource-poor rural settings, including mass- or home-fortification, nutrition education and behaviour change communications (BCC), and agricultural and food value chain strategies that aim to increase the accessibility of nutrient dense foods. However, the selection of appropriate foods to fill nutrient intake gaps requires quantitative information on the usual dietary intake patterns of the target population, and the selection of appropriate intervention strategies to increase intake of those foods requires qualitative information on the social, cultural, physical and economic context.

Methods: Two distinct food-insecure rural Kenyan populations were studied, one in a semi-arid area with low population density (Kitui County) and one in a more fertile but densely populated region (Vihiga County). This analysis combined information from: i) a quantitative analysis using OPTIFOOD linear programming that identified a set of food-based recommendations (based on millet, beans, green leafy vegetables, fish, milk and fortified cereal mixes) designed to fill IYC intake gaps for most nutrients within constraints of current dietary patterns; 'problem nutrients', for which intake gaps require solutions beyond currently consumed food items and dietary patterns, were also identified (iron and zinc, and calcium in Vihiga only), and; ii) a qualitative analysis using Focused Ethnographic Studies to identify contextual factors relevant to applying the food-based recommendations, including appropriateness of the recommended foods for IYC diets, and other social or physical factors that determine accessibility of those foods; six concepts were used to define the caregiver's knowledge structure related to properties or characteristics of IYC foods through a 5-point score: healthiness, child acceptance, cost, ease of acquisition (availability), and the influence of others. Information was then categorized as a constraint or potential opportunity for implementation of the food-based recommendations through different strategies.

Findings and interpretations: BCC may be effective to increase the use of green leafy vegetables by raising caregiver's perceptions of their health attributes, and encouraging an increased IYC feeding frequency of solid matter rather than just the broth. In contrast, BCC alone for increased utilization of milk and millet are unlikely to have a large impact without concurrent efforts to increase their accessibility due to the strong, positive, cultural and health perceptions that already exist for these foods. Agronomic interventions are required to increase the productivity of millet, and of green leafy vegetables in the dry season. Strengthening of value chains for millet, beans, green leafy vegetables, milk, and small fish should be studied for opportunities to increase their accessibility in local markets. Processor level interventions may increase the accessibility of novel foods providing the problem nutrients, such as partially-cooked fortified dry infant cereal mixes or unfortified cereal mixes incorporating millet and beans. Sustainable improvements to IYC nutritional adequacy may be achievable by addressing both improved accessibility and utilization of relevant nutritious foods across the food value chain; some of these approaches may also serve a dual purpose of improving nutrition and rural livelihoods.

Akter Rumana[1], Baten Abdul, Thorne-Lyman Andrew, Genschick Sven, Akter Rina[2], Akter Asma, Ali Hasan Abu, Karim Manjurul, Keus Hendrik Jan, Ara Ismat, Andersen Anna Birkmose,[3] Thilsted Shakuntala Haraksingh

DIETARY PATTERNS OF WOMEN AND YOUNG CHILDREN IN A NUTRITION-SENSITIVE AQUACULTURE/AGRICULTURE PROJECT IN RURAL BANGLADESH

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Introduction: Increasingly, it is being recognised that improved nutrition is not achieved automatically through increased agricultural production or household income. Integrating nutrition education and behaviour change communication in agricultural interventions may be crucial to improve dietary quality and quantity, at household and individual level. The Aquaculture for Income and Nutrition (AIN) project aims to improve household income through improved aquaculture and horticulture production in southern Bangladesh. A behaviour change communication component was integrated in AIN, with the specific objective of promoting the consumption of nutrient-rich foods, with special emphasis on small fish and micronutrient vegetables, particularly among women and young children.

Methods: One year after the full behaviour change component was integrated in AIN, a survey was conducted in 524 randomly selected households having at least one woman of reproductive age and one child 6-36 months to better understand the links between project implementation, production and dietary patterns and inform the revision of the behavior change component. A pre-coded structured questionnaire was developed and used for data collection. The enumerators were trained for two weeks, after which field testing of the questionnaire was done.

Findings and interpretations: The survey data showed that among children 6-23 months, 50% consumed foods from ≥ 4 food groups and 47.5% had a minimum acceptable diet compared to 21% at national level.[1] In children 6-11 months, 27% had a minimum acceptable diet; and 56% and 53% of those 12-17 months and 18-24 months, respectively. The average age for introduction of small fish in children's diets was 8.7 months (SD 3.8), and for large fish, 7.5 months (SD 2.6).

Among women, 46.2% consumed foods from >=5 food groups in the day preceding the survey. 41.6% and 56.2% of women had consumed small and large fish, respectively; higher than the national values of 33% and 40%[2]. No trend was seen in the proportion of women consuming small fish with household income (over the preceding 3 months) (≤ BDT 50,000, 41.1% of women; > BDT 50,000-≤100,000, 45%; and > BDT 100,000, 36.5%), whereas large fish consumption seemed to increase with increasing income (54.1%, 61.8%, and 68.3%, for the above-mentioned income categories). Follow-up surveys are needed to better understand the effects of the nutrition education and behaviour change component, as well as seasonality and geographic location on the consumption patterns of the project population.

Alan de Brauw[1], Mourad Moursi[2], Bernardino Munhaua[3], and Cheng Qiu[1]

Vitamin A Intakes Remain Higher Among Target Groups Three Years after a Biofortification Intervention in Mozambique

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[3]*Association for Nutrition and Food Security, Mozambique*

Introduction: The HarvestPlus Reaching End Users (REU) Intervention was an integrated agriculture and nutrition program taking place between 2006 and 2009 in Zambezia, Mozambique. The REU objective was to reduce vitamin A deficiency through the introduction of orange sweet potato (OSP). The associated impact evaluation found large impacts on dietary intakes of vitamin A among mothers and children aged 12-35 months, and significantly lower prevalence in the probability of vitamin A deficiency (Hotz et al., 2012). However, the medium term impacts of such programs are unknown. This study reports on a 2012 resurvey of children from participant and control group households.

Methods: The REU was evaluated using a cluster randomised control trial; dietary intakes among both intended participants and the control group were assessed using . The dietary data collection methods used was an interactive, multiple-pass method to estimate 24 hour dietary intakes (Gibson and Ferguson, 2008). In 2012, field teams returned to the treatment and control villages to conduct a socioeconomic survey and another dietary intake survey among mothers, chidlren aged 6-35 months, and children who had been interviewed in 2009 and were 3-5 years old at the time of the 2012 survey. The dietary intake survey in 2012 took place in July, which was a few weeks after peak availability of OSP in the household diet.

Households in the control group were given OSP vines in advance of the 2010 planting season, but no agricultural or nutrition extension; therefore the comparison between treatment and control groups in 2012 is between REU participation between 2006 and 2009 and a single OSP vine distribution in 2010. Children between 6 and 35 months notably had not yet been born by the time of the 2009 dietary intake survey.

Findings and interpretations: In the socioeconomic survey, we find just under 30 percent of treatment group households continue to grow OSP, whereas about 10 percent of the control group grow OSP. Children under 5 in the treatment group are more likely to have eaten OSP in the past seven days than in the control group.

The dietary intake study demonstrates that in 2012, vitamin A intakes are significantly higher among children aged 12-35 months and among mothers, at the 5 percent level or better. Impacts are 110 mcg/RAE among children and 275 mcg/RAE among mothers, both in cross sectional and difference-in-difference analysis. Among both children and mothers, the entire difference in vitamin A intakes between treatment and control groups is explained by OSP intakes. Whereas we find lower prevalence of inadequate vitamin A intakes in the treatment group, the difference is not statistically significant.

We interpret the findings to show that even in a difficult environment for maintaining OSP, agricultural interventions can have lasting effects on micronutrient intakes. The extension was clearly important in causing medium term impacts, as many vines received by the control group were lost. Cost-benefit analysis of agricultural interventions meant to improve nutrition should account for potentially lasting benefits.

Session 3: Innovative metrics & tools

Anna Herforth[1], Selena Ahmed[2]

THE FOOD ENVIRONMENT, ITS EFFECTS ON DIETARY CONSUMPTION, AND POTENTIAL FOR MEASUREMENT WITHING AGRICULTURE-NUTRITION INTERVENTIONS

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Introduction: The food environment in markets constrains and signals consumers what to purchase. It encompasses availability, affordability, convenience, and desirability of various foods. Policy and sociocultural norms affect these facets of the food environment. Many agricultural interventions aim to improve incomes, increase food availability and reduce food prices. Their effects on nutrition could be better understood if food environment measures were used to help explain how additional income is likely to be spent, and how food availability and prices change as a result of interventions. Additionally, measurement of the food environment could identify food gaps and inform the design of interventions.

Methods: We define the term "food environment" and compare it to other definitions. We review the evidence how income growth is related to dietary change, and how availability, affordability, convenience, and desirability of different foods are related to dietary consumption. We also review existing measures of the food environment, and then draw from these tools to suggest ways the food environment could be measured in future agriculture-nutrition studies and monitoring systems.

Findings and interpretations: The extent to which income leads to improved diets is variable and depends on the food environment. Based on existing evidence, the kind of food available, affordable, convenient, and desirable is significantly related to dietary consumption. Despite the emerging efforts to measure the food environment at the community level and the increased recognition of the importance of the food environment in influencing dietary quality and chronic disease, the science of measuring the food environment is in its early stages (Lytle 2009), particularly international food environments. Some existing measures are relevant to apply internationally in rural areas, but none are immediately feasible and scalable. Given its importance to diets, the primary need is a measure of affordability of diverse, nutritious foods. Other non-market parts of the food environment also need to be understood, such as on-farm and natural/wild food environments. Ultimately, metrics are needed to inform strategies for improving food environments. In places where norms and habits support traditional food culture, reducing cost of a healthy traditional diet may be a relatively effective way to improve diets. In places where diets have transitioned to high intakes of ultra-processed foods, more emphasis on convenience and desirability may be needed.

Victor E. B. Pinga;[1] Cesar B. Umali, Jr.[2]

MONITORING NUTRITION-SENSITIVE FOOD SYSTEMS

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Introduction: Understanding the linkages between food systems and nutrition outcomes is crucial particularly in low and middle income countries (LMICs) where malnutrition is most acute. Household-level conceptual pathways consider the interrelationships between determinants of nutrition-sensitive agriculture within the household (Gillespie, Harris and Kadiyala 2012, SPRING 2014), yet the agricultural sector, particularly food systems, encompasses a larger sphere comprising the production, processing, marketing, consumption, and disposal of food, including the inputs and outputs generated at each step (FAO 2013). This paper deals with monitoring nutrition sensitivity in the food system and linkages with health and nutrition variables at the household level.

Methods: We present a conceptualization of the disparate components of the food system, specifically how each affects households that are integral to that system either as actors in value chains or consumers of food. We present a typology of interventions within each food system component from agricultural input supply, production, processing, marketing and distribution, to the preparation and consumption of food, as well as waste and recycling, and detail some plausible nutrition related outcomes as suggested by the literature, and their effects on the household health and nutrition enabling environment.

From this conceptual framework, we propose monitoring methods and approaches, as well as illustrative intermediate indicators underlying supply and demand relationships that may be applied across different agricultural value chains in different settings but especially in LMICs, drawing from the agriculture and economic growth literature. We highlight nutrition-sensitive outcomes in the food system as suggested by Lancet MCN 1 (Black et al. 2013), specifically on food security, feeding and caregiving resources, access to and use of health services and a safe and hygienic environment, mediated by the effects of gender and power imbalances in the food system.

Findings and interpretations: Key outcomes in the food system include increased year round availability and affordability of diverse, nutrient-dense foods, taking into account the temporal, geographic and social distribution across different household types; and reduced workloads for women, among others. Demand side variables include sustained consumption of diverse, nutrient-dense foods and food products as a result of increased nutrition awareness by consumers. Monitoring methods include a simplified cost-benefit analysis to quantitatively assess alternative pathways to nutrition-sensitivity, modified participatory outcome mapping, and qualitative methods such as Most Significant Change (MSC).

The food system conceptual model and typology of nutrition-sensitive interventions will aid in developing a coherent approach to research and metrics, contributing to the understanding of the complex interrelationships within the food system especially as they affect maternal child health and nutrition. This complements the agriculture-nutrition conceptual pathways introduced by Gillespie, Harris and Kadiyala, which has since been adapted and used by agriculture-nutrition researchers. Of note, this paper presents plausible and measurable linkages in the food system beyond the original household and individual level pathways, and highlights the relationships between agriculture and the care and health variables underlying malnutrition, an often overlooked aspect in the agriculture-nutrition literature.

Terri J. Ballard[1], Sara Viviani[1], Anne W. Kepple[2]

THE FOOD INSECURITY EXPERIENCE SCALE - A NEW TOOL FOR VALID AND COMPARABLE MEASUREMENT OF FOOD INSECURITY

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Introduction: All conceptual frameworks demonstrating how agriculture can improve nutrition and health include improved availability, access, and intake of nutritious, safe foods. Investments in agriculture can lead to increased incomes with a potential benefit of enhancing access to diverse diets in poor populations. It has been recommended that measurement of intermediary outcomes along the impact pathway such as food security be included in evaluation of interventions that aim to improve nutrition.

There is great need for valid and standardized food security measures that provide evidence of the effectiveness of agriculture policies and interventions to improve food access.

Methods: Food insecurity at the household or individual level is characterized by lack of access to adequate nutritious food. The FAO Voices of the Hungry (VOH) project has developed an experience-based measure of food insecurity for global monitoring. The Food Insecurity Experience Scale (FIES) is adapted from food insecurity scales validated and used in many countries. It can be used at either household or individual level, with the latter being particularly useful when information on gender or age differences in food insecurity is important. Cutting-edge statistical methods produce cross-culturally comparable prevalence estimates of food insecurity at different levels of severity based on responses to a set of eight questions in the FIES that capture universal dimensions of the experience of food insecurity. The global focus of the VOH is to produce comparable prevalence rates of moderate and severe food insecurity across countries. The methodology is also applicable to national and sub-national uses for evaluating progress in improving people's access to adequate food through programmes and policies in different sectors, including agriculture and health. The FIES has been included in the Gallup World Poll (GWP) since 2014, which is conducted in more than 140 countries with individual respondents 15 years and older.

Findings and interpretation: FAO will release cross-culturally comparable national and regional prevalence rates of food insecurity severity only in mid 2015; however, correlations between FIES indicators and traditional development markers, for example child mortality, literacy and child nutrition, will be presented. Since gender disaggregation is crucial to understand gender dynamics of food insecurity, preliminary regression analyses were carried out combining 122 countries to investigate differences of severe food insecurity prevalence between women and men. There is a significant ($p=0.004$) and negative effect of national urbanization rate (% population leaving in urban areas) on differences in severe food insecurity prevalence by gender, controlling for national prevalence levels. These results suggest that prevalence of severe food insecurity is greater among women in countries characterized by lower urbanization and predominantly smallholder agriculture.

Early analyses from 2014 show that people experience food insecurity in similar ways across the world, making it feasible to use a standard tool to estimate severity of food insecurity in different areas. Gender analysis of food insecurity has implications for targeting women in agriculture and health programmes in settings where women may be disadvantaged. Using standardized, valid metrics in programme evaluation will help build a credible evidence-base of approaches that improve food insecurity.

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BIOFORTIFICATION PRIORITY INDEX: PRIORTIZING COUNTRIES FOR BIOFORTIFICATION INTERVENTIONS USING COUNTRY-LEVEL DATA

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Introduction: Micronutrient malnutrition affects two billion people worldwide (FAO, WFP and IFAD, 2012). In recent years, the global challenge of reducing hidden hunger and improving related health outcomes through agricultural interventions has received much attention. One potential solution is biofortification—the process of breeding and delivering staple food crops with higher micronutrient content. Biofortification could prove to be cost-effective and sustainable, especially in rural areas of developing countries where production and consumption of staple crops is high and high micronutrient deficiency rates are rampant. The aim of this paper is to develop country-crop-micronutrient–specific indexes that rank countries according to their suitability for investment in biofortification interventions.

Methods: The Biofortification Priority Index (BPI) is calculated by combining three sub-indexes using a geometric mean. The Production Sub-Index calculates the extent to which a country is a producer of one of the staple crops, while factoring in the amount of output retained for domestic consumption. The Consumption Sub-Index captures the proportion of the crop under domestic production that is consumed by the country's population. The Micronutrient Deficiency Sub-Index calculates the extent to which a country's population suffers from micronutrient deficiency. Country-level crop production and consumption data are obtained from the Food and Agriculture Organization of the United Nations; data on country-level iron, zinc, and vitamin A deficiency are from the World Health Organization. The combined number is then rescaled into a crop- and micronutrient-specific score that ranges from 0 to 100: 0 indicates a low-priority country for biofortification and 100 indicates a high-priority biofortification country. Crop scores are further ranked in descending priority order such that the country with the highest BPI score receives a rank of 1 (indicating its suitability for biofortification investment). BPIs are calculated for seven staple crops that have been developed and for 127 countries in Africa, Asia, and Latin America and the Caribbean (LAC).

Findings and interpretations: Results reveal that for the 127 countries included in the analysis, African countries rank highest for vitamin A-rich crops, including maize, cassava, and sweet potato, and Asian countries rank highest for zinc-rich cereals, including wheat and rice. For rice, Africa also offers some suitable countries that could generate high levels of impact. For iron biofortified beans, several countries in Africa and some in LAC surface as high return-on investment potentials. Finally, for iron biofortified pearl millet, both Africa (especially West Africa) and South Asia constitute suitable candidate sites for investment.

BPIs should not be used as a one-stop shop for making decisions on biofortification investment decisions because they have several limitations. As they are currently calculated, BPIs do not explicitly take cost-effectiveness into account, neither do they allow for a subnational analysis. Future research will address these shortcomings. Plans to conduct subnational analyses are already underway for larger countries in order to capture the heterogeneity in production, consumption, and micronutrient deficiency that may exist at a subnational level. For now, the BPIs presented in this paper are useful tools for highlighting those countries that may benefit from significant reductions in micronutrient deficiency through biofortification of staple crops.

Day 1: June 3rd, 2015
Poster Abstracts

Theme 1: Women & child health outcomes

Tenaw Bawoke [1], **Emebet Dlasso** [2], **William Garvelink**[3], **Megan Kelly**[4], **Alexandra Rutishauser-Perera**[5]

INTEGRATED PROGRAMMING TO ADDRESS FOOD INSECURITY AND INCREASE RESILIENCE IN WOLAYITA ZONE, ETHIOPIA

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Introduction: Since 2003, International Medical Corps has assisted food insecure communities of Ethiopia drive their own development by building the capacity of local infrastructure.With support from the Humanitarian Aid and Civil Protection department of the European Commission (ECHO), a nutrition, health, water sanitation and hygiene, livelihood, and disaster risk reduction integrated program is being implemented to improve nutritional status and resilience of vulnerable households in two Wolayita Zone Woredas of the Southern Nations, Nationalities, and Peoples Region. Both Woredas continually experience severe droughts resulting in cyclical crop failures, increased seasonal food shortages, and higher vulnerability to malnutrition and other health issues.

Methods: Baseline and intermediate nutrition, livelihood, primary health care (PHC) and water sanitation and hygiene (WASH) surveys were conducted in Damot Pullasa and Boloso Sore Woredas to assess the quantitative and qualitative impact of improving nutritional status and resilience of vulnerable households with children (0-59 months), pregnant and lactating women and malnourished other categories (MOC). Two-stage cluster sampling was applied in Standardized Monitoring and Assessment of Relief and Transition (SMART) surveys conducted at 13 month intervals to analyze nutritional status. Knowledge, attitude and practice (KAP) surveys were conducted among households (n=736 baseline, 658 intermediate) on Infant and Young Child Feeding (IYCF) practices, as well as a cross-sectional descriptive study with women of reproductive age (n=431 baseline, 416 intermediate) and households (n=570 baseline, 431 intermediate) in PHC and WASH studies, and key informant interviews (KII) with Woreda and health officials, and health development armies. The livelihood assessment, integrating the Sustainable Livelihoods Framework (SLF) and malnutrition framework collected data from 240 households from five kebeles (neighborhoods) using Participatory Rural Appraisal (PRA) techniques such as wealth ranking, KII and focus group discussions (FGDs). The Emergency Nutrition Assessment, EPI-INFO and SPSS Statistics software were used for data quality checking, entry, and analysis.

Findings and interpretations: Based on the results this multi-sector integrated program improved nutritional status and health outcomes by contributing to a reduction of childhood GAM and SAM rates, and prevalence of childhood diarrheal and malarial diseases. This has been achieved through increasing access to potable WASH facilities and enabling beneficiaries to better guarantee household food security, while also building the resilience of individuals and communities to adapt to changes in their environment. The promotion of IYCF practices through health worker trainings, community awareness and school community sensitization has helped to achieve high coverage of optimal breastfeeding practices. From its long history providing nutritional support in these districts, IMC has learned that nutrition interventions alone will do little to prevent further nutritional deterioration without addressing the root causes of food insecurity. As a result of livelihood and income generation, crop production has increased and therefore reduced seasonal hunger in the two Woredas. Furthermore, household income has started to improve for those selected beneficiaries provided with

small ruminants and poultry. The government has acknowledged the successes of this first of its kind program, and using it as a model will allow other organizations to scale-up this integrated intervention in other parts of the country.

Jillian Waid[1], Philipp Zanger[2], Amanda Wendt[2], Thalia Sparling[2], Irmgard Jordan[3], Malabika Sarker[4], Sabine Gabrysch[2]

FOOD AND AGRICULTURE APPROACHES TO REDUCING MALNUTRITION (FAARM) - A NEW CLUSTER-RCT IN BANGLADESH

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Introduction: Agricultural interventions that aim to increase dietary diversity, that empower women and that have an education component to ensure hygiene and adequate feeding of young children, are a promising approach to tackle the problem of chronic undernutrition sustainably. However, evidence of their effect on nutritional status is still lacking as most studies in the field did not employ rigorous methodology.

Setting: Bangladesh, a low-income country in South Asia, suffers from particularly high levels of undernutrition with an estimated 43% of children under 5 years of age stunted and 17% wasted. The NGO Helen Keller International (HKI) has been implementing and adapting a Homestead Food Production (HFP) program in Bangladesh since the 1990s, working in partnership with local NGOs. The program comprises trainings for women's groups in year-round vegetable and fruit gardening, poultry, marketing, nutrition and hygiene education. It has been shown to increase vegetable production, dietary diversity and empowerment of women.

Aims and objectives: The aim of this impact evaluation is to test the hypothesis that integrated agriculture, nutrition and hygiene programs such as HFP can reduce undernutrition in women and young children. Furthermore, we aim to illuminate the impact pathway.
The primary objectives are to measure the intervention effect on stunting (main outcome), wasting, micronutrient status (haemoglobin, iron, Vitamin A) and diarrhoea prevalence in young children, as well as underweight and micronutrient deficiencies in their mothers.
Secondary research questions will address potential pathways through which these effects are thought to occur, including the influence of the intervention on harvest yields, family income, food security, dietary diversity, women's empowerment, food distribution within the family, child feeding, health care and hygiene practices.

Study design: We will conduct a cluster-randomized controlled field trial in 96 villages (geographic clusters) in Habiganj District, Sylhet Division, Bangladesh. In each village we selected on average 30 (10 to 65) young women, thus including 2880 women in the trial. After the baseline survey in early 2015, the villages will be randomized into 48 intervention and 48 control villages. In the intervention villages, the women will receive training and support in Homestead Food Production, young child nutrition and hygiene during the following 4 years. We will establish a birth, nutrition and disease surveillance system as part of the implementation and process monitoring. In 2019, we will conduct another survey to compare the nutritional status between intervention and control villages of the 2880 women and their estimated 1500 children under age 3. While the women are the same at baseline and endline, the children at endline will have been born after the start of the trial, and those in the intervention group should thus have benefitted throughout their crucial first 1000 days.
The trial is funded by the German Federal Ministry for Education and Research (BMBF) and the surveillance by DFID through the Nutrition Embedding Evaluation Programme (NEEP).

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WOMEN'S EMPOWERMENT, POVERTY ALLEVIATION AND FOOD AND NURTITION SECUTIRY: THE MULTIPLE CONTRIBUTIONS OF VILLAGE CHICKENS

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Introduction: Village chickens are amongst the most widely owned livestock globally and are frequently the only livestock species overwhich women have some degree of control. Research and development activities leading to the sustainable control of Newcastle disease in village chickens has underpinned ongoing research in support of poverty alleviation, household food and nutrition security and the empowerment of women in many developing countries. These interventions can also be tailored to support HIV&AIDS mitigation and wildlife conservation programs.

Methods: The Australian Centre for International Agricultural Research (ACIAR) has supported village chicken research in many countries since 1984. This research has had some significant outcomes including: the control of Newcastle disease (ND) using Australian derived live thermotolerant vaccines in a variety of poultry production systems in several countries; building a sustainable model of conducting vaccination campaigns using trained members of the community; development of gender-sensitive extension materials; and methodologies suitable for use in remote rural areas in Asia and Africa.

Field research findings have been documented using a combination of quantitative and qualitative methodologies. Questionnaires were designed in collaboration with government partners and included questions on flock management, production levels, awareness and knowledge about ND and its control, and changes in attitudes and practices. Same gender focus group discussions and semi-structured interviews were used to triangulate questionnaire findings and to delve more deeply into social, cultural and economic issues concerning village chicken production and household usage of chicken products. Baseline quantitative and qualitative data collection was followed by annual data collection in participating communities.
Research findings were discussed with both government and community partners to confirm their validity.

Findings and interpretations: The implementation of an effective ND control program in countries such as Mozambique and Tanzania has resulted in increased chicken numbers, increased household purchasing power, increased home consumption of chicken products and increased decision-making power for women. In the south of Mozambique, women have been able to sell excess chickens in order to buy goats and eventually cattle, thus giving them access to resources previously denied to them, as ruminants have been traditionally raised by men. Where families allocate chickens to children, the children are able to sell their chickens to buy school supplies.

Animal source foods, including poultry (meat and organs) and eggs, can provide high-quality protein and micronutrients in bioavailable forms which, even in small quantities, substantially increase the nutrient adequacy of traditional diets based on staple crops. Further research is underway to assess the impact of improved village chicken health and production on maternal and child nutrition in Tanzania, Timor-Leste and Zambia.

Women are recognised as key players in village poultry production systems and successful engagement with this sector should incorporate gender-sensitive approaches.

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EVALUATING THE EFFECTIVENESS OF A NUTRITION-SENSITIVE AGRICULTURE INTERVENTION IN WESTERN KENYA: DESIGN AND PRELIMINARY FINDINGS OF THE MAMA SHASHA PROJECT

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Introduction: Rigorous evaluations of nutrition-sensitive agricultural interventions are a research priority. The Mama SASHA project integrated agriculture and nutrition interventions into antenatal health care services to maximize the potential benefits of orange-fleshed sweet potato (OFSP) on the nutritional status of mothers and children less than 2 years of age.

Methods: The evaluation strategy was developed iteratively using participatory impact pathway analysis and included 2 cross-sectional surveys of pregnant women and mother-child (6-23 months-old) pairs at baseline and endline, a nested longitudinal cohort study following mother-infant pairs from early/mid- pregnancy through 9 months postpartum, two rounds of operations research and monthly monitoring. Data collection for the baseline (n=2742) and endline (n=2505) surveys included anthropometry and vitamin A (VA) status on children as well as information on dietary diversity (household and individual), knowledge and attitudes (related to nutrition, VA and health services), health services uptake, program participation, socio-demographics, agricultural practices, and agricultural knowledge. Data collection for the cohort study (n=505 women and their infants) included food security, dietary intakes, uptake of health services, program participation, knowledge and attitudes; agricultural practices and socio-demographics; anthropometry, maternal hemoglobin, VA and iron status of women; infant VA and iron status, infant anemia, and breast milk vitamin A and carotenoids, and infant morbidity. Extensive monitoring data and project expense reports were used to estimate the financial costs as well as cost-effectiveness of the intervention.

Findings and interpretations: At baseline, no significant differences were observed between intervention and control on household socio-demographics or maternal or child diet, nutrition or knowledge, child anthropometry or VA deficiency (VAD). At endline, significantly ($P<0.05$) greater proportion of intervention households: produced and consumed OFSP; had higher household, maternal and child dietary diversity, consumption of VA rich foods and dietary adequacy for VA; increased utilization of antenatal services; and had higher maternal nutrition, health and childcare knowledge and had lower child VAD**.** From baseline to endline, we observed significant reductions in prevalence of stunting (difference-in-difference impact estimate, DID: -10%; $P<0.001$), underweight (DID: -6.5%; $P<0.01$) and VAD (DID: -5.1%; $P=0.04$) among children from intervention households compared to those from control households. Among those participating in the cohort study, intake of VA was significantly higher among both mothers and children in the intervention group at 8-10 months postpartum, with these differences attributed to OFSP consumption. The intervention was cost-effective: $1882 per DALY averted [< WHO Threshold of 3 X GDP of country ($994 for Kenya)]. Preliminary findings from the Mama SASHA intervention indicate that an integrated agriculture-nutrition-health intervention had a positive impact on maternal and child health and nutrition through improved use of health services and OFSP production and consumption.

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INTEGRATED AGRICULTURE AND NUTRITION PROGRAMS CAN IMPROVE WOMEN'S AND CHILDREN'S NUTRITIONAL STATUS: EVIDENCE FROM HELEN KELLER INTERNATIONAL'S ENHANCED-HOMSTEAD FOOD PRODUCTION PROGRAM IN BURKINA FASO

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Introduction: Integrated agriculture and nutrition programs that target women can improve women's nutrition and empowerment and children's health and nutrition through three primary program impact pathways: 1) increasing production of nutrient-rich foods for own consumption; 2) increasing income from selling surplus foods; and 3) improving women's knowledge and adoption of optimal health and nutrition practices. So far, limited evidence from rigorous impact evaluations of impacts on maternal and child nutritional outcomes or how these pathways contribute to achieving these impacts exists. To help fill this gap, IFPRI partnered with HKI to evaluate their enhanced-homestead food production (E-HFP) model in Burkina Faso.

Methods: We used a cluster-randomized controlled trial and difference-in-difference (DID) impact estimates to assess the impact of HKI's 2 y enhanced-homestead food production (E-HFP) program in Burkina Faso on nutrition and empowerment outcomes of women with children 3-12 m of age at baseline and on the health and nutritional status of their children. To understand how these impacts were achieved we used process evaluation methods and a program impact pathway framework to measure changes in outputs and outcomes along the three hypothesized program impact pathways. We used mixed methods, where quantitative data were collected using baseline (2010) and endline (2012) household surveys conducted with women who had children 3-12 m at baseline and the associated household heads; and qualitative data collected through two rounds of semi-structured interviews conducted in 2011 and 2012 with program beneficiaries and their husbands, non-beneficiaries in control villages and their husbands and program implementers. Program impacts on outputs and outcomes were assessed by combining results from the quantitative data using DID impact estimates and qualitative data coded according to common themes identified through the analysis process.

Findings and interpretations: After 2 y, we found positive program impacts on women's prevalence of thinness (DID=-8.6 pp; $p<0.01$) and three components of empowerment: meeting with women (DID=1.2 points; $p<0.01$), purchasing decisions (DID=0.9 points; $p<0.01$), and healthcare decisions (DID=0.2 points; $p<0.05$) in treatment versus control villages. Children's hemoglobin concentration (Hb) (DID=0.51 g/dL; $p=0.07$) and wasting prevalence (DID=-8.8 pp; $p=0.08$) marginally improved and diarrhea prevalence (-15.9 pp $p=0.00$) significantly improved ($p<0.05$) among children aged 3-12.9 mo in treatment versus control villages; larger impacts for anemia (DID=-14.6 pp; $p=0.03$) and mean Hb (DID=0.74 g/dL; $p=0.03$) were found among children aged 3-5.9 mo.

Supporting these findings, positive impacts along the program impact pathways were found including increases in women's production, household consumption of fish/seafood; meat/poultry; and fruits, women's intake of meat/poultry and fruits, increases in women's knowledge of optimal health and nutrition practices and in children's dietary diversity. Results from qualitative data further support these findings and the impacts on women's empowerment (e.g. women in treatment villages gained control over their gardens, commodities produced and income generated).

HKI's EHFP program's positive impacts on women's empowerment and nutritional status and their children's health and nutritional status likely result from the cumulative impact of a number of small positive changes observed along the three hypothesized program impact pathways.

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MEASURING THE FOOD INSECURITY EXPERIENCE OF PRIMARY SCHOOL CHILDREN IN PERI-URBAN KENYA

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Introduction: Household food insecurity is associated with significant psychological, physical, and social impairments in adults and children (1-5). Less understood are the mechanisms by which food insecurity leads to these adverse individual child outcomes. Experience-based scales are used to assess the quantitative, qualitative, and psychosocial constructs of household food insecurity. However, children's experiences are often unmeasured or measured through proxy report or constructs based upon adults' experiences. Commonly used measurement tools fail to capture the intra-household differences in food allocation and the conditions of low food access that impact children's own nutrition, health, and development, particularly in low-and middle-income countries.

Methods: We utilized a cross-sectional design to investigate the prevalence of food insecurity for school-going children near Thika, Kenya. Primary schools (n=10) were randomly selected from the public schools participating in the Macheo Primary School Programme. During January and February 2014, randomly selected caregiver-child pairs (n=570) were interviewed. Close-ended, interviewer-administered surveys were completed separately for children (ages 9-16) and their mothers. The Household Food Insecurity Access Scale (HFIAS) (6) and a modified version of the U.S. Child Food Securty Survey Module (US-CFSSM) (7) were used to measure household and child food insecurity, respectively. Caregivers and children were also asked questions related to domains of child food insecurity not captured in the US-CFSSM (cognitive awareness and resource management) but linked with child experieces of low food access (8). A dietary diversity score was calculated and anthropometric measurements taken. Pearson's chi-squared was used to assess differences between child and caregiver reports of individual food insecurity conditions (forthcoming analysis of inter-rater discordance for ndividual food insecurity conditions expected March 31.). Descriptive, bivariate, and multivariate analyses measured the association between household and child characteristics, the primary outcome of child food insecurity, and the secondary outcome of low BMI-for-age z-score.

Findings and interpretations: Food insecurity around Thika is high: over half (50.2%) of children have very low food security. These children were more likely ($p<0.01$) than children with higher food security to participate in resource management strategies such as eating meals outside of the home (61.5% vs 16.6%), working for food or money (32.9% vs 6.7%) and begging (57.3 vs 16.6%). Mothers were unaware of their children's participation in these strategies. In multivariate analysis, maternal non-completion of primary school, household food insecurity, and low child dietary diversity were associated with increased odds of child food insecurity. After adjusting for household factors and socioeconomic status, higher child age, male sex, and low maternal body-mass index were significantly associated with increased odds of low BMI-for-age z-scores.
This study reveals dimensions of child food insecurity awareness and coping strategies that are not captured in the HFIAS or US-CFSSM. These tools can be complemented by questions of additional food insecurity conditions to better measure the phenomenon in youth. Better understanding of the food insecurity experiences of school-age children will help establish the pathways between low food access and adverse heath, nutrition, and development outcomes in youth and facilitate the development of targeted intervention strategies.

Jef L Leroy[1], Celeste Sununtnasuk[1]

AFLATOXIN, POVERTY AND CHILD LINEAR GROWTH: RESULTS FROM KENYA AND MEXICO

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Introduction: Aflatoxin is a naturally occurring toxin named after one of the fungal species that produces it (*Aspergillus flavus*). Persistent consumption of aflatoxin contaminated crops poses significant health risks. A small number of observational studies conducted in West Africa have documented an association between aflatoxin exposure and stunted fetal, infant and child growth.(1–4) A key limitation of these studies is that it is difficult to assess to what extent these findings might suffer from confounding due to socio-economic status.(5) We used data from Kenya and Mexico to better understand the association between aflatoxin exposure, poverty and linear growth retardation.

Methods: We used cross-sectional data on around 900 mothers (pregnant or with a child under 24 mo) from a rural area in Kenya's Eastern Province and longitudinal data on approximately 350 children under 24 mo of age from southern Mexico who received a daily multiple micronutrient supplement as part of a supplementation trial. Serum samples were analysed for aflatoxin using the HPLC-fluorescence method.

In Kenya, we first explored the relationship between serum aflatoxin level and a number of household, farm, and individual characteristics. We then used quantile regression to estimate the extent to which the combined characteristics could predict serum aflatoxin levels. We finally used the estimated regression model to predict to what extent the aflatoxin level varied when changing a women's characteristics from the most disadvantaged group (lowest tertile of all socio-economic characteristics in the model) to the most advantaged group (highest tertile).

In Mexico, we estimated the association between serum aflatoxin levels and concurrent and subsequent linear growth using linear regression, controlling for covariates such as child age and sex, household socio-economic characteristics, and supplement use. The standard errors of the parameters in all models were adjusted for the (potential) lack of independence between observations in the same village.

Findings and interpretations: In Kenya, aflatoxin was detected in all women. The median level of aflatoxin exposure was high: 7.47 pg of aflatoxin B1-lysine/mg albumin. A quarter of the sample had aflatoxin toxin levels above 18.6 pg of aflatoxin B1-lysine/mg albumin, and in 1 out of 10 women the level was above 50.6 pg of aflatoxin B1-lysine/mg albumin. Higher exposure levels were very strongly associated with poverty: predicted serum aflatoxin levels in women living in the worst socio-economic conditions were 4.7 to 7.1 times higher than those with the best socio-economic status. The strong association between poverty and aflatoxin exposure had not been shown before. Our results emphasize the need to better understand the strategies used by better-off families to mitigate aflatoxin exposure.

In Mexico, detectable levels of aflatoxin were found in nearly all children. Median levels were low, at 0.6291 pg of aflatoxin B1-lysine/mg albumin, which is considerably lower than levels previously found in children this age in African countries. Mean HAZ at the time when serum blood samples were collected (average child age: 12.3 mo) was -1.07 and 17.5% of children were stunted. The association between serum aflatoxin levels and linear growth will be presented at the conference.

Theme 2: Behaviour change/ Consumer acceptance

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SENSORY EVALUATION AND CONSUMER ACCEPTANCE OF BIOFORTIFIED FOOD IN DEVELOPING COUNTRIES

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Introduction: Hidden hunger, caused by lack of minerals and vitamins in diets, leads to negative health consequences for up to one third of people globally. Biofortification is a promising and cost-effective solution for increasing daily micronutrient intake and hence alleviating micronutrient deficiency in many developing countries. Conventionally bred biofortified varieties of several staple crops are currently being developed for delivery in several developing countries. . In order to successfully contribute to the goal of improving nutritional status, food made with these biofortified crops must be accepted and consumed by target populations.

Methods: In the past years, several studies were undertaken to understand consumers' acceptance of foods made with biofortified crops. This paper reviews and brings together evidence on consumer acceptance of five biofortified crops across seven countries in Africa, Asia and Latin America. Sensory preference is typically measured using a panel trained by the research team, while consumer acceptance can be measured using untrained consumers. Sensory tests objectively measure specific attributes of the foods that are not specifically related to acceptance but help to explain it. Hedonic tests are carried out in the field and are used to test the impact of various factors (i.e., nutrition information) on preferences. Consumers are often selected according to their consumption of the product, age, gender, income, geographic location or ethnic group. Methods commonly used in hedonic testing include difference tests or measures of acceptance or liking using a liking/hedonic scale. Efforts are made to control external factors at the testing locations, which can be a food laboratory, a central location or at home. In these studies we also investigate the impact of visible and non-visible nutrition traits, location of testing (central location and home use) and factors such as novelty and rural and urban differences.

Findings and interpretations: For crops with visible biofortification traits (i.e., vitamin A enriched orange sweet potato, yellow cassava and orange maize, which change colour due to biofortification), consumers' hedonic acceptance was high (over 80%) and usually higher than the conventional counterparts. Across all studies for vitamin A crops, nutrition information resulted in increased acceptance. Preference criteria for biofortified and conventional crops varied within the populations and this may have an impact on promotion strategies that encourage them to switch to the biofortied ones. For all crops, the majority of consumers highly liked both the biofortified and conventional crops whereas niche groups either preferred the biofortified over the conventional or vice versa. How these groups will respond to promotion of the benefits of biofortified crops will therefore differ. For orange sweet potato, there were differences in preference between urban and rural consumers. Sensory evaluation tests explored the relationships between carotenoid content and sensory perception. For crops with invisible biofortification traits (such as beans enriched with minerals such as iron), while there were sensory differences between conventional and high iron varieties, they were not related to iron content. Overall sensory and consumer preference testing are important in investing in and promoting biofortified varieties that consumers like.

Nancy Johnson[1], Chiara Kovarik[1], Ruth Meinzen-Dick[1], Jemimah Njuki[2], Agnes Quisumbing[1]

GENDER, ASSESTS AND AGRICULTURAL DEVELOPMENT: LESSONS FROM EIGHT PROJECTS AND IMPLICATIONS FOR INTEGRATED AGRICULTURE-HEALTH PROJECTS

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Introduction: Increasing women's control of assets has been linked to better health and nutrition outcomes. However, few agricultural interventions consider their impacts on assets. The Gender, Agriculture, and Assets Project (GAAP) worked with eight agricultural development projects in Africa and South Asia to pay attention to gender and gendered ownership of assets into their monitoring and evaluation plans. The eight projects covered different types of interventions with diverse approaches to gender--ranging from gender blind to gender transformative—and to assets, with some projects distributing land, livestock, or machinery and others promoting increased productivity through access to inputs and training.

Methods: Nearly all projects worked with men and women within beneficiary households; however, only five specifically targeted women as beneficiaries. Half of the projects distributed assets, while one distributed vines through farmers groups. Nearly all projects provided human or social capital in the form of training or group formation or strengthening. Two of the projects focused on nutrition outcomes.

Among the eight projects, three used randomized controlled trials, two used propensity score weighted regressions, two compared early vs. late recipients/buyers, and one used comparator control villages. In each project evaluation, both qualitative and quantitative methods were used to look at how participants understood gendered use, control, and ownership of assets, how assets influenced who was able to participate in and benefit from projects, and how projects impacted a range of outcome measures, including women's access to and control over assets. Quantitative data on assets were collected using asset survey modules, and specific questions regarding the identity of the owner of the asset were included in each survey. All of the qualitative and some of the quantitative studies looked deeper into jointness and explored different rights that men and women, individual or jointly, had over different types of assets.

Findings and interpretations: The impact evaluations in the GAAP portfolio illustrate that the use, control, and ownership of assets affect men's and women's ability to take up and benefit from agricultural interventions. While all eight projects were associated with increases in household-level assets, only half increased women's control or ownership of assets, and only one, HKI's Enhanced Homestead Food Production project in Burkina Faso, contributed to reducing the gender asset gap. In general, women found it difficult to increase their relative control over income from projects.
Greater attention to issues of gender and asset ownership in project design, implementation, and evaluation could improve the ability of projects to benefit women. Focusing more on jointness as a way to increase women's control of assets is a potential avenue that deserves further study. Some projects may also have shifted underlying social and gender norms toward empowering women. Even where impact evaluations did not find significant asset or income benefits for women, qualitative and quantitative analysis identified many tangible and intangible ways that interventions improved women's lives and welfare. GAAP demonstrated that collecting sex-disaggregated asset data is feasible within projects, and that asset measures are sensitive to change within development project timeframes, typically 3-5 years.

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SHAMBA MAISHA: PILOT AGRICULTURAL INTERVENTION FOR FOOD SECURITY AND HIV HEALTH OUTCOMES IN KENYA: A PROCESS EVALUATION OF A CLUSTER-RANDOMIZED CONTROLLED TRIAL

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Introduction: Food insecurity and HIV/AIDS are inextricably linked and are leading causes of morbidity and mortality in sub-Saharan Africa. Each condition heightens vulnerability to and worsens the severity of the other**.** We conducted a multisectoral agricultural intervention to improve food security and HIV clinical outcomes in a cluster randomized controlled trial. To understand the implementation successes and challenges of conducting the trial, we performed a detailed process evaluation alongside the *Shamba Maisha* trial.

Methods: *Shamba Maisha* was carried out at two HIV clinics in western Kenya, randomized to the intervention and control arms. HIV-infected patients >18 years, on antiretroviral therapy, with moderate/severe food insecurity and/or body mass index (BMI) <18.5, and access to agricultural land and surface water were eligible for enrollment. The intervention included: 1) a microfinance loan (~$150) to purchase the farming commodities, 2) a micro-irrigation pump, seeds and fertilizer and 3) trainings in sustainable agricultural practices and financial literacy.

We interviewed 40 intervention participants and 20 key informants at two time points, 3-5 months after study start and study end, to understand successes and challenges with implementation for a total of n=120 interviews. We used semi-structured interview guides to probe for feedback on recruitment and retention as well as the key intervention components and elicited suggestions on how to improve each component. Interviews were transcribed verbatim and translated into English. Interviews were coded for broad themes using a computer-assisted qualitative software and a structured coding framework developed from topics covered in the interview guide. A second stage of inductive coding allowed for sub-themes to emerge using a grounded theory approach.

Findings and interpretations: We found that *Shamba Maisha* had high acceptability, delivered strong agricultural and financial training, and implemented home visits in a supportive manner. The robust acceptability of the trial was highlighted in the majority of participant interviews. Participants and key stakeholders reported that agricultural and financial training has strong advantages on its own, and that training was an integral component of improved health outcomes. Our qualitative data also suggested that the microirrigation intervention can be labour-saving. Implementation challenges included participant concerns about repaying loans, adverse weather patterns (e.g. hail) leading to destruction of crops, and a challenging institutional partnership with the microfinance institution. We learnt that a strong microfinance partnership is a prerequisite to sustainably scaling this type of intervention. Participant concerns around loan repayment are an important consideration, particularly in light of recent findings that microfinance may fail to provide enough profit for financially disadvantaged households. Yet, overall, participants seemed highly accepting of *Shamba Maisha*, suggesting that this type of multisectoral agricultural program may be feasible to scale-up to new settings. These findings will prove useful in design and implementation of the definitive cluster RCT to test the efficacy of this multisectoral intervention.

Theme 3: Innovative metrics & tools

Mousumi Das[1]

PATHWAYS FROM AGRICULTURE TO NUTRITION: WHERE DO INDIAN STATES STAND?

Pathways from agriculture to nutrition: Where do Indian states stand?

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Introduction: In the literature on food, agriculture and nutrition security multiple pathways exist to ensure food adequacy and the required nutritional status. The main objective of this paper is to examine the performance of Indian states along these different pathways. We attempt to validate the hypothesis that a single indicator (calorie intake) based measurement of food security is not appropriate for policy making in India. Spatial heterogeneity affects the performance of regions on different food security indicators. Regional and specialized policies instead of universal policy prescriptions like the National Food Security Act are required.

Methods: Data on agriculture, consumption, sanitation and hygiene facilities, care practices, health and anthropometric status for the past four decades are mapped across years from different sources. Table 1 provides the list of food security indicators belonging to the different dimensions and the corresponding source of data. Table 2 provides details of the different variables used. Rank correlation coefficients for the years 1992-93 and 2005-06 among the different food security indicators are estimated (Table 3). A disaggregated dashboard approach is used to show the performance of states according to the different indicators. States are classified into different quartiles based on the value of the different indicators (Table 4). A coloured scale is developed whereby red denotes poor and green the best performance. Further work involves construction of a multidimensional food security index involving the different pathways using the fuzzy set approach. This will provide a measure of the extent of fuzziness. Cost effective solutions can be devised depending on the degree of fuzziness. This will have important implications for the implementation and evaluation of integrated agriculture and health related programs.

Findings and interpretations: In a country with a well-integrated food security policy one would expect that there is similarity in food security status as indicated by the different indicators (adjusting for differences in natural endowments). This would imply that it is irrelevant as to which indicator is used for policy making purposes. Our main finding is that there is evidence of both disconnects and linkages in the performance of indicators across states along the entire food security process. This implies that a well-integrated food security framework with convergence in policies and programs across different sectors should be adopted in India. Focus on calorie intake as the sole measure of food security (as is evident from the recently implemented National Food Security Act) when there are multiple pathways affecting the final nutritional status is quite misleading.

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THE GLOBAL AND REGIONAL HEALTH IMPACTS OF FUTURE FOOD PRODUCTION UNDER CLIMATE CHANGE

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Introduction: One of the most important consequences of climate change could be its impact on agriculture. While much research has focused on questions of food security, less attention has been devoted to assessing the wider health impacts of future changes in agricultural production. We estimate excess mortality due to agriculturally mediated changes in dietary and weight-related risk factors by cause of death for 155 world regions in the year 2050.

Methods: We linked a detailed agricultural modelling framework, the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT), to a comparative risk assessment of changes in fruit and vegetable consumption, red-meat consumption, and body weight for deaths from coronary heart disease, stroke, cancer, and an aggregate of other causes. We calculated the change in the number of deaths due to climate-related changes in weight and diets for the combination of four emissions and three socio-economic pathways, which each included six scenarios with variable climatic inputs.

Findings and interpretations: The model predicts that by 2050 climate change will lead to per-capita reductions of 3%, 4%, and 1% in global food availability, fruit and vegetable consumption, and red-meat consumption, respectively. Those changes were associated with 529,000 climate-related deaths globally (95% CI: 314,000-736,000), representing a 28% reduction in the number of deaths that would be avoided due to changes in dietary and weight-related risk factors between 2010 and 2050. Twice as many climate-related deaths were associated with reductions in fruit and vegetable consumption than with climate-related increases in the prevalence of underweight, and most climate-related deaths were projected to occur in South and East Asia. Adopting climate-stabilization pathways reduced the number of climate-related deaths by 29-71% depending on their stringency.
The health impacts of climate change from changes in dietary and weight-related risk factors could be significant, and exceed other climate-related health impacts that have been estimated. Climate change mitigation could prevent a substantial number of climate-related deaths. Strengthening public-health programmes aimed at preventing and treating diet and weight-related risk factors could be a suitable climate change adaptation strategy.

Lili Jia[1]

MODEL NUTRITION-SENSITIVE FOOD CONSUMPTION

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Introduction: Dietary transition from grain to Animal Source Food (ASF) in emerging countries has attracted increasing attention while empirical approaches to estimate such food consumption transition is so far lacking. Conventional models presume a linear relationship between income and food consumption implying food demand increases as income increases (1,2). However, the linear relationship between income and food consumption is sometimes implausible biologically and nutritionally because nutrients intake may reach satiation even though income continues to grow. This paper particularly focuses on this issue and proposes a novel approach – Nutrition-sensitive Food Consumption Model (NFCM) – to estimate food consumption in a trans-disciplinary context.

Methods: We consider an individual problem regarding grain and meat consumption drawing on an individual utility framework. The individual maximizes utility by choosing consumption of grain, meat calorie and non-food commodities, subject to a set of individual characteristics, for example, gender, education etc. To simplify the analysis, the consumption of vegetables and fruits is not considered. A special concern is given to nutritional feature of food consumption, hereby the calorie intake of each type of food rather than quantity of consumed food is adopted.
In the event of utility maximization, calorie consumption ratio between grain and ASF at equilibrium point can be derived using Lagrange multiplier approach. At the equilibrium of utility maximization, calorie consumption ratio between grain and ASF is determined by their relative nutritional and psychological values. We assume that individuals are bounded rational (3), which means both non-economic and economic factors, such as physical activities, income, price, education, dietary culture, may influence nutritional and psychological values for individuals leading to changes in food consumption.

Findings and interpretations: This paper puts forward to a novel NFCM which incorporates nutrition feature in food demand (grain and ASF) analysis. We argue that the relative values of grain and ASF in nutritional and psychological dimensions jointly shape the grain and ASF consumption decisions of individuals. The relative nutritional and psychological values with respect to grain and ASF are influenced by various economic and non-economic factors. Our analysis suggests that modelling food consumption should consider nutritional and psychological dimensions of food consumption as well as the economic and non-economic factors that influence relative nutritional and psychological values in terms of food consumption.

The NFCM advances food consumption toolkits in a trans-disciplinary fashion. On the one hand, it contributes to nutritionally sensible economic analysis of food consumption, which is particularly important to empirical studies of dietary transition. On the other hand, it theoretically links economic factors, such as food price and income, to nutrition, which is meaningful to empirical studies of nutrition security among the poor population. Empirical tests of NFCM with either micro or macro dataset will be conducted in the next step.

Keith Lividini[1] and John L Fiedler

USING HOUSEHOLD CONSUMPTION AND EXPENDITURE SURVEYS (HCES) TO EXAMINE THE DISTRIBUTION OF BIOFORTIFICATION'S IMPACT: RESULTS FROM CASE STUDIES IN ZAMBIA, BANGLADESH, AND RAJASTHAN, INDIA

[1]HarvestPlus/International Food Policy Research Institute, USA

Introduction: HarvestPlus has pioneered biofortification to address hidden hunger in developing countries[1]. Biofortification uses traditional plant breeding to produce staple crops with higher micronutrient content while still remaining competitive with respect to yield, pest resistance and drought tolerance. We developed a methodology based on Household Consumption and Expenditure Survey (HCES)[2] data to conduct three ex ante analyses to assess the cost-effectiveness and to understand the reach, coverage and impact of biofortification and other nutrition interventions. We analysed high provitamin A maize (PVAM) in Zambia; high zinc rice (HZR) in Bangladesh; and high iron bajra or pearl millet (HIB) in Rajasthan, India.

Methods: We used HCES, drawing on their agriculture module to model farming households' adoption and production and their consumption modules to model the households' food consumption and nutrient intakes. Adoption parameters were specified based on program planning, expert input and comparisons with similar crop varieties. To translate the simulated number of farmers to HCES households, we developed logistic regression models and used the estimated probabilities to identify the sequence of "adopting" households within the data sets. We modelled the adoption and production of biofortified varieties based on data and program parameters of similar proxy varieties.

The IFPRI International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT)'s annual predictions of crop production and demand were used to estimate changes in the size and distribution of production and consumption over 30 years. Based on our analysis of HCES crop disposition data we took into account market structure in modelling biofortication's impact. The prevalence of inadequate micronutrient intake (PII) and the number of Disability-Adjusted Life Years (DALYs) incurred and saved were examined at baseline and endline. We estimated the costs and calculated the cost-effectiveness of each intervention. Finally, these results were compared with fortification and supplementation outcomes simulated with each country's HCES.

Findings and interpretations: We assumed that mainstreaming the high micronutrient trait into a greater proportion of germlines would allow for high adoption rates in Bangladesh (82.1%) and Rajasthan (84.9%). In Zambia, adoption was assumed to achieve 20%. While the reduction in PII was generally largest in rural areas among adopting farmers, purchasers through rural and urban markets represented the largest group of beneficiaries. Over time, urban areas gained an increasing share of biofortification's impact. While the coverage was increased quickly through rural and urban markets, impact increased gradually with increasing production and displacement in the market.

In the case of Bangladesh HZR, we found biofortification to be the most cost-effective option due to greater coverage and consumption of rice vis-à-vis fortified wheat flour. In other countries, biofortification was not the most cost-effective but was competitive and complementary. In Zambia, PVAM coupled with oil fortification offered the most cost-effective two-intervention scenario. In Rajasthan, among HIB and iron fortification through either the public distribution system (PDS) or open market sales (OMS), HIB and PDS together produced the greatest reduction in PII from any two interventions. Finally, over 30 years, while baseline nutrient intake improves, PII will remain high; therefore multiple interventions are necessary.

Hazel Jean L. Malapit[1] and Agnes R. Quisumbing[1]

HOW DOES WOMEN'S EMPOWERMENT MATTER FOR FOOD SECURITY AND NUTRION IN DIFFERENT SOCIO-CULTURAL CONTEXTS? EVIDENCE FROM BANGLADESH, GHANA, AND NEPAL

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Introduction: The Women's Empowerment in Agriculture Index (WEAI) is a survey-based tool designed to measure the empowerment, agency, and inclusion of women in agriculture. 2013). Using data from three different socio-cultural contexts, Bangladesh, Ghana, and Nepal, we: (1) compute and decompose the WEAI to diagnose areas with empowerment gaps; (2) use regression analysis to examine the correlation between indicators that contribute most to disempowerment and a range of food security and nutrition outcomes; and (3) draw upon similarities and differences in the results to hypothesize how empowerment matters for food security and nutrition in different socio-cultural contexts.

Methods: The paper uses: (1) the Bangladesh Integrated Household Survey (BIHS) 2011-2012, which is nationally representative of rural Bangladesh; (2) the Nepal *Suaahara* Baseline Survey 2012, which includes 8 intervention districts where *Suaahara* planned to implement programs, and 8 matched comparison districts; and (3) the Feed the Future (FTF) Ghana Population-Based Baseline Survey 2012, which is statistically representative of FTF's zone of influence. Data to compute the WEAI, as well as indicators of household and individual food security and nutritional status, were collected in all three surveys. To investigate the links between food security and nutrition outcomes and various component indicators of women's empowerment, this paper estimates the following equation using multivariate regression methods:

$$f = \beta_0 + \beta_1 \, empowerment + \boldsymbol{\beta_2}\,\mathbf{h} + \boldsymbol{\beta_3}\,\mathbf{c} + \varepsilon \qquad (1)$$

where:

- f = vector of outcomes
- *empowerment* = measures of empowerment
- β_0 , β_1, $\boldsymbol{\beta_2}$, $\boldsymbol{\beta_3}$ = coefficients to be estimated
- $\mathbf{h}$ = vector of individual & HH characteristics
- $\mathbf{c}$ = vector of community characteristics
- ε = error term

Where possible, we use instrumental variables techniques to deal with the potential endogeneity of empowerment.

Findings and interpretations: Women's empowerment in Bangladesh is positively associated with household-level calorie availability and dietary diversity. Household wealth, education, and occupation are more important than women's empowerment as determinants of adult nutritional status, although negative impacts of group membership and credit on male BMI suggest that intrahousehold trade-offs may exist. In Ghana, women's empowerment is more strongly associated with the quality of infant and young child feeding practices and only weakly associated with child nutrition status, whereas women's empowerment in credit decisions is positively correlated with women's dietary diversity, but not BMI. In Nepal, women's empowerment mitigates the negative effect of low production diversity on maternal and child dietary diversity and HAZ. Women's group membership, control over income, reduced workload, and overall empowerment are positively associated with better maternal nutrition, control over income is positively associated with HAZ, and a lower gender parity gap improves children's diets and HAZ.

These findings suggest that patterns of disempowerment across country and context. Not all domains of empowerment are equally important in determining different outcomes at the household, mother, and child level. Understanding the gender norms in each context is therefore important for recommending policies to empower women and improve food security and nutrition.

Florencia Vasta[1], **Mandana Arabi**[1]

FRAMEWORK AND INDICATORS FOR CROSS-SECTOR DATA INTEGRATION AND NUTRITIONAL IMPACT ANALYSIS

[1]*Global Alliance for Improved Nutrition, USA*

Introduction: Factors outside of nutrition, such as poverty, economy, agriculture, and climate have significant impacts on nutritional status of individuals as well as delivery and uptake of interventions. Reducing the global burden of malnutrition, therefore, requires coordinated action between multiple sectors and at various levels. Despite having globally agreed-upon nutrition-specific actions in different contexts and related information systems, less is known about maximizing the use of data generated within other sectors impacting nutrition. Understanding the context of these relationships and development of cross-sector indicators and data systems can substantially enhance the ability to make decisions for nutrition programming and improve effectiveness.

Methods: Most sectors are limited in using indicators generated within their own sector (e.g. nutrition focusing on antrhopometrics, nutrient status, etc.), while efforts are underway to develop indicators for nutrition-sensitive agriculture[1]. We examined conceptual frameworks for nutrition, agriculture and climate change, and linkages for cross-sectoral analysis of the currently-available data from these sectors. We propose a framework including the continnum of data needs for nutrition sector at multiple levels (from individual to population), in parrallel with agriculture, climate, and health. Cross-cutting these parallel sectors is a matrix of data across sectors and levels. We propose a methodology for integrated analysis of indicators to optimize nutrition interventions. The importance of cross-sectoral data analysis is elucidated in three examples: 1)*Agriculture*-Integrating crop data (quantity composition, safety, price) and household determinants[2] with child malnutrition can reveal critical information, using Ethiopia, where trends in child weight-for-height differ during rainy versus dry seasons[3]; 2)*Climate change*-Tools exist to integrate climate and nutrition information[4]. Timing of specific interventions may be best decided when considering food productivity, animal protein availability, and time of year; 3)Web-accessible maps-superimposing undernutrition and obesity at the population level. These maps can serve as standard tools for development of future utilization of integrated cross-cutting sectoral data.

Findings and interpretations: Framework and examples used demonstrate the importance of integrating already-available data from other sectors to allow for better decision-making. The nutrition sector could significantly improve decision-making processes by including other sectors such as health, agriculture, climate (seasonality of crops and disease), and supply chains, among others. A paradigm shift is required; improved understanding of the context of these relationships would enhance the delivery and impact of nutritional interventions. We present a framework, which identifies the continuum of data and analytical needs, and propose to develop an inventory of indicators at multiple levels to measure the impact of cross-sectoral data on nutrition outcomes. We also explore the potential constraints in cross-analyses of data, e.g. nutrition indicators may be lagged, and as such, capturing time difference into models is an important area of exploration. Seasonality of nutritional deficiencies depend on specific metabolic features of nutrients and need to be considered for meaningful analysis of relationships. Finally, the need for a new generation of data champions and their skill sets will be discussed, to extract/compile, coordinate, and disseminate the data with standard tools, through consistent messages from international organizations and others involved in nutrition on importance/implications of full information, evidence-informed programming.

Lukasz Aleksandrowicz[1,3], Mehroosh Tak[2,3]

COMPARISON OF INDIAN DIETARY INTAKE DATA FROM NATIONAL SAMPLE SURVEY ORGANIZATION AND OTHER DIETARY DATA SOURCES

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Introduction: Lack of anthropometric data for India requires reliance on dietary intake data to inform nutrition and health policies. A common source of these data are the National Sample Survey Organization's (NSSO) multi-year food expenditure surveys. NSSO data suggest a decreasing consumption of calories despite rising incomes, a trend underlying India's malnutrition puzzle. However, recent research hints at NSSO's underestimation of consumption. Given the importance of the NSSO, little work has been done comparing it to other data sources. We propose to compare NSSO data to several large Indian dietary intake surveys, to assess any systematic differences.

Methods: NSSO Round 61 (2004-2005) was compared to the Indian Migration Study (IMS), a health and migration survey conducted in rural and urban regions of Bangalore, Hyderabad, Lucknow, and Nagpur, measuring intake for the years 2004-2006. Consumption in the IMS was measured using a food frequency questionnaire (FFQ). NSSO food expenditure was compared for the relevant regions, rural/urban stratifications, and income groups in IMS, looking at absolute and proportional intake of broad food groups and macronutrients. NSSO household data was extracted for one worker unit (medium physical activity, male, aged 20-39) and compared to males for the same ages in IMS. Further work will compare appropriate NSSO rounds, with similar methods as above, to the Andhra Pradesh Children and Parent's Study (APCAPS), India Human Development Survey (IHDS), and selected National Institute of Nutrition (NIN) reports.

Findings and interpretations: Average daily calories per person were 14% higher in IMS than NSSO (2964 and 2604kcal, respectively) in urban areas. This difference was considerably smaller in rural areas, with a 3% higher intake reported by IMS. Food groups with highest discrepancy between the sources were fruit and dairy, in which IMS had 4- and 2.5-times higher intake in grams/day than NSSO. Consumption of meat and eggs also showed high discrepancy, though had low overall intake. Cereals were the most consistent category, with NSSO values 5% higher than IMS. Regional discrepancies were similar for Nagpur, Bangalore, and Hyderabad, but higher for Lucknow, particularly due to high cereal intake in the NSSO data. It is difficult to assess the absolute validity of either source, however, large under or over-estimates could have considerable impacts for research on health and nutrition outcomes. Higher overall consumption in IMS could be due to NSSO's inability to capture food eaten outside the home [3]. Inherent measurement errors between FFQs and consumer expenditure surveys could also play a role. Further work will explore whether these trends, relative to NSSO, persist in APCAPS and IHDS data, which use a FFQ and consumer expenditure survey, respectively.

Roseline Remans[1,2], Gina Kennedy[1], Fabrice DeClerck[1], Jeroen Groot[3], Natalia Estrada Carmona[1], Celine Termote[1], and Simon Attwood[1] for the Nutrition Sensitive Landscapes Study Group

LANDSCAPE TRANSITIONS AND IMPACT ON AGRICULTURE-NUTRITION PATHWAYS: LOOKING BACK TO THE FUTURE

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Introduction: Change in Sub-Saharan Africa is happening fast and in multiple ways. Over the last five years, large areas of land have been targeted for agricultural intensification, whilst other areas are undergoing rapid urbanization. These transitions are paired with changes in local ecosystems and food systems—from reliance on local markets and production systems to increased access to global markets. The way such agricultural developments impact nutrition is strongly dependent on its local context and dynamics. Varying across locations and time, agriculture can have multiple functions, e.g. income generation, employment, local empowerment, biodiversity habitat, and supplier of nutritious food. Understanding potential synergies and trade-offs between nutrition-related and other functions from agricultural systems, is therefore critical to identify leverage points for win-win scenarios, determine trade-offs, and understand the drivers and implications of change in these systems over time.

Methods: We are piloting an innovative landscape approach to address agriculture-nutrition linkages as part of a socio-ecological system.

By 'landscape', we refer to the spatial extent that influences both nutrition and the environment in the study areas, including socio-economic features such as locations of and prices at markets, and transportation networks and biophysical features such as watersheds and land-use types and trajectories. With 'socio-ecological', we consider the coupled dynamics between societies and their managed/natural environment. This is of particular importance in low-income settings where dependency on, and vulnerability to, rapid changes in ecosystems (and the services they deliver) is high. With a 'systems' orientation, we emphasize interactions to understand synergies, tradeoffs and feedback loops among social (including gender), economic and environmental factors.

A first module adds a package of food environment, ecosystem services and nutrition variables to existing landscape monitoring efforts. A second module integrates these nutrition-related variables into multi-objective models at farm and landscape scales. These models allow us to assess synergies and trade-offs between nutrition-related and other agricultural functions, to explore options for win-win scenarios (and/or avoiding/mitigating certain trade-offs) and to evaluate for change over time in these interactions. A third module focuses on operationalizing these tools and participatory processes for decision-making, project management and monitoring and evaluation. Finally, a fourth module explores how learning across multiple landscapes on agriculture-nutrition linkages can be optimized using an integrated landscape-approach.

Findings and interpretations: Three pilot sites represent different gradients of change. The Barotse floodplain in Zambia represents an agro-ecological gradient from the lowlands in the floodplains, to the uplands, and a rural-urban gradient with Mongu as the major city. The site in Western Kenya, covers an agro-ecological gradient from Kakamega natural forest, to mixed livestock-cropping systems with agroforestry, to monocultures and sugarcane plantations, and towards the urban setting of Kisumu at Lake Victoria. The site in Vietnam represents a transition from subsistence towards agricultural commercialization.

Particularly at the landscape scale, key interactions among biophysical and socio-economic factors are observed. In the biophysical dimension, households and farming systems in rural areas, especially in

low-income settings, are often dependent on resources and ecosystem services available in the landscape. In the social-institutional domain, households and communities continuously interact with each other and with markets, political and social institutions. These interactions have a strong influence on household functioning, food environment and agriculture-nutrition linkages.

Looking back into the future, in view of the post-2015 development agenda, we propose that integrated landscape-based approaches offer potential to enhance our understanding of agriculture-nutrition pathways by considering multiple goals and dynamics simultaneously.

Day 2: June 4th, 2015
Presentations & Posters

Keynote Presentation:

Anna Lartey, *Director of Nutrition Division*- Food and Agriculture Organization (FAO)

LINKING AGRICULTURE WITH NUTRITION WITHIN THE SDG GOAL 2: MAKING A CASE FOR A DIETARY DIVERSITY INDICATOR

Biography:

Anna Lartey is the Director of Nutrition at the Food and Agriculture Organization of the United Nations, Rome Italy. She was a Professor of Nutrition at the University of Ghana. Dr. Lartey attended the University of California, Davis as a Fulbright student and received her Ph.D. in International nutrition. She has worked as a researcher in Sub-Saharan Africa for 27 years. Her research focuses on maternal child nutrition. She was Co-Principal Investigator for the World Health Organization (WHO) Multicenter Growth Reference Study, which resulted in the development of a new growth chart based on breastfed infants. Dr Lartey won the University of Ghana's "Best Researcher Award for 2004". She has served on several global Boards and Committees. She holds the International Development Research Center (IDRC, Canada) Research Chair in Nutrition for Health and Socioeconomic Development in sub-Saharan Africa. She is the recipient of the Sight and Life Nutrition Leadership Award for 2014. Dr Lartey currently wears two global hats: i) as Director of Nutrition at the Food and Agriculture Organization of the United Nations, and ii) as President of the International Union of Nutritional Sciences (IUNS, 2013-2017).

Day 2: June 4th, 2015
Presentation Abstracts

Session 4: Diversifying local agricultural production & diets

Bill Pritchard[1], Anu Rammohan[2] Madhushree Sekher[3]

HOW DOES THE OWNERSHIP OF LAND AFFECT HOUSEHOLD NUTRITION? REVISITING THE AGRICULTURE-NUTRITION DISCONNECT IN TWO NORTH INDIAN VILLAGES

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Introduction: Although the ownership of arable land would seem to be a key contributor to household food and nutrition security in developing countries, recent research has questioned the nature of this assumed relationship. The *Tackling the Agriculture-Nutrition Disconnect in India* (TANDI) initiative (Gillespie et al., 2012) suggests it is not land *per se* which shapes food and nutrition security, but the way in which land assets are enrolled into livelihood pathways. Empirical studies into these processes however remain limited. This paper presents data from a household survey of two villages in India that adds contextual depth to the nutrition-land-livelihoods dynamic.

Methods: A multi-method purposive maximum-variation case study approach was adopted to generate a detailed exploration of land-livelihood-nutrition relations. Two villages were selected that were proximate to one another yet with different landholding patterns. In one of the villages a majority of households held sub-economic plots of land but with access to common properrty forest resources. In the other village, landholding was dominated by elite families, with most households landless. A three-stage household survey strategy was employed. This involved a baseline random survey of approximately 100 households in each site in February 2011, a repeat survey of the same households in February 2013, and finally, a series of in-depth, qualitative interviews with 34 purposively targeted households in February 2014. All fieldwork components were undertaken face-to-face, typically in (or adjacent to) respondents' homes. Nutrition data was derived from a semi-quantitative food frequency questionnaire incorporated into the survey design. Respondents were provided with an extensive list of pre-coded food items and asked whether they had consumed these within the past month, in what quantities, and procured through what means. The 30 day recall period was selected to coincide with the monthly disbursement of Public Distribution System (PDS) rations.

Findings and interpretations: The research found significant differences between the two villages in how land and livelihoods linked to nutrition. In Village A, featured by extensive smallholding, differences in calorie intakes and dietary composition were insignificant between landholding and landless households. This was because: (i) effective PDS eligibility enabled landless households to gain access to adequate quantities of foodgrains; (ii) landholders tended not to use their land to grow fruit and vegetables for self-consumption, and (iii) although landholders were much more able than landless households to self-provision milk via their possession of a cow, cash earned by non-cow owning landless households was used to buy milk. In Village B, however, where landholding was highly concentrated, differences in calorie intakes and dietary composition between landholding and landless households were stark. This result arose because in this case study site, landlesness was strongly associated with livelihood marginalisation. The study's finding of how land executes different influences on livelihood-nutrition relationships across two proximate villages emphasises the highly contextualised character of the agriculture-nutrition disconnect. For research agendas, it stresses the need for grounded and intensive methodologies that give voice to the rich diversity in how rural households navigate land-based and non-land livelihood pathways in the developping world.

Kalle Hirvonen[1], John Hoddinott[2]

AGRICULTURAL PRODUCTION AND CHILDREN'S DIETS: EVIDENCE FROM RURAL ETHIOPIA

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Introduction: There is growing evidence that the quality of children's diets – specifically the consumption of nutrient rich legumes and animal source foods as well as vitamin rich fruits and vegetables – is as important as the quantity of calories consumed. Arimond and Ruel (2004), Mallard et al. (2014) and others find that diverse diets are associated with reductions in chronic undernutrition.

In this paper, we examine the relationship between the diversity of household agricultural production and the diversity of pre-school children's food consumption in rural Ethiopia. While its diverse agro-climatic conditions mean that an enormous variety of foods are grown across the country, pre-school children consume a highly monotonous diet with adverse consequences for their nutritional status.

Promoting production diversity is seen as an important policy tool in Ethiopia and elsewhere to improve children's diets. If some crop or livestock products influence nutrition more than others, there may indeed be a case for either policies that promote these assets and inputs – even if their income effects are comparable to less nutritionally relevant investments. An (often implicit) assumption of this policy recommendation is that food markets are not sufficiently integrated so that production and consumption decisions are nonseparable.

Methods: We use cross-sectional survey data of more than 7,000 households collected in 2013 in five regions of Ethiopia. The data used in the analysis consists of 4,214 children aged 6 and 71 months. Diets of children were assessed using the protocols recommended by the World Health Organization (WHO 2008), and grouped into seven food group categories: Grains, roots and tubers; Legumes and nuts; Dairy products; Flesh foods (meat, poultry and fish products); Eggs; Vitamin A rich fruits and vegetables; and Other fruits and vegetables. We then map our rich household agricultural production data, both crops and livestock, to these seven groups. The main analysis in the paper is based on a careful multivariate regression approach. In particular, we control for a various potential confounding factors, including child sex and age; household education, income and wealth; access to markets and food prices. We also exploit instrumental variable techniques to establish causal relationship between households' production diversity and children's diet diversity. More specifically, we instrument household production diversity with climate (temperature), altitude and slope of the land. We argue that these variables are good predictors of households' production choices but do not affect children's diet diversity (other than through the production channel).

Findings and interpretations: Our unique data allow us to show that, after controlling for a variety of household characteristics including wealth and the level of agricultural production and the endogeneity of production diversity, children's diets strongly depend on households' production choices. This relationship is particularly strong for households with limited access to food markets – but breaks down in households that do have an access to markets where to buy and sell food products.

Does this imply that all households should be encouraged to produce a diverse basket of foods? We think not. Such an approach would seem to neglect the basic economic notion of production based on comparative advantage to say nothing of the limits imposed on production choices by agro-climatic conditions. Rather, they suggest that agricultural interventions that encourage increased productivity (so as to increase household incomes), together with deepening market integration in remote areas (so as to make available foods not easily produced in these localities) and behaviour change communication (information to caregivers on the importance of feeding children a diverse diet) are more likely to result in improved pre-school diets and nutritional status.

Andrew D. Jones[1], Allison Moffitt[1]

EXAMINING THE RELATIONSHIP BETWEEN FARM PRODUCTION DIVERSITY AND DIET DIVERSITY ACROSS SUBSISTENCE- AND MARKET-ORIENTED FARMS IN MALAWI

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Introduction: Previous research from Sub-Saharan Africa and other contexts has demonstrated a positive association between the production diversity of farms and household diets. However, there have been few studies examining this relationship overall, and they have been limited by their use of cross-sectional data. The objective of this study is to determine the relationship between agricultural production diversity and the diversity of diets among of Malawian households. We use longitudinal data, and further examine the modifying influence of the market-orientation of farms, as well as urbanicity on observed relationships.

Methods: We use longitudinal data on n=3,104 households from the 2013 Malawi Integrated Household Panel Survey (IHPS) and the 2010-2011 Malawi Third Integrated Household Survey (IHS3), both nationally representative, multi-topic household surveys. We examine production and consumption data, collected uniformly across both survey rounds, on the subsample of households from the IHS3 that were randomly selected for longitudinal follow up in the IHPS. The IHPS had a 3.8% attrition rate. We use both a crop count variable, created from plot- and crop-specific production data, and a metric of on-farm species richness and evenness to assess production diversity. We use 7-day recall data on household consumption of specific foods, to construct a dietary diversity score using recently developed guidelines based on consumption of foods from ten food groups (5). We further assess the proportion of household production sold for income based on comprehensive yield and use data for each crop and plot. In preliminary models, we first examine cross-sectional relationships during each survey round, and then apply generalized estimating equation (GEE) estimation with exchangeable correlation structure for repeat observations to model the relationship between the change in production diversity and the change in household dietary diversity across survey rounds.

Findings and interpretations: This research is ongoing and we expect to have final results in mid-April. Our preliminary results from GEE models, adjusted for potential causal determinants of household dietary diversity, and the complex survey designs of the IHS3 and IHPS, indicate a positive association between farm production diversity and household diet diversity. We also examine the market-orientation of farms and urbanicity of households as potential effect modifiers in our models. In our preliminary models, the magnitude of the observed association between farm and diet diversity is greater among more strongly market-oriented households. In sub-analyses, we will further disaggregate production diversity based on the contribution of livestock to farm production, and will examine associations with consumption of specific food groups including fruits and vegetables, animal-source foods, and processed foods. We expect that these results will advance the limited empirical literature to date assessing the magnitude and relevance of distinct conceptual pathways linking agriculture to diet and nutrition outcomes. Understanding the capacity of subsistence- and market-oriented farms to contribute to healthy, diverse diets is paramount, especially in low-income countries where poor quality diets remain an intractable problem, and are contributing to the increasing nutritional "double burden" in these settings.

Anne Delaporte[1], Elisabetta Aurino[1], Meena Fernandes[1], Aulo Gelli[2] Charlotte Jordan[3]

FARM PRODUCTION DIVERISTY AND HOUSEHOLD DIET DIVERSITY: EXPLORING VARIATION ACROSS AGRO-ECOLOGICAL ZONES IN GHANA

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[3]CABI

Introduction: Farm production diversity has the potential to promote the diet diversity of farming households leading to improved nutrient adequacy and nutritional status. Agriculture-nutrition linkages may occur through multiple pathways and can be shaped by household, community and environment level factors. With regards to the latter, Agro-Ecological Zones (AEZ) have also been shown to influence production diversity and diets. This paper explores the relationship between farm production diversity, including nutritional functional diversity, and household dietary diversity across different AEZ in Ghana. It focuses in particular on the role of AEZ in shaping production and diets.

Methods: Data from 2,114 small-holder households in 116 communities were collected in September 2013 from all 10 regions of Ghana as part of a baseline survey of an impact evaluation aiming at assessing the impact of a Home-Grown School Feeding (HGSF) programme on farmers' income and food security. We measured production diversity through the count of foods produced and the count of food groups produced in the past 12 months, and through a measure of nutritional diversity of cropping system. Household diet diversity was assessed as the number of food groups consumed by the household in a seven-day recall as well as nutrient availability. Districts were assigned to different AEZ based on information obtained from FAO and Antwi-Agyei et al. (2012). Multivariate regressions were conducted to estimate the association between the measures of production diversity and diet diversity while controlling for potential confounding factors (e.g. socio-demographic characteristics of the household, plot size, distance to markets, etc.). District fixed effects were also included in later iterations of the model in order to control for unobservable district-level characteristics which may influence production and diets. Interactions between AEZ and production diversity were also investigated.

Findings and interpretations: Looking at farming characteristics, on average 50 percent of households sold crops and about 78 percent owned livestock, although substantial heterogeneity existed across different AEZ. In terms of food production, about 13 percent produced food items from just one food group while about 40 percent produced food items from four or more food groups. All the multivariate models showed that the number of food crops produced is statistically associated with higher diet diversity and nutrient availability at the household level. Access to markets through the sale of key food crops (e.g. maize, rice or vegetables) and cash crops was also associated with higher diet diversity, as well as the wealth of the household, suggesting an income pathway to better diets.

In the baseline model, compared to the Guinea Savannah, households located in the Deciduous Forest and Transitional Zone enjoyed higher dietary diversity. This finding requires additional investigation in order to understand whether AEZ alone or other district-level characteristics are associated to household diet diversity.

Given that both production diversity and access to markets seem to be driving household diets in Ghana, these findings suggest that HGSF could provide a platform for enhancing farmer households' nutrition. Using the school as a platform, this could be done through the introduction of a nutritionally balanced menu which would provide a market for diverse, locally produced foods.

Session 5: Value chain approaches to nutrition

Aulo Gelli[1], Corinna Hawkes[2], Jason Donovan[3], Jody Harris[1], Summer Allen[1], Alan de Brauw[1], Spencer Henson[4], Nancy Johnson[1], James Garrett[1], and David Ryckembusch[5]

VALUE CHAINS AND NUTRITION: A FRAMEWORK TO SUPPORT THE IDENTIFICATION, DESIGN, AND EVALUATION OF INTERVENTIONS

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Introduction: Since 2010, researchers have recognized that value chain concepts can be useful in designing strategies to achieve nutrition goals. Central to this approach is idea that private sector actors along a given value chain can benefit from the prodouction and marketing of food products which improve the nutional outcomes of a given target population. Benefits could be achieved by supplying products of higher nutritional value, increased demand for healthy foods, and/or greater accessability of healthier foods. In many cases, partnerships between the private and public sectors may be critical for acheiving these benefits. However, value chain debates so far have focused more on efficiency and economic returns than on the nutritional content of the food being produced. The potential for value chain actors to enhance nutrition outcomes of resource-constrained consumers is clear but to date there has been little documented experience. Of particular relevance in terms of evidence generation is the lack of clarity in terms of the pathways linking value chain activities to nutrition. In this paper we develop a framework to inform the design of interventions in value chains for achieving improved nutrition.

Methods: We define the "value chain for nutrition approach" as the formulation of a strategy that addresses a set of nutrition problems for a given population of resource-constrained consumers through interventions (perhaps in parthership with the governments and develpment agencies) within specific value chains. We outline key steps in the strategy development process, starting with diagnostics of nutrition problems to be addressed within the broader food-system context. An analysis of diets and consumption patterns follows, identifying dietary constraints and relative contributions of specific foods to the overall diet of target populations. This understanding of current dietary patterns provides the context for subsequent food value chain analyses that can identify constraints in supply and demand, while also examining potential entry points for interventions to enhance nutritional value. The final step in the diagnostic involves the estimation of return on investments that would support the prioritization of interventions.

Findings and interpretations: Conceptually, there are 3 main channels for value chains to improve nutrition: 1) through increased consumption of nutritious foods (a demand-side pathway); or 2) through increased incomes from value chain transactions (a supply-side pathway) or 3) through increased "nutrition" value-addition in the chain transactions. These three pathways are interlinked and involve complex dynamics that are not straightforward to understand.

A set of typologies for VCN interventions based on the supply and demand profile of the specific value chain provide further insights on intervention design and evaluation (Figure 1).

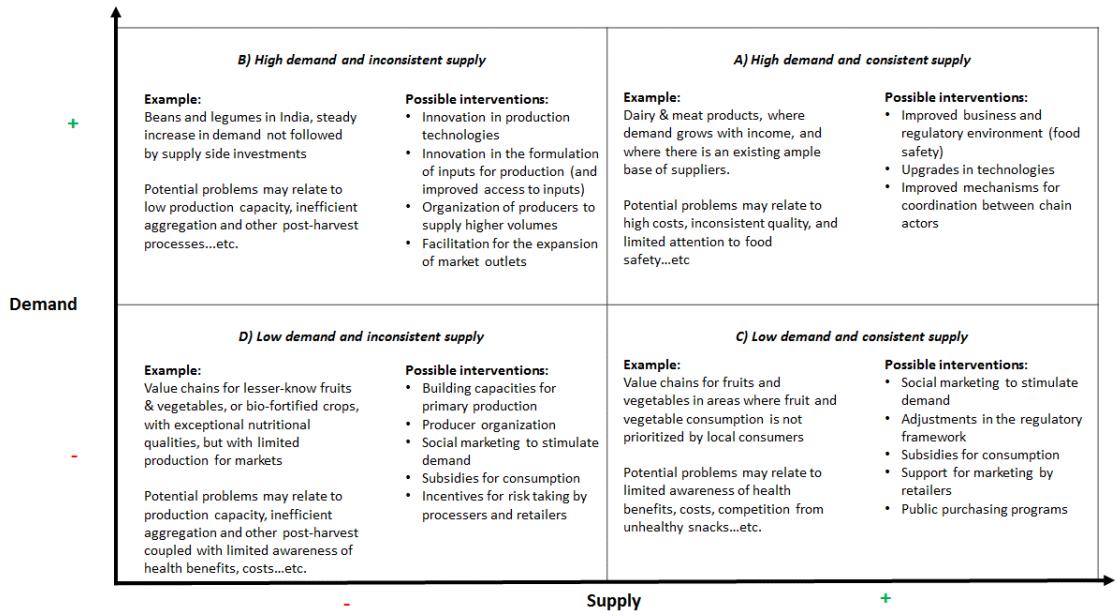

Figure 1: Typology of value chain intervention contexts based on the supply and demand of nutritious foods (Source: Gelli et al., 2014).

Where adequate supply and demand for a specific food exists, interventions would focus on optimising the efficiency and flow of "nutrition" added-value along the chain. Where demand is constrained or overconsumption is a problem, interventions would work primarily to change consumption patterns, either directly (e.g. food transfers) or indirectly (e.g. social marketing) shaping market demand. Where supply is constrained, interventions would focus on enhancing supply-side capacity by improving production practices, organising production and post-harvest activities to increase efficiency, and facilitating the expansion of market opportunities.

Critical evidence gaps remain in terms of understanding the mechanisms, costs and impacts of the interventions involved. Filling these gaps will require generating policy-relevant evidence on costs and welfare effects on producers, consumers and stakeholders involved in nutrition value-creation along the different segments of the value chain. Generating rigorous, policy-relevant evidence will also require partnerships involving policy, programme and research stakeholders working across traditional disciplines.

John Humphrey[1], Ewan Robinson[1]

Markets for nutrient-rich foods: A systemic approach to research, policy and intervention

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Introduction: To reduce the global burden of undernutrition, policymakers are looking for new channels to deliver nutrient-rich foods to vulnerable populations. Markets and value chain approaches are seen as cost effective and sustainable ways to improve access to micronutrients (Gelli et al. 2015; Hawkes and Ruel 2011). However, both the evaluation literature (Bhutta et al. 2008; Suchdev et al. 2012; Yang and Huffman 2011) and policy analyses (Bill and Melinda Gates Foundation 2011; Herforth and Harris 2013) have tended to neglect the complexity and dynamics of market processes, and their implications for achieiving better nutrition outcomes. This paper examines these processes and their implications through case studies of three market-institutional configurations for nutrient-rich products: targeted distribution systems (typified by products such as ready-to-use therapeutic foods), mandatory fortification of basic products (such as wheat flour or salt) and voluntary fortification (such as for complementary foods).

Methods: A combination of a literature review and stakeholder interviews was used to develop the case studies. In the first stage, published materials were reviewed encompassing three areas of research: a) evaluations of nutrient-rich products and delivery mechanisms, b) studies of consumer purchasing behaviour concerning nutrition and health products, c) studies of market failures and market issues affecting relevant product types (including food, health products and services and other consumer goods). Non-peer-reviewed materials that provided concrete qualitative and quantitative accounts of relevant nutrient-rich product types were also reviewed. The literature review was complemented by 92 interviews with key stakeholders in government, private sector, non-profit and research institutions in Ghana, Nigeria and Tanzania. Interviews provided qualitative accounts of specific interventions spanning the three market-institutional configurations covered in the case studies; they also provided stakeholders' various interpretations of dynamics and outcomes. Interviews were analysed through iterative categorical analysis carried out by the primary author. Interpretations were validated through review of preliminary reports by stakeholders in each of the study countries.

Findings and interpretations: We find that a common set of system-level constraints inhibit many market-based interventions from improving access to and use of nutrient-rich products by target groups on a sustainable basis. Drawing on existing literature, we group these constraints into two categories: first, constraints related to targeting low income consumers in 'bottom of the pyramid' markets, particularly the high costs of distributing to these groups; and second, constraints related to the nature of micronutrients as a good, particularly low consumer demand for nutrients and nutrition outcomes, the credence good nature of nutrient-content and strong information asymmetries among value chain actors. The identification of these constraints at the level of market systems suggests the need for nutrition-oriented policy and business initiatives to shift from working at the level of individual firms to working at the level of market systems. There is a need for research on the real-world *effectiveness* of particular market-institutional configurations in reaching key groups, moving beyond the current focus on products' potential *efficacy*. Researchers and policymakers should embrace principles of methodological pluralism and adaptive learning in order to develop relevant evidence and more effective interventions for leveraging food markets to contribute to better nutrition.

Paula Dominguez-Salas[1,2,3], Barbara Häsler[1,3] Elaine Ferguson[3,4], Laura Cornelsen[3,4], Silvia Alonso[2], Eric Fevre M[2,5], Jonathan Rushton[1,3], Delia Grace[2], Pablo Alarcon[1,3]

COMPLEMENTARITY OF VALUE CHAIN ANALYSIS AND CONSUMPTION PATTERNS IN THE DESIGN OF SUSTAINABLE, EFFECTICE AND EFFICIENT FOOD-SYSTEM-BASED INTERVENTIONS

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Introduction: Adequate and balanced nutrition is key for poverty reduction, maternal and child health and the achievement of the Sustainable Development Goals. Malnutrition, particularly micronutrient deficiencies, can be alleviated with nutrient-dense animal-source foods (1). In Nairobi, Kenya, poor informal settlements represent a challenge to the food supply. The purpose of the reported study is to understand the dynamics of: 1) food systems supplying animal source foods using value chain analysis; and 2) consumption patterns of animal-source foods in deprived households. These two components were then linked to facilitate realistic and proportionate interventions and inform food policies.

Methods: We conducted two parallel investigations in Nairobi: a cross-sectional nutrition survey in consumers of 205 randomly selected low-income households, in Korogocho and deprived areas of West Dagoretti; and a large-scale characterisation and analysis of the different animal-source food systems of the city. Retailers were the linkage node between consumers and food systems data. In the household survey, dietary (24-hour recall), anthropometric (weight, height and length), and biochemical (haemoglobin) data were collected from non-pregnant women of reproductive age and children (1-3 years). The questionnaire also included quantitative data on animal-source food consumption patterns and choice drivers, and purchase prices that were used to calculate demand elasticities. In the food systems study quantitative and qualitative data were collected using value chain analysis that included constraints, barriers and potential, and the assessment of the involved food safety and nutritional risks. This analysis included: key informant interviews (e.g. government officers), focus groups, interviews of all the stakeholder types along the chains (farmers, abattoir/market owners and workers, transporters, and retailers) and researchers' observations. Linear programming (in Optifood) was used to formulate population-specific food-based recommendations, and model the effect of incorporating different animal-source foods in the diet.

Findings and interpretations: Results in children showed 42% were stunted and 74% were anaemic; in women, 7.4% had a low and 29% a high- body-mass index and 26% were anaemic. The linear programming analysis identified specific food-based interventions that would ensure, for example, dietary adequacy for all nutrients except for iron in women, requiring among others increases of intake of milk and other animal sources.

The consumption and food systems datasets on animal-source foods were combined to assess availability, affordability, accessibility, preference, and upscaling potential. For example, beef was consumed by most households (81%) at an average of 1.5 times per week. Its demand was principally based on 'taste' and 'nutrition' indicating that consumption would be responsive to nutrition education. The reasons why households did not consume beef were either "price" (71%) and/or 'unknown' (74%). Own-price elasticity of beef was relatively inelastic at -0.68. Food system analysis showed that most beef was destined for higher-income areas Slums were limited to stale, low quality carcases with infrastructure issues producing problems of poor hygiene, food safety and traceability.

The combination of approaches and methods provides a holistic picture of the food systems and its limitations, which allows more informed decision on interventions for poor people.

Simon Ndungu Nyokabi[1]

BIOSECURITY MEASURES IN MEAT AND MILK VALUE CHAINS: A STUDY IN BURA SUB-COUNTY, KENYA

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Introduction: Livestock value chains are an important source of employment, income and nutrition in developing countries. Increasing income has led to high demand for animal source products. Zoonoses pose a public health challenge to people producing, handling, processing and consuming animal products. Value chains create contact networks for transmission.

Over 60 % of emerging diseases are of zoonotic origin. Outbreaks cause huge losses for countries and their populations. Biosecurity measures constitute a cheap, integrated approach and affordable way of disease control from farm to fork as advocated in the concept of one health.

Methods: This research used mixed methods - qualitative and quantitative methods. A semi-structured questionnaire was used to test knowledge attitude and practices of value chain actors. The sampling techniques used were snowballing and convenience sampling as no register of actors existed. Enumerators consulted actors on market days as it was the only time they were available. Snowball sampling was used to reach more actors after recommendation by fellow actors. The aim was to reach as many as possible of the population to eliminate bias associated with methods used.

Participatory mapping exercises were utilised to map the value chain. The activities and biosecurity measures used were mapped to identify biosecurity gaps in actors' day to day occupational activities. This was to evaluate occupational risk, biosecurity measures adopted and possible food contamination due to non-implementation of measures. Key informant interviews were conducted with key actors like government institutions and actors to better understand key issues that arose during survey. Observations were made to compare responses and practices.

Findings and interpretations: The study results indicate that there is low knowledge of disease, symptoms and biosecurity measures among value chain actors, who do not perceive zoonoses as a serious problem. This is reflected by low levels use of protective personal equipment, low levels of medical check-ups, risky occupational activities which expose actors and consumers to zoonotic risks.

Cultural practises like consumption of raw offal, milk and occasional slaughtering of sick or dead animals pose a public health problem. Poor sanitation and hygiene like open defecation, use of untreated water, poor packaging and lack of training in food handling exposes food to contamination by actors. The area lacks a sewerage system and the waste management system is not sufficient to address zoonotic disease associated with animal waste.

Governance challenges include small budget, bureaucracy, understaffing, poor planning and corruption exist leading to non-enforcement of laws and regulation.

There is low institutional support for adoption of biosecurity measures and extension service is poorly equipped to deal with high demand in the region. Hospitals are not equipped to properly and incidences of misdiagnosis are common.

Women have low education, low training, low knowledge and poor access to resources, highlighting gender issues and inequalities in value chains.

Session 6: Nutrition Sensitive Agriculture Policy

Elizabeth Hull[1]

THE POLICY DISCONNECT IN AGRICULTURE AND HEALTH: A CASE STUDY OF SOUTH AFRICA

[1]SOAS, University of London & LCIRAH

Introduction: This paper addresses the issue of governance in agriculture and health, picking up on the theme of LCIRAH's previous annual conference and making a case for future research in this area. Using a case study from South Africa, I focus on the disconnection between agriculture policy and government interventions targeting food insecurity. I argue that the discrepancies between these two policy arenas are caused by political constraints rather than a lack of knowledge. Based upon this, the paper makes a theoretical argument about the relationship between research and policy, arguing that researchers should focus on the situated political constraints in which government policies are made.

Methods: This paper develops a theoretical argument based on a qualitative case study of South Africa. It uses a variety of sources including data from my own anthropological research as well as secondary literature on agricultural policy and food security. I take a wide view of South Africa's policy landscape and how it has changed over time, to assess the strengths but also the limitations of policy interventions in agriculture and health. I address two core areas:

1. Agricultural policy at the national and multilateral levels
2. Policies (both agricultural and other) that address food insecurity explicitly

I identify the important connections and disconnections between these two related policy arenas.

Findings and interpretations: I show that the policy landscape in South Africa is fragmented and at times contradictory, creating a disconnection between agriculture and nutrition outcomes. For instance, South Africa's emphasis on creating highly competitive, open markets runs counter to its insistence on encouraging small 'emerging' farmers. The effects of such discrepancies on health outcomes can be unpredictable and multifaceted.

Rather than arising from a lack of knowledge or institutional capacity, I argue that this fragmented policy scenario is the result of systemic forces that operate both from within South Africa and at the global level. The government, in effect, is in the position of appeasing several competing interest groups.

Using this case study, I argue that due to such diverse influences, governments may be unable or unwilling to implement the policy changes recommended by research even where strong evidence exists. For this reason, I conclude that it is important for research to focus explicitly on the actions of governments and policy-makers as objects of research, rather than seeing them only as the recipients and implementers of research findings or necessarily representatives of public interest.

Jessica Fanzo[1] and Quinn Marshall[2]

THE INTEGRATION OF NUTRITION WITHIN EXTENSION AND ADVISORY SERVICES (EAS): A SYNTHESIS OF EXPERIENCES, LESSONS, AND RECOMMENDATIONS

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[2]*UN World Food Programme, Rome, Italy*

Introduction: There is a heightened awareness globally and within development institutions and governments of the need to better understand the linkages between agriculture and nutrition, and to decipher the ways in which agriculture can contribute to improved nutrition. However the *what* and the *how* of effectively delivering "nutrition-sensitive agriculture" services to rural households, remains less understood. Extension workers are often thought as a promising platform or vehicle for the delivery of nutrition knowledge and practices to improve nutritional health of rural communities because they reach and interact closely with farmers in different settings. Furthermore, they act as significant service providers of crop, livestock, and forestry aspects of food security, consumption, and production. However, the context and mechanisms for delivery on the ground have been less clear or under-evaluated.

Methods: In 2013, the Global Forum for Rural Advisory Services and the World Bank's Secure Nutrition Knowledge Platform supported a comprehensive study that examined the integration and linkages of nutrition within extension and advisory services (EAS) and workers in Africa, South Asia, and the Americas. This study analyzed the current state of knowledge on the role of nutrition in EAS, highlighted good practices stemming from eight specific country case studies, and noted comparative advantages of different types of programme models.

Researchers used a systematic literature review, survey, and semi-structured key informant interviews. Data were collected between December 2012 and June 2013. The systematic review utilised the GFRAS "Worldwide Extension Study" database and both white and grey literature from 1960 to the present. The literature search resulted in 232 documents of which 25 were deemed relevant and summarised in the report. The online survey was targeted at respondents familiar with either nutrition or EAS, and was hosted on eight agriculture/nutrition websites and advertised through various agriculture/nutrition communities. In total, 68 responses were received. Semi-structured key informant interviews were conducted in the language of the participant, recorded and transcribed, and analysed using Daily Interpretative Analysis. In total, 38 interviews were conducted.

Findings and interpretations: This study did a comprehensive sweep of the literature, landscape, and opinions, with a call for input globally, and found that the integration of nutrition (and home economics) into EAS often remains archaic, scattered, or side-streamed. Most of the programmes lacked measures of "efficacy" because of the scant collection of data, peer reviewed publications, or evaluations examining the impact of integrated programmes on dietary and nutritional outcomes. This makes *scalability* and *sustainability* recommendations for nutrition-sensitive EAS more challenging.

The study does highlight some areas that can provide lessons for scaling up, including reach and adoption, resource capacity (human, institutional, and organizational), technical ability, delivery mechanisms, and contextual factors. The data in this study highlights lessons that can be extrapolated, if EAS were to take on elements of nutrition for scale. *Scalability* will depend on: achieving high-level government buy-in and multi-sectoral coordination; effective and equitable use of ICTs and other low-cost technology; and flexibility and resourcefulness in deciding who participates in EAS formally and informally. *Sustainability* will depend on a separate set of factors, including: the ability of EAS to be demand-driven and empower communities; the quality of nutrition education and training for EAS; and the stability of funding for EAS, and the operational continuity and stability of EAS that results.

Pablo Alarcon[1,2], Domitille Kauffmann[3], Christophe Breyne[4], Paula Dominguez-Salas[1,2,5]

PERCEPTIONS, EXPERIENCES AND CHALLENGES IN LINKING LIVESTOCK INTERVENTIONS AND HUMAN NUTRITION IN WEST AFRICA COUNTRIES (CHAD, MALI, BURKINA FASO, NIGER, SENEGAL, MAURITANIA)

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Introduction: The potential for livestock livelihoods and animal-source foods (ASFs) to improve nutrition in the arid conditions of the Sahel countries, especially for vulnerable and crisis-affected households, is important. However, this potential has been at present underutilised and there is a need to better understand the gaps and linkages between the two fields. This work assesses the current barriers to the implementation of "livestock-nutrition" interventions and discusses challenges as identified by both nutrition and livestock experts working in the West Africa region. It also highlights lessons learnt from institutions in strengthening human nutrition and livestock linkages in humanitarian interventions.

Methods: Methods included a combination of a cross-sectional qualitative study, a literature review and a regional workshop, conducted in 2014. The cross-sectional qualitative study involved a total of 36 participants from 27 national and international institutions working in West-Africa. A semi-structured questionnaire was used to collect data on their perceptions and experiences on the current importance to link livestock and human nutrition, existing gaps, key linking factors, type of interventions implemented and their impact on nutrition, tools currently used or with potential to be used, and livestock and nutrition coordination issues. A thematic qualitative analysis of the data was performed to identify the relevant themes for each of the groups of questions asked. The review aimed to support with ideas, frameworks, and experiences from the literature the information gathered through the cross-sectional qualitative study. A regional workshop was finally held involving sixty participants from West African countries. The workshop focused on identifying knowledge gaps and operational challenges in linking livestock interventions and human nutrition. The workshop included a session on presentations of interventions implemented in the region and discussion on their lessons learnt, as well as group activities to collectively brainstorm on the potential pathways from livestock interventions to improved nutrition.

Findings and interpretations: There was a general agreement on the importance of livestock and ASFs to reduce the high malnutrition levels in the Sahel which coexist with high livestock presence, notably in pastoral areas. However a disconnect between livestock and nutrition activities exists as livestock interventions usually neglect nutritional goals, mainly due to the complexity of impact pathways between livestock interventions and nutritional outcomes, and the multiple roles of livestock in local livelihoods. Key factors that affect how livestock interventions impact nutrition include whether income is generated and how it is used, mobility, food taboos, gender inequalities and use of ASFs preservation techniques. Lessons learnt indicated the importance of bringing a nutrition lens to the design of livestock interventions by clarifying impact pathways, using relevant indicators, and adjusting targeting strategies to maximize impact. Other key elements included the need to consider household priorities and gender aspects, to mobilise adequate nutrition and livestock expertise, and engage in effective multidisciplinary work and coordination.

Evidence gaps currently impede progress in the design of nutrition-sensitive livestock interventions and policies. Stronger collaboration between researchers and implementers in livestock and nutrition could significantly contribute to expand the current body of evidence to inform successful intervention design.

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AGRICULTURE, NUTRITION, AND THE GREEN REVOLUTION IN BANGLADESH

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Introduction: Although agriculture is widely thought to be an important sector for influencing nutrition outcomes, there is a remarkable dearth of rigorous evidence on the role of large scale agricultural programs, such as Asia's Green Revolution. This paper therefore analyzes agriculture and nutrition linkages in Bangladesh, a country that achieved rapid growth in rice productivity at a relatively late stage in Asia's Green Revolution, as well as unheralded progress against undernutrition. To do so we create a synthetic panel that aggregates nutritional data from five rounds of the Demographic Health Surveys (1997 to 2011) with district-level estimates of rice yields. Using various panel estimators, they test the impact of growth in rice yields on anthropometric and child feeding indicators.

Methods: In this paper, we exploit these rich data sources to construct a synthetic panel dataset comprising nutritional indicators from five rounds of the Bangladesh Demographic Health Surveys (DHS) (during 1996/1997 to 2011) and district-level data on rice yields from the Bangladesh Bureau of Statistics. With these data, we examine the impact of rice productivity growth on preschool nutritional status, controlling for district-level fixed effects and time period effects as well as other time-varying factors that might also explain nutritional improvements in Bangladesh, such as the rapid expansions in women's education, sanitation, health and family planning services, women's empowerment, and nongovernmental organization (NGO) services. We assess the robustness of our time and location fixed-effects models through the use of panel generalized methods of moments (GMM) estimation techniques that address endogeneity concerns regarding the estimated impacts of rice yields. Hence we are able to purge our regression models of factors that potentially confound the inferences drawn from the cross-sectional econometric literature referenced above.

Findings and interpretations: We find that increases in rice yields have large and statistically significant impacts on child weight gain. The result appears to be explained by increased food consumption for young children, particularly the timelier introduction of solid and semisolid foods in the critical early window of child development. Conversely, we find no substantial evidence that growth in rice productivity has significantly improved linear growth of young children or the dietary diversification processes that are significantly associated with linear growth. Thus, while the estimated effects of yield growth on WHZ scores are large enough to account for much of the improvement in weight gain observed in rural areas of Bangladesh from 1997 to 2011, we find no evidence that yield growth explains much of the rapid improvement in stunting observed during this period. Of course, this does not mean that no such effects exist. Rice productivity growth might have had general equilibrium price effects—which our model is not suited to identifying—that favorably affected linear growth in children. Another possibility is that rice productivity growth had improvements on maternal nutrition, which heavily determines a child's birth size. While there are some indirect indications that birth size improved quite substantially from 1997 to 2011 (Headey et al. 2015), the DHS do not directly measure birth size, meaning that we are unable to directly test this hypothesis.

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LINKING AGRICULTURE TO NURTITION IN NORTHERN RWANDA

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Introduction: Current data in Rwanda[1] show an overall improving trend for malnutrition. This is a testament to the country's commitment as they relate to nutrition. In spite of the advancements made, high rates of stunting among children still prevail. A recent Comprehensive Food Security and Vulnerability Analysis and Nutrition Survey[2] conducted by the Government of Rwanda, in part revealed the expected, that stunting in children is associated with food insecurity *except* in the northern volcanic areas. Considered the bread basket in Rwanda, it was paradoxical that stunting levels in children under 60 months ranged between 44 - 66 % this region.

Methods: A study was therefore conducted to better understand the interlinkages between agriculture production and nutrition in Rwanda. The basis was a conceptual framework of developed by Herforth and Harris[3] on the "key pathways between agriculture and nutrition". The conceptual pathways for improving nutrition through agriculture-led activities as proposed in the framework can be divided into three main routes at the household level: 1) food production; 2) agricultural incomes; and 3) women's empowerment and employment. A case-control survey investigating pathways linking agriculture to nutiriton, and the determinants of malnutrition in children under 24 months, has been conducted in Rubavu, Ngororero, Gakenke, Musanze, Kirehe, Nyagatare, Nyaruguru, Nyamagabe and Gasabo districts in Rwanda. Cases and respective controls were selected based on evidence of childhood stunting in the households. Controls were matched 1:1 to cases on the basis of sex, age, and location. Information on variables of interest for both groups was collected using questionnaires. Selection of indicators was guided by the "key pathways between agriculture and nutrition" framework. Regression analysis and odds ratio were used for context assessment, to determine the critical pathways and components between agriculture and nutrition, and validate pathways linking agriculture to nutrition outcomes in the Nothern province of Rwanda.

Findings and interpretations: Odds ratio (95% confidence limits, n) for childhood malnutrition as relates to livelihood activities were: no livelihood activity 1.33 (0.57-3.08, n=29), agriculture as main livelihood activity 1.93 (1.22-3.04, n=444), and agriculture as other livelihood activity 1.00 (0.48-2.07, n=45). The reference group was livelihood activities other than agriculture (n=95). Agriculture as a main livelihood was significantly associated with stunting in children (p = 0.005) with 54.1 % of children in these households stunted.

In the Northern province of Rwanda, the risk of a child being stunted increases by 93 % if the main source of livelihood to the household is agriculture; as compared to households whose sources of livelihood exclude agriculture. It is probable that the data analysed reflects a disconnect between agriculture to nutrition outcomes, especially among farming households. There is therefore, a need for more and better designed research to clarify what agricultural programs can do to achieve positive maternal and child nutrition outcomes. How could agriculture improve nutrition outcomes if it explicitly included health and nutrition goals? What kinds of policy and programming changes would be needed to leverage agriculture's contribution to nutrition? And what would be the key pathways in linking agriculture to nutrition in Northern Rwanda?

Day 2: June 4th, 2015
Poster Abstracts

Theme 4: Diversifying local agricultural production & diets

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IMPACT OF SALINITY ON SHRIP-PRAWN FARMING AND HOUSEHOLD FOOD CONSUMPTION PATTERN AT DIFFERENT AGRO-ECOLOGICAL LANDSCAPE IN BANGLADESH

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Introduction: Aquaculture is well established for ensuring food security, economic development, improved nutrition and poverty alleviation. But the shrimp and prawn farming issues due to socio-economical and environmental degradation require further consideration. However very little effort has been given to provide a holistic scenario of shrimp-prawn farming and its direct and indirect impacts on food and nutrition security in LIFDCs including Bangladesh. This multi-disciplinary work was aimed at identifying the existing farming systems and overall outcomes (both aquatic and terrestrial crop) at different agro-ecologic landscapes in the south-west coastal seafood farming area in Bangladesh and its impact on community food security. These data will endeavour to a better understanding of the shrimp-prawn farming contribution on food distribution, health outcomes of community people.

Methods: On the basis of water salinity level, the shrimp-prawn farming areas were divided into four different agro-ecological zones: (high saline>10ppt, mid saline<10>5, low saline<5ppt; freshwater area 0ppt). About 40 farms from each agro-ecological area were selected on the basis of the global project SEAT working framework and a course of survey was done with a semi-structured questionnaire. A well-being practice was executed at the community level according to Haque, 2007 and about 1120 households were interviewed in 4 communities and categorized into better off and worse-off on the basis of their livelihood profiles. In the second phase, a short questionnaire was developed to reveal the demographic, farming and family level information. At the final stage 60 households were selected from each community equal share from better off and worse-off while one criterion for selection of households was having at least one adolescent girl. 24hrs foods recall method and food frequency questionnaire were developed and administrated with two replications and the anthropometric data height, weight, age, sex, MUAC were collected to address the preparedness for critical 1000 days issues. Blood samples from finger tips were collected and dried on a sample pad to identify the n-3 fatty acid level being one of the vital biomarkers to address the adolescent health outcomes that are mostly related to seafood consumption.

Findings and interpretations: About 54 different species were commonly available and tiger shrimp, speckled shrimp, mud crab, freshwater prawn are the main export commodities that varied from 20-48% in terms of volume and with the rest being consumed locally and regionally. Rice and about 22 varieties of dyke vegetables are available and main items are gourd, cucumber etc. In terms of volume, 20% fish, 60-80% rice and 5-10% vegetables were consumed at household level and the rest of them are destined for local, regional and international markets. Annual fish consumption pattern at household levels were obtained 164.43, 320.76, 185.78 and 246.52 kg/year in HS MS LS and FW areas respectively. Fish consumption was obtained 8 to 10 days while meat consumption was below 3 days in 2 weeks food frequency pattern. Regarding the intra-household allocation of fish consumption of adolescent girls these ranged from 80-148gm/day while the household head father consumed 123-205 gm. Anthropometric and biomarker studies will give a more concrete scenario of the food and nutrition security of the area. Most previous assertions are based on poorly generalisable 'worst case' scenarios. This paper attempted to consider the aquatic and terrestrial diversity and its impacts on household consumption and nutritional outcomes of vulnerable adolescent girls.

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COULD AGRICULTURE DIVERSIFICATION IMPROVE THE QUALITY OF FOOD CONSUMPTION WITHIN AGRICULTURAL HOUSEHOLDS? EVIDENCE FROM BURKINA FASO

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Introduction: It is common sense belief that increased agricultural production leads to better nutrition. However, recent studies and literature reviews show ambiguous effects of higher agricultural productions on overall diet and nutritional outcomes of the members of farm households.

These results raise questions considering that at the macro level, food security policies commonly recommend boosting agricultural production. Agricultural research and policies have focussed on increasing yields, with little attention put on improving to improve nutritional outputs.

In the study presented here, we investigate more precisely the relationship between agricultural production and the quality of food consumption.

Methods: A randomly selected sample of 580 agricultural households was followed over one year in Western Burkina Faso. This region was chosen because despite good average agricultural production and surpluses of cereals, children chronic malnutrition rate remains high (stunting prevalence was 39% in 20111).

To capture seasonal variations, the survey was repeated at three different periods: dry season (May 2013), lean season (August 2013) and post-harvest season (February 2014). Indeed, agricultural outputs, stocks, monetary resources or energy needs vary significantly according to seasons.
Data included socio-demographic characteristics of the household (including members who eat together), farm and agricultural production characteristics, farm and non-farm income of farm heads and women.

Qualitative 24-hour recalls were used to compute Dietary Diversity Scores (DDS) for both children 6-24 months old and their mothers. The nutritional status of children has been measured using anthropometric indicators. The originality of our study is to create a "Production Diversity Score" which computes the number of crop groups produced within the farm, comparable with nutritional groups.

Findings and interpretations: In this paper, we investigate the correlation between agricultural household's resources (crops, farm and non-farm income) and the DDS of women.

During the first period, women dietary diversity was associated positively with the Production Diversity Score and the agricultural income ($P<0.05$), but not with the number of crops (including livestock), nor with the Simpson's Index. Moreover, households who produce outputs like roots, tubers or fruits have on average a better dietary diversity ($P<0.01$), contrary to cotton producers.

Furthermore, gathering wild resources was positively related to the DDS during the first survey, when trees have their leaves (especially the baobabs). This variable is hardly ever collected and studied.

During the lean season, none of resources from agriculture has a significant relationship with the quality of food consumption, because most crops have been consumed and the farm income largely spent. Hence, the non-agricultural income was associated to food diversity: especially the women's income which has twice the effect of the farm heads' income. Indeed, spending depends on gender: women are in charge of providing food and men pay for external expenses (like school or health).

Finally, the effect of age or ethnic groups should show that food consumption depends on tradition, cultural identity or preferences.

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HUMAN AND ECOSYSTEM HEALTH: EFFECTS OF HUMAN ILLNESS ON ENVIRONMENTAL SUSTAINABILITY

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Introduction: Environmental and human health are closely linked, yet we rarely consider the impact of human illness on environmental change. Reliance on the environment as a safety net, physical limitations, and medical expenses borne of illness threatens ecological stewardship. Such dynamics may also portend increased harvest pressure and deleterious practices. Links among disease, livelihoods, and vulnerability have perhaps been best understood through the case of HIV in Africa, where agricultural labor and food availability are affected by disease. We ask how household morbidity affects fishing practices and resource sustainability in the Lake Victoria fishery.

Methods: We conducted this work on Mfangano Island, Kenya. Located within Lake Victoria, Mfangano has an HIV prevalence of over 25% and is home to approximately 21,000 people. Household data were collected from December 2012 – March 2013 and are a subset of a larger study of fishing livelihoods, fish consumption and child nutrition. Responses included here represent data from 4 time points: baseline, 3-months, 6-months and 12-months. Data were collected for 303 participant households randomly selected from an enumerated sampling list of all households with a child <2 years of age and living on Mfangano Island, Kenya. Data presented here are those from adult male respondents/fishermen, who were initially present in 251 (83%) of households. Surveys measure adult morbidity using the Measured Outcomes Survey-HIV (Wu, Rubin et al. 1991; Wu, Revicki et al. 1997), fishing activities, and fishery access. Statistical analyses use generalized estimating equations (GEE) with an unstructured correlated matrix to derive population averaged estimates of effects of morbidity and covariates on particular fishing methods. Final models are in progress.

Findings and interpretations: When controlling for regional differences, individual variation, and the productivity of different fisheries (catch per unit effort), morbidity score affects engagement in particular fishing activities. Specifically, individuals with higher morbidity are more likely to fish using illegal gillnets and beach seining methods. Individuals with higher morbidity are less likely to engage in fishing dagaa, a more abundant species that is fished at night. That illegal methods generally have lower physical demands than legal methods means that HIV has an amplified effect on the fishery. While death is also a common outcome in the region, and fisherman also reported curtailment of fishing activities due to personal illness, overall fishing pressure on Lake Victoria has been sustained. That morbidity affects specific fishing activities indicates that illness directly impacts the sustainability of the fishery and long term future of fish stocks. This work has important implications for not only fishery systems, but agricultural, forest-based, and pastroal livelihoods. Where resource stewardship and ecological knowledge depend on long-range perspective, illness in the short and long term can affect the use of sustainable practices to manage land, soil, forests, and animal resources.

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UNDERSTANDING RESOURCE DEVELOPMENT, FOOD SECURITY AND NUTRITION NEXUS IN LAO PDR

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Introduction: The paper draws attention to interdisciplinary approach to study the nexus of resource development, livelihood and food security in resource rich but economically poor developing countries. During the last two decades, private investment in resources sector including hydropower and mining has significantly increased in Lao People's Democratic Republic (hereafter Laos or Lao PDR), a least developed country in the mainland Southeast Asia known for its resource wealth. Although increased investment in resources sector has contributed to the growth of national economy in Laos, child under-nutrition remains close to 50 percent.

Methods: The paper presents research outcome from a project funded by the Australian Centre for Intenrational Agricutlral Research Centre during 2012 and 2015. The project (Facilitating Livelihood Adaptations to Natural Resource Pressures in Lao PDR) applied spatial analysis and household survey to understand the linkages between resource development, land use change, people's access to food and their nutrition status, and further exmined the diferent processes of livelihood adaptation in the country's economically critical watershed, the Nam Ngum. The current paper especially focuses on the results of spatial analysis and household survey. The project carried out wall-to-wall land use chage detection of Landsat images between 2000 and 2015 for the entire Nam Ngum watershed, and assessed the relationship between resource development and land use change. The project also carried out household survey across the watershed in total of 157 villages in four topographic zones during January and May 2014. Household survey included information on household socio-economic characteristics, agriucltural activities, access to food as well as anthrpometric measurements of children under five years old, and men and women of reproductive ages. Statistical analysis of survey data were carried out using STATA 13 software.

Findings and interpretations: The results of spatial analysis indicates that the Nam Ngum watershed is among the fastest degrading resource base in the country. Hydropower development in particular has contributed to a significant loss of forest area during the last decade especially in the highland zone. Preliminary assessment of the household survey data indicated that out of 3,212 households, 2.8% were classified as having poor food security based on the food consumption score. Among the food insecure households, the highest percentages were found in the highlands zone (5%) and among the poorest households (10%). Yearly income of household, monthly expenditure on food, wealth index and owned agricultural land (in hectare) were positively correlated with food consumption score. Although the incidence of food insecurity based on food consumption score were relatively low in the Nam Ngum watershed, there were higher incidences of child under nutrition across the watershed. Preliminary results indicated that from 1,331 children under age of five, 4.4% were wasted, 14% underweight and 25.8% were stunted. The highest prevalence of underweight (19%) and stunting (31%) was observed in the highland zone, while higher levels of severe wasting was seen in the mountainous zone.

Bronwen Powell[1], Shakuntala Haraksingh Thilsted[2], Amy Ickowitz[3], Celine Termote[4], Terry Sunderland[3], Anna Herforth[5]

IMPROVING DIETS WITH WILD AND CULTIVATED BIODIVERSITY FROM ACROSS THE LANDSCAPE

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Introduction: While there is exciting dialogue about the importance of agriculture for nutrition, there is relatively little emphasis on the role of biodiversity in food and agricultural systems. In the context of developing countries, diversity within rural and agricultural landscapes may be an important part of a food environment that supports healthy dietary choices (Jones et al. 2012; Powell et al. 2013a). Ensuring sustainability and resilience is probably the best known roles played by biodiversity in the food system; however, biodiversity serves multiple functions: this paper aims to review studies that have examined the impact of biodiversity on diets and nutrition.

Methods: Literature review was conducting using Google scholar and Web of Science. Because the literature on this topic is scattered across diverse disciplines (including nutrition, nutritional ecology, anthropology, agriculture, fisheries and aquaculture and forestry) we also: drew on our collective experience and knowledge; identified key journals where we expected to find information and reviewed the table of contents and abstracts; and reviewed the reference lists of previous papers and reviews. We focused on primary research from low- and middle-income countries that examined relationships between various aspects of diversity within the agricultural system and landscape and measures of diet or nutrition.

Our search for papers that looked at the impact of "agrobiodiversity" or "crop diversity" or "production diversity" on diet or nutrition described above we were able to identify 12 studies which reported primary data that examine these relationships (of these 9 included a measure of dietary diversity). Our search for papers that measured the contribution of wild foods to diets identified 24 papers. Of these 13 included information on all types of foods, two provided only information on meat, two on fish and meat, two looked exclusively at vegetables, two at fruit and, two others at wild plant foods.

Findings and interpretations: Two thirds of studies that tested the relationship between agrobiodiversity and dietary diversity at the household or individual level, reported a possitive association. Studies showed possitive association between crop diversity and: mean nutrient adequacy across multiple nutrients; positive infant and young child feeding practices; and, intake of nutritious foods such as fruits and vegetables. Despite limitations, and a possible bias for publication of positive results, the consistency of a relationship between dietary outcomes and crop diversity across existing studies is notable.

The results for studies on wild food were highly variable: in some wild foods made up a significant portion of the diet, in others no wild food use was reported. The contribution to total energy intake was reported to be low in most studies but despite this, wild foods accounted for a large portion of micronutrients consumed in a number of sites (in Gabon, Tanzania and the Philippines). In some contexts wild vegetables made up the majority of vegetables consumed, but in studies from the Amazon, wild vegetables were virtually absent. There was similarly large variations in the importnace of bushmeant.

A number of land-use and agricultural practices that enhance on farm and landscape diversity were also shown to have a possitive association with dietary quality including: home gardens, aquaculture and capture fisheries and forest and tree-based systems.

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IMPROVING DIVERSE DIETS AND IMPROVED NUTRITION THROUGH AGRICULTURAL INTERVENTIONS AND BEHAVIORAL CHANGE COMMUNICATION

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Introduction: Despite a clear potential for agricultural change to improve nutrition in low and middle income countries, most agricultural interventions have not been able to improve nutrition or health within participating households. A lot more evidence is needed on how to design, implement, evaluate, and scale up successful, integrated agriculture-nutrition-health programme models for improved nutrition outcomes.

To achieve optimal nutrition and healthy diets for the poor, agricultural, nutrition and public health interventions will need to be implemented together. Currently, there is little empirical evidence of such approaches on child nutritional status and so research is urgently still required in many regions including West Africa where very little of agriculture and nutrition related research have so far been carried out.

Against this background, the International Institute of Tropical Agriculture (IITA) in collaboration with the Ghana Health Service (GHS) and the University for Development Studies (UDS) has initiated a new project in selected districts of Northern Ghana. Under this new paradigm, the focus is to evaluate the impact of linking the production and consumption of locally available micronutrient-rich foods with public health behaviour change communication (BCC) strategies on dietary diversity and nutritional status.

Methods:

Primary Hypothesis: We hypothesize that the nutritional status of children and pregnant women particularly can be improved through combined BCC with nutrition sensitive agriculture interventions that promote production and consumption of diverse, locally available, nutrient-dense and affordable foods (e.g., dark green leafy vegetables, legumes, and animal source foods).

Study Design, Study Population and Sampling

A cluster non-randomized controlled trial will be used to collect quantitative data from mother/child pairs. Households with moderate to severe malnourished children aged 6-23 months will be selected from 24 Africa RISING intervention communities and will be randomly assigned to one of the following treatment arms:

A. Legumes, Vegetables and Livestock + BCC delivered through community GMP
B. Legumes, Vegetables and Livestock + BCC delivered through Positive Deviance (PD) approach.

Both groups of intervention communities will receive nutrition sensitive agricultural interventions including production of nutrient-dense crops (cowpea, soybean, groundnut, vegetables) and/or rearing of small ruminants coupled with BCC strategies. However, the delivery of BCC in two groups of intervention communities will differ. In one group BCC will be delivered at GMP reinforced through home visits. In the other group, BCC will be delivered through Positive Deviance (PD) approach. Comparison communities will receive only the agricultural interventions.

Findings and interpretations: The project is still on-going and so only a summary of the key findings in the baseline survey are presented here.

i. Consumption of foods known to have a good content of micronutrients and protein remains poor as most children (90.8 %) were fed on cereal-based foods. For example, only 14.3 % of children were fed on vitamin A rich fruits and vegetables. Overall, consumption of flesh meat and eggs was reported in less than 12 %. Legumes consumption was reported in 45.5 % of the households interviewed.
ii. Of the 778 children aged 6–23 months; 57.3 % met the minimum meal frequency, 61.8 % received the minimum dietary diversity (≥ 4 food groups), and only 44.1 % had received an acceptable diet.
iii. Multivariable logistic regression showed that children aged 12-23 months were 26.6 times more likely [AOR 26.57; 95% CI (3.66 - 193.12)] to received appropriate complementary feeding compared to children aged 6-8 months. Children from households that keep chickens,

ducks, or other birds for the meat/sale were 2.1 times more likely [AOR 2.09; 95% CI (1.36-3.23), p = 0.001] to meet minimum dietary diversity, compared to children from households that did not keep such birds.

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CHARACTERISTICS OF COMMUNITY-BASED AGRICULTURAL AND HOUSEHOLD INTERVENTIONS FOR IMPROVING FOOD SECURITY, HEALTH AND THE ENVIRONMENT OF HOUSEHOLDS IN LMIC- A SYSTEMATIC REVIEW

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Introduction: Determining cause and effect of pathways to health are complicated by complex environmental interactions. Some studies have recognised strong linkages between agricultural interventions and nutritional health[1] and the development of clean fuels and improved solid fuel stoves in reducing household air pollution and adverse health[2]. However, the effectiveness of combined household interventions to improve health, nutrition and the environment has not been investigated. A systematic review was conducted to identify community-based agricultural and household interventions (either alone or in combination) for improving food security, health and the household environment in low and middle income countries (LMIC).

Methods: A systematic search of Ovid MEDLINE, PUBMED, EMBASE and SCOPUS databases was performed in January 2015. Key search words were generated reflecting the PICOS approach and a comprehensive search strategy was developed following PRISMA recommendations[3]. The database search for EMBASE used keywords and Medical subject heading (MeSH) terms and truncations. The search strategy for Ovid MEDLINE, PUBMED and SCOPUS databases were then derived from those search terms.

Any community-based agricultural and household interventions such as the introduction of home gardening, animal husbandry, livestock farming, improved stoves, biogas, drinking water purification or nutrition education were eligible for inclusion in this review if the focus of the intervention was to improve at least one of the outcome measures of interest. All relevant study designs employing any of these interventions alone or in combination were included if the studies were conducted in LMIC. Review articles, clinical and occupational studies were excluded from the review. The primary reviewer independently evaluated articles using a structured data extraction form. Quality assurance of 10% randomly selected titles, abstracts and full text extractions were performed by three other reviewers. Due to the heterogeneous characteristic of the intervention components, a narrative review was conducted.

Findings and interpretations: A total of 123 studies were included and grouped into four intervention domains; agricultural (n=27), air quality (n=34), water quality (n=32, and nutritional (n=30). Most studies were conducted in Asia (39.2%) or Africa (34.6%) with the remaining 26.1% in Latin America.

Very few studies (n=11) combined interventions across domains. Six studies looked at the combined impact of agricultural and nutrition education interventions, one study examined the impact of a combination of agricultural and air quality interventions, three on air and water quality interventions and one was a combined water quality and nutritional intervention. No cross-domain studies were identified for agricultural and drinking water quality, or for a combination of air quality and nutritional interventions. The majority of agricultural and nutritional studies were conducted in Africa and Asia, whereas the majority of air quality interventions were conducted in Latin America. It is clear that very little interdisciplinary research has been done with the majority of studies still being discipline specific. It also seems that certain LMIC regions seem to focus on domain-specific interventions. The review emphasizes the need to develop holistic, cross-domain intervention packages. Further investigation of the data is being conducted to determine the effectiveness of these interventions.

Theme 5: Value chain approaches to nutrition

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BEEF, SHEEP AND GOAT FOOD CHAINS SUPPLYING NAIROBI: ANALYSIS OF 'VALUE CHAIN PROFILES' TO INVESTIGATE FOOD SECURITY AND SAFETY RISKS

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Introduction: Beef, sheep and goat meat consumption provides essential nutrients in highly bioavailable form, and poses a zoonotic pathogen threat. In Nairobi, these luxury products are difficult to access by poor households, yet little is known on the city's food system in terms of food safety and security risks. An understanding of the food systems is essential to assess and contextualize the chains supplying poor households and to determine population exposure to hazards. Mapping is therefore crucial to assess food security and food safety risks. The present study characterised the Nairobi beef, sheep and goat food systems using value chain analysis.

Methods: Data collection targeted the different stakeholders involved in beef, sheep and goat meat food systems from: (1) urban and periurban farmers; (2) livestock and meat traders, abattoir/market owners and workers, and livestock and meat transporters in all Nairobi markets; (3) managers of the main beef, sheep and goat meat processing companies; (4) urban and periurban retailers; (5) 205 low income consumers and (6) government/regulatory officers. Data were collected through focus groups discussion and individual interviews, and complemented with secondary data. Qualitative data were obtained on people, animals, products and chains interactions to identify all the existing stakeholders and chains, and assess their organizational, spatial and temporal structure. Quantitative data were collected to assess flow of products in the different chains and their contribution to the supply of these commodities to Nairobi. Data were recorded and entered in thematic templates for analysis. Mapping analysis was done through the creation of 'Chain profiles', which groups patterns of operations/flows of commodities. Mapping of these profiles was done at 3 levels: (1) people chain profile (map interactions of actors); (2) Geographical chain profiling (map of routes of animals and products); and (3) Product profiling.

Findings and interpretations: Eight chain profiles that make up the beef, sheep and goat meat food systems were identified. A critical profile was the 'less integrated terminal markets', composed of chains where no group or person own a large proportion of different activities. This profile represents three quarters of the city's beef, sheep and goat meat supply and contains two significant markets (Figure 1). Large companies integrate market, product transport and distribution, and mainly export or supply to high class retailers and consumers. Six beef keeping activities were identified in the city, mainly as temporary settlements. Sheep and goat keeping was mainly small scale (1-5 animals) and their animals are mostly slaughtered in households for festive occasions. In low income households beef was obtained from butcheries (83%), while goats were obtained from butcheries (51%) and markets (40%).

This study shows the importance of specific chains to the food security of a city, and describes the dimensions of urban human-livestock interactions. In combination with an understanding of chains governance and barriers, this study provides a powerful approach, missing to date, for the investigation of nutrition and food safety risks.

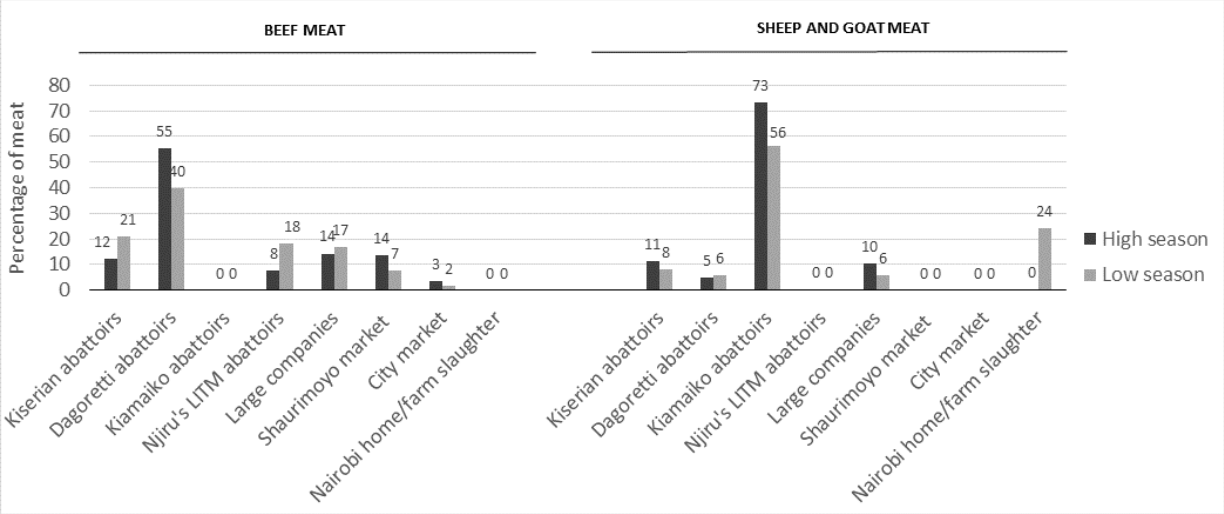

Figure1. Contribution of main chain nodes to the Nairobi beef, sheep and goat food products.

Maud Carron[1,2], Pablo Alarcon[1,2], Barbara Häsler[1,2], Jonathan Rushton[1,2], Eric Fèvre[3,4], Maurice Karani[3], Patrick Muinde[3], James Akoko[3], Joshua Onono[5]

PLANNING FOR CHANGES IN COMPLEX FOOD SYSTEMS: VALUE CHAIN MAPPING OF DIFFERENT POULTRY PRODUCTION SYSTEMS IN NAIROBI AS A FIRST STEP TO FOOD SAFETY, LIVELIHOOD IMPROVEMENT AND MICRONUTRIENT SUPPLY ASSESSMENTS

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Introduction: Research on livestock food systems in developing countries remains limited yet these systems are undergoing rapid and ongoing changes. Poultry meat in Nairobi is a good case study to investigate the changes that result from increasing demand for animal protein[1], in particular how different systems affect the supply of macro and micronutrients, livelihood improvement and food safety risks. The aim of the current study was to map the broiler and indigenous chicken meat value chains of Nairobi to provide a thorough context (*milieu*) for future food safety and socio-economic assessments of the wide poultry meat system.

Methods: Focus groups and individual questionnaires were used to collect data from:

- Broiler and indigenous farmers (in Dagoretti, reflecting peri-urban chains, and Kibera informal settlement, for urban chains);
- Retailers in Viwandani, Korogocho (informal settlements), and Dagoretti;
- Three larger broiler production companies;
- Livestock production and public health officers, meat inspectors, city council, National Environment Management Authority, and a village chief.

The following data were collected for each chain and entered in templates:

- Categories of farms, retailers, products and consumers; production practices and performance; relative flows of birds and products, their sources and seasonality; market outlets; regulations enforcement and institutional context; interactions and involvement of people in the chains' nodes; biosecurity measures.

Analysis allowed detailed characterisation and graphical representation of the food system. Within the system the following "chain profiles" were identified: 1) peri-urban and 2) urban broilers; 3) peri-urban

and 4) urban indigenous chickens; 5) large and 6) medium integrated companies; 7) live and 8) meat poultry markets; 9) main poultry chains in each sub-county; 10) characterisation of poultry retailer types. Each profile has a distinct set of flows, interactions, market potentials, risk practices, production and distribution characteristics, useful for food safety, food security and governance assessments.

Findings and interpretation: Within the poultry meat food system the chains in urban areas had fewer intermediaries and smaller geographic span than those in peri-urban areas – overall they were "shorter". The limited space in urban areas appeared to reduce flock size and hence increase one-off transactions. Use of brokers in peri-urban chains made transport of meat, rather than birds, more practical.

Greatest homogeneity was seen in the chains with commercial broiler chickens (birds for meat production) with one large company supplying 60% of Nairobi's day-old chicks to small-scale farmers. A small number of larger companies supply broiler chicken meat to high-end retailers across Nairobi, yet there are many more small-scale broiler farmers who sell birds close to their farms, or in Nairobi markets. Indigenous breed chickens are kept in backyard farming systems and are kept for home or local consumption. Birds are also sourced from remote areas of Kenya.

Different meat products reach different consumers, based on their value. The lowest value products are heads and legs from broilers of large-scale and peri-urban small farms, which are sold in informal settlements via roadside vendors.

The description of the chicken meat food system provides the context for further food safety and food security analysis.

Sarah Kehoe[1], Aulo Gelli[2], Kalyanaraman Kumaran[1], Ramesh Potdar[3], Rengalakshmi[4], Caroline Fall[1]

IDENTIFYING NUTRITION-SENSITIVE INTERVENTIONS TO IMPROVE MATERNAL DIET QUALITY IN RURAL INDIAN SETTINGS USING VALUE CHAIN ANALYSIS

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Introduction: Poor quality diets among women during pregnancy are linked to sub-optimal development *in utero* (a risk factor for low birth weight and stunting). We have shown that fruit and green leafy vegetable consumption before and during pregnancy are associated with improved maternal cardio-metabolic health and higher birth weight[1,2]. Intakes of these foods are very low among Indian women of reproductive age.[3,4]
Little is known about opportunities whereby value chain actors could benefit from marketing agricultural products of higher nutritional value[5]. We aim to design interventions to achieve this and translate the methodology to other low-income settings.

Methods: This ongoing inter-disciplinary project started in November 2014 and it is expected that data collection will be complete by September 2015. The research involves agricultural scientists, public health nutritionists, economists and social scientists. We aim to build on a conceptual framework linking value chains with nutritional interventions that has recently been developed[6]. Using this framework we will conduct a value chain analysis of exemplar fruit and green leafy vegetables in a rural area of Vidarbha in the state of Maharashtra. Firstly we will hold workshops with key stakeholders including representatives of state government, farmers unions, vendor and consumer groups in order to gain insights from their perspectives and design data collection tools accordingly. We will then hold focus group discussions with women in the study area to identify constraints to consumption of these foods. Next we will hold interviews with landowners, farmers, wholesalers and vendors. Secondary

food price data will be used to calculate cost per nutrient metrics against which the cost-efficiency of candidate interventions will be benchmarked.

Findings and interpretations: Responses from value chain actors will be grouped by theme and constraints to production, supply, demand and consumption of the exemplar foods will be identified. We will aim to ascertain whether the same constraints are perceived by all actors within the value chain.

Based on the synthesis and analysis of our primary and secondary data we will derive a number of candidate intervention designs. These could range from policy change (eg subsidisation of fruit crops) to introducing measures to increase consumer demand (eg reducing visible contamination of green leafy vegetables). We will then discuss these candidate interventions with the key stakeholders from the initial workshop to get their input. We will combine these responses with the results of our cost per nutrient analysis in order to prioritise and select the candidate interventions that are most likely to be effective in achieving an increase in consumption of these foods.

Following on from work in this study and in the longer term we aim to implement interventions to increase women's intakes of micronutrient-rich foods in Maharashtra and other low income settings.

Georgia Ladbury[1], Matayo Melubo[2], Jo Sharp[3], Sarah Cleaveland[1], Jo Halliday[1]

WORKING INTERDISCIPLINARILY ALONG DAIRY VALUE CHAINS IN NORTHERN TANZANIA: CHALLENGES ENCOUNTERED AND LESSONS LEARNED

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Introduction: Agri-health research, of necessity, requires close inter-sectoral and interdisciplinary working. However, different professional sectors and academic disciplines have different norms, institutions, traditions and languages which can make successful collaborative working challenging. In order to improve our practice as agri-health researchers, it is necessary to learn from each other how such challenges might be overcome. This requires open and frank communication not just of the results of the research, but also of the difficulties encountered during its design and implementation, the measures taken to tackle these difficulties, and the degree to which those measures were (un)successful. This type of reflective approach to the research process is typical of the social sciences, but less common in biological science spheres.

Methods: This presentation draws on experiences gained during research investigating the infectious disease risks posed by dairy product consumption by urban residents in Moshi municipality, the rapidly expanding capital of Kilimanjaro region, northern Tanzania. We integrated quantitative and qualitative methods (randomised surveys; in-depth interviews; proportional piling; focus groups; time-use analysis; and participant observation) to describe dairy product consumption and acquisition patterns in Moshi municipality, and to characterise the main dairy value chains supplying the town. We conducted epidemiological risk analyses along these chains in order to identify risk hotspots for pathogen introduction and propagation.

Findings and interpretations: The use of mixed methods generated insights into the emergent risk pathways for pathogen transmission between cow and consumer, and also the socio-cultural and economic factors driving those risks. Such insights could not have been generated without approaching the research questions from a variety of angles and using a range of methodological tools. However, the development of protocols that integrates a broad spectrum of methods and analysis of the data generated is not straightforward. In this study, the research process highlighted the continued need for negotiation and dialogue between the generalist and the expert; the benefits and pitfalls of co-locating researchers from different disciplines to facilitate interdisciplinary working;

the need for both flexibility and pragmatism at all stages of study design and implementation; and the obstacles encountered when it comes to presenting results to different audiences. In particular, we argue that the established convention of presenting biological scientific research as "dispassionate" and "objective" can be misleading as it leaves little room to formally reflect on the journey followed to arrive at the eventual protocol. This absence of critical, contextual reflection may ultimately impede the key goals of repeatability and reproducibility that such disciplines aspire to.

Hung Nguyen-Viet[1], Sinh Dang-Xuan[2], Tran Thi Tuyet Hanh[3], Pham Duc Phuc[2], Delia Grace[1], Fred Unger[1], Kohei Makita[4]

RISK-BASED APPROACH FOR FOOD SAFETY APPLIED TO PORK VALUE CHAIN IN VIETNAM

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Introduction: Food-borne disease is a major public health issue in Vietnam. The contamination of popular foods can occur all along the food value chains. It is important to understand how and where food safety issues arise in order to mitigate and prevent food-borne diseases. Risk-based approach is a tool for managing food safety, however in Vietnam it is rarely applied and the capacity for application is still lacking. This paper describes how food safety risk assessment research has been applied for the pork value chain in Vietnam.

Methods: We have conducted a risk assessment research to assess health risks related to pork consumption in the context of pig smallholder value chains and pork traded in informal markets. We collected 216 samples from 72 pig farms (floor swab, drinking and waste water), 545 samples from 49 slaughterhouses (carcass swab, lymph node, rectal feces, floor swab and washing water) and 514 samples from 220 pork retailed shops at informal markets (pork cuts, ground pork and cutting board swab) in Hung Yen and Nghe An provinces in the north and central of Vietnam. These 1275 samples were analyzed to detect qualitatively and quantitatively for *Salmonella* and *E. coli*. Chemical hazards (antibiotic, growth promoters, and heavy metal residues) in 190 pork samples from informal markets were also analyzed. Pork consumption behavior and cross-contamination modalities during pork preparation were assessed.

Findings and interpretations: Overall prevalence of *Salmonella* combined from all types of above mentioned samples at pig farms, slaughterhouses and pork shops were 35%, 30% and 37%, respectively. *Salmonella* contamination in the final product (pork at market) was 45% and an average concentration of 9 MPN/g was recorded. *E. coli* average loads along different points of the chain were 5.3±1.4 (farm floor swabs), 2.9±0.9 (carcass swabs), 3.1±1.0 (slaughterhouse floor swabs), and 3.3±1.1 (market shop cutting board swabs) logCFU/cm^2, whereas pork from market had 3.4±0.9 logCFU/g. Demonstrated high levels of *Salmonella* in the final product (pork at market) induces the potential health risks for the consumers. High values for *E. coli* indicates general poor hygiene along the chain. 50% and 16.7% pooled samples were positive with sulfamethazine and chloramphenicol, with average residue levels of 156 µg/kg and 0.54 µg/kg, respectively. A quantitative risk model is being developed and integrates information on contamination along the pork value chain to characterize the health risk caused by *Salmonella*. Appropriate hygiene practices and management are required to achieve better pork quality and reduce the risk for the consumers.

Theme 6: Nutrition Sensitive Agriculture Policy

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NUTRITIONAL IMPLICATIONS OF THE GROWING AQUACULTURE SECTOR IN BANGLADESH

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Introduction: Fish is an irreplaceable food, both culturally and nutritionally, in the diet of millions. A key policy response to widespread malnutrition and food insecurity in Bangladesh has been development of aquaculture as a means to boost food supply. This has led to a shift in national fish consumption away from indigenous species towards farmed species (Belton et al., 2014). Earlier work however, has shown that the vitamin and mineral content of certain indigenous fish is far superior to commonly farmed species. It is therefore unclear as to whether growth in aquaculture has actually increased food system supply of micronutrients.

Methods: Samples of 55 fish, shrimp and prawn species were collected from markets in five districts in Bangladesh; 37 from inland capture fisheries, ten commonly produced in homestead and commercial aquaculture, and eight from marine capture fisheries. Species were cleaned to obtain raw, edible parts according to traditional practice, using non-metal equipment. Samples were analysed for protein, fat, minerals, vitamins A, B12, D, E, folate and essential fatty acids, using standard analytical methods. The potential contribution of each species to recommended nutrient intakes (RNIs) during the first 1,000 days was calculated first by assigning an average RNI target for each nutrient, to account for variations in requirements throughout the trimesters of pregnancy, the first 12 months of lactation, and for infants, throughout the age period 7-23 months (FAO and WHO, 2004); then by calculating the contribution from a standard serve of each species (50g/day for pregnant and lactating women and 25g/day for infants) as a percentage of the average RNI. A temporal analysis of nutrient intakes from capture fisheries and aquaculture will be conducted using fish consumption data from the Bangladesh Household Income and Expenditure Survey (2000-2010), combined with the above- mentioned data on the nutrient composition of different species.

Findings and interpretations: Important differences were found in the nutrient composition between species. When considering nutrients of public health concern (iron, zinc, calcium, iodine, vitamin A and B12), several species were identified that would contribute to ≥25% of RNIs for three or more nutrients simultaneously, if consumed daily in either a 50g or 25g portion by pregnant women and young children, respectively. Interestingly, all of these species are from inland capture fisheries and all are classified as small indigenous species (SIS, except one species which is a prawn). These results show that from a nutritional perspective, species from inland capture fisheries, particularly SIS hold potential to have a much greater impact on micronutrient intake of vulnerable groups compared to common aquaculture species. This supports the compelling argument that to effectively target malnutrition, resources should be directed towards ensuring a more balanced approach to both sustainable capture fisheries management and aquaculture (Thilsted, 2013). It is expected that temporal analysis of nutrient intake from fish species will provide important insights into the nutritional implications of shifts in fish species supply and will further the evidence base for framing priority settings and investments in food production systems, in terms of nutritional quality as well as quantity.

Jennifer Coates, PhD[1] and Tina Galante, MSc[1]

AGRICULTURAL COMMERCIALIZATION, PRODUCTION DIVERSITY AND DIETARY DIVERSITY AMONG SMALLHOLDERS IN ETHIOPIA: RESULTS FROM A 2012 NATIONAL INTEGRATED AGRICULTURE AND SOCIO-ECONOMIC SURVEY

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Introduction: Evidence of the relationships between increased production of food and cash crops, the diversity of crop production, and linkages to improved overall dietary quality is inconclusive. Similarly, there is controversy over whether agricultural commercialization leads to healthier, more diverse diets and for whom. The study of smallholder households in Ethiopia sought to answer the following 3 questions: 1) is agricultural commercialization associated with greater household dietary diversity and, if yes, under what circumstances? 2) Is greater food production diversity associated with dietary diversity? To what extent does the production of a specific food group increase the likelihood of its consumption? 3) What other factors are associated with dietary diversity among smallholder rural households, and how do these factors interact with commercialization to affect dietary diversity outcomes?

Methods: The data for this research are derived from the 2012 Living Standards Measurement Study-Integrated Surveys on Agriculture: Ethiopia Rural Socioeconomic Survey (LSMS-ISA:ERSS), implemented by the Ethiopian Central Statistics Agency (CSA) with technical support from the World Bank. Ordinary Least Squares (OLS) and Poisson regression analyses were conducted on data from the 2,234 households meeting World Bank definitions of «smallholder», to test the association between agricultural commercialization and dietary diversity and production characteristics and dietary diversity and to identify other predictors of dietary diversity while controlling for possible confounders. Logistic regression analysis was then employed to test the association of a similar set of factors (agricultural commercialization, production characteristics, and other factors) with household consumption of individual food groups.

Findings and interpretations: Greater income from agricultural sales, controlling for non-agricultural income and other confounding variables, was associated with higher household dietary diversity, with femaleheaded households experiencing greater diet diversity from commercialization than maleheaded households. Regardless of headship, dietary diversity was greater in households where a female owned at least one large asset, intended as an indicator of empowerment. The same model demonstrated that greater food crop production diversity was not significantly associated with greater dietary diversity, while cash crop diversity was found to be positively associated with dietary diversity. Furthermore, results from logistic regression models showed that households producing vegetables, fruit, pulses, dairy, and eggs had a higher chance of consuming these foods than those that did not produce the foods at all. The results suggest that smallholder agricultural commercialization may improve household diet through increased income. Additionally, policies that focus on increasing production of nutrient-rich foods and policies that empower women and enable them to have greater control over assets and other decision-making may likely see improved dietary diversity both together with, and independent of, commercialization efforts.

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UNDERSTANTING PATHWAYS TO BETTER NUTRITION AT DISTRICT LEVEL: LESSONS FROM UGANDA

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Introduction: For countries looking to implement multisectoral nutrition plans, it's critical to understand what actually works in a country context. In scaling-up nutrition, there is need to know how programs should be delivered and scaled-up (Horton Susan, 2001). Countries can learn from each other on how to adapt to new information, evidence and events related to scaling-up and district stakeholders can play important roles in implementation of this multisectoral plan. As part of "Pathways-to-Better Nutrition" case study being conducted by USAID-funded SPRING Project in Uganda, we set out to explore district-leaders' perceptions of the nutrition situation, programs and opportunities for integration.

Methods: Between December and January 2015, qualitative data were collected through key informant interviews and 2 focus group discussions that were purposively sampled. Thirty-five district and local leaders with district management and leadership position in south-west (Kisoro district) and Northern Uganda (Lira district) were interviewed. All those interviewed belonged to the district or sub-county multisectoral nutrition committee. Grounded Theory Approach was used to identify themes to code data. The domains included: learning, adaptation, and evidence on scale-up; adaptation of innovations/interventions to local context, financing of nutrition-sensitive activities and long-term planning for sustainability. In addition, quantitative data collected by the Nutrition Innovation Lab of Tufts University were analyzed (n=600 households) in each of the district to provide district nutrition snapshots. The qualitative research protocol and tools were approved by Institutional Review Board (IRB) of John Snow, Inc. (JSI) in the US and the IRB of Makerere University School of Public Health in Uganda.

Findings and interpretations: Malnutrition in the study districts is worse than the national average for stunting, anemia, and women's underweight. 91% of district level respondents were not familiar with these nutrition statistics. Both districts have formed nutrition multisectoral working groups (District Nutrition Coordinating Committees) and have developed local management structures to implement interventions. Government stakeholders from every-nutrition sensitive sector referred to the lack of clear government programs that support nutrition directly in the local policy environment. Key agricultural-related programs are focusing on wealth creation, value-addition or increasing agricultural productivity without nutrition lens (are not "nutrition sensitive"). Nutrition is not on the 'list' of key priorities of district health departments unlike HIV/AIDS, Malaria or Sexual Reproductive Health. About 69% respondents believe they lack operational capacities and soft-power skills to design, implement and manage nutrition interventions such as leveraging of resources and being able to convey evidence. The understanding of "Scaling-up Nutrition" also differed by respondent, and this has resulted in different goals and measurements. Challenges related to nutrition financing were also noted, including, fiscal decentralization, the use of Output-Based Financing (OBT) mechanisms, limited flexibility to re-allocate funds for nutrition, and lack of standard reporting procedures or implementation strategy to assist districts.

Marie-Caroline Dodé[1], Janice Meerman[2], Charlotte Dufour[1]*

LEVERAGING FOOD AND AGRICULTURE POLICY MAPPING AND ANALYSIS FOR NUTRITION-SENSITIVE PLANNING

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**Poster presented by Domitille Kauffmann*

Introduction: Food and agriculture policies can support nutrition by increasing incentives for the production, processing, retail and consumption of healthy diets[1]. A preliminary step in provision of such support is improved understanding of how existing policies, legal frameworks and investments shape food environments.

Currently, multiple initiatives are underway to map and analyse food and agriculture policies. Although these initiatives' intended function is informing agricultural policy makers on productivity and other conventional sector goals, their outputs also represent *an untapped resource* for better understanding how food and agriculture policies impact the producer and consumer behaviours which shape food environments and eventually, nutrition.

Methods: In 2014, FAO's Nutrition and Agricultural Economics Divisions commissioned a stocktaking of food and agriculture policy mapping initiatives, with the objectives of understanding what information is available and how that information can be used to inform nutrition-sensitive agriculture planning[2].

Methods consisted of a desk review of documents and websites, as well as semi-structured interviews with over 50 FAO staff. Thirty FAO and thirty-four non-FAO initiatives were included in the exercise. Each was classified according to *function* (e.g. knowledge repository, provision of analytic assessment services), *elements mapped* (e.g. policies, legal frameworks, investments), and *output*s (e.g. database, technical briefs, web portals, and/or "soft" products such as contributions to capacity development and policy dialogue).

As follow-up to the stocktaking exercise, roundtables and a workshop are pending to explore options for:

1) Leveraging the outputs of existing food and agriculture policy mapping and analysis initiatives for pro-nutrition advocacy and analysis.
2) Ensuring that the design of emerging policy mapping and analysis initiatives will be more nutrition-sensitive.

This work stream builds on research and advocacy conducted by LCIRAH and the Global Panel for Agriculture and Food Systems, namely a conceptual framework for understanding how agriculture and food system policies link to diet quality and nutrition[3].

Findings and interpretations: Data and information generated by the initiatives under review include, among others, commodity price monitoring and analyses, mapping of consumer-facing food and social protection policies, statistics on investments in agriculture, evaluations of cash transfer programmes, and monitoring of food security.

These outputs could - potentially - provide valuable information on how certain policies shape food environments and subsequent diet options. For example, initiatives which analyze price policies for maize, rice and other staple crops provide important background on producer incentives. This type of information is imperative to inform pro-nutrition efforts to diversify food crop production. Similarly,

initiatives which analyze cash transfer and food subsidy programmes can provide valuable information on the incentives which shape consumer food choices in a particular context.

Demand to promote nutrition-sensitive food systems is growing, not least among policy makers seeking practical examples of how to prioritize nutrition investments across sectors. Keeping pace with this demand surely requires innovation in research; however there are also existing initiatives which remain untapped. Many of these activities already aim to inform policy dialogue at country level, as such leveraging their nutrition potential should be seen as a way to increase their value within, and beyond, agriculture.

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DEVELOPING A SUSTAINABLE NUTRITION RESEARCH AGENDA IN SUB-SAHARAN AFRICA IN THE YEARS TO COME

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Introduction: Nutritional status in sub-Saharan Africa (SSA) has not been improving in comparison to other regions of the world. Despite substantial international commitments and concerted action by international stakeholders, the nutrition research on the continent is fragmented. To guide action in nutrition in sub-Saharan Africa, it is essential to identify priorities for investment in nutrition. This paper presents the findings of the SUNRAY "Sustainable Nutrition Research for Africa in the Years to come" project. It presents priorities for a nutrition research agenda and a revised approach for action to organize nutrition research on the continent.

Methods: SUNRAY was led by academics from 4 European institutions, 4 universities from SSA, an International Non Governmental Organization (NGO) and an organization that funds research in SSA. SUNRAY was organized in 3 stages. We first analyzed the nutrition research landscape in SSA through a review of networking and nutrition research conducted in SSA published between 2000-2010, an analysis of the perceptions of nutrition researchers regarding nutrition research (3), an assessment of the nutrition research priorities by stakeholders, and the identification of research needs for environmental challenges.

In stage 2, three regional workshops in Africa were organized to set priorities. A total of 117 stakeholders involved in nutrition research, representing 40 countries in sub-Saharan Africa, participated in three regional workshops in Africa in 2011-12. They defined and ranked thematic priorities for nutrition research and priority actions to create an enabling nutrition research environment using participatory approaches. The findings were further developed during an international consultation round.

Findings and interpretations: Three priorities areas for nutrition research were identified: (i) Community interventions to improve nutritional status, (ii) Behavioral strategies to improve nutritional status and (iii) Food security interventions to improve nutrition. Four priority actions to establish an enabling nutrition research environment were shortlisted: (i) Better governance of nutrition research, (ii) Alignment of nutrition research funding with African priorities, (iii) Increased capacity development for nutrition research, and (iv) Enhanced information and communication of nutrition research.

The findings of this analysis illustrate that nutrition research needs to be more responsive to policy needs, promote governance of nutrition research and trigger international commitment to nutrition research priorities from an African perspective and a rational dissemination of nutrition research

findings. The renewed attention and commitments to nutrition in Africa is a great opportunity to leverage nutrition in SSA but it will not yield success unless traction is gained at national level.

A renewed approach for nutrition research needs to foster specific mechanisms to translate this evidence into context specific recommendations for decision makers in SSA. Similar to health research, developing a nutrition research agenda should be an inclusive process initiated by decision makers in SSA in collaboration with other stakeholders. Much like health technology assessment, such a process should follow transparent and well-established procedures to ensure an objective outcome. Following SUNRAY, we are piloting an evidence-based approach to support evidence-based decision making in nutrition in Africa. This network 'EVIDENT" will focus on the use and adaptation of existing evidence in policy and programming in Africa and develop appropriate tools for decision makers.

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PATTERNS OF FOOD CONSUMPTION IN UZBEKISTAN AGRARIAN CHANGE: IS COTTON IN COMPETITION WITH QUALITY FOOD?

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Introduction: Uzbekistan is one of the leader producers of cotton, a non-food primary crop. Its national agricultural policy foresees grain self-sufficiency, regulation of staple food price and subsidies rural production inputs which it has brought to achieve national food security. However, there are still nutritional issues in regards to the lack of micronutrients in the diet, especially in rural areas. This research contribute to the "food for subsistence" versus "crop for cash" debate applied to Uzbekistan which is a very much unexplored country but which holds very insightful elements for the analysis on food-nutrition nexus.

Methods: This research explores the agrarian change in the rural area of Uzbekistan, which holds fascinating insights due to a unique mix of historical, cultural and sociological elements. In fact, for centuries Uzbekistan, located at the heart of the ancient Silk Road, was a hub of trade and cultural exchanges, as travellers and their caravans from Europe, Arabia, Persia, China, India and Mongolia passed through on their journey between the Mediterranean Sea and the Pacific Ocean. Based on secondary data collection I will inductively show the implications of cotton and grain cultivation for the national food security and its indirect effects on poverty in a political economy perspective. Therefore, by acknowledging the multidimensional and cross-cutting aspects of the object of study, a mixed method, the so called "Q squared approach", is believed to be suitable to understand the Uzbek rural economy. This investigation has tried to grasp the dynamic interlinks of the production of surplus of cash crops towards other more added value sectors and the potential dichotomy with grain independence objective for land use through in depth interviews and secondary data descriptive analysis.

Findings and interpretations: The GoU‟s political and economic strategy has certainly diverted from the conventional rulebook. The "Uzbek model" has been blamed for experiencing a deindustrialisation spiral and an over-specialisation in primary resources due to lack of investments and incentives for producers which allegedly resulted in low agricultural productivity rates and missing inter-locking markets. The low elasticity of poverty vis-à-vis national income, by showing that between 2001 and 2005, whereas income increased by 25%, poverty decreased by only 8% would support this thesis. Nonetheless, sectoral squeeze evidence is that, during 2000-2005, while urban poverty decreased from 22.5% to 18.3%, rural poverty remained steady at around 30% and households spent almost 70% of their income on food. Therefore, if we scan dynamically the whole economic context, it is argued that such a transitory deflection, is reasonably attributable to the distortive surplus transfer currently in action. Despite this sectoral taxation, GoU has fulfilled most of the population‟ basic needs by keeping public services expenditures high (60% of total expenditure) in health care (5.5% of GDP) and education with overall decline of extreme poverty and low inequality. Certainly the country faces many obstacles linked to the volatility of commodities prices, decrease yields of cotton due to desertification, natural resources dependence, depressed rural market labour and technological lag. Notwithstanding, the alteration of its given comparative advantage through distortive policies and

import-substitution, has permitted Uzbekistan to keep favourable output performances on agriculture, steady GDP growth at above 8% and eventually avoid conditions of extreme poverty and malnutrition in rural areas.

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QUANTIFYING THE HEALTH IMPACTS OF AGRICULTURAL INTERVENTIONS AND EXPOSURES: A SYSTEMATIC REVIEW OF THE EVIDENCE

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Introduction: Two years ago, the attention of the global community was drawn to the potential of agricultural interventions for enhancing the nutrition and health of populations, although up to then rigorous studies evaluating health impacts were rare[1]. Since then, studies are increasingly being conducted and reported, especially biofortification interventions testing effects of enhanced food micronutrient content. We therefore are systematically reviewing the published literature i) to produce updated summary estimates of health effects, not only of agricultural interventions, but of agriculture-related indicators; ii) to determine the burden of diseases, especially child and maternal adverse outcomes, that could consequently be alleviated globally.

Methods: We conducted a comprehensive search of the Pubmed and Embase databases to retrieve all studies of agricultural interventions and exposures in Low-and-Middle-Income-Countries published by December 31, 2014 (these databases curate health-related studies). Final analyses will involve wide-ranging agricultural exposures, but we report here on vitamin-A/β-carotene biofortification interventions published from 2009 to 2014. For this sub-analysis, interventions considered are β-carotene-rich sweet potato (OFSP), provitamin A/β-carotene-enhanced cassava and provitamin A-biofortified maize; outcomes are serum or plasma retinol concentrations (μmol/L) and prevalence of vitamin A deficiency (adjusted serum retinol <0.7 μmol/L). Summary effect estimates are obtained by random-effects meta-analyses when possible. Effect estimates are then used to quantify the potential impact of biofortified crops on reducing disease and mortality burdens, if feasible and optimal levels of consumption of biofortified crops are reached. We estimate population attributable fractions associated with increased consumption of vitamin-A/β-carotene biofortified crops, exploring a range of optimum feasible prevalences of population-wide food consumption. Estimates of overall burden of death and Disability-Adjusted-Life-Years (DALYs) lost due to vitamin A deficiency are obtained from Lim 2012[2].

Findings and interpretations: Three provitamin A/β-carotene biofortification studies qualified for this sub-analysis: two randomized controlled trials provided OFSP (Turner 2013[3], Hotz 2012[4]) while one provided provitamin A-biofortified maize (Gannon 2014[5]). Two studies contributed to the summary estimate for the effect of provitamin A biofortification interventions on serum or plasma retinol concentrations[3,5]: biofortification resulted in a mean retinol increase of 0.04 μmol/L (95% CI -0.09, 0.16 μmol/L). Vitamin A deficiency causes disability and mortality of children and women in developing countries. If regularly consuming provitamin/β-carotene biofortied foods reduces the risk of vitamin A deficiency by as much as 32.9%[5] and prevalence of consumption of such foods increases from 5% to 95% of the population, the global burden of Vitamin A Deficiency could be reduced by an estimated 31.7%, possibly equivalent to 38,000 fewer deaths (95% CI 19,588 to 60,884) and 3.4 million fewer DALYs lost (95% CI 1.8 million to 5.4 million). As more studies of agricultural interventions and exposures are being conducted and reported, we are proposing an approach of presenting results in a manner that emphasizes potential health impacts. This is to assist policymakers in understanding and quantifying possible health gains of agricultural interventions to facilitate the prioritization of interventions.

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AGRI-HEALTH IN EUROPEAN COMMON AGRICULTURAL POLICY

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Introduction: The triple burden of malnutrition – undernutrition, obesity and micronutrient deficiencies is a worldwide increasingly worrying phenomenon. Many scientific disciplines address this emerging issue and the link between agriculture, food, nutrition and health is gaining increasing attention. The objective of the research is to analyse to what extent past (2007-13 programming period) and current (2014-2020 programming period) European agricultural policy addresses the link between agriculture, food, health and nutrition (agri-health), how the relation is conceptualised, and whether past and/or current member countries' European programming documents address this issue.

Methods: The research activity aimed at a content analysis divided in four phases joined by a common research approach. The first phase aims to study the concept of agri-health and identify the attributes' grid. The second phase aims to investigate the existence and frequency of the concept in European and Member states agricultural policy and programmes. The third phase is the relational and semantic analysis of the agri-health concept by examining the relationships among agri-health and other topics and policy areas. The final phase is aimed at constructing mapping representations of the agri-health concept with cognitive mapping technique. The objective is to graphically display and numerically analyse the resulting maps, so to visually represent the relations and possibly clusters among the attributes and identify pattern concepts. The analysis uses NVIVO and SPSS programmes.
Data and information gathering included 2007-2013 and 2014-2020 European funding regulations and programming documents:

i) 2007-2013 European Structural Funds Regulations (No 1083, 1260, 1080, 1081, 1082, 1084 of 2006) and 2014-2020 European Structural and Investment Funds Regulations (No 1303, 1301, 1304, 1299, 1302, 1300, 1305 of 2013);
ii) 2007-2013 and 2014-2020 approved European countries' Rural Development programmes and when not yet available the most recent and advanced agricultural and rural programming documents at national level;
iii) Member countries' European Partnership Agreements.

Findings and interpretations: The research is ongoing therefore the presented results are preliminary. The interconnection between agriculture, food, health and nutrition is present, but still limited. There are some differences in the two programming period. Whereas in 2007-2013 the link between health and nutrition is mostly related to food safety and food quality, the current programming period timidly includes the concept of diet and healthy lifestyles, healthy ageing, and public health. Currently health concept is still strongly related to animal health and husbandry and to the concept of health/e-health care and infrastructures. Member countries' programming documents, even though necessarily consistent with European legislation, show that the attention over agri-health varies significantly from one country to the other, but it is relatively constant over time within the same country.

From the first data analysis, there seems to be a triple paradigm (*Prevention, Food offer, Food chain*) shift from:

i) a curative and infrastructural approach for human health to a more preventive and wellness orientation;
ii) an agricultural and commodity production to a food offer approach as a means to more effectively impact on human health;
iii) a farmers focus to a multi-actor and multi-stakeholder approach, expressing the need to activate the whole food chain to benefit public health.

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DEVELOPING A CONSENSUS FOR INTEGRATING AGRICULTURE, NUTRITION AND HEALTH IN TANZANIA: A MODEL FOR LOW AND MIDDLE INCOME COUNTRIES

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Introduction: Integrating agriculture for improved nutrition and health is gaining prominence as a strategy to reduce disease burdens in Low-and-Middle-Income-Countries (Ruel 2013, Masters 2014). However, what integration entails in this context is still unclear to many in the agriculture and nutrition research and practice communities. We sought to develop an interwoven agriculture, nutrition and health research and training agenda, which would be nutrition and health outcomes sensitive, using Tanzania as a model for other sub-Saharan African countries.

Methods: Africa Academy for Public Health (AAPH) co leads a joint forum for Agriculture Nutrition for Health in Tanzania. On January 21, 2015, a symposium on Integrating Agriculture and Nutrition for Health at the Community Level in Tanzania was conducted in Dar es Salaam, Tanzania as part of the mission of the Joint Forum for Agriculture, Nutrition and Health. The forum is led by researchers at the Africa Academy for Public Health, the Sokoine University of Agriculture, Tanzania, and the Harvard T.H. Chan School of Public Health. The objectives were to: i) establish a common understanding among stakeholders, of the linkages between agriculture, nutrition and health, ii) identify priority areas for interventions in the context of integrated agriculture, nutrition, and health continuum, and iii) initiate plans for future research and training activities required for the integrated agriculture, nutrition health approach. Participants were drawn from Tanzanian and international universities and research institutions, the Tanzanian development community (DFID, UNICEF, HKI, CDC, WHO), as well as government ministries and parastatals (Health and Social Welfare, Agriculture, Prime Minister's office). The Prime Minister's Office was represented by Tanzania's Scaling Up Nutrition (SUN) Government Focal Point. Additionally, we conducted discussion sessions with participating experts to identify next steps for integrated research and training actions for Tanzania.

Findings and interpretations: While there has been a mixed picture of nutrition trends in Tanzania, with gains in life expectancy to above-average levels for African countries, the country has experienced little significant progress in stunting and disparities reduction, despite economic growth. Areas requiring attention were identified, including siloead research, training and practice approaches of universities and government sectors (fragmented strategic plans, inadequate and poorly informed budgets); and a paucity of robust implementation and evaluation designs for research studies. Proffered solutions include packages of integrated interventions that are feasible for scaling up; an incentivized multisectoral approach for increased awareness and stakeholder buy-in; integrated trainings and specialty-targeted curricula for mid-career professionals, and medium to longterm changes to develop professionals trained to integrate agriculture and nutrition for health. The forum outlined strategic areas to be prioritized in research and training ageanda for agriculture nutrition intergration for health. The need to build local capacity for rigorous impact evaluations was also stressed. This presentation will map out gaps and opportunities in research and training aspects necessary in enhancing agriculture nutrition interventation in practice in Tanzania.The forum will convene regularly as a policy driver for engaging Tanzanian leaders, as the integrated framework is developed and advanced. It can serve as a model for driving the agenda for integrating agriculture, nutrition and health outcomes for researchers, government, and other stakeholders in LMICs. Involvement of the different stakeholders would facilitate smoother intersectoral collaborations and faster adoption of research for policy.