

The logo for ANH Academy features the text 'ANH Academy' in a white, handwritten-style font against a teal background. The 'A' and 'N' in 'ANH' are larger and more prominent than the 'H'. The word 'Academy' is written in a cursive, lowercase font.

Agriculture, Nutrition and Health Academy Week

ANH Academy Week 2018

CONFERENCE INFORMATION

AND

ABSTRACT BOOKLET

Accra, Ghana

25 – 29 June, 2018

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WELCOME TO THE AGRICULTURE, NUTRITION & HEALTH ACADEMY WEEK!

It is our enormous pleasure to welcome you to the 3rd Agriculture, Nutrition and Health (ANH) Academy Week. Following successful events in Ethiopia in 2016 and Nepal in 2017, we are delighted to bring our event to West Africa, adding exciting regional perspectives to this global gathering.

With a rapidly changing environment and a renewed commitment from the international community to fighting malnutrition at the global level, there has never been a more important time to focus on the complex linkages between agriculture, nutrition and health. It is only through a concerted effort cutting across sectors and disciplines that we can achieve real progress in ensuring adequate nutrition and health for everyone through sustainable and inclusive policies and interventions in agriculture and food systems.

Over the next five days more than 300 research, policy and programming experts working across agriculture and food systems, nutrition and health will gather under one roof to learn, share and innovate. We very much encourage you to make the most of this opportunity to gain new knowledge and skills, and foster new interdisciplinary collaborations.

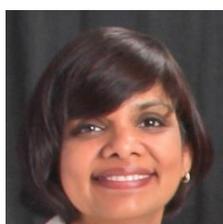
We are proud to present to you a programme packed full with skill-enhancing workshops, inspiring keynote speeches, through-provoking panel discussions and innovative presentations from researchers hailing from four continents. We have also created spaces for less formal interaction and learning, including poster sessions and social events.

The ANH Academy and the CGIAR Research Program on Agriculture for Nutrition and Health (A4NH) have been championing research and partnerships with policy and practice in this area for several years, working together with many of you. It is thanks to our combined efforts that we can meet here in Accra and push this ambitious agenda forward.

We are grateful to our partners, in particular the University of Ghana and the African Nutrition Society; to our sponsors and supporters; and to members of the Advisory, Scientific and Logistics Committees for shaping this event and making it a reality.

Thank you for joining us for this exciting ANH Academy Week.

With best wishes,



Dr. Suneetha Kadiyala,
Associate Professor in
Nutrition-Sensitive
Development, London School
of Hygiene & Tropical
Medicine (LSHTM); Principal
Investigator, IMMANA



Dr. John McDermott,
Director, CGIAR Research
Program on Agriculture for
Nutrition and Health (A4NH)

WELCOME TO AFRICA!

On behalf of the African Nutrition Society (ANS) and the University of Ghana, we welcome you to Africa, and to the 3rd Annual Agriculture, Nutrition & Health (ANH) Academy Week, being held here in the sunny city of Accra, Ghana. We are proud partners of this exciting event.

Established in 2008, ANS is the continent's leading professional society of scientists working in the fields of nutrition, food science, agriculture, and public health with the goal to promote the harmonization of nutrition workforce training, and to build the human capacity needed for nutrition policy, programming, and implementation. Members of the ANS play significant roles in national nutrition coalitions, for instance through the formation of the Scaling Up Nutrition (SUN) Movement and the creation of national SUN Academic Platforms. ANS continues to work with regional and international organizations like the FAO to promote training in nutrition education in Africa, and currently supports the implementation of the African Development Bank's African Leaders for Nutrition (ALN) initiative. Since 2016, ANS has worked with the ANH Academy to support research capacity strengthening initiatives for emerging African scientists.

Founded in 1948 for the purpose of providing and promoting university education, learning and research, University of Ghana has built an image of one of the continent's most reputable universities. The School of Public Health (SPH) was established in 1994, in response to a growing demand for a cadre of Public Health Practitioners to provide leadership in Public Health reforms in the country. The Philosophy of the SPH is a 'School of Public Health Without Walls', one that attempts to achieve an 'optimum mix' of classroom and field-work. Our mission is to train Public Health Practitioners who will be leaders and change agents for health development in Ghana and the wider African context. The School of Agriculture is one of several specialized entities in the University, impacting national agricultural development through quality teaching, research and extension, and integrating system-wide innovations to realize tangible and practical results. The School consists of six academic departments and three research centres that encourage multi-disciplinary and collaborative approaches to research and teaching, across diverse fields.

The ANH Academy Week presents a unique opportunity, as it brings together an eminent interdisciplinary scientific community as well as young scientists, and other stakeholders whose work relates directly or indirectly to agriculture, nutrition, and health - to share and to deliberate on research, policy, and practice. The timing of the conference and its overarching focus – the nexus of agriculture-food systems, nutrition and health – reflects contemporary global and Africa priorities. Like other regions of the world, Africa is experiencing a surge in obesity and nutrition-related non-communicable diseases, a phenomenon that is linked to the rapid changes in our food systems. Given ANS' and University of Ghana's demonstrated interest in supporting national and continental efforts aimed at addressing such challenges, we are pleased to collaborate with ANH Academy to implement this conference.

We are sure that we will all be treated to very stimulating presentations over the coming week. We wish you all fruitful deliberations and thank you for participating actively and constructively.



Dr. Amos Laar
President, African Nutrition
Society, & Senior Lecturer,
School of Public Health,
University of Ghana



Prof. Richard M.K Adanu
Dean, School of Public Health
University of Ghana



Prof. Daniel Bruce Sarpong,
Dean, School of Agriculture
University of Ghana

ABOUT THE ANH ACADEMY

The Agriculture, Nutrition & Health (ANH) Academy is a global research network in agriculture and food systems for improved nutrition and health to serve as a platform for learning and sharing.

The ANH Academy is part of the three workstreams of the Innovative Methods and Metrics for Agriculture Nutrition Action (IMMANA) programme. It is also a broader partnership that aims to bring together researchers and users of research cutting across disciplines and sectors to tackle the complex interactions between agriculture/food systems, nutrition, health and environment. It is particularly focused on facilitating rapid sharing of innovative methods, metrics and emerging research findings and strengthening research capacity in this interdisciplinary area.

The ANH Academy is jointly founded and initial coordination is provided by the Leverhulme Centre for Integrative Research in Agriculture and Health (LCIRAH), IMMANA and CGIAR's Research Program on Agriculture for Nutrition and Health (A4NH). Diverse institutions, scientific societies, research programmes and donors support the Academy activities. We welcome new partnerships to collectively deliver the ambitious agenda.

Objectives

- Share innovative research in agriculture and food systems for improved nutrition and health
- Stimulate the development and harmonisation of new research
- Help strengthen the capacity of the research community to undertake inter-sectoral and interdisciplinary research
- Facilitate the uptake of robust evidence in policies and programming in agriculture and food systems for improved nutrition and health

Activities

- An annual Academy Week with learning sessions and a research conference
- Technical working groups
- Online seminars
- Online and face-to-face training opportunities
- An online collaborative platform

Membership

Membership of the Agriculture, Nutrition & Health Academy is free and open to researchers, policymakers and practitioners. Visit the ANH Academy booth in the Atrium to sign up.

Connect with us:

Visit our website: www.anh-academy.org

Email us: ANH-Academy@lshtm.ac.uk

Find us on Twitter: [@IMMANA_Res](https://twitter.com/IMMANA_Res)

The ANH Academy Week is the sum of many parts and could not take place without the valuable inputs of a wide range of partners and supporters. We would like to make a special thanks to Learning Lab facilitators, Research Conference presenters and panellists, and all those who participate in person or who follow online.

The 2018 ANH Academy Week is organised and funded by:



in partnership, and with the support of:



ANH ACADEMY WEEK 2018

SCIENTIFIC SYMPOSIUM & ACADEMY WEEK COMMITTEES

SCIENTIFIC COMMITTEE

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ANH ACADEMY WEEK 2018

SCIENTIFIC SYMPOSIUM & ACADEMY WEEK COMMITTEES

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| Zachary Gersten | Tufts University |

SCIENTIFIC SYMPOSIUM KEYNOTE SPEAKERS



Jan Low

2016 World Food Prize Co-Laureate,
Principal Scientist & co-Leader,
Sweetpotato for Profit and Health Initiative,
International Potato Center

Jan Low is currently a principal scientist with the International Potato Center (CIP), based in their regional office for Africa in Nairobi, Kenya. She manages the Sweetpotato Action for Security and Health in Africa (SASHA) project and co-leads the Sweetpotato for Profit and Health Initiative (SPHI) with the director of the Forum for Agricultural Research in Africa (FARA). The SPHI seeks to improve the lives of 10 million African households in 17 target countries by 2020, through access to improved varieties of sweetpotato and their diversified use.

Dr. Low obtained her doctorate in agricultural economics at Cornell University, minoring in nutrition. She has focused with her team on developing and promoting biofortified orange-fleshed sweetpotato to combat vitamin A deficiency. She has worked over 25 years in sub-Saharan Africa and served as President of the African Potato Association (APA) from 2011-2013. In 2016, along with two CIP sweetpotato breeders and Dr. Howarth Bouis of HarvestPlus, Dr. Low was awarded the World Food Prize for her work on biofortification.



Matilda Laar

Lecturer, School of Agriculture,
University of Ghana.

Matilda Essandoh Laar, MPH, PhD, is a Lecturer with the Department of Family and Consumer Sciences, School of Agriculture, University of Ghana. Dr. Laar's background is in Nutrition and Public Health. Her research interests have focused on nutrition education in health systems, the development of appropriate tools and methods in the Agriculture, Nutrition and Health nexus, and the role of food environments in the food security of mothers and children in low-resource settings. Dr. Laar is a Round 1 IMMANA fellow whose research aimed at strengthening the monitoring and evaluation of the Ghana School Feeding Program through the development of simplified, user-friendly tools for effective monitoring of the program. Currently, her research work contributes to the discussion on food environments including the effect of "supermarketization" on the nutrition of the urban poor and the nutritional quality of meals and snacks available in schools.



Bassirou Bonfoh

Director General Centre Suisse de Recherches Scientifiques en Côte d'Ivoire
Director Afrique One-ASPIRE

Bassirou Bonfoh holds a DVM and a PhD in epidemiology. He worked for five years in West Africa as a livestock development program coordinator for *Vétérinaires Sans Frontières*. He went for a four-year epidemiology postdoctoral fellowship at the Swiss Federal Institute of Technology Zurich (ETHZ) and Swiss Tropical and Public Health Institute (Swiss TPH) on health risks and determinants of dairy sector development. He subsequently led for four years a research group on "Avenues of extensive pastoral production system" in the Horn Africa, West Africa and Central Asia in the framework of the Swiss National Competence in Research North-South (NCCR North-South) where he contributed to validate the One Health concept on risk analysis and zoonosis control at human, animal and environment interface (e.g. brucellosis in Kyrgyzstan). Since 2009, he is Managing Director of *Centre Suisse de Recherches Scientifiques en Côte d'Ivoire* (CSRS, www.csr.ch) where he leads the North-South science diplomacy. He is also the Director of the consortium Afrique One (www.afriqueoneaspire.net) contributing to the capacity of 60 fellows in the area of zoonotic diseases. Bonfoh is a guest lecturer at University of Lomé (Togo), University of Liège (Belgium), University of Basel (Switzerland), University of Abidjan (Côte d'Ivoire) and the Pan African veterinary school in Senegal and a member of the scientific advisory board of several agriculture and health research institutes and initiatives in Africa.

SCIENTIFIC SYMPOSIUM

SESSION 1: GENDER PATHWAYS IN AGRICULTURE TO NUTRITION

Session Chair:

Catch-Up Growth During Infancy in Rural Pakistan: A Longitudinal Analysis of the Women's Work and Nutrition Study

Rebecca Pradeilles¹, Tom Norris², Elaine Ferguson¹, Haris Gazdar³, Sidra Mazhar³, Hussain Bux Mallah³, Azmat Budhani³, Rehid Mehmood³, Saba Aslam³, Alan Dangour¹, Elizabeth Allen¹

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Introduction

Fetal growth impairment is common in low- and middle-income countries (LMICs), contributing to high rates of stunting in children under five years of age. In our previous study, we found that intensive agriculture during pregnancy was negatively associated with infant length-for-age z-scores (LAZ) in early infancy, suggesting fetal growth was compromised. The adverse outcomes of early infant stunting can be improved by early catch-up growth but little is known about the factors associated with catch-up growth in LMICs. This study aimed to estimate the prevalence of, and factors associated with, catch-up growth among infants in rural agricultural communities in Pakistan.

Methods

A longitudinal study of mother-infant dyads (n=1161) was conducted in rural Sindh province from December 2015 to February 2016 (infants aged 0.5-3 months), with follow-up (n=1029) from November 2016 to January 2017 (infants aged 9-15 months). Interviewer-administered questionnaires and infant anthropometric measurements (weight and height/length) were collected. The outcome was catch-up growth in length (defined as a change in conditional LAZ > 0.67) between baseline and endline (approx. 11 months). Exposure variables included cotton harvesting performed in the past season (we hypothesized that heavy agricultural workloads might compromise catch-up growth because mothers will have less time to devote to infant care); individual (maternal age and height, infant sex) and household-level factors (maternal/paternal education, household wealth index, household food insecurity, number of adult females per household, number of children under 5 years of age); nutrition-related factors (Infant and Young Child Minimum Dietary Diversity score, maternal nutrition knowledge, breastfeeding status); and health-related factors (child health and maternal depression). Associations were examined using multivariable logistic regression analyses. Hypothesized pathways from the exposure variables to catch-up growth were derived from the available literature and drawn as directed acyclic graphs to inform the model building process.

Findings and Interpretations

The prevalence of stunting was 45.3 percent at baseline (mean age = 1.6 months) and 60.7 percent at follow-up (mean age =12.1 months). Twenty-nine-point-six percent of infants exhibited catch-up growth. Factors associated with the presence of catch-up growth were a taller mother (OR=1.08 [1.05; 1.11]), a wealthier household (OR=3.61[1.90; 6.84] for infants living in the wealthiest households compared to those living in the poorest ones), an educated mother (OR=2.43 [1.30; 4.56] for mothers who achieved middle, secondary or higher education vs. none) or father (OR=1.46 [1.05; 2.03]), and whether the household included two adult females (vs. one) (OR=1.91 [1.26; 2.88]). Factors associated with a reduction in catch-up growth were whether the household had two or more preschool children (vs. one) (OR=0.64 [0.45; 0.89] for two children vs. one and OR=0.44 [0.29; 0.66] for three or more children vs. one) and whether the child was currently breastfed (OR=0.59 [0.41; 0.88]). Infants of women working in cotton-harvesting in the past season were less likely to display catch-up growth (OR=0.60 [0.39; 0.90] for mothers who worked more than 2 months vs. none), however this association attenuated to the null on adjustment.

Conclusions

This study generated new evidence with regards to catch-up growth and its associations in infants living in rural Pakistan. Our analysis showed that a substantial proportion of infants experienced catch-up growth despite living in a challenging environment associated with extremely high rates of stunting. The modifiable environmental factors associated with catch-up growth, in this rural Pakistan environment, emphasise the need to develop and/or strengthen existing nutrition-sensitive programmes (e.g. programmes targeting maternal and paternal education, socio-economic status and agriculture income generation) to improve infant linear growth. Tackling wider and proximal determinants of catch-up linear growth will help achieve the internationally-agreed targets for reducing childhood stunting (< 5 years of age) by 2030, as part of the Sustainable Development Goals.

What Dimensions of Women's Empowerment Matter for Nutritional Outcomes? Evidence from Six Countries in Africa and Asia

Agnes Quisumbing¹, Kathryn Sproule², Hazel Malapit¹, and Elena Martinez¹

¹International Food Policy Research Institute, USA

²Independent consultant, USA

Introduction

Although linkages between increasing resources controlled by women and nutrition are well established, the linkages between women's empowerment and nutrition have been more difficult to quantify, owing to the difficulty of measuring empowerment. Directions of impact between empowerment and nutrition outcomes may be ambiguous, may involve tradeoffs between different objectives, and may differ across cultural contexts. This paper conducts new empirical analysis using the Women's Empowerment in Agriculture Index (WEAI), based on large-scale surveys in six countries in Africa and Asia, to identify which dimensions and indicators of women's empowerment matter for different diet and nutrition outcomes.

Methods

We use data collected on the WEAI from Feed the Future population-based surveys from Bangladesh, Nepal, Cambodia, Ghana, Mozambique, and Tanzania. To analyze the relationship between nutritional outcomes and women's empowerment, we estimate the following equation using ordinary least squares:

$$N_h = a_0 + a_1 \text{ empowerment} + a_2 I + a_3 H + \epsilon$$

where N_h is a vector of nutritional outcomes at the household, woman, or child level; empowerment is a measure of empowerment derived from the WEAI; I is a vector of individual characteristics; H is a vector of household characteristics; a_1 , a_2 , and a_3 are the parameters to be estimated; and ϵ is an error term. The key coefficient of interest is a_1 , which captures how the primary female's empowerment is correlated with the nutritional outcome of the household, primary female member, or child, having controlled for a conventional set of observable household characteristics. The child regressions control for child's age and sex and the mother's age, height, and literacy, in addition to household characteristics. Household-level outcomes include the household hunger score, household dietary diversity, and household calorie availability. Women's outcomes include dietary diversity and BMI, while child outcomes include indicators of infant and young child feeding (IYCF) practices, dietary diversity, and anthropometric measures.

Findings and Interpretations

Associations between dimensions of women's empowerment in agriculture and food security and nutrition outcomes are not consistent across countries. Some indicators contributing to empowerment have positive effects on food and nutrition security, while others have negative associations, indicating that the context matters

greatly for shaping gender-sensitive nutrition interventions in agriculture.

Higher women's empowerment scores (according to the five domains of empowerment [5DE]) are almost always associated with positive nutritional outcomes, except for Bangladesh, which has mixed results. Across countries, higher women's empowerment tends to improve children's nutritional outcomes, suggesting nutritional programs that also aim to empower women overall could have greater impacts on nutritional outcomes than those that do not.

Greater household equality (a smaller gap between men's and women's empowerment scores) is almost always associated with better nutritional outcomes. Cultural preference for boys over girls is evident in Bangladesh, Nepal, and Ghana; increased women's empowerment often worsens girls' anthropometric outcomes relative to boys.

Improved nutrition is not necessarily correlated with being empowered across all empowerment domains, indicating the possibility of tradeoffs. In Nepal, control over incomes improves women's BMI, but if intensifying participation in agriculture increases workload, then both maternal and child nutrition could be at risk.

Conclusions

The WEAI can be used to identify policy and programming priorities by disaggregating the contribution of each indicator to women's disempowerment. Previous analyses identified the top two or three contributors to disempowerment and recommended that programs be designed to support empowerment in these specific areas. However, comparing the results from analyzing the top two contributors to disempowerment versus all 10 component indicators, we find that analyzing the top two indicators may be misleading because different empowerment indicators matter for different nutritional outcomes, with country-specific results. The model with all 10 indicators provides a much fuller picture of which indicators affect nutritional outcomes in specific contexts. Our findings suggest prime areas for policy and programming whenever overlap exists between a top contributor to disempowerment and a strong association between an indicator and positive nutritional outcomes. Interventions targeting top contributors to disempowerment that could potentially improve a range of nutritional outcomes could also be very cost-effective. However, because our results are based on associations, gender- and nutrition-sensitive agricultural programs that address the top contributors to women's disempowerment would need to be rigorously evaluated both in terms of impact and cost-effectiveness to guide future programming.

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Women's Empowerment: Pathways Toward Child Nutrition Outcomes

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Introduction

Empowering women improves child health. We examined the pathways by which domains of women's empowerment (WE) influence child nutritional status (CNS).

Methods

We conducted a secondary analysis of data from the most recent Demographic and Health Surveys (DHS) (2011-2016) for married women with children aged 6-24 months in Ethiopia, Kenya, Rwanda, Tanzania, and Uganda (n=13,780). We operationalized CNS using anemia, height-for-age-z score (HAZ), and weight-for-age-z score (WHZ). WE was evaluated using three previously identified latent factors for 1) women's human/social assets (HSA); 2) intrinsic agency (beliefs and attitudes towards domestic violence (BA)), and 3) instrumental agency (Decision-making (DEC)). We used structural equation models with latent constructs to estimate the strength of *a priori* hypothesized pathways from WE to CNS through the mediators, maternal body mass index (BMI) and child's dietary diversity score (CDDS). Due to our second *a priori* hypothesis of socioeconomic status (SES) being a mediator of the hypothesized model of WE to CNS, we used the DHS household wealth index as a measure of SES to evaluate these path models stratified by household wealth tertiles. Models were run for individual countries as well as for a pooled full sample. Our interpretations of the adequacy of model fit are based on theoretical interpretation and four measures of goodness-of-fit.

Findings and Interpretations

WE domains were directly and positively associated with maternal BMI [(estimate,SE) (HSA: 0.17,0.03) (BA: 0.23,0.03) (DEC: 0.03,0.01)] and CDDS [(HSA: 0.16,0.03) (BA: 0.17,0.08)]. Maternal BMI was directly and positively associated with child HAZ (0.08,0.04) and child WHZ (0.35,0.03). CDDS was

directly and positively associated with child WHZ (0.11,0.06). No direct effects from WE domains were associated with CNS outcomes. Women's HSA was indirectly associated with child WHZ through BA and DEC through maternal BMI. DEC was the only predictor associated with anemia (0.08,0.04). All estimates were significant at $p < 0.01$.

In stratified analyses, the estimates of direct and indirect effects between WE and CNS differed. In the lowest wealth tertile, HSA was directly and positively associated with anemia (0.05,0.02). BA was the only WE domain associated with maternal BMI (0.11 0.04). Both mediators were associated with WHZ [(BMI: 0.27,0.03) (CDDS: 0.13,0.08)]. In the highest wealth tertile, WE domains were directly and positively associated with maternal BMI [(HSA: 0.42,0.03) (BA: 0.22,0.08)] and CDDS (BA: 0.15,0.08). Maternal BMI was directly and positively associated with child HAZ (0.13,0.08) and WHZ (0.31,0.04). There were no significant predictors associated with anemia. Women's HAS was indirectly associated with child WHZ through BA through maternal BMI. Findings further differ by individual country.

Conclusions

This study incorporates a multi-disciplinary approach to evaluate child nutritional status through the use of Kabeer's framework from sociology and the use of psychometric tools for quantitative analysis. Although WE was not directly associated with CNS, the indirect associations suggest that improving WE in East Africa would improve CNS through increased maternal BMI. Our results helped delineate the importance of improved gender equality and the implications for household nutrition. However, a minimum household wealth threshold may be needed to translate empowerment benefits into CNS outcomes.

Linkages Between Local Poultry Trade, Gender Norms, and Dietary Diversity in Rural Settings of Burkina Faso

Jean-Marie Zongo¹, Sita Zougouri¹, Romain Kenfack¹, and Hannah Guedenet¹

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Introduction

According to a 2015 Food and Agriculture Organization of the United Nations (FAO) policy brief, four pathways (stability of food supply and prices, diversity of supply, lower food prices, and increased income) are central to how trade can improve nutrition and food security. Our study focuses on how trade and market support food diversification opportunities in rural Burkina Faso and thus improve the nutritional status of women and children. We would argue that in addition to trade and market opportunities within local poultry production, socio-cultural drivers, such as gender norms, are significant in shaping food environments and consumer behavior to achieve nutritional outcomes

Methods

The purpose of the study was to show how the pathways of food availability, accessibility, and consumption affect diets and nutritional outcomes for women and children in Burkina Faso's poultry producing communities. To understand this, we measured and analyzed food purchase (market access, cost of foods in market, and household decisions on what to buy), intra-household distribution of food, and food consumption (using women's food consumption as a proxy for the household). One hundred twenty households and 10 local markets in 30 villages covering two regions of Burkina Faso (Centre Ouest and Boucle du Mouhoun) were selected for data collection. The choice of villages was conducted using probabilistic sampling. In each village, four households with a mother of a child age 6-23 months were targeted. The study included a mix of households (polygamous versus monogamous) and for polygamous households, a range of women holding different positions in that household.

The methodological approach is based on mixed methods combining quantitative (market analysis, 24-hour food group recall, and food consumption frequency) and qualitative (semi-structured interviews, 24-hour direct observation) tools. The study also collected food price data from 10 local markets.

Findings and Interpretations

Households in the study area depend on diets of a staple (maize, millet) food and leaf sauce. Generally, households have one or two meals per day.

Households depend on cereals stocks that last two to six months depending on the region.

Women do not always have the power to decide and initiate positive changes for household diet diversity. Men generally

make available only the cereals that women have helped to produce; the provision of condiments and foods rich in animal protein is not their concern.

Most of the 10 food groups are available in the markets. For a six person-household, a diversified daytime meal costs \$2.63 and \$2.86 in the respective regions.

Food accessibility is determined by some stable agricultural trade activities that generate regular incomes, which is potentially poultry production. Market analysis has identified an end-market demand that can absorb significant increases in supply and, in turn, reward productivity investments by poultry producer households. Therefore, households that intensify production can benefit from a significant income flow for increased diet diversity.

However, female decision making determines mainly how this trade opportunity and food availability in the market could influence diet diversity and the nutritional status for women and children.

Conclusions

The impact of local markets and value chains such as local poultry affects the ability of households to achieve food diversification in rural settings of Burkina Faso. With income and food purchase opportunities, poultry producer households can access a stable diet diversity in the rural settings of Burkina Faso. However, the findings suggest there are larger factors at play beyond trade, cost of food, or access to food that are driving households' decisions about food diversification. Our study found that gender roles have a significant impact on who has the power and ability to make decisions around food purchases and decisions. Regardless of what is available and accessible in the market to achieve a nutritious diet, women do not have the power to decide how income can be used, thus limiting their ability to make purchase decisions that increase household dietary diversity. Yet empowering women through their participation in the production and sale of poultry, increasing their access to knowledge on poultry diversification and production, and facilitating greater control over their income and an increase of their decision-making capacity is essential to achieving household dietary diversity and nutrition outcomes for women and children aged 6 to 23 months.

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SESSION 2: AGRICULTURAL PRODUCTION AND NUTRITION LINKAGES

PARALLEL SESSION 1

Session Chair:

Reassessing Africa's Health and Nutritional Outcomes Through the Lens of Its Diverse Farming Systems

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Introduction

Sub-Saharan Africa's (SSA) reliance on rainfed agriculture and its diverse agricultural conditions merit a deeper understanding of its farming systems. Farming systems represent broadly defined groups of individual farms sharing similar resource bases, livelihood strategies, and constraints. These systems not only respond similarly to agro-climate conditions, but have broadly similar development pathways and policy needs. This study analyzes trends and the current state of health and nutritional outcomes in SSA through the lens of its diverse farming systems. We aim to identify system-specific challenges and potential entry points.

Methods

Data from 24 countries in SSA are analyzed through descriptive and multivariate analysis. Geo-referenced and nationally-representative health, nutrition, and socioeconomic data come from Demographic and Health Surveys (DHS). Depending on the country, one to five rounds of DHS are available covering the period since the 1990s. The source of farming systems data is Dixon (2001). Gridded landscape-level data on agro-climatic, biophysical, and economic factors (e.g., elevation and market access) is CELL5M (HarvestChoice, IFPRI, and University of Minnesota, 2017). SPAM (IFPRI and IIASA, 2016) is the source of gridded data on agricultural production. Indicators of nutritional outcomes are constructed based on anthropometric data collected from children under five years old and adult women. The incidence of various diseases (e.g., diarrhea, malaria, cough, fever) are also examined. Data from the most recently available DHS waves are used to assess the current state of health and nutrition while trends are examined for a sub-sample of countries with multiple round of DHS. The multivariate analysis combines ordinary least squares (for linear nutritional outcomes) and logistic regression (for dichotomous outcomes).

Findings and Interpretations

Multivariate analysis is currently underway but preliminary descriptive results suggest significant heterogeneity in the incidence malnutrition and diseases by farming systems. For example, highland perennial system is associated with the lowest incidence of moderate stunting and wasting. In addition to cereals and pulses, this system is dominated by crops that are resilient to drought and heat, such as plantain, false banana, and cassava. On the other hand, the maize-mixed system – upon which about 15% of the regional

population relies for livelihood – has one of the highest incidence of under-five stunting as well as diarrhea among children aged 6-23 months. Forest-based, humid lowland tree crops, roots and tubers, and cereal-root crop mixed systems are associated with a high incidence of malaria among children 2 to 10 years old. These systems generally receive above average precipitation, a factor that is conducive for vector breeding.

Conclusions

While there is an admittedly significant degree of heterogeneity within any single farming system, identification of system-specific nutritional and health constraints can assist with the devising of system-wide interventions and strategies. This is especially the case in the current era where increased emphasis is placed on making agriculture more nutrition- and health-sensitive. Linkages between farming systems and health and nutritional outcomes are expected through two main channels – the supply of nutritious foods and the spread of diseases and infections. Preliminary results show significant heterogeneity in health and nutrition across Africa's diverse farming system, which may merit a system-specific approach for ensuring food and nutritional security in the region.

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The Role of Livestock Ownership in Child Nutrition in East Africa

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Introduction

The objective of this paper is to investigate the influence of livestock ownership on child dietary outcomes in view of understanding how policies in the livestock sector might contribute to reduced malnutrition. Two pathways are investigated. First, the direct link between improved nutrition and livestock ownership is investigated by linking cattle ownership with consumption of milk and chicken ownership with egg consumption. Second, the indirect effect of livestock ownership and nutrition through improved income is explored by linking the nutritional diversity score of children with livestock ownership against those without.

Methods

This paper makes use of the most recent Demographic Health Surveys (DHS) in East Africa that contain a 24-hour recall of child nutrition as well as information about livestock ownership at household level. In addition, for each DHS observation, geographical layers are queried to extract location-specific information about bio-physical and socioeconomic contexts, namely the climatic agro-ecological conditions and market access. Econometric models are fitted to identify the drivers that explain milk and egg consumption and diversity score, including livestock ownership.

Findings and Interpretations

Preliminary results show that children in cattle-owning household have a much higher probability to drink milk. Also, in dairy high-potential areas such as the East African highlands, children are much more likely to get milk in general, while at the same time proximity to market decreases a child's probability to get milk. Likewise, children living in chicken-owning or wealthier households are more likely to eat eggs. Unlike drinking milk, proximity to market enhances the chance of a child to eat eggs.

Finally, DHS data suggests that diet diversity increases with market access, wealth, and number of livestock owned.

Conclusions

Increasing evidence shows that animal-sourced food plays a critical role in reducing child malnutrition in low-income countries. Simultaneously, food systems in these countries are rapidly changing as a result of urbanization and increased wealth. Livestock production systems at farm level respond to those changes often by enhancing livestock productivity.

These transformations offer an unprecedented opportunity to improve the income of livestock keepers as well as to improve the availability of animal-sourced food and therefore could address the issue of child malnutrition in the region. The preliminary results show that both better incomes and livestock ownership are likely to improve children's diets. However, improved market access can influence children's nutrition in two opposite ways: improved access to different food items can lead to a more diversified nutrition, but it also reduces children's chances to get milk, as this high-value product that used to be for home consumption gets sold in the market.

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Assessing the Contribution of Agriculture to Nutrition: Results from a Household Survey of Two Agro-ecological Zones in Ethiopia

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Introduction

We assess the relative and absolute importance of agricultural influences on food security and nutritional outcomes in two agro-ecological zones in Ethiopia. Although there have been an increasing number of studies aimed at measuring the impact of agriculture on nutrition in recent years, many focus on only one or two agricultural influences and few have examined the influence on measures of micronutrient status. This study analyses associations between agricultural and other variables and food security and nutritional indicators using regression analysis.

Methods

The analysis uses data gathered in an 800-household survey conducted in two food-insecure Ethiopian regions. The survey was aimed at providing a detailed understanding of agricultural practices in both regions in relation to food and nutrition security outcomes. Particular emphasis was placed on maternal and child nutrition, with a more detailed survey of nutrition indicators for a subset of 200 households with mothers and children under two years of age.

Our conceptual framework focuses on the pathways by which different groups of predictor variables are hypothesised to influence food security and nutrition outcomes. We selected two less-commonly used nutritional indicators, maternal zinc and maternal ferritin, together with two standard food security measures, the household food consumption score (HFCS) and household dietary diversity score (HDDS). The selection of predictor variables was informed by the literature and those showing the strongest correlations with the dependent variables. The predictors were then categorised into four groups: household characteristics, agricultural factors (including crop and livestock production and diversity), income issues, and food consumption decisions. We then performed ordinary least squares hierarchical multiple regressions on each outcome variable using the same four groups of independent variables in the same order, as informed by the conceptual framework.

Findings and Interpretations

The results highlight a significant difference in average maternal zinc and ferritin between the two agro-ecological zones, despite similar mean food security scores.

We found that agricultural factors have a significant association with our selected food and nutrition security indicators. Our models for maternal ferritin and zinc outcomes explain some 58 and 53 percent, respectively, of their variance (adjusted R-square). The food security models explain 47 and 34 percent, respectively, of HFCS and HDDS

variance. The group of agricultural variables explain about 10 percent of the variance in maternal zinc, household dietary diversity, and food consumption scores, and some 20 percent for maternal ferritin.

Statistically-significant positive associations were found between total livestock units and maternal zinc outcomes, women's empowerment in farming decisions and maternal ferritin, and area farmed with both HFCS and HDDS. Negative associations were found for larger cash crop areas in the lowland region with maternal zinc and iron outcomes, as well as for crop diversity with HFCS and HDDS. Strong positive associations were recorded for fruit and vegetable and meat per capita consumption with maternal micronutrient outcomes, as well as asset wealth and quality of water source.

Conclusions

Despite the relatively small sample size, our regression models significantly explain a large proportion of food security and micronutrient variance for the dependent variables selected. Our conceptual framework also provides a theoretical grounding for the hierarchical regression in order to evaluate the relative importance of different sets of predictor variables, including a group of agricultural factors. This approach enables us to estimate the importance of key agricultural influences on food security and nutrition in relation to other important determinants.

Our results suggest that agriculture plays an important role in food security and nutrition outcomes, but that other factors, such as food consumption choices, asset wealth, and water quality are often more influential. Of the agricultural factors that were significantly associated with maternal micronutrient outcomes, the negative association between per capita cash crop areas and both maternal zinc and ferritin outcomes was somewhat surprising. This may be because cash crops such as groundnuts account for larger areas grown in the lowland region, which could be at the expense of food crops for households in that region. The models provide direction for further research.

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Effect of Home Gardening on Food Security and Diet Quality of Households in Ijebu-Igbo, Nigeria

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Introduction

Sustainable access to adequate, safe, and nutritious food is required for a healthy and active life, either through own production or purchase. However, food poverty and poor diet quality remain high in many developing countries with an increasing burden of diet-related noncommunicable diseases. Ensuring food security and a high-quality diet is therefore essential to promote health in low-income settings. Home gardening's potential to enhance food security is known, but impacts on diet quality remain unclear. This study was designed to assess the effects of home gardening on food security and diet quality of households in Ijebu-Igbo, Nigeria.

Methods

This comparative cross-sectional study involved 387 women of reproductive age selected using a cluster sampling of the four local council development areas in Ijebu-Igbo Community, Ogun State, Nigeria. Based on home gardening practice, respondents were stratified as Non-Home Gardeners (NHG) and Home Gardeners (HG). Information was collected on socio-demographic characteristics, food security, and 24-hour dietary recall using a semi-structured, interviewer-administered questionnaire. Food security was assessed using the Household Food Insecurity Access Scale classified as food secure, mild, moderately, and severely food insecure; and dichotomized into food secure and food insecure for regression analysis. A multiple-pass 24-hour diet recall was conducted for all respondents for two weekdays and one weekend. The 24-hour diet recall data were used to calculate diet quality using the Diet Quality Index International method categorized as high (>60), medium (41-60), and low (0-40). Body weight and height were assessed to determine body mass index and categorised using World Health Organization standards. Data were analyzed using descriptive statistics, Chi-square test, and binary logistic regression analysis at $p=0.05$. Four focus group discussions of 10 respondents each were held with Home Gardeners to identify likely pathways of influence of HG on FS and DQ and analyzed thematically.

Findings and Interpretations

Respondents' age (years) was 40.4 ± 12.8 and 41.7 ± 15.9 for NHG and HG. Majority in both NHG (72.1%) and HG (73.9%) were traders, and incomes between ₦10000-₦30000 were most common in both NHG (54.8%) and HG (51.3%); groups were not statistically different. Only 29.2 percent of respondents practiced HG, duration of practice was 6.96 ± 5.57 years; and commonly grown crops were staples (44.0%), vegetables (26.0%), and medicinal plants. Food security was significantly higher among HG (31.3%) compared to NHG (15.1%) and severe food insecurity was four times higher among NHG (33.1%) compared to HG (8.7%). High diet quality was higher among HG (58.8%) than NHG (53.9%).

Overweight (33.1%; 32.0%) and obesity (23.5%; 21.0%) were higher among NHG than HG and underweight (5.9%) occurred exclusively among NHG. Home gardeners had three times higher odds of being food secure than NHG (OR=2.24, CI= 1.07-4.69) and two times higher odds of having high quality diet (OR=1.221, CI=1.18-1.89). Focus group discussion respondents identified the benefits of home gardening to include enhanced income, increased physical access to foods, and inclusion of available food stuff during food preparation. Identified challenges to home gardening included inadequate space, limited time, and free range domestic animals' intrusion into the home gardens.

Conclusions

The practice of home gardening is only at 29.2 percent among households in Ijebu Igbo community, Nigeria. Home gardening practice enhances household food security and diet quality and is significantly associated with good anthropometric characteristics among women of reproductive age. Identified pathways of improvement were increased income, increased physical access to foods, and increased utilization of available foodstuffs during food preparation. Increased efforts to promote home gardening and supports including incentives and training for cultivation of nutrient dense crops are hereby recommended as part of the ongoing social protection activities in the country. Policy and strategies to ensure provision of space for home gardening activities and prohibit free range animals should be put in place to encourage home gardening.

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A Participatory Agroecological Intervention Amongst Rural Tanzanian Farmers Increases Crop Diversity, Food Security, and Maternal Dietary Diversity: A Midline Evaluation

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Introduction

Our formative research in Singida, Tanzania, indicated that smallholder farmers faced several barriers to optimal nutrition: limited agricultural knowledge, high levels of food insecurity, sub-optimal infant and young child feeding practices, and gender inequity¹. The Singida Nutrition and Agroecology Project (SNAP-TZ; NCT02761876) is a randomized effectiveness trial of a participatory intervention to improve these outcomes. Rural farmers with children under one year of age were recruited from 20 villages (n=587). We report on the impact of SNAP-TZ on crop diversity, household food security, dietary diversity, and women's empowerment after one year of the three-year study, as well as lessons learned from implementation.

Methods

The intervention began by selection of 'mentor farmers', one man and one woman from within each of the ten intervention villages (n=20). In 2016, they visited a similar project in Malawi, followed by a two-week intensive participatory course which integrated agroecology, nutrition, and gender issues. All participating farmers in intervention villages (n=279) received ongoing support from mentor farmers on these issues and legume seeds to plant in December 2016. Participants are surveyed (1) on socio-demographic, agricultural, and health annually and (2) on food security, diet, and experiences with the intervention twice annually. Qualitative data collection included participant observation of village meetings and household visits, semi-structured interviews with mentor farmers (n=20), and 10 focus group discussion with participating households (n=33).

Difference-in-difference (DID) analysis between baseline (BL) in the growing season (BL_{growing}) and follow-up (FU_{growing}) was used to evaluate impact on crop diversity (range:0-7) and the Abbreviated Women's Empowerment in Agriculture Index (A-WEAI, range: 0-1). DID analysis between BL_{harvest} and FU_{harvest} was used to evaluate impact on the Household Food Insecurity Access Scale (HFIAS, range: 0-27), UNICEF's Child's Dietary Diversity Score (CDDS, range: 0-7), and Minimum Dietary Diversity for Women (MDD-W, dichotomous) in STATA14. Clustered standard error was used for all analysis.

Findings and Interpretations

In January and July of 2016 (at baseline), crop diversity, HFIAS, DDS, MDD-W and A-WEAI scores did not differ between intervention and control households, indicating effective randomization.

By January and July 2017, 88.9 percent and 64.4 percent of female and male participants, respectively, had attended mentor farmer meetings, reporting 2.7±1.6 and 2.4±1.6 meetings a month, respectively. DID analysis indicated that households in intervention villages had an increase in crop diversity ($\beta=1.06$, $p<0.001$), decrease in HFIAS ($\beta=-2.08$, $p=0.016$), and were more likely to meet MDD-W than those in control villages (OR: 2.06, $p<0.001$). There were no significant differences in CDDS ($\beta=-0.04$, $p=0.86$) or A-WEAI ($\beta=0.01$, $p=0.75$).

Qualitative data analysis revealed several themes: (1) mentor farmers saw the intervention as feasible based on the observed successes of their Malawian counterparts; (2) having both a male and female mentor farmer in each village is important to show that nutrition and agriculture are the concern of both men and women; (3) there is a widespread perception that the study is solely for women due to its messaging around nutrition; and (4) mentor farmers tended to put less emphasis on gendered topics, e.g. family planning, during meetings to reduce resistance from participants.

Conclusions

We have begun to observe shifts in three important indicators along the pathway to improved nutritional outcomes among women and children: crop diversification, maternal dietary diversity, and food security. We have yet to see impacts on child nutrition or gender equity. Greater emphasis on empowering both men and women participants to change these social and nutrition-related behaviors may improve these outcomes. As such, the implementing team has added renewed focus on addressing gender inequity in the program with a special gender training and continued efforts to involve men in discussion regarding nutrition and gender. Because agriculture projects are seen as men's domain and nutrition projects as women's domain, having both male and female mentor farmers discussing agriculture, nutrition, and social equity has been very important. Rapid qualitative and quantitative analysis to improve program implementation has also been helpful in ensuring improved quality of implementation.

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Agriculture to Nutrition: Promoting Vegetable Production for Improving Dietary Diversity in Ethiopia and Tanzania

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Introduction

Despite significant progress towards improving nutrition, the global community is still grappling with multiple burdens of malnutrition. Two billion people lack key micronutrients like iron and vitamin A. Evidence shows that actions delivered through the 'nutrition sector' alone can only go so far, hence, the call to address the root cause of poor nutrition. Agriculture is the backbone of diet and nutrition, therefore agricultural interventions also need to address nutrition. The Agriculture to Nutrition project, therefore, seeks to provide evidence for agriculture's potential to deliver positive nutrition outcomes in Ethiopia and Tanzania, where selected Nutrition-Sensitive Interventions (NSI) are being tested.

Methods

Agriculture to Nutrition (ATONU) is testing three pathways to deliver improved nutrition to smallholder farming households: (i) agricultural production for own consumption, (ii) use of agriculture income to purchase other nutritious foods, and (iii) women's empowerment to improve agency and nutrition. The pilot project uses a cluster-randomized design to estimate the effect of the interventions on the primary outcome of dietary diversity among women of reproductive age in rural Ethiopia and Tanzania. However, this paper will focus on the production for own consumption pathway.

A total of 1600 farming households (800 in Ethiopia and 800 in Tanzania) with women of child-bearing age and children under the age of five were selected from 20 villages in each country. ATONU introduced a package of NSIs that included vegetable production for own consumption in order to improve the dietary diversity of participating farming households. The households were visited regularly by trained field assistants, during the evaluation period from April to December 2017 for delivery and re-enforcement of ATONU messages and collection of process data. Both quantitative and qualitative data were collected on agricultural production, food consumption patterns, and vegetable production and consumption at the baseline and after one year of interventions.

Findings and Interpretations

The baseline survey revealed that the proportion of households that were involved in vegetable production was less than 10 percent in Ethiopia and less than 40 percent in Tanzania. However, following a year of delivering nutrition-sensitive interventions, the uptake of vegetable production increased to ~84 percent in Tanzania and 100 percent in Ethiopia. The results also showed increased consumption of vegetables (especially the dark green vegetables) from 35 percent to 93 percent in Tanzania and from 20 percent to 100 percent in Ethiopia. Vegetable production contributed to increased vegetable consumption as 71 percent of the households consumed vegetables from their own gardens, whilst only 29 percent of the households sourced their vegetables from the market. Although some households produced up to six different types of vegetables, most households produced an average of two different vegetables in Tanzania, whilst in Ethiopia, each household produced an average of three different types of vegetables following the introduction of NSIs. Green leafy vegetable varieties were the most produced in both countries.

Conclusions

The focus of this intervention was to make sure that households produced some vegetables for home consumption in order to improve their dietary diversity rather than for sale. The uptake of this intervention was a success and most households (96 percent of producers) produced enough vegetables for their own consumption, with a surplus for sale. For those households that did not produce any vegetables, the main reasons cited were lack of water, lack of land, lack of time, and chickens and wild birds eating the vegetables; hence those households preferred to buy rather than produce. Households are being encouraged to use some of the income from vegetable sales to buy more seed so as to make the practice more sustainable. It is hoped that the increase in vegetable consumption will contribute significantly to dietary diversity of women of child-bearing age and children under the age of five.

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SESSION 2: AGRICULTURAL PRODUCTION AND NUTRITION LINKAGES

PARALLEL SESSION 2

Session Chair:

Adoption of a Government-Led Homestead Gardening Program in Ethiopia

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Introduction

Since their development by Helen Keller International in Bangladesh in the 1980s, homestead gardening (HG) programs have become increasingly popular throughout the developing world. However, HG evaluations have solely focused on NGO-led interventions, many of which were not implemented at scale or across diverse agroecologies or market access settings. In this paper we explore the implementation of a government-led nationwide HG program (HGP) in Ethiopia that involved implementation by health extension workers. Our objectives are (1) to study barriers to adoption of HGPs, and (2) to assess the extent to which HGPs can improve dietary diversity in different environments.

Methods

This study is based on primary survey data collected in 2017 on households with young children (under 24 months of age). The survey is large – more than 2,500 households – and widespread, covering 88 districts (woredas) and 264 sub-districts (kebeles) in four regions of the country. In addition, the survey team conducted in-depth interviews with 264 front-line health workers working in the same localities. We use descriptive statistics and regression analysis to understand patterns of HGP adoption among poor rural households in Ethiopia, the extent of HG promotion by front-line health workers, and explore the potential impact of HGPs on dietary diversity after controlling for confounding factors.

Findings and Interpretations

More than 85 percent of front-line health workers reported promoting HGs to their clients in the past 12 months. Despite this, only 25 percent of households reported cultivating a homestead garden during the same period. Both households and health workers quoted poor access to water as one of the most important reasons for low adoption rates, and households located in areas characterized by ample rainfall and short distance to a water point are considerably more likely to adopt HGs. Households with better access to food markets are also more likely to adopt homestead gardens, as are wealthier and larger households. Results suggest that

children from households that operate an HG have marginally higher dietary diversity and are marginally more likely to consume green leafy vegetables. We also find that poor access to water and poor access to markets are relatively highly correlated.

Conclusions

Both poor access (physical/financial) to food and limited knowledge of the nutritional importance of nutrient-rich foods are key constraints to improving dietary diversity in poor countries (GNR, 2017). The promotion of HGs can, in principle, address supply-side constraints. However, this policy prescription assumes that: (1) food markets are highly imperfect such that households need to produce additional foods themselves; and (2) that households have access to all necessary inputs (water, land and ideal agroecological conditions) needed to produce nutritious foods.

Our results show that households with poor access to food markets and poor access to water are less likely to operate a HG. Moreover, poor access to food markets and poor access to water are highly correlated. Together, these findings suggest that the more remote households who would theoretically benefit most from HG production are not able to do so because of limited access to water. This implies that HGs may not be a 'low-hanging fruit' to address poor dietary diversity in rural Ethiopia; improving water access is an important but potentially costly prerequisite for the adoption and effectiveness of HG production.

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Association of Dietary Diversity with Nutrient Adequacy and Socio-Economic Parameters Among Rural Adolescents from Pune, India

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Introduction

Nutrient deficiencies, excesses, and lack of dietary diversity are public health concerns in developing countries including India. Early identification and improvement of such diets will be a cost-effective preventive measure. However, this is hampered by the current nutritional assessment methods that are time consuming and require technical expertise. Dietary diversity scores (DDS) provide a rapid measure of diet quality but are under-investigated in the Indian scenario. Only few studies have validated DDS with bio-markers of circulating micronutrients. These research questions are addressed by this study among rural adolescents in India to assess validity of DDS against vitamin B12, hemoglobin concentration.

Methods

Pre-collected data of 18-year follow-up (year 2012-2014) on 650 apparently healthy adolescents of the Pune Maternal Nutrition Study (PMNS, a prospective birth cohort) was analyzed. Dietary diversity scores were calculated based on frequency of consumption of a food per day (FAO 2013 guidelines). Only foods that were consumed at least once a day and in daily quantities of more than 10g were considered. The nutrient adequacy ratio was calculated using reference recommended values by Indian Council of Medical Research (2010). Socio-economic status was assessed against the Indian National Family Health Survey standards (2012). Standard of living (SLI) scores were classified as Low= 0-14, Medium= 15-24, High = 25 to 67. Those with circulating vitamin B12 <150 pmol/L and with Hb <12 g/dL were considered deficient. Data were analyzed using Spearman correlation coefficient, ROC and analysis of variance tests.

Findings and Interpretations

At 18 years, 42 percent of boys and 55 percent of girls were undernourished (BMI<18.5 kg/m²), and 8 percent of boys and 4 percent of girls were overweight (BMI>25kg/m²) (WHO 2009). Average caloric intakes were 2964 and 2068 kcal/day in boys and girls. One third of boys consumed inadequate quantities of nutrients particularly energy and vitamin B12 while 50 percent of the girls consumed inadequate energy,

protein and iron and 80 percent had low vitamin B12 intakes. Of the most frequently consumed twenty foods, ~60 percent were carbohydrate rich (cereals, legumes, and pulses).

Average dietary diversity score was 4/9 for boys and girls. Mean adequacy ratio (MAR) was 0.64 for boys, 0.45 for girls and was directly associated with DDS (r=0.58, P<0.01). Almost 60 percent of boys and girls had deficient circulating vitamin B12 levels and >50 percent of girls had hemoglobin levels <12g/dL. Maximizing sensitivity and specificity, DDS of 5 was the best option among boys and girls for achieving 50 percent of MAR as well as for identifying those with deficient circulating levels of vitamin B12 and hemoglobin.

The majority of adolescents (90 percent) belonged to high socio-economic status. DDS was associated with economic status (income, type of house, occupation), place of residence (hostel vs family), and source of foods (own farm vs purchased) (p<0.05 all).

Conclusions

The current study demonstrates a high prevalence of macro as well as micronutrient deficiencies among Indian rural adolescents with low dietary diversity scores, low body mass index, and deficiencies in vitamin B12 and nutrients required for red blood cell synthesis. These deficiencies are remarkably high among adolescent girls. Dietary diversity scores were useful proxy indicators of nutrient adequacy as well as micronutrient status of rural adolescent boys and girls. Socioeconomic parameters were found to play a significant role in determining dietary diversity of rural adolescents.

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Determinants of Participation in a Homestead Food Production Program in Rural Bangladesh

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Introduction

Many nutrition-sensitive agriculture programs rely on behavior change activated through convergent thematic pathways at several levels of engagement (participation, initial uptake, long-term uptake, and translation of knowledge, for example). For interventions where there is observed impact, and especially those without, challenging the theory of change through monitoring the implementation process will lead to more effective programs, especially through systems that can address delivery and uptake challenges early on in the program cycle. As part of an ongoing process evaluation during a four-year complex nutrition intervention, we aim to assess the predictive factors of initial program participation in rural Bangladesh.

Methods

We used data from the baseline survey and program implementation monitoring system of the Food and Agricultural Approaches to Reducing Malnutrition (FAARM) cluster-randomized trial in northeastern Bangladesh. In an analysis of 1290 participants (the intervention arm who also completed the baseline survey), we investigated the factors related to attendance at training sessions on horticulture, poultry production, nutrition, care, and hygiene practices. We investigated socio-demographic characteristics and household wealth; knowledge on nutrition topics; food insecurity and diets; gardening characteristics including land size, seasonal land changes, number of different crops grown, improved horticulture practices undertaken at baseline, earnings from sale of agricultural goods; screening positive for depression; and woman's agency measured in social support, mobility, communication, and ability to make decisions. In a multilevel linear regression model adjusting for the clustered design and with fixed effects for field facilitators in charge of the area, we examined the influence of these factors on the number of training sessions attended in the previous year and a half. Sixteen group events were delivered in this time: nine nutrition and hygiene courtyard sessions, three horticulture trainings, two poultry trainings, and two marketing sessions. We then conducted a dominance analysis including all variables from the multivariable regression with $p < 0.2$ to assess the relative contribution of these factors in predicting session attendance.

Findings and Interpretations

The mean number of training sessions attended was 10.4 (SD 5.36), ranging from 0 to 19, but 16 being attendance at all sessions. Each additional year of a woman's age was associated with a 0.18 increase in session attendance and each younger year of age at first marriage resulted in 0.27 sessions less attendance. Higher household wealth was related to less attendance (-0.88 per wealth score unit).

Women whose husbands had higher education were less likely to attend (-.25 per educational level). Women who came from families where the near land was under water for longer periods of time during the year were less likely to attend sessions, and women who came from families who owned their agricultural land and made more money selling dairy and eggs were more likely to attend (0.69 more sessions for owning agricultural land and 0.66 for each level of income from dairy sales). Women with better communication with their husbands, natal family, and peers (0.36 per communication score unit), less remittances from abroad, and less money earned from sale of fruits and vegetables were more likely to attend sessions, although these factors were only significant at $p < 0.1$. Many of the groups of field facilitators in charge of delivering the program were also a significant factor in predicting attendance at sessions.

The dominance analysis ranked the village, the field facilitators, household wealth, age of index woman, husband's educational category, age of the woman at first marriage, total amount of agricultural land owned, household food insecurity, money earned from sale of dairy and eggs, and length of time near land underwater during the year as the most important factors contributing to attendance.

Conclusions

Attendance in program training sessions was strongly influenced by the village in which they took place (possibly encompassing socio-cultural aspects, topography, and the intervention delivery characteristics) and the field facilitators delivering the program, highlighting that staff characteristics are an important factor in participation. Other factors most associated with increased attendance in program activities were being poorer, higher age of the woman, marrying later, and husband's lower education. Some factors of land size, land characteristics, and agricultural productivity were associated with increased attendance while other similar factors were not. These results can contribute to tailoring programs to those most likely to participate and thus benefit, as well as to understanding the importance of field staff and the community dynamics underlying any intervention.

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Magnitude of Fish Post-Harvest Loss and Its Intervention in Small-Scale Fisheries of Ethiopia: A Missing Link but Viable Approach for Food and Nutrition Security

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Introduction

As the world population is expected to become 9 billion in the near future, increasing food production by 70 percent becomes an ever more urgent priority. However, a vital yet neglected step toward this end is to reduce the food losses that occur through the entire food system. Ethiopia loses more than US\$8 million due to post-harvest loss of 10,000 metric tons of fish, which is one third of the total production. Reducing losses is therefore an important development goal in this sector. Vital to this end is to characterize the important factors and their magnitudes of fish loss in this sector.

Methods

The data was collected monthly for seven years between 2011 and 2017 from nine water bodies which provide about 70 percent of the total national fish production. The study was carried out by adopting three methods: Informal Fish Loss Assessment Method (IFLAM), Load Tracking (LT), and the Questionnaire Loss Assessment Method (QLAM). On the first step, IFLAM, an informal method based on participatory rural appraisal principles, was used to generate qualitative and indicative quantitative post-harvest fish losses data. Then, LT was used to quantify losses at stages along the distribution chain or losses related to specific activities such as fishing, transport, processing, and marketing. Finally, QLAM was adopted by interviewing a population sample in a community (geographical area) using a questionnaire to validate data generated by IFLAM and LT.

Review of secondary data, such as existing socioeconomic and production information, and Initial contacts with a community through key individuals, such as local fishery officials and fishers was done before conducting fieldwork in order to have a thorough background knowledge of key issues.

Findings and Interpretations

From about 180 fish species that are found in Ethiopia, Tilapia, African cat fish, Barbus, Bagrus, Clarias, Labeo, Lates, and Nile perch species are the major contributors and commercially important fish, yielding about 90 percent of total production. Based on IFLAM, the factors which contribute to post-harvest fish losses appraised were spoilage, size discrimination, species preferences, operational losses, less market access, controlled fish price regulation, and others. Then the procedure of LT and QLAM were followed. Accordingly, the results indicate that from the total annual 21,084 tons of fish catch, the total post-harvest fish loss constitutes 9,066.2 tons (43 percent).

Conclusions

The determinant factor for post-harvest fish losses include less market access, size and species preference, inadequate infrastructure for fish handling, processing, storage, transportation, controlled fish price regulation, and distance from the central market. Fish will become unfit for human consumption within twelve hours of capture unless subjected to some form of cold preservation or further processing. Cold preservation through refrigeration and freezing is not applicable as it is very expensive and difficult to access electric power around the production (fishing) area. Thus, from this paper, it is possible to conclude that fish post-harvest technology such as fish drying, fish marinating, fish retaining cages, fish smoking, fish meal, and fertilizer processing as alternative means for discarded and lost fish, fish processing kits, and solar ice making are very important in reducing mass and nutrient loss which plays a great role in securing food and nutrition. Therefore, it is very important to further adopt, verify, popularize, and disseminate these technologies for end users to secure food and nutrition.

The Importance of Forested Landscapes for Food Security and Nutrition Across Agricultural Transitions: A Multi-Country Comparative Analysis

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Introduction

Smallholder family farms are increasingly becoming commercialized and transitioning away from diverse subsistence systems towards specialized market-orientated operations, leading to dramatic shifts in the scale and nature of agricultural landscapes and the associated effects on the environment, ecosystem service provisioning, livelihoods, well-being, and health of local populations. We examine how changes in agricultural landscapes manifest themselves as dietary transitions which represent an often-overlooked social dimension of tropical conservation. We show there are some complex interactions between forests, people, and landscape configurations with consequences for health and nutrition that hold true across a broad range of diverse landscapes.

Methods

We have applied a novel methodological approach as part of the Agrarian Change Project, which aims to explore the nature of forest loss and landscape-scale agricultural transitions in tropical forested areas across seven landscapes in different countries: Indonesia, Burkina Faso, Ethiopia, Nicaragua, Bangladesh, Cameroon, and Zambia. Each landscape has historically undergone and is currently undergoing agriculture-driven landscape transformation, and three experimental zones we established within each landscape represent increasing levels of deforestation and transition away from forest-based livelihoods. Zones represented different stages of transition and were paired with household surveys (n=1904) exploring the diets and livelihoods of local people. Zone 1 represents landscapes where people are carrying out subsistence farming and are heavily dependent on forests. Zone 2 represents areas with an intermediate or mixed-farming system with less access to forests. Zone 3 represents locations that have been converted to monoculture agricultural systems with very little access to forests. We conducted a comparative analysis by using a mixed model approach that allowed us to draw some broad conclusions about the impacts of agricultural intensification, forests, and diets at the landscape scale.

Findings and Interpretations

After controlling for a wide range of variables known to contribute to the status of a household's food security and nutrition, including relative wealth, education levels, household size, land availability, etc, we found that both a households' position along the forest transition/agricultural intensification curve and its reliance on forests can have large impacts on food security, dietary diversity, and consumption frequency of nutritionally-important individual food groups.

Reduced reliance on forests can negatively impact food security to varying degrees across zones, whereas dietary diversity is significantly better for those who have an intermediate-level reliance on forests. Furthermore, in both cases, the size of the effects of forest use are mediated by an interaction with landscape configuration. The impact of reduced reliance on forests for food security is amplified for those who remain forest-dependent in the highly modified agricultural zones. Contrastingly, the positive effects of maintaining a moderate level of forest dependence are diluted when maintained in the heavily modified zone. Other factors that consistently impact food security and nutrition are wealth, the amount of land owned, and self-producing staple foods.

Conclusions

We show that no matter what the landscape, there are some complex yet generalizable patterns that emerge when transitioning from forests and subsistence-based livelihoods to more market-based monoculture commodity production. Interactions between landscape configuration and forest use have significant impacts on food security and nutrition for local people in developing rural areas. The unique experimental design of this project allows us to gain some insights into some of the less obvious trade-offs related to agricultural intensification at the expense of forests systems. To look from the more forested parts of a landscape towards the heavily modified is in many ways like looking into the past as the frontier of deforestation has continued to encroach into more natural areas. Forests play important roles for food security and nutrition, and we have shown that as a landscape evolves to meet the needs of rural development, the importance of forests for people is maintained, or in many cases increases, as its extent within a landscape is diminished. Landscapes are complex by their nature and understanding the tradeoffs inherent in any land use change is an important step to creating relevant and high-impact policy, especially in the areas of human wellbeing.

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Impact of Different Agroecosystems on Household Food Consumption, Health Outcomes and Autonomy of Adolescent Girls in Seafood Farming Communities in Bangladesh

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Introduction

Fish is a core item of peoples' diets. In Bangladesh, fish provides 60 percent of animal protein. Fish and fishery products offer a rich source of protein, micronutrients (LC n-3 PUFA), and are low in saturated fats. Aquaculture is well established for ensuring food security, whilst shrimp-prawn farming in Bangladesh is dynamic. This work was designed to develop an integrated metric for the impact of access to aquatic foods on health and nutrition – the Aquatic Food for Health and Nutrition index – with a special focus on adolescent girls as an at-risk group for poor nutritional status.

Methods

On the basis of water salinity, four different agroecological zones and one seafood processing community were selected for the study. As religion may influence food consumption patterns at the household level, communities with two adjacent para (small unit of a village), one which is Muslim-dominated and the other Hindu-dominated, were selected for each agroecology. The seafood processing community (SPH) was predominantly Muslim. Village and resource maps were drawn by local participants, subsequently, a well-being ranking was executed using methodology applied in previous studies. Twelve qualitative FGD's were conducted to design a measure of female autonomy that can predict health and nutritional wellbeing in a Bangladeshi context. A pretested survey tool was developed and implemented at the household level. At the final stage, 60 households were selected from each community, ensuring equal representation from different social wellbeing classes and religious communities, including at least one unmarried adolescent girl (12-16 years old). Food frequency questionnaires were developed and administered. Anthropometric data (height, weight, age) and blood and urine samples were collected at a central location in each community. A separate set of questions was asked to the adolescent girls under a different domain to understand their autonomy at the household level.

Findings and Interpretations

The intra-household food allocations were found to be heterogeneous across the saline gradients. Adolescent girls and mothers consumed less food than what is required and also compared with the fathers and any brothers in the same household. Education, mobility, ambition, access to food, social safety and security, sports and outdoor activities, and health and hygiene all impacted female autonomy. Adolescent girls from Hindu communities enjoyed more autonomy in terms of mobility, ambition, and food choice compared to individuals from Muslim communities across the saline gradients. Girls living in the higher saline areas typically consumed more fish with a higher content of LC n-3 PUFA, and also had a higher omega-3

index, compared with girls from lower salinity areas, irrespective of social wellbeing and religion. We are currently continuing to refine the preliminary metric with the help of local health workers to align the outcomes of local practitioners to implement the metrics in the real world.

Conclusions

Establishing the relationship between aquaculture agroecosystems producing nutritious foods and their impact on the health and nutritional status of local communities living in such dynamic aquatic eco-zones is challenging due to the complex ecological dynamics of seasonal and annual fluctuations in freshwater supply and variable salinity gradients in aquatic environments, which is especially relevant for a country like Bangladesh. Another difficulty is the accurate assessment of fish consumption, and how this relates to individual health outcomes, as this relationship can be confounded by many factors, including the health impacts of poor living conditions, the high prevalence of infectious diseases, and more generally, the poor nutritional quality of diets. Here we demonstrate a novel application of the use of a new metric and how this could be applied in different agroecological settings. The paper also highlights the advantage of mixed methods and using qualitative methodology to inform the design process when trying to distil often complex concepts. Such work provides guidance to further the development and incorporation of other, broader agricultural concepts into nutritional security and a healthy life.

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SESSION 3: PROGRAMME EVALUATIONS AND OPERATIONAL RESEARCH

Session Chair:

Integrated Nutrition-Specific and Nutrition-Sensitive Maternal and Child Health Program Design in Asia and Africa: Experience from a Multi-Country Baseline Study

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Introduction

Malnutrition continues to be a major public health problem, particularly in South Asia and sub-Saharan Africa. The most recent Joint Child Malnutrition Estimates indicated insufficient progress in achieving Global Nutrition Targets 2025 and Sustainable Development Goals 2030. To accelerate the progress, integrated nutrition-specific and nutrition-sensitive interventions at scale are required to address both direct and underlying causes of malnutrition. A baseline assessment of the ENRICH (Enhancing Nutrition Services to Improve Maternal and Child Health in Africa and Asia) project examined direct and underlying causes of malnutrition in four countries that helped modify the nutrition-specific and nutrition-sensitive program design.

Methods

Our analysis is based on data from four large cross-sectional household surveys (HHS) conducted in targeted rural areas of Bangladesh, Pakistan, Kenya, and Tanzania as part of impact evaluation of the ENRICH project being implemented by World Vision Canada. Although a quasi-experimental mixed method design was used for overall impact evaluation, and non-program comparison areas were chosen from comparable communities outside the program areas, this analyses only included data from program areas. The sampling strategy used a proportional stratified three-stage cluster selection approach with villages as the primary sampling unit. The target age groups for HHS are children 0-59.9 months distributed across three age strata: 0-5.9 months, 6-23.9 months, and 24 to 59.9 months, selected randomly from specific clusters. The sample size included in the analyses was 884 in Bangladesh, 936 in Pakistan, 858 in Kenya, and 936 in Tanzania. Mothers were interviewed at their homes using pretested and locally-adapted structured questionnaires consistent across all four countries. Digital data collection through the Open-Data Kit platform using android tablets was done. Data were imported into SAS v9.4 for analysis (SAS Institute Inc., Cary, NC, USA), and PROC SURVEYFREQ with the CLUSTER option used to account for clustering.

Findings and Interpretations

Maternal dietary diversity was lower in Pakistan (14%) and Tanzania (17%) in comparison to Bangladesh (24%) and

Kenya (28%). Reported iron-folic acid consumption during previous pregnancy was very low in Pakistan (1%), Kenya (4%), and Tanzania (11%) relative to Bangladesh (34%). Exclusive breastfeeding rates were 71, 63, 43, and 73 percent in Bangladesh, Pakistan, Kenya, and Tanzania, respectively. Minimum dietary diversity among children 6-23.9 months was lowest in Pakistan (19%) and highest in Bangladesh (39%). Consumption of micronutrient powder or biofortified crops among children 6-23.9 months were almost non-existent.

Severe household food insecurity was more prevalent in Tanzania (32%) and Kenya (23%) in comparison to Bangladesh (11%) and Pakistan (16%). Improved toilet facilities were very low in Tanzania (16.4%) and Kenya (12%) relative to Bangladesh (37%) and Pakistan (47%). Access to better handwashing practices was less than 50 percent in all four countries. Mothers' knowledge of child feeding, care, and nutrition during pregnancy was inadequate in all countries. Household heads were mostly male (ranged from 85-95%); economic empowerment of mothers was very low in Bangladesh (8%) in comparison to Pakistan (25%), Tanzania (34%), and Kenya (51%); these reflect male dominance and gender inequality in household decision making and purchasing power.

Conclusions

Both direct and underlying factors are prevalent in four ENRICH countries, likely contributing to the poor nutritional status. Interventions only addressing direct causes (nutrition-specific interventions) are not sufficient to tackle malnutrition; projects should also focus on nutrition-sensitive interventions to address underlying causes through a multi-sectoral approach.

In addition to nutrition-specific interventions such as promotion of breastfeeding and complementary feeding, dietary diversity among women and children, community-based growth monitoring and promotion to ensure timely identification and treatment of nutritional deficiencies, the ENRICH project is also designed to deliver nutrition-sensitive interventions using the delivery platform of HarvestPlus in production of agroecologically appropriate nutrient-dense local vegetables and fruits, and promotion of biofortified

crops, and small animals. Partnership with Nutrition International is supporting distribution of micronutrient powder among children 6-23 months. The project considered capacity investments in health system strengthening to improve access to, and utilization of, quality health and nutrition information and services. In Tanzania, health services planning and budgeting needs and challenges of the Regional and District Health Management Teams are being addressed in partnership with the Canadian Society for International Health. Local-level advocacy through Citizen Voice and Action is also included in program design to enhance social protection and accountability.

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Lessons from the Implementation of Shamba Maisha: A Multisectoral Agricultural and Finance Intervention Randomized Trial to Improve Food Security, Nutrition, HIV, and Child Health in Western Kenya

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Introduction

Multisectoral health interventions have significant challenges with implementation and scale-up due to several factors. Each sector has unique interests, incentives, and regulations, which may obstruct collaboration and governance of a project. We conducted an informal evaluation among the partners conducting a multisectoral agricultural intervention trial to better understand challenges, and to propose solutions to improve the conduct of future research at the intersection of agriculture, nutrition, and health.

Methods

Shamba Maisha (NCT03170986 & NCT02815579), a cluster-randomized controlled trial (RCT), uses a multisectoral agricultural and microfinance intervention to improve food security, household wealth, empowerment, HIV clinical outcomes, and childhood growth and development among HIV-infected farmers and their children. The trial is designed to test the hypothesis that the intervention leads to improved HIV and childhood health outcomes through addressing the dual epidemics of food insecurity and poverty. The transdisciplinary research team includes the following disciplines: HIV medicine, pediatrics, epidemiology, nutrition, statistics, social science, agriculture, economics, health economics, banking and finance, and nonprofit social enterprise development. The RCT is underway at 16 health facilities randomized 1:1 to intervention and control groups in western Kenya. HIV-infected patients older than 18 years, on antiretroviral therapy, with moderate/severe food insecurity and/or body mass index less than 18.5, and access to land and surface water are eligible for enrollment. The intervention includes: 1) a farming commodity loan (~\$175) including a micro-irrigation pump, seeds, and fertilizer; and 2) structured training in sustainable agricultural practices and financial literacy. We have conducted continuous internal consultation, team reflection, and dialogue during the design and implementation phases of Shamba Maisha.

Findings and Interpretations

1. Transdisciplinary agriculture, nutrition, and health (ANH) research requires a collective-impact framework that specifies common goals, shared measurements, and clear roles and responsibilities for all partners. Frequent communication, coherent implementation of memoranda of understanding, and establishment of a joint-intervention implementation team has improved overall uptake and performance of the intervention.

2. Implementation of a finance intervention requires a nuanced understanding of credit, financial practices, and laws in the local context, with full participation of a lending institution open to implementing innovative practices. Working with the banking partner, we reduced the amount of the down payment, created additional incentives within groups to encourage loan repayment, and coordinated financial literacy training with the agricultural training to help farmers improve production and income generation.

3. Multisectoral ANH research requires thinking and acting outside the normal global-health research paradigm with frequent innovation and problem solving throughout study implementation. To keep on track with the training targets and overall study timelines, we shifted management and supervision of the agricultural trainers to the local study manager to improve oversight and coordination of study activities, leading to greater uptake of the intervention.

Conclusions

Cross-sectoral research collaborations require mobilizing partners with differing goals, orientation, strategies, motivations, and definitions of success. Complex social challenges, such as those presented by HIV and food insecurity, require the development of a common agenda, matching set of priorities, shared measurements for success, development of a shared vocabulary, and constant communication in order to achieve the desired results.

A Randomised Controlled Trial to Examine the Effectiveness of Biofortified Wheat as a Strategy to Reduce Zinc Deficiency in Pakistan

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Introduction

Zinc deficiency is a global problem, particularly in low and middle-income countries where access to animal-source foods is limited. In Pakistan, zinc deficiency affects over 40 percent of the adult female population. The consequences of zinc deficiency include stunted growth and development, increased susceptibility to infections, and complications during pregnancy and childbirth. Biofortification of staple crops has potential as a sustainable means of increasing population dietary zinc intake. The aim of this study is to examine the effect of consuming flour made from biofortified wheat on the zinc status of zinc-deficient women living in a rural community in Pakistan.

Methods

We are conducting a double blind, randomised controlled trial with crossover design, in a low resource setting in North West Pakistan. Fifty households were recruited into this study, which runs from October 2017 to February 2018. Each household includes a female aged 16-49 years who is neither pregnant nor breastfeeding, and not currently consuming nutritional supplements. These women are the primary study participants. Households were provided with flour milled from biofortified wheat grain (Zincol-2016/NR-421) or control wheat grain (Galaxy-2013). All households received control flour for an initial two-week baseline period. In the first eight-week intervention period, 25 households received biofortified flour (Group A) and 25 households received control flour (Group B). In the second eight-week intervention period, Group A and B crossed over and received control flour and biofortified flour, respectively. Tissue samples (blood, hair, and nails) are being collected from the women at five points: baseline, mid and end of period 1, mid and end of period 2. This study will compare established biomarkers of zinc status (plasma zinc concentration) with novel indicators, including markers of DNA damage and a new laser technique for measuring nail and hair zinc concentration. The trial protocol was prospectively registered: ISRCTN83678069.

Findings and Interpretations

The study findings will show whether or not consuming flour made from biofortified wheat has a beneficial effect on the zinc status of zinc-deficient women living in a rural community in North West Pakistan. With four weeks

remaining to the end of the trial, the retention rate is 90 percent (45/50 households).

The biofortified wheat was developed by HarvestPlus using conventional plant breeding techniques. Its zinc concentration for this study was further increased using agronomic techniques – the application of zinc enriched fertilisers. The zinc concentration of the grain was 62 mg/kg, compared to 23 mg/kg on average in traditional varieties of wheat.

The main outcome measures will be:

1. Plasma zinc concentration, measured by inductively coupled plasma mass spectrometry,
2. DNA fragmentation, measured using the comet assay, and
3. Hair and nail zinc concentration, measured by laser induced breakdown spectroscopy.

One of the key challenges in measuring zinc status is the lack of a sensitive biomarker that is suitable for use in remote settings. Therefore, this study is innovative in the field of zinc biology as well as its implications for agriculture, nutrition, and health.

Conclusions

This study is the first randomised controlled trial to examine the effect of consuming flour made from biofortified wheat (developed using conventional plant breeding coupled with agronomic techniques) on the zinc status of women of child-bearing age. It will offer new insights into the potential for strategies involving the biofortification of staple crops such as wheat to reduce zinc deficiency in Pakistan and other countries. It will also evaluate the use of novel biomarkers of zinc status in low resource settings. Non-invasive measures of hair and nail zinc concentration may be particularly useful – if found to be sensitive and reliable biomarkers – for researchers operating in similar settings where cultural sensitivity is paramount. Therefore, the findings of this study will be of interest to nutritionists, public health specialists, plant and soil scientists, and policymakers.

Funding was awarded by the Biotechnology and Biological Sciences Research Council (BBSRC) Global Challenges Research Fund.

Effect of Nutrition Education and Milk Processing on Milk Consumption and Nutritional Status of Under-Five Children Among Dairy Farming Households in Dedza District of Malawi

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Introduction

Despite the role dairy production can play in mitigating impacts of under nutrition, milk consumption among dairy farming households in Malawi is poor and so is stunting status of under-five children. A study was therefore conducted to explore the effect of incorporating nutrition education and milk processing pathways within dairy production intervention and assess their effect on household milk products processing and milk and milk product consumption by under-five children and their nutritional status.

Methods

A quasi-experimental study involving 61 dairy farming households and 79 children aged 6 to 52 months was conducted in two milk bulking groups (intervention and control) in Dedza district, from April to December 2016. Nutrition education and milk products processing training were provided concurrently, four times for three days at two months intervals. Chi square tests were done for proportions and t-test for means in SPSS. Standardized nutrition messages adapted from the Scaling Up Nutrition (SUN) 1000 days key messages for Malawi were given to child caregivers in both milk bulking groups. P-value < 0.05 was considered significant.

Findings and Interpretations

Consumption of milk (≥ 250 ml) per day by under-five children increased from 3.3 percent to 48.3 percent at the

intervention and reduced from 6.7 percent to 3.4 percent at the control group. Household milk products processing increased by 93.5 percent resulting in a subsequent increase (86.2%) in consumption of homemade dairy products by under-five children at the intervention group. Differences in household milk product processing and consumption by under-five children were statistically significant between intervention and control. Stunting dropped from 34.2 percent to 20.5 percent and increased from 31.6 percent to 35.1 percent at end-line for intervention and control respectively but not significant. Mean height difference increased from 0.6 to 1.5 cm in favor of intervention group. Proportion of children from both milk bulking groups combined that met the minimum dietary diversity increased by 10.6 percent at end-line from 80 percent at baseline.

Conclusions

Study findings reveal that nutrition education and milk product processing training has positive effects on daily milk quantity consumption, household milk product processing, and consequently, consumption by under-five children, hence improved nutrition status. Similarly, nutrition education on age-appropriate complementary feeding is vital in improving dietary intake for under-five children. Therefore, dairy production nutrition interventions should incorporate nutrition education and milk products processing to effectively contribute to improved nutritional status of under-five children.

Some Good Food Today or Some Advice on Better Food Choices for Tomorrow?

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Introduction

There is evidence suggesting that cash, voucher, and food transfers increase food consumption, improving the quantity and quality of food consumed by poor households. However, differences emerge in the types of food consumed, with food transfers leading to larger caloric intake and vouchers to greater dietary diversity. There is also evidence of “production to consumption” impact pathways for nutritious foods in ag-nutrition interventions, with positive associations between production diversity, dietary diversity, and essential micro-nutrient intake. However, nutrition education often fails to improve micronutrient intake above recommended levels. We assess and compare a social transfer to an ag-nutrition intervention in Malawi.

Methods

This study is based on three rounds of surveys from the Nutrition Embedded Evaluation Program Impact Evaluation (NEEPIE) study. NEEPIE is a cluster-randomized controlled trial (cRCT) of a communication-based behavioral change nutrition and agriculture intervention targeting preschool children aged 3-6 years. Data was collected at baseline in September 2015 (postharvest season), at midline in February 2016 (peak of the lean season), and at endline in September 2016 (12 months after baseline). Sixty food-insecure communities and 1,200 households were randomly selected in two stages of sampling within the Zomba district in southern Malawi. Households were assigned to one of two treatment arms. During the same period, following extreme flooding in the 2015 production season, the government of Malawi and development partners scaled up food transfers to affected communities. Fifteen percent of households sampled (175 households) in NEEPIE had received lean season food transfers. We employ quasi-experimental and experimental methods to compare short (6 month) and medium (12 month) term effects of lean season food transfers and a behavioral change intervention on food security outcomes. We evaluate food transfers by combining propensity-score-matching difference-in-difference (DID) and multilevel (mixed-effects) DID regression to estimate cRCT treatment effects.

Findings and Interpretations

We detect a positive NEEPIE impact at the household level on the consumption of various food groups (legumes, nuts, and seeds; meats; eggs; oils and fats; sweets) driving up household dietary diversity score (HDDS) at 12 months, but not at 6 months. More crops and food groups were produced at 6 and 12 months (cereals, roots and tubers, legumes, vegetables) and poverty, measured as \$1.25 PPP pc/day, was eight percent lower among treated. At the child level, we observe lower rates of stunting (17%), higher HAZ scores (0.49), and greater food variety and dietary diversity scores (roots and tubers, vegetables, fruits, fish, milk).

Lean season food transfers have a strong impact at 6 months, but no impact at 12 months. Impact is detected at the household level on: food expenditure (20% higher), lower poverty (12%), more crops and food groups being planted (cereals), and greater HDDS. At the child level we detect lower rates of wasting (8%) for children aged 6-24 months at baseline, and greater food variety and diversity scores (fish, milk, oils, sweets). We do not find compelling evidence suggesting that impact is concentrated in the poorest quintile of households. However, we find that targeting of transfers can be improved.

Conclusions

During the lean season, significant declines in food security, diet quality, and nutrition status were present. We find the communication-based behavioral change nutrition and agriculture intervention targeting preschool children aged 3-6 years had protective effects during a period of high food insecurity (2016 lean season). This suggests a potential role for similar interventions within social protection portfolios. Community-owned preschools can provide effective platforms to scale up nutrition interventions and change household behaviors related to food production and consumption. The positive impact is detected both in the short (6 month) and medium-term (12 month) for most outcomes, but impact magnitude (DID) tends to be stronger at 12 months.

The analysis undertaken on social transfers suggests that lean season food distribution had important short-term benefits (protective effects on food security), but failed to improve dietary and nutritional outcomes in the medium-term once distribution of social transfers ceased. However, there is strong evidence that these transfers can improve both the quantity and quality of food consumed when distributed. Targeting of transfers can be largely improved as 20 percent of households in the richest quintile received transfers.

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On the Radio: Using Serial Mini-Dramas to Promote Orange Sweet Potato in Uganda

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Introduction

Since 2012, HarvestPlus and its partners have been disseminating biofortified vitamin A-rich orange sweet potato (OSP) in Uganda. As part of its scaling strategy, HarvestPlus worked closely with Farm Radio International (FRI) to raise awareness about OSP. "My Children", an interactive radio mini-drama, was aired for two seasons, and included all the elements of a drama (love, domestic strife, family, money, and power) as well as information about the nutritional benefits of and best agronomic practices for the crop.

Methods

The purpose of this paper is to present key findings from a study that assessed the effectiveness of "My Children" in promoting OSP nutritional knowledge and influencing the production and consumption of OSP among program listeners. Cross-sectional survey data were collected in five districts in Uganda. The survey was implemented in two distinct communities in each district, one in which HarvestPlus was directly implementing the intervention and the FRI-sponsored radio program was broadcast (410 households, called H+ villages), and a second which was outside the reach of HarvestPlus' direct intervention, but where the FRI-sponsored radio program was broadcast (367 households, called non-H+ villages).

The relevance of using interactive radio drama as an integral component of a scaling strategy of vitamin A biofortified Orange Sweet Potato (OSP) was assessed, by applying Propensity Score Matching to see the impact on knowledge, planting and consumption of OSP, and Dose-Response Function to demonstrate the range of episodes that contributed to OSP knowledge gain."

Findings and Interpretations

"The radio drama had a significant positive impact on the knowledge of the overall sample. Listening to MC increased the OSP knowledge of the overall households by 7 percent. Looking at the village types separately, the OSP knowledge of the non-H+ villages was improved by 8 more percentage points than the H+ villages just because of MC, because, HarvestPlus has been already promoting OSP through its program, making the impact of the radio drama in the H+ villages less than those of the non-H+ villages.

The impact of MC on practices, namely growing and consuming OSP, is positive. Looking at the impacts disaggregated by the types of villages, the impacts on consumption are only significant for the H+ villages, because, consumption is something that requires prior familiarity and abundant availability of OSP. In the case of planting OSP, we see that MC has a positive impact on both types of villages.

In terms of the effect of the length of the radio program, it was good it was a series with more than 40 episodes. However, the results show the maximum number of episodes that would bring the desired change on knowledge was 44.

Conclusions

The results indicate that the radio drama "My Children" was effective at achieving the intended study objectives. It improved the overall knowledge of OSP, as well as the intention to grow and consume OSP, in rural households. Additionally, the program bridged gaps by creating awareness of and knowledge about OSP to areas where HarvestPlus had not been operating in until the time of broadcast. This indicates that the radio show complemented the efforts to spread OSP awareness and knowledge across the country. However, in areas where HarvestPlus was not operating, the radio drama had a weaker effect on the intention to grow and consume OSP. This might be because planting materials were unavailable in those communities, or because the radio program was not as intensive and visual as face-to-face demonstrations in H+ communities. Overall, it can be concluded that the radio program was effective and useful in complementing the efforts of delivery of biofortified crops as radio is one of the most widely used media. It helps to reach more people that would have not been reached otherwise

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Is Anything Still Growing? Sustainability of an Urban Nutrition-Sensitive Agriculture Project

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Introduction

Despite considerable interest in nutrition-sensitive agriculture (NSA) as well as genuine recognition of the need for development projects to aim for sustainability, little is known about the sustainability of nutrition-sensitive agriculture approaches. Indeed, sustainability was identified as a key gap in a recent review. Similarly, despite major urban growth and high burdens of malnutrition among urban populations in developing countries, there is scant information about NSA programs that can reach urban consumers. This study helps to fill these gaps by assessing sustainability of an NSA program implemented in urban Senegal (2013-2016) and the factors facilitating sustainability.

Methods

The intervention consisted of support for horticulture and poultry production using compact 'micro-gardens' and henhouses as well as social behavior change communication on nutrition and hygiene topics and women's empowerment activities. Impacts were expected to be achieved primarily through own consumption of home production, given the small scale. We define our main metric of sustainability as continued production of vegetables or chickens/eggs using the project-provided tables and henhouses, applying the project-promoted practices, and consumption of the associated produce. Secondarily, we consider nutrition/hygiene knowledge levels and practices compared to during the project.

Data come from a cross-sectional survey of a random sample of 262 former project participants (20 percent of the total) 18 months after the project's end. To minimize acceptability bias (i.e., falsely reporting continued use of project-provided items to curry favor in the eyes of the implementers), the survey included observations at each household to assess the current existence and functionality of the microgardens and henhouses, verified by photographs. Quantitative data analysis was performed using STATA SE15. The survey results were used to inform questions and identify respondents for 20 semi-structured interviews with women who were particularly successful at continuing activities. The resulting transcripts were analyzed using nVivo.

Findings and Interpretations

Results show widely different levels of sustainability for the two project components. The vast majority of former participants (80 percent) no longer grew vegetables, and 72 percent had not even retained the microgardens provided by the project. There were low levels of production even among those producing, and almost none had expanded production or delved into marketing: production was used for home

consumption, making modest but regular contributions, and for social functions, such as gifting.

In contrast, 75 percent of former project participants continued to raise chickens. Moreover, 20 percent had expanded production, with 29 percent using poultry rearing as a source of income—in some cases considerable amounts of income. Among those actively raising chickens, some had diversified into other breeds or types of birds: whereas the project provided laying hens, the majority (69 percent) of the active chicken-raisers were raising broilers, for meat production. Qualitative data suggested that gardening was seen as a 'passion project', whereas poultry could be a true livelihood—thus motivating greater continuation. Both gardening and chicken-rearing were used to improve household diets, but the more significant contribution came from poultry-rearing, given the larger scale and higher associated income. Most nutrition knowledge and practices remained at or near levels seen during the project.

Conclusions

The project was successful at increasing poultry rearing in a sustainable manner, whereas the urban approach to vegetable gardening proved unsustainable. Earning income through small-scale commercial chicken-rearing increased sharply after the end of the project and proved to be empowering to the women taking part, in addition to adding to household incomes. Some nutrition impacts, though slight, appear to have been sustained both through own consumption of poultry (and to a lesser extent, garden) products and increased income from chicken sales. However, the widespread shift in chicken breeds to broilers was associated with a decrease in egg production—and hence in egg consumption among young children, a key goal of the project. Moreover, the results show clearly how urban residents are embedded in a different food system context than rural residents, suffering from increased pressure on production space but benefiting from an easy outlet for food sale (and purchase) nearby. Over time, this market context shaped their choices related to agricultural production and sale. Given easy access to markets, the main long-term operational 'pathway' to improved nutrition in this population thus appeared to be increased income. Future urban NSA projects might consider heavier reliance on this pathway in project design.

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Community-Based Early Childhood Development Center Platform Promoting Diversified Diets and Food Production Improves the Adequacy of Nutrient Intake of Pre-school Children in Malawi: A Cluster Randomized Trial

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Introduction

Young children in Malawi face widespread problems of low-quality diets and chronic malnutrition. This study aimed to evaluate the impact of providing a nutrition behavior change communication (BCC) intervention through community-based pre-schools on the nutrient adequacy of diets of young children in Malawi.

Methods

A longitudinal cluster-randomized design was implemented in 60 community-based childcare centers, including 1,248 children aged 3 to 6 years. Nutrient intakes were estimated using an interactive 24-hour recall. Impacts were assessed by difference-in-difference (DID) estimates, adjusted for geographic clustering, child age and gender.

Findings and Interpretations

Intervention groups were similar for most baseline characteristics. The attrition rate was low (7 percent over the 12-month period). Participation in the intervention was high

(>90 percent enrolment and ~80 percent attendance rate during the five days prior to the survey). Improvements were significantly greater in the intervention group, compared to control group, for consumption of different food groups (cereals, vegetables, fruits, fish and sea foods, and sweets) and dietary diversity (DID: 0.36 percentage points [pp]). Significant impacts were observed for the probability of adequacy of several individual micronutrient intakes: vitamin A (DID: 10pp), vitamin C (16pp), riboflavin (10 pp), zinc (9pp), vitamin B12 (5pp), and for the mean probability of adequacy for the 11 nutrients considered (5pp). These impacts were mostly driven by effects on younger children (aged 3 to 4 years) and children living in poor households.

Conclusions

Using a pre-school platform to roll-out nutrition BCC is an effective strategy to improve the adequacy of micronutrient intake of pre-school children in rural, food-insecure settings.

SESSION 4: TOOLS, METHODS, AND METRICS: INNOVATION AND VALIDATION

Session Chair:

Development and Validation of a Health and Nutrition Empowerment Module for the Women's Empowerment in Agriculture Index

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Introduction

The Women's Empowerment in Agriculture Index (WEAI) (Alkire et al, 2013) is widely used to measure women's empowerment in the agricultural sector. The current phase in advancing the WEAI includes adapting it to measure impacts at the project level (pro-WEAI) and developing a module to measure aspects of women's empowerment related to health and nutrition outcomes. Herein we draw on baseline data from the Gender Assets and Agriculture Project, Phase 2 (GAAP2), a portfolio of agricultural development projects, to validate the pro-WEAI health and nutrition module and develop indicators of women's empowerment in making decisions related to health and nutrition.

Methods

Baseline surveys from the impact evaluations of five GAAP2 projects (2016-2017) administered the pro-WEAI health and nutrition module to women: TRAIN (n=5,040) and FAARM (n=287) in Bangladesh, SE LEVER (n=1,777) and Grameen Foundation (n=380) in Burkina Faso, and World Vegetable Center (n=713) in Mali. Respondents were asked about decision-making on key topics related to their general health and nutrition (six items) (e.g. consulting a doctor when ill), their health and nutrition while pregnant and/or breastfeeding (11 items) (e.g. eating specific foods when pregnant/breastfeeding), and their child's health and nutrition (13 items) (e.g. feeding a sick child). For each topic, the woman was first asked which household members generally make the decision, and if jointly, the extent to which she participates in the decision (none, small, medium, or high). Additionally, respondents were asked about the purchasing and ease of acquisition of 12 health and nutrition related products (e.g., specific foods, medications/vitamins/supplements).

We conducted exploratory factor analysis (EFA) for a randomly selected half sample from the two largest samples, one from each region (TRAIN and SE LEVER). Based on the proposed factor structure, we will conduct confirmatory factor analysis (CFA) for the remaining sample and the projects with smaller sample sizes.

Findings and Interpretations

Initial descriptive analyses revealed that nearly all respondents reported participating in these decisions and that doing so to a medium or high extent was correlated with characteristics normally correlated with empowerment (e.g.

age). Based on this, we classified a woman as having adequate input into a decision if she was the sole decision maker or reported participating to at least a medium extent in joint decisions. Binary variables, indicating adequate input, were constructed for each decision and used for EFA and CFA.

Preliminary results from the EFA using data from TRAIN Bangladesh suggest a four-factor structure for the health and nutrition module with the following domains: purchasing decisions, product acquisition, general health and nutrition decisions, and feeding children animal-sourced foods. Continued analysis will proceed by 1) further exploring the factor structure in the TRAIN data, 2) using EFA to explore the factor structure of the module in SE LEVER (Burkina Faso) data, and 3) using CFA to confirm the proposed factor structure using the other randomly selected half samples from the TRAIN and SE LEVER baseline survey and data from the other GAAP2 projects (FAARM, Grameen Foundation, and World Vegetable Center).

Conclusions

Many agricultural development projects aim to both empower women and improve nutrition and health outcomes. Yet currently, there are no standardized metrics to measure women's empowerment in nutrition and health domains. Development of the WEAI, until now, has not adequately considered the barriers faced by women in making strategic decisions in the areas of health and nutrition (Alkire et al. 2013). Limitations faced by women in these domains are distinct from those experienced in the productive sphere. Increased income and/or production of nutrient-rich foods may not necessarily translate into consumption of these foods by women and children within the household unless women are also empowered to make health- and nutrition-related decisions. The pro-WEAI health and nutrition module has the potential to improve how we measure the full scope of impacts of nutrition-sensitive agricultural development projects and to explain how such programs might lead to improved health and nutrition outcomes.

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Seasonal Patterns of Energy Expenditure, Time-Use, and Food Intake: An Intra-Household Perspective from Rural Ghana

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Introduction

The adverse effects of seasonal hunger on rural livelihoods in low and middle-income countries (LMICs) are widely recognised. Yet, seasonal pressures on labour availability and time use within the household are neglected dimensions in the analysis of food security, nutrition, and health. We fill this gap investigating seasonal intra-household variations of energy expenditure data using accelerometry devices together with individual data on time-use and food intakes.

Methods

Accelerometry devices are widely used in the context of High-Income Countries to examine pathways between non-communicable diseases (NCDs) and physical activity. This paper describes a novel methodology - developed in an IMMANA funded project - that adapts such technologies to improve the empirical measurement of energy expenditure associated with agricultural activities in low income countries contexts.

The study explores the use of accelerometer devices in rural Northern Ghana, across two agricultural systems (irrigated and rain-fed) to account for the role of technology in agricultural production. Data from accelerometry devices, worn for four non-consecutive weeks by two members of 20 households across a full agricultural cycle, are complemented with information on dietary intake and time-use.

Findings and Interpretations

The methodology developed can provide a robust and comprehensive delineation of gender-differentiated energy expenditure across agricultural seasons and production systems. 26,880 hours of detailed data suggest that rural population in Northern Ghana face challenges in terms variations of energy balance ('energy in - energy out') over agricultural seasons, across agricultural systems, age groups, and gender. These preliminary results provide relevant evidence for policies addressing food security, nutrition and health status in rural settings of LMICs.

Conclusions

There is growing recognition of a need to incorporate the human energy expenditure dimension and intra-household

labour allocation in evaluating policies addressing malnutrition in rural areas in LMICs, where seasonality plays a key role. The proposed methodological approach can provide an improved and comprehensive picture of all facets of rural household activities, intra-household labour allocation, energy expenditure, and their variations across seasons. Accelerometer devices have been successful in monitoring and understanding of physical activity in relation to 'lifestyle diseases' and this study demonstrates that the adapted approach can prove useful to gain an improved picture of the pressures of seasonality on undernutrition in rural areas.

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Country Prioritization for Biofortified Crop Interventions across Africa, Asia, and Latin America

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Introduction

Globally, two billion people suffer from micronutrient malnutrition. Micronutrient malnutrition impedes proper health and development, also leading to a lifetime of income losses (Alderman et al., 2006). Biofortification, the process of breeding staple food crops to have higher micronutrient content, has proven to be efficacious and cost-effective in addressing micronutrient malnutrition (Bouis and Saltzman, 2017). To determine where and in which crop-micronutrient combinations to invest, this research develops an improved Biofortification Prioritization Index (BPI). This paper improves upon the original methodology, includes an additional eleven crop-micronutrient combinations, and utilizes updated data for 128 countries in Africa, Asia, and Latin America.

Methods

The BPI is a composite, crop-specific index which accounts for the intensity and level of supply and demand of a specific crop, in a country, and the micronutrient deficiency rates for the micronutrient(s) that can be bred into the specific crop(s) (Asare-Marfo et al, 2013). Three necessary conditions must be met for a country to be considered for a biofortified crop intervention: (1) the country must be a producer of the crop, (2) the country's population must consume a large portion of the crop, and (3) the country's population suffers from micronutrient deficiencies. The production sub-index is comprised of three variables while the consumption sub-index is comprised of two, with both indices utilizing three year-averaged data to smooth seasonality or shocks. Each of the micronutrient deficiency sub-indices (vitamin A, iron, and zinc) are comprised of two variables. A geometric mean is used for the BPI analysis so that the sub-indices complement one another. A country's BPI is calculated by using secondary, country-level data primarily compiled from the Food and Agriculture Organization, the World Health Organization, UNICEF, the World Bank, and Wessels et al. (2012). Where needed, data imputations were calculated based on available data to address data constraints.

Findings and Interpretations

The country-crop-micronutrient specific BPIs rank countries both globally and within regions (Africa, Asia, and Latin America) according to their suitability for biofortification intervention investments. Preliminary results show that Africa is the priority region for the introduction of vitamin A enriched crops, with first country crop rankings as follows: vitamin A maize (Malawi), vitamin A cassava (Angola), vitamin A sweet potato (Equatorial Guinea), vitamin A banana (Burundi), and vitamin A plantain (Gabon). An African country ranks number one in five of the six iron-crop combinations: iron bean (Burundi), iron pearl millet (Niger), iron cowpeas (Niger), iron sorghum (Burkina Faso), and iron potatoes (Malawi). While Africa is not the priority region for the introduction of zinc biofortified crops, two African countries

rank number one for the introduction of zinc sorghum and zinc potatoes; Burkina Faso and Malawi, respectively.

Further analysis will calculate area-weighted and population-weighted BPIs for each crop-micronutrient combination which decision-makers may prioritize given their agenda. As is evidenced, Africa remains the prioritized region of the world which can most readily benefit from the introduction of biofortified staple food crop interventions. While BPI results can be used to inform biofortification investment decision-making, they should not be used as the sole tool.

Conclusions

As biofortification continues to prove its efficacy and effectiveness in alleviating micronutrient malnutrition, analyses are needed to help identify the most fruitful areas of investment and implementation. This research develops an improved Biofortification Prioritization Index (BPI) which ranks sixteen country-crop-micronutrient combinations for their biofortification potential across 128 countries in Africa, Asia, and Latin America. Africa ranks as the priority region for the introduction of the five vitamin A biofortified crops and five of the six iron crops. While Asia ranks as the priority region for zinc biofortified crops, two African countries, Burkina Faso and Malawi, are ranked as the priority country for zinc sorghum and zinc potatoes. Due to Africa's great potential benefit from biofortified crops, continued efforts in developing biofortified crop varieties is essential while also conducting nutrition and economics research to maximize impact and build the evidence base.

The BPI can guide biofortification investment decisions but should not be the sole tool used for decision-making. While the level of analysis in this research is at the national level, subnational BPIs are also being developed to identify proper areas for biofortification interventions within heterogeneous countries such as Ethiopia (Funes et al, 2015) and Nigeria (Herrington et al, 2018).

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Investigating Food Environments in Low and Middle-Income Countries Using a Novel Qualitative Geographical Information Systems (Q-GIS) Approach: A Case Study from Telangana, India

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Introduction

Food environments in low and middle-income countries (LMICs) pose significant challenges to existing methods and metrics developed in high income-countries. Qualitative geographical information systems (Q-GIS) may provide new insights into food environments and food acquisition practices by integrating participatory visual methods with in-depth interviews (IDIs). This paper presents a novel methodological approach, featuring geo-tagged mobile phone photography and graphic-elicitation interview techniques. A case study from two urbanising villages in Telangana, India, is presented to illustrate the research design and implementation. Findings address the performance of the mobile technology, participatory photography, graphic-elicitation techniques, and participant's experiences throughout the research process.

Methods

Two rapidly urbanising Indian villages, Patelguda and Thummaloor (from the Andhra Pradesh Children and Parents Study - APCAPS), were purposively selected to provide a sampling frame of participants exposed to a range of built and food environments. Households from the APCAPS Household Survey (2013) were eligible for inclusion if an adult male and female aged 18-65 was living at the residence. Households (n=8) were randomly sampled, and an adult male and female were recruited from each.

Participants (n=16) received a brief training session and were subsequently tasked with photographing their food environment and food acquisition practices over a three-day period using a GPS-enabled Samsung J2 mobile phone.

Participants' photographs were downloaded, mapped in ArcGIS software, and printed onto chart paper. Charts visualising maps and photographs were used in conjunction with graphic-elicitation techniques in follow-up in-depth one-to-one interviews with participants about a) daily food acquisition practices, and; b) experiences with the participatory photography.

Analysis featured triangulation and cross-examination of maps, photographs and interview transcripts. Coding of data sources provided contextualised geo-narratives of food environment interactions, including situated knowledge, understanding and perceptions of food acquisition practices as part of daily life. Thematic analysis was used to identify convergent and/or salient themes.

Findings and Interpretations

Preliminary findings revealed that participants took on average 42 photographs over the three-day data collection period (minimum 7, maximum 86). Participants selected a mean of 15 photographs for inclusion in the follow-up interview. Eighty-seven percent of all photographs were successfully geo-coded with GPS.

Participants successfully photographed their food environment using the mobile phone, reporting no hindrance to their daily activities. Regular support visits during data collection were highly valued by the participants.

Participants photographed a range of food sources, including formal and informal markets, own production, and transfers/gifts. Participants documented their food environment throughout the diurnal cycle, reflecting the intricate spatio-temporal realities of food acquisition. Key food environment dimensions captured in photographs included food availability, vendor and product properties, and marketing.

Follow-up interviews featuring graphic-elicitation techniques probed additional dimensions, revealing knowledge and critical perspectives on prices, accessibility, affordability, convenience and desirability. Transcripts revealed in-depth situated knowledge and understanding about how people interact with their food environment and make food choices as part of their daily lives.

Conclusions

This paper presents a novel qualitative geographical information systems (Q-GIS) approach that may be used to investigate food environments and food acquisition practices in LMICs.

The integration of participatory photography with graphic-elicitation techniques and IDIs provides a unique opportunity to study food environments from the emic perspective, providing insights into the who, what, when, where, why and how of food acquisition and consumption.

This case study reveals how the novel Q-GIS research design presented can elicit the kinds of tacit, situated and embedded knowledge of intra-household gendered food acquisition practices within LMIC settings. Such knowledge is vital in order to inform the design of targeted interventions and policies that are able to facilitate healthier food environments, improve food security and tackle malnutrition in all its forms.

Development and Testing of a Household Water Insecurity Measure that is Equivalent Across Countries

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Introduction

Water insecurity - the inability to access and benefit from affordable, adequate, reliable, and safe water for wellbeing and a healthy life - will worsen with projected climate change, increased water use, and inequalities in distribution, with far-reaching social, political, health, and economic consequences. Global epidemiologic data on the prevalence, severity, and changes in household water insecurity are unavailable, however, because no cross-culturally validated tool exists to measure such phenomena. Therefore, we sought to develop the first scale to assess household-level water insecurity across a variety of ecological and cultural settings.

Methods

We developed, validated, and implemented a 20-item household water insecurity scale in Kenya (clinicaltrials.gov - NCT02979418; Boateng et al, under review; clinicaltrials.gov - NCT02815579). This questionnaire was expanded through literature review, expert consultation, and qualitative work to include 32 items that captured experiences of water scarcity and excess elsewhere e.g. Texas, Bolivia, and Ethiopia.

To refine and test the 32-items, a researchers' network spanning multiple sites in low- and middle-income countries was established: the Household Water InSecurity Experiences (HWISE) Consortium (<http://sites.northwestern.edu/hwise/>). For each site, a questionnaire with water insecurity and other items for validation was translated to local languages. Cognitive interviewing was conducted with the target population. The questionnaire was then revised and administered to approximately 250 households per site.

Resultant data were analyzed using both Classic Test Theory and Item Response Theory. In each site, exploratory factor analysis was used to examine the structure of responses, compare the number of factors with expectations based on content knowledge, and compare the factor structure. Using Rasch modelling, a subset of items that appeared promising for measuring a primary dimension of water insecurity were analyzed by site to examine misfit. Subsequently, scores will be compared for measure and scalar equivalence, and further validated.

Findings and Interpretations

To date, the 32-item questionnaire has been administered in 15 sites: 9 in sub-Saharan Africa, 4 in Latin America, and 2 in Asia. Another 10 sites are expected by the end of the study. A total of 4,651 individuals have been surveyed. Based on cognitive interviewing and field experiences during survey implementation, 10 items were eliminated for being idiosyncratic. In some sites, the data were consistent with a one-dimensional model, whereas in the majority of sites, the data were consistent with two dimensions. Four items commonly associated with a second dimension were set aside, and the remaining 18-items were analyzed for misfit and equivalence. Infit estimates were consistently good in each site. Some of the items showed consistent severity ordering across sites, while others did not. For example, the items "worrying about not having enough water for all household needs", "feeling upset about one's water situation", "water supply from main source being interrupted" and "sleeping thirsty" were ordered consistently across sites, while items such as "not being able to wash hands" were not.

Conclusions

Based on the analyses to date, the likelihood of achieving a scale that is scalar equivalent across sites is high. Analyses to further reduce the number of items to an equivalent subset and to assess validity will be concluded by August 2018. The next step will be to implement the scale in available large-scale surveys in order to assess population prevalence and severity. Cross-culturally appropriate cut-off points will then be determined.

The final scale is expected to illuminate the relationships between food and water insecurity, as well as determine the influence that water insecurity has on economic, nutrition, and physical and psychosocial health outcomes. These data will help to inform policy regarding water insecurity, and to measure the impact of interventions that are designed to improve water security. Ultimately, this scale will allow for a more complete understanding of the causes and consequences of water insecurity across multiple disciplines.

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Designing a Discrete Choice Experiment to Understand Food Choice based on Maize Price Variations in Rural Malawi

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Introduction

Discrete choice experiments (DCEs) are attribute-driven experimental techniques used to elicit consumers' preferences, with potential to identify underlying preferences more clearly than survey data. DCEs describe behaviours, e.g. food choices, using particular characteristics or 'attributes', and must critically be informed by the particular study context. Greater rigour has been called for in implementing and reporting the process of designing DCEs, including attributes and attribute levels (i.a. Coast, 2007). This paper describes the process of and key issues encountered with developing a DCE for investigating food choice responses to a change in price of a staple (maize) in rural Malawi.

Methods

To design the DCE, attributes and attribute-levels were derived from household and market surveys conducted in May 2017 in Phalombe and Lilongwe Districts of Malawi. The household survey asked respondents to list foods, and their respective quantities, purchased from local markets by households in the previous seven-day period. Food quantities were elicited using standardised measures such as kilograms, or where non-standardised measures were used (e.g. a 'bucket' of maize), the study used two standardised cups. The 'large cup' held one litre of water; the 'small cup' 500 millilitres of water. A market survey collected market price data of the food products and quantities identified previously. The study estimated that on average, a household consumed food products valued at MK1000.00 (US\$1.40) each two to three days. Based on this, a DCE was designed consisting of ten scenarios. Each scenario contained three baskets. Each basket contained maize (the staple), and a maximum of rice (maize substitute), cabbage (rare vegetable), dried fish (a healthy protein food), and the soda 'Frozy' (similar to Fanta; an unhealthy product), and costing between MK900 and MK1100. The DCE was piloted three times, with data collectors, in a rural area near Zomba city, and in a poorer region of Zomba.

Findings and Interpretations

Using a modified Federov algorithm in NGENE software, a d-error-minimising efficient design generated two sets of five DCE scenarios each (10 scenarios in total). One set of five scenarios had maize at a high price (MK400/kg); the other had maize at a low price (MK150)/kg). The scenarios were presented to 200 respondents in each district; and in different orders to avoid ordering bias. We will conduct analysis in STATA15 software, using multinomial, mixed and

latent class logit models (analysis of pilot data already complete).

Four broad issues were faced: establishing an appropriate model of food choice when it was possible to have only five goods as attributes; constructing baskets that provided sufficient attribute variability; constructing a viable instrument, with appropriate, easily interpreted photographs; and establishing a choice scenario around prices and basket values was clear to respondents. Our piloting exercises provided an opportunity to understand the importance of assumption setting and implementation context.

We identified important issues regarding attribute inclusion and context setting that may be of interest to others seeking to use a DCE approach for understanding food choice. Our results show that the DCE approach can be a useful addition to the tools used by researchers.

Conclusions

Based on information derived from a household and a market survey in two districts of rural Malawi, the research team has designed a DCE to be used in assessing the impact of maize price changes on food choice and dietary diversity. The overall study will make some key contributions to the literature on food choice. First, we found that using a cup to standardise food quantities improved the internal validity of the study findings. Secondly, this is among a small number of studies to have used a DCE approach to study food choices, and the only study of which we are aware to have done this in a low- or middle-income country setting, and to document the process and issues faced with the DCE development. Data for the experiment were collected in January and February 2018, and we are currently analysing the study results. To date, very few studies have used DCE study approaches to elicit food choice preferences, and the growing number of studies expected in this area would likely benefit from awareness of the process, issues, and novel solutions that we have encountered and developed.

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NUTRI-P-LOSS: A Methodology to Estimate Nutritional Postharvest Losses

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Introduction

A third of food produced is lost between harvest and the consumer. This is a particular concern in low and middle-income countries (LMICs) where postharvest losses can translate into nutritional deficits for families who already suffer from food security challenges. Global population growth necessitates innovative solutions to limit food waste and loss, which causes nutritional losses that could impact people's nutritional intake. The NUTRI-P-LOSS project is developing a methodology to estimate nutritional postharvest losses (NPHLs) in the food system, from harvest to market.

Methods

NUTRI-P-LOSS uses a three-fold approach that comprises a 1) literature review, 2) laboratory trials to measure nutritional loss (under controlled conditions) and 3) field experiments to validate a predictive model of NPHLs. We focus on three crops: maize (including biofortified orange maize), sweet potato (including biofortified orange fleshed sweet potato) and cowpea, in Uganda and Zimbabwe, and on key-nutrient loss: macronutrients (protein, lipid, carbohydrate) and micronutrients considered the most important in terms of deficiencies (vitamin A, zinc, and iron). The NUTRI-P-LOSS tool will enable prediction of NPHLs related to: (1) physical weight losses; (2) other changes not associated with weight loss. Initially we undertook an online survey to consult experts and stakeholders working in nutrition, agriculture and the food security sectors about the usefulness of the NPHL estimate. The survey sought to understand the needs of the potential users of the platform with regards to NPHL estimate. Laboratory and field trials compared nutritional changes in stored commodities with and without insect infestations. Our final outcome is an estimation model to predict NPHLs. The model will be developed as a Nutri-P-LOSS algorithm that will be freely accessible through the African Postharvest Losses Information System (APHLIS) online platform.

Findings and Interpretations

The expert consultation indicated the key-nutrients selected by the NUTRI-P-LOSS project were the most important and relevant for the application. In addition, experts had an interest in antinutrients (e.g. cyanogens, phytates).

Laboratory trials showed that insect infestation significantly increases humidity (water activity) in the commodity, which will impact quality. Storage time significantly influenced on some nutrients in dried orange-fleshed sweet potato: carotenoids followed a rapid loss (90% loss in trans-B-

carotene after 16 weeks) and glucose, fructose, sucrose increased with time (around 20% after 16 weeks). With maize and cowpea, the relationship between percentage damage and percentage weight loss and nutritional change could be visualised and demonstrated that insect infestation has more complex impacts than simple physical loss.

Household surveys with 600 farmers across two countries (Zimbabwe and Uganda) provided insights into storage techniques and attitudes which can be used to inform improvements.

The model must include factors associated with fractional loss (through insect damage) as well as weight changes through shelf life (with and without insect damage.) This is most critical for maize as insect-mediated fractional loss of germ may selectively impact lipid content and stability of provitamin A carotenoids in grain through enhancement of lipid oxidation.

Conclusions

A combination of literature review, laboratory simulation, and field work helps build a robust estimate of nutritional losses throughout the value chain. Challenges, however, are to reconcile those different approaches to develop a coherent and realistic model for estimating nutritional losses. The NUTRI-P-LOSS system presents opportunities to predict impacts of different storage scenarios in order to aid farmers, extension specialists and other actors in making informed decisions about when to keep or consume a stored commodity.

The survey's results confirmed the need for a nutritional postharvest loss estimate in the agriculture and nutrition community and suggested that there will be scope for the NUTRI-P-LOSS's concept and methodology to be applied to other nutrients and crops. Based on case studies use of the NUTRI-P-LOSS tool, policy recommendations can be generated regarding nutritional implications of nutritional loss at different steps of the food system.

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SESSION 5: FOOD POLICY FOR NUTRITION AND HEALTH

Session Chair:

Food Safety and Nutrition for the Urban Poor - Exploring the Social Justice Policy Dilemma of Consumption

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Introduction

This paper addresses the challenge of equitable development in health-inducing food accessing opportunities in urban Asia. It goes in detail on the impact of urban food safety governance, which promotes formalised modern retail outlets over more traditional outlets, on the dietary intake of the urban poor. Based on citizen background inequalities - income and gender - the paper examines the quality and diversity of the diet - in terms of food safety guarantees and nutrition composition - in relation to time-spatial and social-cultural dimensions of accessing food.

Methods

Building on empirical evidence from Hanoi, Vietnam, the study addresses food accessing capabilities by linking (i) food retail infrastructures - discussing the retail typology, assortment on offer, food health and safety claims, and price levels -, with (ii) the food shopping practices and preferences of 400 women of reproductive age. It then proceeds with mapping the actual food practices with (iii) the measured dietary intake of this same group of women.

Data were collected with a retail outlet census and two household questionnaires administered on non-consecutive days to women responsible for household food provision. The first questionnaire was on food safety and shopping practices, followed by a nutrition questionnaire including a quantitative 24hour recall and knowledge and attitudes. A sample of 400 poor women of reproduce age was randomly selected using a pre-defined door-to-door sampling method.

Findings and Interpretations

Our results reveal a minimal level of diet quality is maintained through traditional and importantly informal market channels with 74 percent of daily energy and 80 percent of daily vitamin A, zinc, iron and calcium intakes came from foods purchased from traditional food retail outlets. However, these channels do not provide for formal food

safety guarantees, most commonly found in modern retail channels. Women were shown to be practically de-capacitated of shopping in supermarkets. Further the research uncovered that modern channels offer a higher percentage of ultra-processed foods than traditional channels, and are mainly frequented for purchasing less/unhealthy foods. Although, only 7 percent of the foods consumed came from supermarkets, 60 percent of the ultra-processed foods consumed were purchased from modern retail outlets.

Conclusions

This paper uncovers a conflicting duality in governing food security that requires urgent attention. The struggle with food safety is a well-recognized problem throughout Asia. Across Asia, similar transformations in urban food retailing are observed, that push modernization and ban traditional vending structures as remedy for recurrent food safety incidences. Our research demonstrates how these one-dimensional ideal-type policies risk to jeopardize dietary quality for the urban poor through two pathways: depriving access to nutritious foods and stimulating less healthy diets.

The paper suggests, that the dual public responsibility for ensuring access to nutritious and safe foods requires an inclusive retail diversity approach. In preventing the shaping-up of nutrition desserts for the urban poor, food safety policies should recognize the importance of allowing for a versatile and hybridized food retail environment to evolve.

We argue that, in converging the apparent competing priorities of food safety and nutrition for the urban poor, there is a need for intervention studies that consider dynamic societal interactions, allowing for co-creation, involving consumers, producers, retailers and policymakers within the local food business ecosystem to identify options for inclusive and healthy retail diversity.

The Role of Evidence in Nutrition Policymaking in Ethiopia: Institutional Structures and Issue Framing

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Introduction

Malnutrition is the single greatest contributor to the global burden of morbidity and mortality, with most cases arising in low- and middle-income countries. However, the multi-sectoral nature of nutrition policymaking adds considerable complexity to the implementation of effective programs. This raises questions about why or how relevant policy change may come about within different country settings. This paper examines multi-sectoral nutrition policymaking from the health sector perspective, focusing on sectoral perspectives and the role and use of evidence. The Ethiopia case study provides a unique example of the challenging nature of multi-sectoral nutrition policymaking, even with a strong coordinating infrastructure.

Methods

The paper draws on findings from 23 in-depth semi-structured interviews held in December 2014 with stakeholders from key health sector organizations and a related documentary analysis, coinciding with the end of the first National Nutritional Plan (which ran from 2008-2013).

Key participants were identified through purposive and snowball sampling strategies. We endeavoured to conduct interviews with health policy actors representing a diverse range of perspectives, including government representatives, aid providers, multilateral organizations, and academic researchers.

Interviews focussed on key themes including: the structures and functions of evidence use within the Ethiopian health sector, the institutional mechanisms for evidence uptake, and investigation of the roles of evidence in influencing recent or important health policy decisions in the country. Consent was obtained at the initiation of each interview, with respondents given options on levels of anonymity desired. Ethical approval was provided by the London School of Hygiene & Tropical Medicine; and research permission obtained from the Ethiopian Public Health Institute.

The interviews were nested within a wider review of the use of evidence in health policymaking in Ethiopia. Key policy documents were reviewed in order to compile an official view of the challenges and opportunities in the area of nutrition multisectoral policy.

Findings and Interpretations

The framing of policy issues greatly influences the types of evidence considered policy-relevant. Malnutrition has historically been framed in Ethiopia as an acute issue, but this is changing, with greater consideration of overweight/obesity and non-communicable diseases, as well as undernutrition

and micronutrient deficiencies. However overweight/obesity-related concerns are still less evident in policy documents, in terms of space accorded these issues and the setting of performance indicators.

Some interviewees critiqued 'downstream', less structural approaches to addressing nutrition, for example a micronutrients approach instead of 'an integrated dietary approach'. Others described how reasons driving policy action in agriculture often differ to those in health, reflecting a general challenge of enacting structural policy changes when doing so requires agreement with other sectors over policy goals.

While multi-sectoral plans to address malnutrition are in place, respondents suggested nutrition being seen as predominantly a health sector issue was reinforced by the nature of evidence collected. As they described, evidence such as under-five mortality, rates of diarrhoea and infections, and prevalence of overweight/obesity do not have the same importance to other key stakeholders required for sustainable, effective, policy action. Other stakeholder institutional logics may be based around a different normative position or set of goals.

Conclusions

This paper focuses on health stakeholder perspectives, and thus can only explore some of the issues involved with multi-sectoral policymaking to address malnutrition. Despite this, it illuminates three issues. First, it helps explain the problems in the coordination of mandates and evidence, and suggests likely areas for continuing challenge. Second, we have argued that there is still a lack of clarity about the role of upstream interventions, and despite a framework for integrating targets, this may be worsened by the tension with some agricultural sector targets. Third, despite the improvements in the evidence base, we argue that further evidence is needed to inform nutrition policymaking in Ethiopia, and that more evidence is needed to inform policy in non-health sectors on nutrition-specific interventions.

Despite Ethiopia's strategic framework and its progress in achieving some nutrition targets, it shares the challenge of countries elsewhere in addressing nutrition as a multi-sectoral issue. It also provides a useful case of institutional logics and how assumptions about the type and role of policy-relevant evidence for nutrition policy action may not hold across sectors. This study of nutrition policymaking in Ethiopia highlights the complex interaction of evidence within different conceptualisations of policy problems and responses.

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Agricultural Trade Policies and Child Nutrition in Low- and Middle-Income Countries: A Cross-National Analysis

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Introduction

Child undernutrition can have serious consequences, including mortality, impaired cognitive development, reduced educational and economic potential, and increased chronic disease risk. Despite efforts to reduce undernutrition, it remains a global challenge with nearly a quarter of young children being stunted. Increasingly, governmental and non-governmental organizations have acknowledged the potential for agriculture to influence nutrition. Likewise, there is growing interest in the role of trade in health and diets. However, there is a lack of rigorous research examining the links between agricultural trade policies and nutritional status. This cross-country study explores whether policies affecting tradable agriculture are associated with child nutrition.

Methods

Data on government distortions to agricultural prices were linked to 61 Demographic and Health Surveys from 22 countries between 1991 and 2010 in a repeated cross-sectional design. The sample included 212,258 children aged 6 to 35 months. Country fixed-effects linear regression models that control for all time-constant, country-level factors were run to examine the association between changes in five-year average rates of assistance to tradable agriculture and changes in child nutritional status (height-for-age, weight-for-age, and weight-for-height Z-scores). Child, maternal, household, and time-varying country covariates were included in the models, and interactions with parental occupation (non-agricultural, self-employed in agriculture, earning wages in agriculture) and proportion of tradable agriculture were added to examine potential differential effects.

Findings and Interpretations

Five-year average nominal rates of assistance to tradable agriculture in this sample ranged from -72.0% to 45.5% (range: 117.5 percentage points) with a mean of -5.0%. Fixed-effects regression analyses showed that a 10-percentage point increase in five-year rates of assistance to tradable agriculture was significantly associated with improved height-for-age (0.02, 95% CI: 0.00-0.05) and weight-for-age (0.05, 95% CI: 0.02-0.09) Z-scores in the overall sample. For all nutritional outcomes, increases in nutritional status were greatest among children who had at least one parent earning wages in agriculture, and this difference was significant for weight-for-age and height-for-age Z-scores. In addition, positive associations between rates of assistance to tradable agriculture and weight-for-age and

weight-for-height Z-scores were stronger when countries had a lower percentage of tradable agriculture; however, this effect decreased as the share of tradable agriculture increased.

Conclusions

The results of this analysis suggest that government assistance to tradable agriculture may have medium-term impacts on child nutritional status, and this may potentially operate through income pathways, given the stronger association among children with a parent earning wages in agriculture. However, such assistance may also be less important to nutrition as the share of trade in agriculture increases and agricultural economies become more globalized. Further research is needed to confirm these results and to better understand the role that agricultural policies may play in child nutrition.

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The Impact of Agricultural Specialization and Trade on Inadequate Nutrient Consumption over Time

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Introduction

From 1990 to 2016, the total burden of nutritional deficiencies in DALYs lost is estimated to have fallen by over 12 percent, with the remaining burden of 61 million DALYs falling disproportionately on children under 5 years of age in Sub-Saharan Africa and South Asia. This paper addresses the role of agricultural specialization and trade globally in the fight against nutritional deficiencies. There is some evidence of convergence in the number and types of foods consumed across countries, which suggests that global food trade may have contributed to reductions in inadequate nutrient consumption over time.

Methods

The primary data source is the Global Expanded Nutrient Supply (GENuS) Model in which national nutrient supplies for 23 nutrients were estimated by calculating and matching the per capita edible food availability of 225 foods to regional food composition tables. The GENuS model is used for this study to determine how changes in production and trade from 1961 to 2011 have interacted relative to national nutrient requirements to affect the prevalence of inadequate nutrient consumption for 152 countries.

Nutrients will be mapped to their primary food sources. Annual population demographics will then be combined with age and sex-specific nutrient requirements to determine total annual national nutrient requirements. Quantitative techniques for data visualization will then be used to illustrate trends in the contributions of food production and trade to consumption of various nutrients and for meeting national nutrient requirements.

Regression methods will be used to test the hypotheses that specialization in production and trade have brought countries closer to their nutrient requirements over time; that much of the progress toward meeting nutrient requirements has been through the greater availability of animal source foods; and

that progress toward meeting nutrient requirements has been dampened due to changing population demographics in some countries.

Findings and Interpretations

We expect to find that changes in production and trade have brought countries closer to their nutrient requirements over time. We further expect that the effect of trade has been greater specifically since the 1990s in which agriculture was included in the reform agenda of the Uruguay Round of multilateral trade negotiations. The Uruguay Round included the Agreement on Agriculture which established a set of rules and disciplines specifically geared toward reducing trade-distorting support from governments. We also expect to find—particularly for developing countries— a specific effect from animal source foods. This is because developing countries have been increasing their net imports of temperate-zone commodities, which include meat and dairy, since the 1960s. Finally, because nutrient requirements change with age, we expect to find that changes in age-specific demographics result in slower progress toward meeting national nutrient requirements where production and trade have only kept pace with per capita food consumption.

Conclusions

The outcomes of the study will be valuable to multiple stakeholders including government policymakers and donors that are responsible for crafting legislation on food trade policies, allocating budgetary resources for appropriate micronutrient intervention and for funding micronutrient intervention research. The results will provide valuable insights as to the importance of trade for supplying essential nutrients globally.

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Linkages Between Public Investments, Agriculture and Dietary Diversity in Rural India

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Introduction

India is home to a quarter of the world's chronically undernourished population, and the prevalence of micronutrient deficiency is high. Rural public capital expenditures in agriculture, roads, and education have the potential to promote diet diversity by making a range of foods, particularly perishable nutritious foods, widely accessible. Even though the Indian government spends large sums on the development of rural infrastructure and agriculture, it remains a neglected aspect of the agriculture-nutrition research agenda, and relatively little is known about the linkages between public expenditure in nutrition-relevant public capital and dietary diversity.

Methods

Based on a system of equations (SEM), the study estimates impact of public expenditures in infrastructure and public capital on dietary diversity in rural India. Based on a review of existing literature we first construct a framework conceptualizing the pathways between public expenditure and dietary diversity with a focus on state-level factors. Subsequently, the paper constructs and exploits a rich household consumption expenditure dataset from 1970-2012 containing four measures of dietary diversity (DD) for Indian states. DD data are combined with cross-sectional time-series data on economic growth, infrastructure and public expenditures to build a panel dataset. The model is jointly estimated with a system of seven equations and marginal effect of every million rupees spent on five categories of state expenditures is estimated on dietary diversity. As a robustness check, we replicate the analysis on all four indicators of dietary diversity including dietary diversity score (12 food groups), entropy and simpson indices and share on non-cereal consumption in food basket. We also conduct a path analysis to better understand both direct and indirect mechanisms through which such expenditures can improve consumption of more diverse and healthy diets. We rank different categories of public expenditures based on their impact on dietary diversity.

Findings and Interpretations

The analysis confirms the nutrition sensitivity of public expenditures in most public capital in India. It is found that state expenditures that support diversification of agricultural production diversity, market density, road density, and female literacy have played a positive role in the diversification of rural Indian diets. Governmental spending agricultural R&D is found to have the largest association with

dietary diversity of 0.032 food groups. This is followed by state spending in food storage and warehousing (0.019 food groups increase), transport (0.01 food groups increase) and education (0.003 food groups increase). In contrast, irrigation spending is associated with a decline of 0.01 food groups. This may be because public expenditures in irrigation promote specialisation of agricultural production.

Conclusions

The paper investigates linkages between public expenditures, infrastructure, and dietary diversity in rural India in the face of high economic growth and alarming rates of malnutrition. In particular, the diet diversity implications of government expenditures on agricultural R&D, food storage and warehousing, irrigation, transport, and education are reviewed using a structural equation framework. The structural models find support for the hypothesis that public expenditure in irrigation has been largely geared towards boosting staples in diets, while neglecting micronutrient-rich foods such as fruits, vegetables, and pulses. Simultaneously, other expenditures made by the state, such as in agricultural R&D, food storage and warehousing, transport, and education were found to be nutrition-sensitive. We also find that the expenditures that support diversification of agricultural production and market density play a positive role in diversification of rural Indian diets. The findings make a case for renewing interest in state expenditure in rural public capital via diversification of production and access to diverse foods as a pro-nutrition strategy in a country marred by micronutrient deficiencies and chronic malnutrition.

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SESSION 6: PLANETARY AND HUMAN HEALTH LINKAGES

Session Chair:

An Additional Approach for Controlling Malaria in Rural Agricultural Settings of Malanville in the Northern Benin: Minimal Tillage and Intermittent Flooding is Likely to Reduce Anopheles Breeding Sites and Densities in Rice Field Agro-Ecosystems.

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Introduction

Recent work in rice-growing areas in Mali has revealed the link between poor agricultural practices and the proliferation of malaria vectors. In this context we proposed to reduce the density of Anopheles in rice growing areas using two innovative approaches, namely, minimal tillage and intermittent irrigation. The aim of our study is to confirm that minimum tillage and intermittent irrigation are likely to reduce the density of Anopheles populations in the Malanville rice area.

Methods

Through direct observations of rice plots, group discussions, and individual interviews, the different tools and types of tillage and irrigation used by farmers were identified. Direct observations were conducted by small groups of researchers and producers. Group and individual discussions involved both men and women in order to deepen the information gathered during the direct observations, to get farmers' perceptions on the link between rice production and mosquito proliferation and their perceptions on the management of malaria. Discussions with health actors were also carried out to collect information on periods of high and low incidences of malaria corresponding to rice cultivation periods. Farmer field training courses were organized to identify, through a participatory approach, agricultural practices which could reduce mosquito density in rice-growing areas. Finally, mosquito larvae were collected in the test and control plots and quantified according to the rice developmental stages (transplantation, tillering, and maturation). The data were analyzed by calculating the relative abundance of larvae in control and test plots and by comparing the larval density between plots.

Findings and Interpretations

Direct observations revealed that farmers use the hoe, plough, and tiller for the tillage. The deep tillage system is practiced by most farmers. The irrigation method known and used by farmers is permanent irrigation with Niger River water and boreholes. Through the individual interviews, several farmers recognized that rice cultivation is a source of mosquito proliferation and the stagnant waters around houses also favor the proliferation of mosquitoes. Insecticide treated nets is the main method used by farmers to prevent malaria. According to the actors of the sanitary system, it emerges that the cases of malaria are more detected during the season of rice production. Farmer field school trainings enabled farmers to link rice cultivation with mosquito proliferation and to understand that minimal tillage and intermittent irrigation are able to reduce the development of mosquito larvae while maintaining agricultural yield. Minimal tillage and intermittent irrigation reduced larval density by 8.83 times during transplantation, 3.88 times during tillering, and 4.75 times during maturation. During the three phenological stages of rice, the system of minimal tillage and intermittent irrigation significantly reduced the density of mosquito larvae ($p = 0.0001$) compared to the deep tillage and permanent irrigation system.

Conclusions

The results from our study confirm a strong proliferation of mosquitoes in the rice fields. It shows that in a rice-growing environment, the system of deep tillage and permanent irrigation maintains a high density of mosquitoes throughout the entire rice development cycle. This study establishes also the capacity of minimal tillage and intermittent irrigation to significantly reduce the densities of malaria vectors in rice-growing areas. However, the adoption of these technologies requires a strong awareness of farmers.

Impacts of Agricultural Land-Use Change on the Ecology of Aedes Arbovirus Vectors in Yellow Fever and Dengue Foci in Palm Plantations in Côte d'Ivoire

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Introduction

Aedes mosquito-transmitted arboviruses have (re)emerged from their sylvatic reservoirs of Africa and the Americas under terrestrial-ecosystem anthropization forces and caused many diseases worldwide. As the resurgence and geographic expansion of arboviral diseases and ecology of Aedes vectors can alter under human-driven landscape alteration, identifying priority areas among intensive agricultural areas for integrated vector management (IVM) is crucial for public health. We explored the impacts of agricultural land-use change on the ecology of Aedes mosquitoes along a gradient of anthropogenic disturbance in large industrial oil palm plantation areas within yellow fever and dengue foci in Côte d'Ivoire.

Methods

Between January and October 2014, Aedes mosquitoes were sampled as eggs, larvae, pupae and adults among four major land-covers (rainforests, polycultures, oil palm monocultures, and rural housing areas) using standard procedures (bamboo-ovitraps, metallic-ovitraps, larval surveys, and human-baited double-net trap methods). Specimens were identified at species level. A total of 28,276 Aedes specimens belonging to 11 species (*Ae. aegypti*, *Ae. africanus*, *Ae. dendrophilus*, *Ae. fraseri*, *Ae. furcifer*, *Ae. lillii*, *Ae. luteocephalus*, *Ae. metallicus*, *Ae. opok*, *Ae. palpalis*, and *Ae. vittatus*) were collected. No Aedes-positive microhabitat and only four specimens of *Ae. aegypti* were found in oil palm monocultures. The highest abundance of Aedes mosquitoes (60.9%) was found in polycultures, while the highest species richness (11 species) was observed in rainforests. *Ae. aegypti* was the predominant Aedes species, and exhibited high anthropophilic behavior inflicting 93.0 percent of total biting to humans. The biting rate of Aedes mosquitoes was 34.6 and 7.2-fold higher in polycultures and rural housing areas, respectively, compared to rainforests. *Ae. aegypti*, *Ae. dendrophilus*, and *Ae. vittatus* species bit humans in polycultures and rural housing areas, with respective biting rates of 21.48 and 4.48 females/person/day. Unexpectedly, all three species were also feeding during darkness. Aedes

females showed bimodal daily feeding cycles with peaks at around 8:00 a.m. and 5:00 p.m. Host-seeking activities were interrupted between 11:00 a.m. and 2:00 p.m. in rural housing areas, while no such interruption was observed in polycultures. The rainforest-dwelling Aedes species displayed little preference to feed on humans.

Conclusions

In Côte d'Ivoire, the agricultural land-use/land-cover changes due to the transformation of rainforests into vast industrial oil palm monocultures influence the ecology (abundance, distribution, and host-seeking behavior) of anthropophilic and non-anthropophilic Aedes resulting in the migration of arbovirus vectors towards the polyculture and rural housing areas. As result, humans (villagers and farmers) are increasingly exposed to Aedes bites and yellow fever and dengue transmission virus risk around their homes and farming plots. Hence, the polyculture and the rural housing ecotopes represent priority areas for vector control and surveillance. In oil palm-planted areas, arboviral disease control strategy should encompass integrated vector management (IVM), including landscape ecology and epidemiology and ecotope-based vector control, agricultural practices and rainforest management.

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What Are the Nutritional Effects of Climatic and Weather Shocks? Evidence from Sub-Saharan Africa

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Introduction

There is a growing literature on the linkages between climatic shocks and nutrition outcomes, often motivated by agricultural mechanisms but there is limited work on disentangling possible mechanisms. Existing studies involving young children do not adequately account for the dynamics of growth faltering and failure to analyze nutritional effects of climatic shocks for different cohorts of kids can produce biased results. This study examines the nutritional effects of climatic shocks in sub-Saharan Africa (SSA) by exploring possible pathways (through yield and spread of diseases) and possible growth faltering.

Methods

The empirical analysis combines data from the following sources. Nutritional outcomes of under-five children and adult women as well as other household-level socioeconomic outcomes for 24 countries come from the Demographic and Health Surveys (DHS). A time series of precipitation and temperature data come from the Climate Research Time Series Grid Version 3.23 at the University of East Anglia. Gridded landscape-level data on agro-climatic, biophysical, and economic factors (e.g., elevation and market access) is CELL5M. Different thresholds of weather conditions are identified by major farming systems based on documented responses of yields and diseases to changes in temperature and rainfall. Shocks are defined by calendar year, growing season, and timing of the child's exposure (in utero or afterwards). A flexible non-parametric bin approach is employed to estimate the effects of precipitation and temperature shocks on undernutrition. Heterogeneous effects are examined along several dimensions (e.g., past exposure to shocks, farming systems, household's socioeconomic conditions).

Findings and Interpretations

Preliminary results show both drought and excess rain during the growing season increase the incidence of under-five wasting in general and wasting among 25-59 months old children. Exposure to repeated drought condition also has a significant positive effect on stunting among older cohorts. While drought condition negatively affects seed germination, plant growth, yields, and livestock, excess rainfall may lead to surface runoff and soil waterlogging - especially in already degraded areas-, cause damages to crops and livestock, worsen phyto-pathological conditions, and cause overall logistical challenges. A higher incidence of wasting has previously been linked with (repeated) exposure to flooding. Above average temperature in the preceding growing season reduces child stunting in highland mixed and roots and tubers farming systems, relative to maize mixed system. Findings are in line with model-based predictions where a warming trend

in high- and mid- altitude areas could help extend the growing seasons, potentially enabling more productive agricultural seasons.

Conclusions

Climatic and weather shocks are important determinants of nutrition and health outcomes in sub-Saharan Africa, given the region's reliance on rainfed agriculture and projected climatic changes. While the link between weather shocks and agricultural productivity is relatively clearer, the linkage between weather shocks and nutrition is more complex and operates through multiple channels. As such, establishing causal links between weather variability and nutrition is challenging. Additional challenge relates to ensuring one does adequately capture the spatial and temporal climatic variation relevant to the farming systems and livelihood strategies under consideration. Preliminary results from this study indeed show significant variation in the effects of weather shocks on undernutrition, including by farming systems, age-cohort, and intensity of previous exposure.

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Healthy Diet: A Step Toward a Sustainable Diet by Reducing Water Footprint

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Introduction

Water shortage is an important crisis humans are facing currently. The problem is more severe in some parts of the world. The average rainfall in Iran is less than a third of the global average. The declining water resources are best seen by almost eradication of Urmia Lake. Building dams and diverting water resources for human and agricultural use, alongside with overuse of surface water seems to be the main contributors. Changing the population's eating pattern toward a more healthy diet can help reduce water use. This paper aims to assess different scenarios that reduce water use by following healthy diet recommendations. In this study, the food frequency questionnaire was used to assess usual food intake of a 723-individual sample from Urmia, capital city of West-Azerbaijan province in Iran. The water footprint method was applied to calculate water use for production of food items (168 items). Linear programming technique was used to find a healthy diet with low water footprint in three scenarios. The objectives and changing variables for all three scenarios were minimizing the blue water use, which refers to consumption of surface and ground water resources along the supply chain of a product, and intake of food items, respectively. To consider dietary habits, the changing variables were constrained to vary between first and third quartiles of usual intake. Additionally, for the first scenario, the model-produced diet should have energy intake equal to that of usual intake. In the second scenario, in addition to energy constraint of earlier scenario, the changing variables are constrained to follow the advised serving size of food groups by Iranian food dietary pyramid. In addition to the constraints of the second scenario, Dietary Reference Intake for macronutrients, micronutrients were considered as constraints in the third scenario. The energy intake constraint was relaxed at this scenario.

Methods

The average energy intake of the sample was 2920Kcal. The highest proportion of calorie was supplied by "bread-cereal-rice-pasta" (39%). The lowest contribution belongs to "fruit" and "vegetables" groups (8%). The amount of water to supply daily diet for a person was 4.11m³.

At first scenario, the share of "bread-cereal-rice-pasta", "vegetables", and "fruit" in supplying daily energy increased by 44, 58, and 4 percent, respectively. The contribution of "milk-yogurt-cheese" (92%), "meat-poultry-fish-drybeans-eggs-nuts" (31%), and "fats-oils-sweets" (28%) decreased. The lowest amount of water needed at this scenario was 1.78m³, a 57 percent decline.

For second scenario, compared with real diet, the energy share of "bread-cereal-rice-pasta", "meat-poultry-fish-drybeans-eggs-nuts", and "fats-oils-sweets" have decreased by 28, 21, and 0.1 percent, respectively. Furthermore, the

contribution of "vegetable" (86%), "fruit" (21%), and "milk-yogurt-cheese" (40%) have increased. The amount of water needed to supply one person for a day at this scenario was 2.17m³, a decline of 47 percent from the real.

For third scenario, the share of "bread-cereal-rice-pasta", "meat-poultry-fish-drybeans-eggs-nuts", and "vegetable" in providing average daily energy have decreased by 37, 28, and 45 percent, respectively, compared with real diet. Likewise, the contribution of "fats-oils-sweets" (8%), "fruit" (68%), and "milk-yogurt-cheese" (99%) have increased. The amount of water to supply this diet was 2.1m³, a 49 percent decline.

Conclusions

A healthy diet with greater proportion of fruits and dairy instead of a diet with high consumption of "meat-fish-poultry-eggs" and "bread-cereal-rice-pasta" can supply all recommended dietary allowances while reducing water use. The decline in water consumption in the recommended diet of this study is mainly due to decrease in share of animal products. Meat-based diets have a larger water footprint compared with vegetarian diets. A high proportion of water footprint for animal products is due to their consumption of feed which accounts for 98 percent of the total water footprint. Although dairy products have higher water footprint as well, their contribution increased in this study's recommended diet. Dairy products are rich in a large variety of essential nutrients such as minerals, vitamins, and easily digestible proteins with balanced amino acid profiles which are important to support overall body function.

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'Because of Galamsey, There Isn't Food in the Town': A Photo Story of Small Scale Mining and Food Security in Ghana

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Introduction

Small scale mining, popularly known as 'galamsey' in Ghana, has come under political and media scrutiny since 2017, due to its known devastating effects, including land degradation, destruction of forests, and pollution of water bodies. However, little is known about the linkages between galamsey and food systems in mining communities. The current study was designed to describe community perceptions and experiences of galamsey and its effects on food security and livelihoods.

Methods

This cross-sectional study was carried out in the East Akyem Municipality (EAM) of Ghana between December 2017 and February 2018 using multiple data collection techniques: photovoice, photo exhibition, in-depth interviews and a survey. Thirty male and female respondents comprising of adults and adolescents were selected purposively from 3 communities in EAM to take up to 15 photos that 'describe the food security situation in their community and how this is shaped by small scale mining.' All respondents were given training, and supplied with a mobile phone (iTel 17100) with a camera feature for taking photos. Three to four days after the training, respondents returned the photos and in an in-depth interview and discussed the motivation for taking 5 photos of their choice. The photovoice data was validated with a photo exhibition, which provided additional opportunity to learn about community responses to food security in the Municipality. In addition to the photovoice data collection, 300 respondents selected using cluster sampling from 10 communities in the Municipality completed an interviewer-administered survey. The data was analysed based on a food security framework comprising of food availability, access, and utilization.

Findings and Interpretations

Several and diverse themes emerged from the evidence indicating community perception of how galamsey affects food production. The themes included destruction of land fertility, reduced crop yield, limiting water supply for farming, limited physical accessibility to farms, as well as ruining aquaculture systems. Galamsey was also linked with limited

food access through its creation of food scarcity which makes food more expensive at the community level. As a result, there was report of community members needing to travel outside EAM to purchase food from nearby communities. This scarcity occurs within the context of not having a food market in the Municipality. On the other hand, galamsey credited with creation of jobs for women who sell prepared food to the miners. Finally, galamsey was linked with poor food safety as a result of toxic mercury entering the food system and creating diseases. In the 10 communities surveyed, 66% of households reported insufficient food intake.

Conclusions

Ghanaian communities with heavy mining activities consider small scale mining as a significant threat to food security. The implications of the above findings are discussed in this presentation, focusing on the need to ensure that food security is not compromised by mining activities. Specific attention is given to how degraded mining sites could be reclaimed for smallholder sustainable agriculture for improved food and nutrition security. The presentation also discusses how the positive aspects of galamsey could be leveraged to counteract its negative consequences.

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Quantifying Selenium Status in Malawian Population

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Introduction

Selenium (Se) is an essential micronutrient with many roles in human health. Deficiency of Se decreases selenoprotein expression and activity, thereby compromising immune function, thyroid function and cognitive development, and increasing risks from non-communicable diseases. The prevalence of Se deficiency is not known in many countries with particular knowledge gaps in sub-Saharan Africa. High risks of Se deficiency were predicted in Malawi based on widespread inadequate dietary Se sources and a high prevalence of Se deficiency in small cross-sectional studies. We quantified nutritional Se status and deficiency at a national scale as part of the Malawi Micronutrient Survey (MNS) 2016.

Methods

The survey comprised a nationally representative sample of preschool children (PSC), school-aged children (SAC), women of reproductive age (WRA) and adult men. The scope of the MNS, including details of the sampling design, ethics, informed consent, and individual confidentiality procedures, are described in the survey report. Plasma Se concentrations were determined using inductively coupled plasma-mass spectrometry (ICP-MS). In total, data were obtained for 2761 individuals from 1233 households, located in 102 clusters, 84 and 18 of which were located in rural and urban areas, respectively. Data were analyzed using a linear mixed model¹¹ to quantify long- and short-range sources of variation linked to Se status. Based on output from this model, the probabilities of plasma Se concentration of <84.9 ng/mL and <64.8 ng/mL in adults were computed. These thresholds are linked to optimal activities of the selenoproteins glutathione peroxidase 3 (GPx3) and iodothyronine deiodinase (IDI), respectively. These probabilities were presented as maps, using a verbal scale to visualize the probability that plasma Se falls below the thresholds of interest.

Findings and Interpretations

Across all demographic groups, the mean and median plasma Se concentration was 73.2 ng/mL and 68.2 ng/mL, respectively. Deficiency was widespread: for example 62 percent of WRA had plasma Se concentration below the threshold for optimal GPx3 activity and 30 percent had plasma Se concentration below the threshold for optimal IDI activity. There was strong spatial structure to the data with environmental factors such as soil type and proximity to Lake Malawi strongly influencing Se nutritional status. There was close association between Se deficiency and household wealth, with 70, 68, 59, 59, and 56 percent of WRA from households in the poorest to wealthiest quintiles, respectively, below the threshold for optimal GPx3 activity.

These results are consistent with estimates of inadequate dietary Se supplies among 92, 86, 81, 72, and 51 percent of households from the poorest to wealthiest quintiles, respectively. The prevalence of Se deficiency among WRA in urban areas was lower than in rural areas (34% compared to 62% using the threshold for optimal GPx3 activity). Although the spatial statistical analysis in this study focuses on WRA, due to accepted deficiency thresholds, the potential risks of Se deficiency among children are also of great concern.

Conclusions

These findings provide robust evidence of widespread Se deficiency in Malawi across all demographic groups. We demonstrate that the prevalence of Se deficiency is under strong environmental controls with the entry of Se into food systems severely constrained by soil factors. There is limited scope to alleviate Se deficiency through increased dietary diversity with the concentration of Se in livestock products (as well as livestock productivity and health) constrained unless animals have access to Se supplements in feeds. Thus, deficiency is likely to remain high even with urbanization and increasing wealth. From a public health perspective, Se deficiency has similarities to iodine deficiency whereby some local food systems are unable to supply adequate amounts for human (or livestock) nutrition. Iodine deficiency has been effectively addressed in many countries including Malawi through iodization of table salt, although this is unlikely to be an appropriate approach for Se. Agronomic biofortification of maize using Se-enriched fertilizers has been proposed as a potential cost-effective strategy to alleviate Se deficiency in Malawi, as previously adopted in Finland. The efficacy and effectiveness of any fertilizer-based intervention would need to be assessed carefully in the context of other public health spending.

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SESSION 7: DRIVERS OF FOOD CHOICE

PARALLEL SESSION 1

Session Chair:

Do Gendered Food Choices and Time Allocation Preferences Influence the Nutrition of Agricultural Households?

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Introduction

Observing how food choices of rural family members change when receiving cash and nutrition information, as well as how they allocate their time (out of the home or at home), is key to understanding measures to improve their nutrition. However, these choices are difficult to observe. For example, a household member may recall general household food consumption, but not each person's share. Therefore, it is unknown how increases in income, or new information about nutrition, may change family allocations of time and food, which in turn influence nutritional status. In particular, it is unknown if these changes vary by gender.

Methods

We design and implement choice experiments to measure how food and time allocation decisions vary with income and information. We examine differences among men and women within the household, and relate these to household nutrition. Important features of our experiments are: 1) For replicability by researchers and program implementers in rural areas of developing countries, we implemented choice experiments instead of randomized control trials, which are very expensive, 2) To prevent hypothetical biases we provided a voucher with a real money value, to be exchanged for food in a local store, 3) Accounted for heterogeneous preferences of men and women within the household, and 4) Allowed for interaction between household members to capture intra-household dynamics.

We implemented these experiments in two regions of Guatemala, one with strong indigenous influence (West), and one with more white and mestizo inhabitants (East). Information was elicited from 250 households through three different types of instruments: a household questionnaire, an individual questionnaire, and the choice experiments. We elicited information from couple-headed households only. The experimental games involved having each couple make decisions, first, separately, and then jointly; and with three different budget levels. One of the budget-choice combinations involved real purchase of food and products.

Findings and Interpretations

We are still finalizing our data analysis, yet preliminary findings show that individuals that receive additional income still choose low levels of food diversity, preferring high amounts of staples and expensive foods (like meat). In the East, women tended to prioritize food quantity more than men. One potential reason being that women often did not have the opportunity to purchase foods on a frequent basis. Generally, men had more mobility and went to the larger market to purchase food on trips where they also addressed other businesses. Indeed, the working roles and preferences that men and women have in a household are tightly related to the roles they play along the chain of food access-choice-consumption. Experiments measuring labor preferences show that, in spite of being traditional communities, there is a large heterogeneity in the preferences of men and women for agricultural versus home cooking and cleaning work, and many men would be willing to dedicate more hours to the home if they received enough benefits. Additional findings are that indigenous households appear to have more rigid food preferences, with less variety in their choices, and the least healthy food choices were mostly selected by households with young children.

Conclusions

Preliminary results show the relevance of considering gender roles and intra-household work dynamics in designing nutritional interventions. Both men and women's decisions play a significant role in the chain of events that determine household resource allocation to nutrition and hygiene, yet roles vary across communities and households. In fact, they are dynamic, and in many households, flexible. Thus, nutritional interventions should not only target women because they are traditionally seen as the ones making food-related decisions, but also should provide incentives to the men who are willing to contribute to home production activities. This is particularly important in areas (like Eastern Guatemala), where women allocate a higher share of their time to labor outside the home. Men also play an important role in the choice, type, and diversity of food due to their higher mobility and market access.

The Cost of Nutritious Diets in Africa and South Asia: New Insights from Food Price Data

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Introduction

Access to adequate food for all is a cornerstone of the development agenda. Agriculture has an essential role toward increased availability and affordability of nutritious food, but information is lacking to inform effective actions. Food price monitoring typically prioritizes foods based on economic importance and omits nutritional adequacy. Existing data, however, can be harnessed to understand the cost of nutritious diets, and to compare costs across seasons and regions.

Methods

Using the same food price data that national agencies routinely collect, we calculate the price of nutritious diets in Ghana, Tanzania, Afghanistan, India, Pakistan, and Sri Lanka. We apply three methods to account for nutrition in the price of food: the Cost of a Recommended Diet (CoRD), the Cost of Nutrient Adequacy (CoNA), and the Nutritious Food Price Index (NPI). CoRD shows the minimum cost of meeting food-based dietary guidelines, which represent diets that are intended to meet nutrient needs and protect health in the long term. CoNA, a metric based on linear programming, models the minimum cost of achieving nutrient adequacy, and compares this to the cost of caloric adequacy. The NPI is an index that shows the price of nutrient-dense foods relative to the price of foods typically purchased.

These methods, first developed in the IANANDA project (Indicators of Affordability of Nutritious Diets in Africa) under an IMMANA grant, have been applied to gain new insights into seasonality and within-country regional variation in South Asia through the South Asia Food and Nutrition Security Initiative (SAFANSI) managed by the World Bank, and in Africa through the CANDASA project (Changing Access to Nutritious Diets in Africa and South Asia).

Findings and Interpretations

We find that the cost of recommended diets is higher than the cost of nutrient adequacy; both are higher than the cost

of caloric adequacy, and more seasonally variable. In Ghana, a nutritionally-weighted food basket is more expensive in some regions than others, relative to the typical food basket. In Tanzania, seasonality in the price of food is larger in more remote locations such as the far west (Kigoma) and north (Kilimanjaro), but also in southern “breadbasket” areas such as Iringa and Ruvuma.

In South Asia, CoRD highly varies across cities, largely due to the variation in the cost of vegetables. Using the NPI, we further find that compared to a typical food basket, the price of a nutritious food basket is more subject to seasonality, and for Pakistan and India it has been increasing faster over time. While the prices of the most energy-dense foods (cereals, oils and fats, sugars) are the most stable, the prices of the most nutrient-dense foods are increasing faster and are more variable. The pronounced seasonality and faster increase seems driven by vegetable prices.

Conclusions

We find that the price of the most nutrient-dense foods is generally rising faster, and is more seasonally and regionally variable, than the price of energy-dense, low-micronutrient foods. In particular, vegetable prices drive pronounced seasonality and inflation in the cost of nutritious diets in South Asia. The energy-dense foods generally have a longer shelf-life for storage and transportation than the most nutrient-dense foods, which tend to be highly perishable. Food security and agriculture policies have historically emphasized energy-dense foods. Increased attention in the agricultural sector to the most nutrient-rich foods may be needed to improve year-round access to adequate food. In particular, actions to reduce prices and seasonality of vegetables, and to better integrate markets for vegetables and other perishable, nutrient-dense foods, can reduce the cost and price volatility of nutritious diets.

“Eating Down” Amongst Rural Tanzanian Women: Examining the Association Between Socio-Cultural Beliefs and Diets in Pregnancy

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Introduction

Inadequate nutrition during pregnancy is a known risk factor for poor birth outcomes, globally. While several factors can cause inadequate diets and nutrition in low socio-economic contexts, including lack of income and environmental constraints, research suggests socio-cultural beliefs may also contribute. “Eating down,” reducing food intake during pregnancy due to socio-cultural pregnancy-related beliefs, is documented as contributing to inadequate maternal nutrition throughout many cultures. Using community perspectives, we examine this phenomenon through: 1) experiences of facing pressure to comply with diet practices, 2) perceived negative consequences of eating ‘too much’, and 3) beliefs that certain foods can cause birth complications.

Methods

From February to October 2017, qualitative data were collected in two phases from six rural towns in the Handeni and Tanga districts of Tanzania. Sites were purposively selected to include extensive pastoral, extensive sedentary and intensive sedentary communities. Each phase included three primary data collection methods (i.e. in-depth interviews (IDI), key informant interviews (KII), and focus group discussions (FGD)). Using a grounded theory approach, Phase I preliminary results were analyzed and used to inform objectives for Phase II. IDIs and KIIs were administered to eligible and consenting residents of each town. FGDs were conducted with each of the six respondent categories: female and male youth (16-30 years old), women and men of reproductive age (31-64 years old), and female and male elders (>65 years old). Ethnic groups interviewed included Zigua, Maasai, and Pare.

All qualitative data was collected in Kiswahili or the local language and transcribed/translated by multi-lingual Tanzanian research team members. Transcriptions were coded using MaxQDA and analyzed for major themes and patterns using a combination of thick description and theory development.

Findings and Interpretations

Participants included members of the Zigua, Maasai, Pare, Gogo, and Mburu groups and ranged from 16 years to 80 years old. The majority of respondents, 52 percent (n=104), had no schooling, with 29.44 percent (n=58) completing primary school and 12.18 percent (n=24) completing secondary school. Preliminary analysis suggests that women in these communities commonly reduce food consumption and avoid specific foods during pregnancy. Foods were reduced or avoided to prevent weight gain by the mother, weight gain by the fetus, disruption of the umbilical cord, difficult delivery, and complicated deliveries. Overall, the

most commonly avoided foods cited by participants were eggs, milk, and meat; these foods were perceived to contribute the most to fetal growth. Eating down and food avoidance were most commonly mentioned amongst the Maasai, though other groups also mentioned practicing these restrictions. Foods, such as eggs, fish, and cold foods, were also avoided by pregnant women because they caused nausea and vomiting. Despite food reductions and avoidance, preliminary results also suggest that some pregnant women are prioritized for specific special foods, depending on their ethnic group. These foods are believed to promote stimulation and proper functioning of the body and included sheep fat, animal blood, ugali, and Irish potatoes.

Conclusions

Eating down and specific food restrictions are common in this rural Tanzanian setting. Despite the eating down phenomenon, other high-quality foods are promoted for pregnant women. These findings have implications for the design of culturally sensitive programs aimed at improving maternal diets in pregnancy. This study was specific to pastoral and cattle-keeping communities and thus may not be applicable to other subsistence agriculture communities. Exploration of these issues in other ethnic groups and agro-ecological zones will be needed to better understand these practices in Tanzania and make culturally appropriate food-based recommendations for pregnancy nutrition.

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Factors Associated with Dietary Behaviours in Urban Africa from Adolescence to Adulthood - Extending the Reach of a Systematic Mapping Review: A TACLED Study

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Introduction

Dietary patterns within Africa are changing. The nutrition transition describes the way in which diets in low- and middle-income countries are shifting away from traditional diets and eating habits in rapidly urbanising environments. Available evidence links the increasing prevalence of obesity to the nutrition transition. This systematic review mapped the factors associated with dietary behaviours among adolescents and adults living in urban Africa and identified priority areas for future research.

Methods

A systematic mapping review was conducted to extend and update an existing review of drivers of food choice of women living in urban Africa, which was undertaken in 2015. Aside from women, the current review included adolescents (11-17 years of age) and men. A protocol was defined and registered on the PROSPERO database (registration number CRD4201706893). Electronic searches across MEDLINE, EMBASE, PsycInfo, CINAHL, African Index Medicus and ASSIA were conducted alongside citation tracking (forward and backward citation tracking) using Google Scholar (through Publish or Perish™). Quality appraisal occurred in parallel with data extraction. Factors were compiled into a map adapted from an existing socio-ecological model based on research in high-income countries. Findings were synthesised narratively.

Findings and Interpretations

Thirty-eight studies were included in the final mixed-methods data synthesis. Populations included 12 studies of adolescents, 11 of adult females and 14 mixed adult studies. In total 65, 47 and 42 factors were identified for adult women, adult men and adolescents respectively. Significant associations were found between dietary behaviours and socio-economic status. Stress levels were found to be significantly associated with unhealthy dietary behaviours in a mixed adult population with the effect being more pronounced in men. Biological level factors found to be significantly associated with dietary behaviour in adults were

morbidity, age and parity. Factors specific to the adolescents were self-esteem, body satisfaction, ideal body size, dieting, school registration, gender, body composition, pubertal development, BMI and fat mass. However only age, BMI, and fat mass were found to be significantly associated with dietary behaviours. There were more social level factors (e.g. friendship) identified in adolescents compared to the adult. The role of religious groups on dietary behaviours was investigated in one study, however, religious groups cannot be accommodated within the existing sub-levels defined by Story et al. (2008). Macro-level factors were neglected by all groups with only four factors identified.

Conclusions

In all population groups studied, the individual and household domains of the socio-ecological model were the most represented by included studies. This may indicate that by targeting cognitions, skills and behaviours, lifestyle, biological and socio-economic factors, the general population of urban Africa may benefit. The dominance of studies exploring individual-level factors however, suggests a need for research to explore the social, physical and macro-level environments. By understanding factors influencing dietary behaviours within separate population groups, specific targeted interventions can be developed to combat nutrition-related non-communicable diseases in urban Africa. The evidence from this review will contribute towards developing a conceptual framework for the study of factors influencing dietary behaviours in urban Africa.

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Understanding the Drivers of Diet Change and Food Choice Among Tanzanian Pastoralists

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Introduction

Pastoralists represent more than 300-600 million people globally. In response to increasing environmental, social, and political pressures, pastoral communities are shifting to more sedentary livelihood strategies (sedentarization) - a process shown to adversely impact both maternal and child nutrition. To explore contributors to diet change in transitioning cattle-keeping communities we conducted a longitudinal mixed methods study to document factors driving changes in food availability, affordability, and valuation. Research was conducted in six villages representing different stages of sedentarization across two livelihood zones in Tanga and Mvomero, Tanzania.

Methods

From February to October 2017, we conducted two rounds of qualitative data collection using a grounded theory approach and three rounds of market surveys using the Cost of Diet approach in six villages in Handeni and Mvomero, Tanzania. Sites were purposively selected to include extensive pastoral, extensive sedentary and intensive sedentary communities. In total we conducted 47 in-depth interviews, 52 key informant interviews, and 38 focus group discussions. Respondents were primarily Massai, Zigua, Pare, or Mburu ethnic groups. Interviews and focus group discussions were conducted in Kiswahili or the local language, and translated into English during the transcription process. We used MAXQDA to code data and constant comparative analysis to examine findings across sedentarization patterns.

Findings and Interpretations

Analysis of market surveys using the Cost of Diet approach revealed that, for the poorest households in Tanga, 63.3 percent of household income was required to afford a diet meeting energy requirements, an additional 30.1 percent of income to attain a nutritious diet (energy plus protein, fat, and micronutrients), and an additional 9.4 percent for a nutritious diet that reflects local food habits. In Mvomero, the poorest households would need to allocate 55.5 percent of household income to meet basic energy requirements, an additional 39.7 percent to meet protein and micronutrient needs, and another 4.7 percent to obtain a nutritious diet meeting local food habits. Qualitative research identified food affordability and seasonal availability as key determinants of immediate /short-term food choices. Drivers of longer term diet change included: 1) livelihood diversification in response to land conflicts and diminishing crop and livestock yields under climate pressure, 2) cross-

cultural transfer of diet practices (foods and cooking practices) due to increased inter-tribal interactions, including intermarriage, 3) pressures from children exposed to new diet options through formal schooling, and 4) shifting roles and time allocation of women as a result of greater availability of income generating opportunities in sedentary communities.

Conclusions

Multiple factors, many linked to transitioning livelihoods in response to climatic and other changes, are contributing to changing diet patterns in pastoral communities. We are currently analyzing the second round of qualitative data to more fully elaborate those prominent influencers of diet change and distinguishing how these differ depending on sedentarization pattern. Our work will ultimately lead to the development of a theory of diet change in the pastoral context and a framework for policy and program action.

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Food-Based Recommendations can be Formulated in Optifood, for Rural 12-23 Month Old Children in Low-and Middle-Income Countries, Using Household Consumption and Expenditure Survey Data Instead of 24-hour Recall Data, Allowing for Rapid Generation of Evidence to Inform Programmatic Decisionmaking

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Introduction

The linear programming tool “Optifood” is used to identify nutrient gaps in local diets and design population-specific food-based recommendations (FBR). It can also inform nutrition-sensitive decisions within agriculture programmes by modelling the nutritional implications of alternative interventions. A barrier to the broader application of Optifood is the requirement for dietary intake data. Consumption data from Household Consumption and Expenditure Surveys (HCES), which is routinely collected worldwide, has been used for estimating food and nutrient intakes. Our study tested the relative validity of HCES data for developing the dietary input data required for Optifood modelling.

Methods

Public HCES data was sourced from Bangladesh, Uganda, Kenya and Guatemala. The adult male equivalent (AME) was applied to redistribute household food consumption and estimate individual food intakes for 12 to 23 months-old children, assuming mean age-appropriate breast-milk consumption. Twenty-four-hour dietary recall datasets from previous studies were also accessed for two regions of Uganda, four regions of Kenya and one region each in Bangladesh and Guatemala. The datasets from each 24-hour recall analysis region (eight in total) were paired with HCES data from the same regions. Food intake data from each data pair were used to develop inputs for Optifood models, including a list of available foods, target-group specific portion sizes and consumption limits for foods, food sub-groups and food groups. The inputs were compared across data pairs. A standard Optifood analysis was run for all data sets. The analysis identified nutrient gaps (i.e., nutrients for which requirements could not be met using local foods within acceptable ranges of consumption), and the best local food sub-group sources of multiple nutrients. These food sub-group sources of nutrients were then tested to identify the best sets of FBRs. All results were compared between each dataset pair.

Findings and Interpretations

Food lists developed using HCES data were not different from those developed from paired 24-hour recall data. Similar food groups and foods were represented. Serving sizes and consumption limits tended to be slightly larger when derived from the HCES than 24-hour recall data, allowing on average 1.6 times more food to be modelled. This finding might be the

result of unaccounted food wastage or incorrect assumptions about either breastmilk intakes or intra-household food distribution. As expected, based on the inputs, the number of problem nutrients identified, in the HCES-based Optifood analyses, were either lower (50 percent of the analyses) or the same as (50 percent of the analyses) the 24-hour recall based Optifood analyses. Overall however, percent agreement was >90 percent between both data sources. Across all datasets similar food sub-groups were identified as being good sources of nutrients, these included green, leafy vegetables, beans and lentils, whole grains, dairy products, red meat, eggs and small fish. The percent agreement in best food-sub group sources of nutrients between the paired datasets ranged between 77 and 100 percent. FBRs were identified from the best sources and tested for each dataset. The final FBR sets were similar, with percent agreement ranging from 82 to 100 percent.

Conclusions

Despite a tendency to allow for the modelling of higher food quantities using HCES compared with 24-hour recall data, the Optifood outputs were similar, including problem nutrients and FBRs. These results suggest HCES data can be used instead of 24-hour recall data to run an Optifood analyses; at least for rural 12 to 23 months-old children. HCES consumption data are a relatively good proxy for 24-hour recall surveys in order to identify problem nutrients and best food sources and test FBR using Optifood. Conducting 24-hour recalls is time and resource intensive and often outside of the capacity of agricultural programmes in the planning phase. The ability to rapidly access and process existing, routinely collected data, such as HCES would allow users to identify nutrient gaps in local diets and food systems and test population-specific FBRs and interventions. This ability would especially allow rapid evidence generation to inform decision-making on how agricultural programmes could best impact nutrition outcomes. This analysis is based on a number of assumptions and has been carried out for one age-specific target group only. Further testing should explore the validity of HCES data as an input for Optifood Analysis for other age groups, urban populations or other geographical regions.

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SESSION 7: DRIVERS OF FOOD CHOICE

PARALLEL SESSION 2

Session Chair:

Food and Nutrient Gaps of Smallholder Farming Households in Rural Northern Ghana

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Introduction

Current transformations of food systems driven by climate change, urbanization, income growth and population growth are often associated with unhealthy diets: they fail to provide sufficient, diverse, nutritious and safe food for all. Food-based dietary guidelines (FBDGs) provide guidance to policy makers, private sector and consumers to redesign food systems and to improve diets of vulnerable populations. As appropriate FBDGs are based on the actual dietary patterns and their costs, it is assumed that the recommended foods are available, affordable and acceptable for the population under study.

Methods

Using quantitative dietary intake data of infants and young children in rural northern Ghana, we developed local FBDGs. We studied whether these FBDGs are supported by the diversity and quantity of household's foods production among 329 households, identifying nutrient and food gaps at household level. In addition, we conducted a rough analysis of food gaps at district and national level. Further, as diversifying crop production is often mentioned as a potential solution for increasing the diversity of foods available, we studied individual associations between household's food production diversity, household's food and nutrient coverage and child's dietary diversity and nutrient adequacy.

Findings and Interpretations

We found that 40 percent of our subjects were stunted and their nutrient intakes were far below the required amounts: the probability of adequacy for most nutrient intakes was below 50 percent. At household level, the developed FBDGs were on average not able to sufficiently cover the household requirements for fat (60.4 percent of recommended nutrient intake (RNI)), calcium (34.3 percent), iron (60.3 percent), vitamin A (39.1 percent), vitamin B12 (2.3 percent) and vitamin C (54.6 percent). The food production of over half the households supplied insufficient calcium (75.7 percent),

vitamin A (100 percent), vitamin B12 (100 percent) and vitamin C (77.5 percent) to cover their needs. Of all households, about 60 percent of the households did not produce enough to cover their optimised required amounts of grains and legumes and none of vegetables. At district and national level, grain requirements were covered at both levels (267 percent and 148 percent, respectively); legume requirements only at district level (268 percent) but not at national level (52 percent); and vegetable requirements not at both levels (2 percent and 49 percent, respectively). We found that household's food production diversity was positively related with household's food and nutrient coverage. However, household's production diversity, food and nutrient coverage were not related with the child's dietary diversity and nutrient adequacy.

Conclusions

This study shows that although local FBDGs are based on actual dietary patterns and costs, the availability of food can be a limiting factor in the ability of populations to adopt the FBDGs. Therefore, the promotion of food-based dietary guidelines through nutrition education or behavior change communications activities alone is not enough to lead to improvements in diets. Additional strategies are required such as agricultural- and market-based strategies, especially for vegetables, in combination with nutrition-specific interventions including food fortification, and home fortification options. These may offer opportunities to further facilitate adoption of recommendations and provide additional support to improve diets of vulnerable populations.

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Does Caregivers' Nutritional Knowledge and Attitudes Mediate Seasonal Shifts in Children's Dietary Patterns – A Case Study of Rural Young Children in Western Kenya

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Introduction

Globally 800 million people are still hungry and another 2 billion people are suffering from hidden hunger. Rural households dependent on rain-fed agriculture are worst hit. They experience variations in food and nutrient availability occasioned by seasonality of production patterns. This results in periods of nutrient abundance in plenty seasons followed by periods of nutrient inadequacies and malnutrition. This pattern contributes to a cycle of deteriorating health and nutrition status and deprives children of their ability to realize full developmental potential. This study investigates the role of caregiver's nutritional knowledge and attitudes in mediating effects of seasonality on children's diets.

Methods

Repeated cross-sectional surveys were conducted on 151 randomly selected households with children aged 12-23 months in the plenty and lean seasons to collect dietary data of the children and assess the caregivers' nutritional knowledge and attitudes related to child feeding. Dietary data was collected using two non-consecutive quantitative 24-hour recalls and caregiver's nutritional knowledge and attitudes assessed using interviewer administered questionnaire. Quantities of food ingredients consumed by children were converted to individual nutrient intakes using food composition tables in the Lucille for food intake software and the micronutrient of the diets assessed using the nutrient adequacy ratio (NAR) and mean adequacy ratio (MAR) of 11 micronutrients (niacin, thiamine, riboflavin, vitamin B6, vitamin B12, vitamin C, vitamin A, folate, iron, zinc, and calcium). The responses to knowledge and attitudes were assigned scores ranging from 0 to 12 for knowledge and -19 to 19 for attitudes in order to obtain scale variables. A correct response to knowledge question earned 1 score while for the attitudes a positive attitude was awarded a score of 1, negative attitude score of -1 and an 'ok/so – so' or no response was awarded a score of 0.

Findings and Interpretations

Sixty-five percent of the caregivers had attained a primary level education or less. There was a positive modest correlation between caregivers' nutritional knowledge and their attitudes ($r=0.3$, $p<0.000$, $\alpha=0.01$). The MAR of the children's micronutrient intakes was 0.84 (± 0.11) during the plenty season decreasing to 0.80 (± 0.11) during the lean season ($t_{150}=3.53$, $p<0.001$). The NAR was more than 0.7 for all the nutrients during the plenty season except for zinc, iron and calcium. The minerals zinc, iron and calcium were the most problematic micronutrients with both seasons recording high prevalence of dietary inadequacies of up to 84 percent. Multivariate regression to model the effect of

caregiver's nutritional knowledge and attitude scores while controlling for the effect of socio-demographics and MAR at first season (plenty) found that caregiver's nutritional knowledge ($\beta = -.007$, $SE=.003$, $p=.027$, 95% CI= (-.013,-.001) $\eta^2 =.033$) but not attitudes ($\beta = -.003$, $SE=0.002$, $p=.209$, 95% CI= (-.007, .002); $\eta^2 =.011$) had significant effects on the changes in MAR between seasons. Improving the caregivers' knowledge score by one unit would result in a reduction of the deviation in the quality of the diet by 0.7 percent.

Conclusions

Our study confirms findings of earlier studies that indicate seasonal variations in dietary intakes of children among rural households; however, we further demonstrated that caregiver's nutritional knowledge is an important factor that mediates seasonal changes in diets. Therefore, increasing nutrition knowledge among these households will help stabilize dietary intakes across seasons. Moreover, we recommend that programs that aim at improving dietary intakes among children should consider changing attitudes in addition to nutrition education.

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Dietary Transitions in Ghanaian Cities: Using Innovative Methods to Map the Social and Physical Food Environments that Drive Consumption of Unhealthy Foods and Beverages, to Identify Contextually Appropriate Policies and Interventions: the DFC Dietary Transitions in Ghana Project

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Introduction

Dietary habits are transitioning in urban Africa and nutrition-related non-communicable diseases (NR-NCDs) are becoming an important public health problem, particularly amongst women. Energy-dense nutrient-poor (EDNP) food and beverage consumption is associated with increased energy consumption and lower micronutrient intake. The overconsumption of EDNP products is therefore implicated in the onset of NR-NCDs and contributes to micronutrient deficiencies. This DFC Dietary transitions in Ghana project 1) investigates the factors in the social and physical food environments that drive consumption of EDNP food and beverages in women and adolescent girls, and 2) harnesses this understanding to develop context-relevant interventions to improve diets.

Methods

Setting: Two Ghanaian cities of different demographic transition stages: Ho-population>270,000; Accra-population>1.8 million.

Study populations: n=192 women/adolescent girls throughout the reproductive life course (13-49 years). Community informants (n=24) and national stakeholders will also be interviewed 2017-2019.

Tools: Socio-ecological approach using innovative qualitative and quantitative methods. So far, we have:

- Collected dietary information on 192 participants using a qualitative 24-hour recall that accounts for participants' social practices. Following the classification of foods as EDNP or not using a nutrient profiling tool, we will explore what drives EDNP food and beverage consumption by analysing how 'tempo', 'periodicity' and 'synchronisation' are associated with EDNP intake;
- Completed Photovoice interviews with 64 participants. These will lead to the development of community photography exhibitions in Accra/Ho (launch in June 2018);
- Mapped food environments using Geographic Information System (GIS) to assess the availability of foods/beverages and the food advertising environment in both cities.

The next phase integrates these findings on drivers into developing priorities for context-specific interventions by using innovative methods to consult with local community

informants (Community Readiness Model); and national stakeholders (the Food-EPI tool across the seven domains of food environments in the INFORMAS framework for benchmarking policy in relation to healthy food environments).

Findings and Interpretations

Preliminary findings indicate that drivers of food choice act across all socio-ecological levels. Food safety, encompassing microbiological safety, food handling, toxicity from pollutants, and the sanitary environment around food outlets emerged as key drivers of food choice. The cost of food and financial access were also identified by participants, especially in Ho. GIS mapping has indicated that a diverse range of both healthy and unhealthy foods and beverages are available in both cities. Sugar sweetened beverages are widely advertised in Accra and Ho (over half in Accra and one-third in Ho of food advertisements). All drivers have been incorporated into the development of an evidence-informed conceptual framework to illustrate the social and physical environmental drivers of EDNP food and beverage consumption that have emerged, which will be further developed and validated. The framework will identify the key drivers that could be targeted so that culturally appropriate interventions can be developed. The adaptation of a nutrient profiling tool is underway to classify the 144 foods consumed as EDNP (or not) using nine nutrients to encourage and three to avoid. Forty potentially relevant policies to prevent NR-NCDs were identified in Ghana across the seven domains of food environments in the INFORMAS framework.

Conclusions

The use of these novel qualitative and quantitative methods in this context has allowed us to shed light on how food environments are shaping food choices. The triangulation of findings and building of an evidence-informed framework will allow us to identify drivers that are important and specific to African cities. Using methods that give communities a voice (PhotoVoice and the Community Readiness Model) allow unique context relevant insights. The Food-Epi assessment of the food policy environment has indicated that there is already a lot of relevant policy activity in Ghana. An important challenge is to ensure that such policy does no harm on other forms of malnutrition, therefore the double-duty nature of such actions will be assessed during the prioritization process.

Market Access and Changes in the Structure of Food Consumption: Evidence from Nigeria

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Introduction

As food systems change, diets and diet quality also change in response. This process varies substantially over space and time, depending on underlying preferences, food availability, and market integration. In Nigeria, the food system currently has clear deficiencies, with high levels of both stunting and wasting (43.6% and 10.6% respectively) and rising obesity (as high as 22% in Lagos). In this paper, we examine how household level food consumption changes, both with increases in consumption levels and changes in market availability, in order to understand how diets are evolving in Nigeria.

Methods

We use all six rounds of the Nigerian LSMS-ISA survey in our analysis, with surveys conducted both post-planting and post-harvest in 2010-2011, 2012-2013, and 2015-2016. The panel study included 5000 households in 494 communities across Nigeria including both urban (156) and rural (338) areas. These data allow us to isolate changes in household level food consumption both seasonally and over time. Using the household consumption module, we calculate food expenditure aggregates for broad categories including grains, fruits, vegetables, meats, pulses, dairy, and fats, incorporating both food consumed within and away from home. We can then link these expenditures to both total household consumption, as a welfare measure, and changes or perceptions in changes of market access.

We conduct both descriptive and econometric analyses. In the descriptive analysis, we examine trends in the data to understand how food consumption is evolving over time, by region and location (rural/urban) as well as by region (North/South). In the econometric analysis, we use specifications suggested by Deaton and Paxson (1998), looking at changes in welfare on food expenditures while using household level and community-survey round fixed effects and exploring heterogeneity by region, wealth, and rural areas.

Findings and Interpretations

Preliminarily, we find a number of intriguing trends in the data. Our initial analysis has largely been focused around trying to describe both trends in consumption generally and to understand how consumption both evolves over time and by region.

Many of the basic facts in the data are as expected. As consumption increased, non-food consumption increases faster than food consumption. Rural areas have higher

consumption levels of grains despite lower consumption overall; and dairy is more often consumed in the North while fruits and meat are more often consumed in the South. Of all other categories, whereas the North has higher consumption of grain, pulses, and dairy and the South broadly shows higher consumption of fruits and meat.

Informed by these trends, we next use the econometric approach described above to study the relationship between overall household expenditures and budget allocations to the different food expenditure categories. Somewhat surprisingly, we find as consumption increases, relative to the trend, both grain and meat consumption rise. Simultaneously, we find a decline in the share of expenditures on vegetables and oils. These responses are stronger in the North and in rural areas. Analysis incorporating changes in market access is ongoing.

Conclusions

In sum, our preliminary findings are that as households have increases in consumption, they eat more grains and meat, and reduce their consumption of vegetables; this finding appears robust to various econometric specifications. Although we are not measuring diet quality directly, correlations between household level consumption and diet quality imply that if incomes and consumption were to rise substantially, diet quality could get worse — at least on average — rather than improve. Further analysis is exploring the difference in these findings both by location — e.g. urban versus rural — and by variables that measure how market access has changed over the course of the panel, particularly in rural areas where such variation may be more important for diet quality.

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Multiple Regression Analysis of Drivers of Food Choice in Tanzania

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Introduction

Several studies have addressed the impact of seasonality on food choice in sub-Saharan Africa in terms of childhood nutrition, human capital development, and household caloric consumption. This paper seeks to examine the relationship between seasonality, affordability, and frequency of consumption employing regression analysis of Cost of the Diet data collected in two livelihood zones in Tanzania. The paper serves two purposes: 1) expand the use of the Cost of the Diet methodology for secondary analysis and 2) provide a nuanced understanding of food consumption habits in Tanzania.

Methods

The Cost of the Diet (CoD) methodology was used to collect market data and food habits from two livelihood zones identified by the Household Economy Approach (HEA): Mvomero and Tanga. Over the course of 12 months, data were collected from 11 markets, 41 traders, and five villages in Mvomero for 252 food items. In the Handeni data were collected across seven markets, 27 traders, and four villages for 252 food items. Food habits and frequency of consumption data were collected using interviews and validated through focus group discussions according to the standard CoD methodology.

Lastly, regression analysis was employed to examine the relationship between self-reported frequency of consumption and the following variables: price (per 100 grams), seasonality (market availability by season), price volatility (standard deviation of price across three seasons), and affordability (percentage of daily household income required to purchase a standard portion of each food item). According to Kaminski et al., (2016) seasonal variation can result in a 10 percent adjustment in caloric intake in poor urban households. The CoD methodology enables an assessment of collected market data disaggregated by livelihood zone, providing a nuanced understanding of the drivers of food consumption of poor rural households.

Findings and Interpretations

According to the regression analysis, annual average price and seasonality were the most statistically significant drivers of food choice for the households surveyed. Price volatility and affordability were the least statistically significant. Other factors not included in the model e.g., convenience, additional inputs needed for cooking (water, cooking fuel, etc.), taboos, taste, and personal preference, are not accounted for in the model, but also constitute significant drivers of food choice.

Affordability of each food item was calculated based on cost per standard portion (as determined by the CoD food items database) as a percentage of daily household income per

family member for very poor households. This approach was replicated from a Miller et al. (2016) study that interpreted affordability as the price per recommended serving of food items. The study also found that food items that cost ≤ 20 percent of household daily income per family member were considered affordable. Wild foods may result in a reduction in the annual cost of the diet for poor and very poor households, particularly in areas with large concentrations of agro-pastoralists. For this reason, daily household income per family member was used to determine affordability rather than percentage of household food expenditure.

Conclusions

One of the challenges identified of assessing seasonality in markets in SSA is the collection of food price data primarily in urban locations. While urban markets may provide a closer approximation of national average prices, they may not be representative of markets accessible to poor and very poor households. By using the CoD methodology, markets were identified and surveyed where consumers are primarily comprised of the lowest two wealth groups. In addition, the food item price provided is the quantity or volume of food most frequently purchased by low-income consumers. The aim of which is to provide better information for the formulation of policies and interventions designed to target poor and very poor households.

These findings are particularly relevant for understanding consumer behavior of poor and very poor households and the consumption of specific food items. Annual price per 100 grams was found to be slightly more statistically significant as a driver of food consumption habits than seasonality. These results suggest that both annual price and market availability need to be considered when designing policies to increase the consumption of specific, nutritious foods more so than price volatility and affordability per standard portion size.

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What Influences (un)Healthy and Environmentally (un)Sustainable Dietary Practices Among Uganda Women? A Qualitative Study Using Photovoice

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Introduction

Rapid urbanisation in low- and middle-income countries is associated with changes in dietary practices, including reduced consumption of traditional, plant-based diets in favour of 'westernised' diets rich in animal protein, salt, sugar, saturated fat and processed food. 'Westernised' diets have been associated with high greenhouse gas emissions, i.e. less environmentally sustainable and associated with an increased risk for nutrition-related non-communicable diseases. In sub-Saharan Africa women are particularly vulnerable to these dietary changes. To achieve healthy and environmentally sustainable dietary practices amidst urbanisation, an understanding of what influences Ugandan women's dietary practices is imperative.

Methods

A quota sampling method was used to recruit women (n=73) from Nakawa division, Kampala city (urban), (n=40) and Nakawuka and Bulwanyi parishes, Wakiso district (rural), (n=33) to participate in a mixed-methods study. The study participants, varying in socioeconomic status and occupation, first completed a qualitative 24-hour recall interview and then one woman was randomly chosen, from within each quota, to participate in a subsequent Photovoice exercise. Of the participants sampled for Photovoice (n=18), those who agreed to take photographs (n=14) were given digital cameras to take pictures depicting their dietary practices and food environments within a one-week period, then photographs were discussed in face-to-face interviews. Participants who opted not to take photographs (n=4) agreed to discuss their dietary practices and perceived food environments, during in-depth face-to-face interviews. Data collection took place between September 2017 and January 2018 and interviews were conducted in English, Luganda or Luo. Interviews were audio recorded, transcribed verbatim and analysed thematically. Codes used in the thematic analysis were generated inductively and deductively, i.e. based on the ecological model [8] and social practice framework. This paper will focus on the preliminary results from the Photovoice exercise.

Findings and Interpretations

Factors that influenced (un)healthy and environmentally (un)sustainable dietary practices were identified at the individual level, and in participants' social, physical and macro-level food environments.

Individual: Participants in both settings identified food waste, preference and perceptions, health, physical and sensory food attributes, food safety and hygiene, and 'adulteration'

as influencing their dietary practices. Food cost and hunger/satisfaction were important among rural participants. Cost, 'cooking skills' and 'type of food' were hindrances towards more environmentally friendly and efficient cooking fuels, e.g. electricity versus charcoal/firewood.

Social networks: Family was a key influence on participants' dietary practices. Participants described food choices in terms of care (e.g. plant-based foods as more healthy than animal-based foods); 'how we grew up' (parents, grandparents, and family); and family members' food preferences. Good customer relationships with food retailers were important.

Physical environment: Rural and urban participants expressed how important 'home' gardens were to produce their own food. Proximity to food retailers, type of food retailers and type of products available were important.

Macro-level environment: The media was highlighted as a mediator of information and consequently attitudes/perceptions towards dietary practices, by some higher-income participants in Kampala; whilst community interventions promoting healthy eating 'skills' were salient influences among rural participants.

Conclusions

The preliminary findings from this study illustrate that the dietary practices of participants in both rural and urban Uganda were influenced by factors that fell within four domains. These included the individual-level (personal need, motivation, desire), within social networks (e.g. family and friends), the physical environment (e.g. 'home' gardens and neighbourhood/community food retailers) and the macro-level environment (e.g. social and cultural norms, media and community-based interventions). Participants' narratives reveal how (un)sustainable and (un)healthy dietary practices (food sourcing, cooking and eating) might be perpetuated when the requisite elements in each domain come together in the practicalities of daily life and in meeting the demands of work, schooling and parenting. These findings demonstrate how the food environment in which one is situated, might influence the execution of dietary practices in daily life and highlight the importance of incorporating factors across these four domains in policy documents or other recommendations aimed at promoting healthy and environmentally sustainable dietary practices in Uganda and other similar contexts.

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SESSION 8: AGRICULTURE, FOOD SAFETY AND HEALTH

Session Chair:

The Aflasafe Initiative: Mitigating Aflatoxin Contamination of Maize and Groundnut Using Atoxigenic Strains of *Aspergillus Flavus* as Biocontrol Agents

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Introduction

Aflatoxin contamination of staple crops is frequent across sub-Saharan Africa (SSA). This negatively impacts health, food security, and trade sectors, and affects farmers, traders, markets, and consumers. Several *Aspergillus* species produce aflatoxins. However, certain *Aspergillus flavus* genotypes do not produce aflatoxins (atoxigenic) due to defects in the aflatoxin gene cluster. Atoxigenic genotypes used as active ingredients in biocontrol products efficiently reduce crop aflatoxin contamination from field to plate (up to 100 percent).

Methods

An environmentally friendly aflatoxin biocontrol technology was developed in the United States, where almost a million acres of susceptible crops are treated annually. The technology has been improved for use in SSA under the tradename Aflasafe. IITA, USDA-ARS and national partners have developed several Aflasafe products. To date, products are registered in Nigeria, Kenya, Senegal, The Gambia, and Burkina Faso. Efforts are underway to develop and register Aflasafe products in other SSA nations. In parallel, state of the art technology has been developed for large-scale manufacturing of Aflasafe. Since 2013, The AgResults Aflasafe project, funded by the Bill & Melinda Gates Foundation (BMGF) and the Governments of Australia, Canada, United Kingdom, and the United States, began to incentivize agribusinesses to promote adoption of Aflasafe in Nigeria.

Findings and Interpretations

With a single application of 10 kg/ha, all Aflasafe products, registered and under experimental use, reduce aflatoxin concentrations in treated crops by >80 percent compared to untreated crops in both field and storage conditions. The technology consistently and efficiently reduces crop contamination to safe levels. This has sparked interest to commercialize Aflasafe products and treated crops. IITA is currently identifying key partners for production, commercialization, and use of Aflasafe at scale in 11

countries as a part of the Aflasafe Technology Transfer and Commercialization project, funded by USAID and BMGF. Large-scale use of Aflasafe is resulting in production of safe and nutritious crops and this allows farmers to reach aflatoxin-conscious premium markets.

Conclusions

Based on effectiveness of biocontrol technologies, use of atoxigenic strains to displace toxigenic fungi should be the central component of a comprehensive management strategy, which must include all available practices in the target nation/area. The strategy must include sensitization, training, institutional (e.g. inclusion of aflatoxins in national health and agricultural agendas, development of aflatoxin-conscious markets), and policy (e.g. disposal systems, testing facilities) actions. Only a holistic aflatoxin management system approach will result in reduced food insecurity, decreased health disorders, increased productivity, and increased income and trade.

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Food Safety Capacity Building in Africa: Current Efforts, Future Prospects

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Introduction

Food safety is a fundamental social value and challenge worldwide, substantially affecting public health, food security and the productivity of the population. Recent findings from the World Health Organization suggest the burden of foodborne disease is comparable to that of malaria, HIV-AIDs or tuberculosis. The heaviest burden falls on children and sub-Saharan Africa has the highest per capita burden. The food safety landscape and challenges in sub-Saharan Africa are complex and diverse. We present findings from a recent study with the objective of providing data, analysis and recommendations to improve and coordinate food safety capacity building in Africa.

Methods

The project mapped and analyzed the initiatives, projects and resources devoted to food safety capacity building in Africa by a wide range of public organizations, including multilateral development organizations, such as the World Bank, the UN agencies, and the STDF; major bilateral donor agencies in the United States, Europe, and Japan; the African Union, the African Development Bank, and the African regional economic communities. Major food industry capacity building initiatives were noted. Discussions and in-depth interviews were held with food safety experts and stakeholders in east, west and southern Africa as well as those from Europe and the United States with extensive knowledge of food safety in Africa. A symposium with lead private sector actors was held in Kenya. A conceptual framework was developed based on risk analysis and the Paris Declaration and this was used to organize and analyse the results

Findings and Interpretations

We identified global, regional and national governance institutions involved in food safety in Africa. We also listed

donors and food industry actors with an interest in African food safety. We used this information to populate a database of projects on food safety between 2010 and 2017. This contains over 500 projects organized by various criteria. Key findings include: the small number of donors responsible for the great majority of food safety projects; the consistently different interests of donors; the poor relation between donor projects and domestic health burden; the tendency of projects to be driven by external rather than African concerns; the growing interest in food safety and the broadening of approaches to investment. We present a quantitative and qualitative synthesis of the findings.

The questionnaire survey and private sector symposium confirmed these salient features and raised additional issues. These included: the focus on outputs rather than outcomes and impacts; the focus on farm and value chain rather than consumer; the challenges of regulation including fragmentation, unclear mandates and low governance; the need for different and specific approaches to support the formal and informal sector; the relative neglect of gender and equity in food safety projects.

Conclusions

We conclude there is massive under-investment in food safety, and current investments are not well-adapted to reducing the burden of foodborne disease. We develop recommendations that address: 1) goals and strategy, 2) implementing framework and mechanisms, and 3) possible approaches to strengthen capacity building in the formal and informal sectors of the African food system. Given the focus of this report on donor community capacity building efforts, they apply primarily to donors and national governments, but in most cases the recommendations entail consultation and involvement with the private sector and a wide range of civil society organizations.

Aflatoxin Contamination of Village Grains in Central Tanzania: Food and Agricultural Practices in Relation to Contamination and Exposure Risk

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Introduction

Food contamination with aflatoxins is a serious threat to human health worldwide, particularly in sub-Saharan Africa. Aflatoxins are toxic and carcinogenic fungal metabolites or mycotoxins produced mainly by *Aspergillus flavus* and *A. parasiticus* on a variety of crops, foods and feeds. Maize and groundnuts are major dietary staples in sub-Saharan Africa and are frequently contaminated with significant quantities of aflatoxins. Aflatoxins may cause severe acute hepatotoxicity and even death, liver cancer in adults, reduced growth rates in children, increased risk of infection, as well as reduced productivity and death of livestock.

Methods

The aims of this project were to 1) explore food practices that may be associated with increased risk of aflatoxin contamination of village grains and exposure of villagers and 2) determine the degree of contamination of various village grains. Our study area was eight villages from two wards in a semi-arid Manyoni District, Central Tanzania. In Majiri ward, the villages were Kinangali, Majiri, Mpandagani and Mahaka, and in Sanza ward, the villages were Sanza, Ntope, Chicheho and Ikasi. Adults (55 women, 21 men) were interviewed using a structured questionnaire to collect information on activities related to food production by village farmers, including crop cultivation, harvest, storage, food processing and knowledge of food toxins. Random and convenience sampling strategies were employed to obtain and enrol participants. Samples of village grains were randomly collected immediately post-harvest (n=134) and during storage (157). Samples were screened by ELISA (AflaCHECK, Vicam) and those containing ≥ 10 $\mu\text{g}/\text{kg}$ aflatoxins, were quantified using HPLC-FLD after immunoaffinity column clean-up. The Tanzania maximum tolerable level (MTL) for total aflatoxins is 10 $\mu\text{g}/\text{kg}$. The respective number of new and stored grain samples were: maize (35, 47), groundnuts (39, 17), sorghum (24, 41), sesame (11, 23), sunflower (9, 10), bulrush millet (6, 7), rice (6, 8), and green gram (4, 4).

Findings and Interpretations

The following practices and factors were identified as increasing the risk of aflatoxin exposure: lack of irrigation, fertilizer and insecticide use on grain crops; prolonged sun-drying of harvested crops; drying over exposed surfaces; reliance on sensory means to determine grain dryness; house storage and storage in polythene bags; lack of use of storage insecticides; in-storage grain damage by insects and vermin;

consumption of non-refined grain based foods; and lack of knowledge of aflatoxins and limited extension services. Total aflatoxin concentration was significantly higher in maize and groundnut ranging up to 192 $\mu\text{g}/\text{kg}$ and 198 $\mu\text{g}/\text{kg}$ respectively, in immediate post-harvest grain samples and up to 213 $\mu\text{g}/\text{kg}$ and 351 $\mu\text{g}/\text{kg}$ respectively, in stored grain samples. In addition, two stored sunflower seed samples were found to contain significant (164 $\mu\text{g}/\text{kg}$ and 171 $\mu\text{g}/\text{kg}$) concentration. We could note a concentration of 10.45 $\mu\text{g}/\text{kg}$ in a single stored green gram sample. The overall mean aflatoxin concentration was lower (25.46 $\mu\text{g}/\text{kg}$) in immediate post-harvest grain samples compared to stored grain samples (50.83 $\mu\text{g}/\text{kg}$).

Conclusions

Village grains for human consumption in central Tanzania, particularly maize and groundnuts may be contaminated with high concentrations of aflatoxins that can pose significant health risk. Existing agricultural and food practices as well as lack of knowledge on aflatoxins may assist aflatoxin contamination of grains as well as human exposure. Therefore, village farmers would benefit from better extension services, using livestock manure as fertilizer, being assisted with drought tolerant seeds as well as better grain drying and storage technologies to achieve optimal and safe food production.

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The Impact of Reducing Dietary Aflatoxin Exposure on Child Linear Growth in Kenya: A Cluster Randomized Controlled Trial

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Introduction

Aflatoxins (AFs) are a group of naturally occurring mycotoxins that pose important health risks. AFB₁, the type of AF produced by *A. flavus* and *A. parasiticus* can lead to death from aflatoxicosis when consumed in high doses and is a potent carcinogen. Observational studies have shown an association between AFB₁ exposure and reduced linear growth in utero and in infants and young children; an inherent limitation of these observational studies is that they cannot fully exclude confounding.

Methods

The study was conducted in rural areas within Meru and Tharaka-Nithi counties in Kenya, an area where maize is the predominant crop and frequent aflatoxicosis outbreaks and widespread contamination of maize have been reported. A cluster randomized controlled design assessed the effectiveness of reducing aflatoxin exposure on child linear growth and serum aflatoxin levels. The intervention consisted of a swapping (contaminated maize was replaced with safe maize) and a stockist component (households were encouraged to purchase from a stockist supplied with clean maize). Women in the fifth to final month of pregnancy were invited to enroll in the study. Outcomes were child length-for-age Z-score (LAZ), the prevalence of stunting, and child serum AFB₁-lysine adduct level 24 (endline, primary outcomes) and 16 months (midline, secondary outcomes) after trial commencement, respectively. Ordinary least squares regression analysis was used to estimate the impact of the intervention. We estimated models that controlled for pre-specified baseline covariates, and reduced models (retaining only the statistically significant socio-economic covariates). Sensitivity analyses were conducted to assess the importance of observations lost to follow-up. In addition, we used multiple imputation to fill in missing values. The standard errors were adjusted clustering.

Findings and Interpretations

Of the 1,230 unborn children enrolled in the study, 881 (72%) were included in the LAZ and 798 (65%) in the serum AFB₁

analysis. Children were on average around 22 months old at endline and four out of 10 were stunted. AFB₁-lysine adduct was detectable in all analyzed serum samples with a mean serum level of 18.1 pg /mg albumin (median 6.1 pg /mg albumin). The intervention significantly reduced In serum AFB₁-lysine adduct levels at endline (intervention effect - 0.273, 95% CI -0.547 to 0.001; one-sided p= 0.025), but had no effect on child LAZ or on the prevalence of stunting at endline. At midline, the intervention increased LAZ by 0.16 (95% CI -0.009 to 0.33; one-sided p=0.032) and reduced the prevalence of stunting by 7 percentage points (95% CI -0.125 to -0.007; one-sided p=0.015), but had no impact on serum AFB₁ levels. The sensitivity analyses (reduced model, model including the predicted log-odds of dropout, multiple imputation) did not change any of the findings.

Conclusions

This study, carried out in eastern Kenya, is the first cluster-randomized controlled trial to test whether aflatoxin exposure stunts child linear growth. The intervention significantly lowered serum aflatoxin levels: at endline, children in treatment communities had serum aflatoxin levels that were 27% lower than in the control communities. The intervention, however, did not improve child linear growth. The midline growth effect (secondary outcome) leads to important questions regarding the timing of toxicity of aflatoxin for growth. The intervention appears to have had a large positive growth effect when children were on average between 13 and 14 months old, but this growth effect was no longer observed in the same children at endline. This suggests that the toxic effect of aflatoxins might vary by age. Future studies should explore these age-varying effects. Even if future studies find no effect of aflatoxin on linear growth, research should focus on better understanding the (hypothesized) effects of aflatoxin exposure on environmental enteric dysfunction, systemic inflammation, immunomodulation, and changes in the hepatic metabolism of micronutrients. Several of these pathways are likely to affect other critical outcomes, such as child health and development.

Assessment of the Microbiological Safety of Fermented Milk (Nunu) in Northern Ghana and the Influence of Hygiene Training

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Introduction

In some low- and middle-income countries (LMICs) fermented milk products are used in complementary feeding of young children, but research in Ghana by Omore et al. (2009) found that many ready-to-consume dairy products including fermented milk (nunu) failed to meet quality standards for faecal coliforms, indicating poor hygiene during milk collection and processing. Consequently, DFID-funded training was carried out on personal hygiene and good manufacturing practices for producers of dairy products in northern Ghana in 2012. This study aimed to assess the presence of coliforms and other pathogenic bacteria in nunu, and whether training influenced the findings.

Methods

Ten trained and 10 untrained nunu producers were recruited randomly from a large volunteer group. Samples of nunu were collected from each producer at designated venues, days and dates agreed and fixed by researcher and producers. Repeat samples were collected from each one week apart during June 2015. Samples were collected into sterile Stomacher Circular 400 Standard bags (BA6141; Seward West Sussex, United Kingdom) and immediately packed on dry ice in ice chest and transported to the Animal Research Institute Laboratories in Accra, Ghana by air. The samples were stored in the laboratories at -20 °C in deep freezers until microbiological safety assessment by culture and non-culture methods. Denaturing Gel Gradient Electrophoresis (DGGE) and Next Generation Sequencing of the bacterial 16S rRNA was used to assess the full bacterial composition of 10 out of 40 samples from which DNA had been extracted. Producers were also interviewed using a semi-structured questionnaire to establish how they routinely prepared and stored nunu and to assess adherence to the DFID funded training recommendations. The training was on personal hygiene and good manufacturing practice to avoid the public health risk of pathogenic organisms especially coliforms in fermented milk products.

Findings and Interpretations

Between half to three-quarters of all samples from both trained and untrained milk processors contained coliforms including *E. coli*. There was no significant difference in the presence of coliform bacteria, including *E. coli*, in samples from trained producers (75%) compared with untrained producers (50%) $p=0.102$. Adherence to training recommendations was poor. Common practices by both trained and untrained producers of nunu include use of unpasteurised milk, no cooling/refrigeration of milk during

handling or processing of fermented milk, milk was not cooled or refrigerated during handling and/or processing use of plastic containers and calabashes, and starter cultures were not used. Results from the sequence analysis and DGGE indicate that although the most prevalent bacteria in nunu were streptococci, there was also a relatively high abundance (often exceeding 10% of total bacterial content) of other potential pathogens e.g. *E. coli* or *Shigella* species and *Enterobacter* were prevalent comprising more than 10 percent of the total bacteria identified in 7/10 samples and *E. coli* or *Shigella* species comprised more than 10% of total bacteria present in 4/10 samples analysed. The current training methods do not therefore alleviate the problem of bacterial contamination, illustrated by minimal difference in bacterial contamination of samples from trained versus untrained producers.

Conclusions

Coliforms and other pathogens were common in the nunu samples and there was no evidence of an effect of training on the presence of pathogens. To meet these challenges, alternative methods such as the Lactoperoxidase Milk Preservation System may be used in place of refrigeration or the adoption of the Village Milk System involving pasteurisation and packaging of fermented milk products. It is also important to consider using probiotic starter cultures in the processing of fermented milk products. It has been suggested that fermented milk in complementary feeding for the prevention of anaemia could be an innovative theme to focus and there is some limited evidence of the potential of using probiotics to promote child growth. Therefore, an alternative strategy could be the promotion of the production of 'probiotic fermented milk products' using novel bacteria starter culture of *Lactobacillus rhamnosus* yoba 2012 and *Streptococcus thermophilus* C 106. Provision of training methods which can be readily adhered to by predominantly rural producers, and monitored compliance is essential if these products are to be produced in a safe form, especially for complementary feeding.

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The Rapid Degradation of Lambda-Cyhalothrin Makes Treated Vegetables Relatively Safe for Consumption

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Introduction

Lambda-cyhalothrin (λ -cyhalothrin) is the most used pyrethroid insecticide for vegetable farming in Benin. This insecticide is misused and overused by farmers hence may pose health hazards to consumers.

Methods

We monitored λ -cyhalothrin residues in lettuce and cabbage from farms to market gates in Cotonou and Parakou using High Performance Liquid Chromatography (HPLC) analysis techniques. Lettuce samples were collected from Houeyiho farms located in Cotonou and many other sales collection points within the same town. Similarly, cabbage samples were collected from Bawera vegetable farm in Parakou and also in identified vegetable sales points within this same town. Collected samples of lettuce and cabbage were taken to the laboratory and analysed for λ -cyhalothrin residues using HPLC. On farm sampling for monitoring the presence of insecticide residues on the two vegetables was conducted a day after insecticide treatment (D1), subsequently, sampling was conducted every 3 days till the 14th day.

Findings and Interpretations

Results revealed that λ -cyhalothrin residues in lettuce from Houeyiho reduced from 4.2 mg/kg on Day 1 to about 0.2mg/kg on Day 7. On Day 9, analysed lettuces were all λ -cyhalothrin free. In contrast, even 14th days post treatments of cabbage from Bawera (Parakou), still recorded presence of λ -cyhalothrin residues in analysed samples. For samples from market gates, λ -cyhalothrin residues were found in lettuce from two markets out of the nine surveyed in Cotonou. Interestingly, none of these contaminated samples had residues above the Maximum Residue Limit (MRL=0.5 mg/kg). Similarly, at Parakou, samples from all 5 surveyed vegetable markets were contaminated with λ -cyhalothrin residues at concentrations below MRL (MRL=0.2 mg/kg).

Conclusions

We conclude that λ -cyhalothrin residues in lettuce and cabbage from farms and markets in Parakou and Cotonou are within the MRL hence, are relatively safe for consumption.

Assessment of Milk Quality in Smallholder Dairy Systems in Kenya and the Impact of Social Networks on Stakeholders' Behaviours and Practices in the Dairy Value Chain

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Introduction

The dairy sector plays an important role in the Kenyan economy. Farmers are becoming more market-oriented in their production strategies, yet the quality of the raw milk reaching the market is not improving. In the absence of appropriate market governance, and institutions capable of ensuring that milk is produced to the quality standards required by the dairy industry, poor quality milk has become a bottleneck to development of the formal value chain, and the growth and expansion of the vibrant and dynamic dairy sector in Kenya, undermining its ability to access profitable higher-end markets, within and beyond its national borders.

Methods

This study was carried out in Nakuru Nyandarua and Laikipia counties in Kenya. This research was conducted using a multidisciplinary, mixed methods approach and farms were sampled using a spatial framework that considers market quality and takes into account urban and peri-urban locations (PUL), mid-rural locations (MRL), and extreme rural locations (ERL). Sampling sites were randomly selected using Grass software to capture spatial distribution. Milk was sampled along different nodes of the formal and informal value chains and analysis for composition and somatic cell count using Ekomilk analyser and Ekomilk somatic cell counter. Culturing of bacteria using MacConkey agar and blood agar was done to test for microbial contamination. Finally, milk ring test for brucellosis was undertaken. Social network analysis (SNA) of dairy value chain was conducted using a Net-Map exercise to map the value chain, actors' interactions and the impact of this interactions on milk quality. Stakeholder meetings were organised for each county and participatory mapping done with the actors representing the various groups in the value chain. Perceptions of power and influence, milk quality challenges and opportunities for improvement elicited during the discussions. Netmaps were redrawn using Visualizer software and transcripts of the discussions analysed using Atlas.ti.

Findings and Interpretations

Results show that milk composition varies according to locations. The mean protein content was slightly below the standard in PUL and ERL while it was slightly above the standard for MRL. Mean freezing points were below the standard range in all locations while the other values were acceptable. When compared based on counties, only Nyandarua satisfied the protein content requirement while the mean freezing points were below the standard range in all counties. There was high microbial contamination of raw milk especially with *Pseudomonas* spp and *E. coli* due to poor

handling of raw milk, lack of testing of milk quality, poor infrastructure in rural areas, the lack of an economic incentive and contractual obligations for smallholder farmers to produce high quality milk. Netmap results show farmers, processors and cooperatives are the core actors in the value chain. There are low levels of vertical and horizontal integration in the informal value chain and it is not fully entrenched in the formal value chains. Contacts guiding transactions and specifying product quality were absent as was economic incentive to improve milk quality. Poor milk prices, poor infrastructure and low access to information contributes to poor food safety performance in the dairy industry.

Conclusions

There is need for concerted efforts to improve milk quality through increased milk testing by the industry, bridging of information asymmetries and establishment of quality management systems to enforce quality control and food safety standards. The various physicochemical composition of milk determines the end product that can be produced by processors. The low protein levels have implication on processing and also falls below the nutritional standards set by the government. The high levels of milk contamination evidenced in this study may expose consumers to public health risks. The findings of this study highlight the need to create an enabling policy environment both in national and county governments to foster growth of the dairy sector through improved milk quality. The governance challenges facing the various government institutions need to be addressed to enable them to implement and enforce policies. There is need for the government to invest in critical infrastructure important to dairy sector such as roads, extension services and testing facilities and equipment as a way of improving milk quality. Milk quality is constrained by information asymmetry which is essential towards improving stakeholders' knowledge and hygienic practises.

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POSTER PRESENTATIONS

| TITLE | PRESENTER |
|--|--|
| Defining and categorising healthy and unhealthy food to develop public health interventions: a systematic review | Zakia Abdul-Haq <i>University of Sheffield</i> |
| Explaining dietary gaps: evidence from Ethiopia and Nigeria | Thom Achterbosch <i>Wageningen University</i> |
| Understanding dietary diversity of children in Kenya: A doer/non-doer approach | Wema Adere <i>International Livestock Research Institute (ILRI)</i> |
| Effect of milk price on dairy consumption in low income households in Nairobi | Silvia Alonso <i>International Livestock Research Institute (ILRI)</i> |
| Capitalizing on incentives: training and certification of dairy traders as a pathway to improved milk safety, health and nutrition | Silvia Alonso <i>International Livestock Research Institute (ILRI)</i> |
| Fathers' nutrition knowledge is associated with household's, women's, and child's dietary diversity in the Agriculture to Nutrition Study in Ethiopia. | Ramya Ambikapathi TBC <i>Harvard University & Purdue University</i> |
| Tracing the Supply Chain for Fresh Milk and Dairy Products Sold in Informal Milk Markets in Accra, Ghana | Joris Gerald Niilante Amissah <i>University of Ghana</i> |
| Effect of Quality Protein Maize on protein status and linear growth of Ethiopian Children: A randomized controlled trial | Masresha Tessema Anegago <i>Wageningen University & Ethiopian Public Health Institute</i> |
| Measuring the Spread of a Homestead Agriculture and Nutrition Intervention in Rufiji, Tanzania | Mia Blakstad <i>Harvard T.H. Chan School of Public Health</i> |
| Participatory farm diversification and nutrition education increases dietary quality in Western Kenya: A cluster randomized control trial | Julia Boedecker <i>Bioversity International</i> |
| Rice Agrosystems and its Effect on Malaria in Africa | Kallista Hay Ching Chan <i>London School of Hygiene and Tropical Medicine</i> |
| Does Household Participation in Food Markets Increase Dietary Diversity? Evidence from Rural Malawi | Ephraim Chirwa <i>University of Malawi</i> |
| Dietary diversity in early life: Evidence from 67,241 infants aged 6-24 months in 39 developing countries | Samira Choudhury <i>CEDEP, SOAS University of London</i> |

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| Impact of Nutrition-Sensitive Agriculture Interventions on Household Dietary Diversity | Nithya DJ <i>MS Swaminathan Research Foundation</i> |
| Effect of fertilizer micro-dosing and harvesting time on antioxidant activity of polyphenol extracts from traditional leafy vegetables | Modoukpè Djibril Moussa <i>Université d'Abomey-Calavi, République du Benin</i> |
| The Effect of Farmer Nutrition Schools on Household Food Production and Women's Dietary Diversity in Bangladesh | Lidan Du <i>Helen Keller International & The SPRING Project</i> |
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| Supporting small and medium enterprises to procure and produce nutritious foods: programmatic and methodological learnings from the Marketplace for Nutritious Food program | Mduduzi Mbuya <i>Global Alliance for Improved Nutrition</i> |
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| Extensive Capacity Development Needs are a Limiting Factor for Implementing Nutrition-Sensitive Agriculture in Nigeria | Adeyinka Onabolu <i>Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria</i> |
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| Consumption of dairy, fruits and dark green leafy vegetables is associated with lower risk of adverse pregnancy outcomes in a prospective cohort study in rural Ethiopia. | Taddese Zerfu <i>African Population and Health Research Center, Inc.</i> |
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