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Animal sourced foods and child nutrition: Evidence from Bangladesh, Nepal and Uganda

Dr. Shibani Ghosh, Dr. Sonia Zaharia, Dr. Patrick Webb

Feed the Future Innovation Lab for Nutrition



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Q&A



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Egypt

Secondary analysis on causes and solution to address stunting in Egypt

Jordan

Evaluation of USAID Jordan's Community Health and Nutrition activity and build academic capacity to support research on health and nutritional status of PLW and children <2

Nepal

- PoSHAN community studies: research agriculture to nutrition pathways
- PoSHAN policy research: measure the quality of nutrition governance
- Aflacohort study: research maternal exposure to mycotoxins, birth outcomes, and stunting in children
- AAMA: evaluation of sustained activities of an enhanced homestead food production intervention
- Child development in rural Nepal: research the relationship between diet and livestock holdings
- Livestock programs in Nepal effects on health and nutrition 4 years post-intervention
- Capacity building—annual symposia, Bangalore Boston Nutrition Collaborative, and research methods workshops

Sierra Leone

Sub-study to determine how EED influences the effectiveness of supplementary feeding on moderate acute malnutrition recovery

Mali

Supported research

Ethiopia

Supported research

Kenya

Supported research

Tanzania

Assess the impact of the Homestead Agriculture and Nutrition project (HANU) in Rufiji district

Bangladesh

BAHNR study: linking agriculture and health for dietary diversity, income, and nutrition

Uganda

- Uganda panel evaluation of Community Connector Program
- Birth Cohort Study: assess aflatoxin levels in women and infants
- Assessment of EED
- Capacity building—annual symposia, Bangalore Boston Nutrition Collaborative

Malawi

- Development of the first Malawian Food Composition Table
- Promotion of nutrition capacity development to meet national priorities

Mozambique

Assess aflatoxin levels in children 6-59 months of age in Nampula province

Timor Leste

Assess extent of aflatoxin exposure in women and children



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ANIMAL SOURCED FOODS

- Source of high-quality protein, iron, vitamin A, zinc and iodine
- Eaten in small quantities can provide these vital nutrients to infants and young children
- Provision of small quantities of ASFs are an important food-based intervention to ensure growth and development of young children (physical and cognitive)



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COMPOSITION OF ANIMAL SOURCED FOODS PER 100 G

Nutrient	Units	Chicken	Beef	Pork	Eggs	Milk	Requirement (6-23 months)
Energy	Kcal	111	124	236	143	61	730
Protein	g	20.3	21.9	17.1	12.56	3.15	4.25
Fat	g	2.7	3.99	17.9	9.5	3.25	6.4
Calcium	mg	10	14	15	56	113	500
Iron	mg	1.03	2.2	1.05	1.75	0.03	11.6
Zinc	mg	1.19	5.51	2.7	1.29	0.37	4.1
Riboflavin	mg	0.134	0.17	0.275	0.457	0.169	0.5
Vitamin B12	µg	0.36	2.42	0.74	0.89	0.45	0.9
Vitamin A	µg of RAE	13	2	2	160	46	400

Source: USDA Food Nutrient Database



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Calcium	mg	10	14	15	56	113	500
Iron	mg	1.03	2.2	1.05	1.75	0.03	11.6
Zinc	mg	1.19	5.51	2.7	1.29	0.37	4.1
Riboflavin	mg	0.134	0.17	0.275	0.457	0.169	0.5
Vitamin B12	µg	0.36	2.42	0.74	0.89	0.45	0.9
Vitamin A	µg of RAE	13	2	2	160	46	400

Source: USDA Food Nutrient Database





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THE LANCET

THE LANCET COMMISSIONS | [VOLUME 393, ISSUE 10170, P447-492, FEBRUARY 02, 2019](#)

Food in the Anthropocene: the EAT–*Lancet* Commission on healthy diets from sustainable food systems

[Prof Walter Willett, MD](#) • [Prof Johan Rockström, PhD](#) • [Brent Loken, PhD](#)   • [Marco Springmann, PhD](#) •

[Prof Tim Lang, PhD](#) • [Sonja Vermeulen, PhD](#) • et al. [Show all authors](#)

Published: January 16, 2019 • DOI: [https://doi.org/10.1016/S0140-6736\(18\)31788-4](https://doi.org/10.1016/S0140-6736(18)31788-4) •  Check for updates

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/ Where do animal-source foods fit in our concepts of 'healthy' and 'unhealthy' fo...

Where do animal-source foods fit in our concepts of 'healthy' and 'unhealthy' foods, and how do we measure them?



By [Jody Harris](#)
World Vegetable Center and Institute of Development Studies

Twitter: [@justjody23](#) [@go_vegetables](#) [@IDS_UK](#)



DO TYPE AND NUMBER OF ASFS MATTER

Cow milk intake and child growth across marginalized populations in the UK (1900s), USA (1920s) and several low-income countries (Hoppe et al 2006)



Fig. 6.7. Milk advertisement based upon Medical Research Council study. Courtesy of the National Archives, Kew, London.



DO ASFS MATTER: ECOLOGICAL/MULTI COUNTRY ANALYSIS

- 116 countries (FAO Food Balance Sheets, UNICEF stunting data): Quality of protein consumed (ASF versus plant-based) negatively associated with stunting (Ghosh et al 2012) in children under 5 years of age
- 185 countries. (Global Dietary Database): ASF intake negatively associated with disability-adjusted life years linked to stunting in children aged 6-59 months. (Miller et al 2020).
- 39 countries (Demographic Health Survey): Infants and young children who did not consume any ASF in the previous 24 hours had a higher probability of being stunted compared to those who consumed all three types of ASF (egg, meat, dairy) (Krasevec et al 2017)
- 49 countries (Demographic Health Survey): Eating more than one type of ASF was associated with a 2.3% point reduction in stunting. (Headey et al 2018).



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DO TYPE OF ASFS MATTER: MEAT VERSUS MILK

The Journal of Nutrition



Symposium: Food-Based Approaches to Combating Micronutrient Deficiencies in Children of Developing Countries

Meat Supplementation Improves Growth, Cognitive, and Behavioral Outcomes in Kenyan Children^{1,2}

Charlotte G. Neumann,^{3*} Suzanne P. Murphy,⁴ Connie Gewa,⁵ Monika Grillenberger,⁶
and Nimrod O. Bwibo⁷

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J. Nutr. 137: 1119–1123, 2007.



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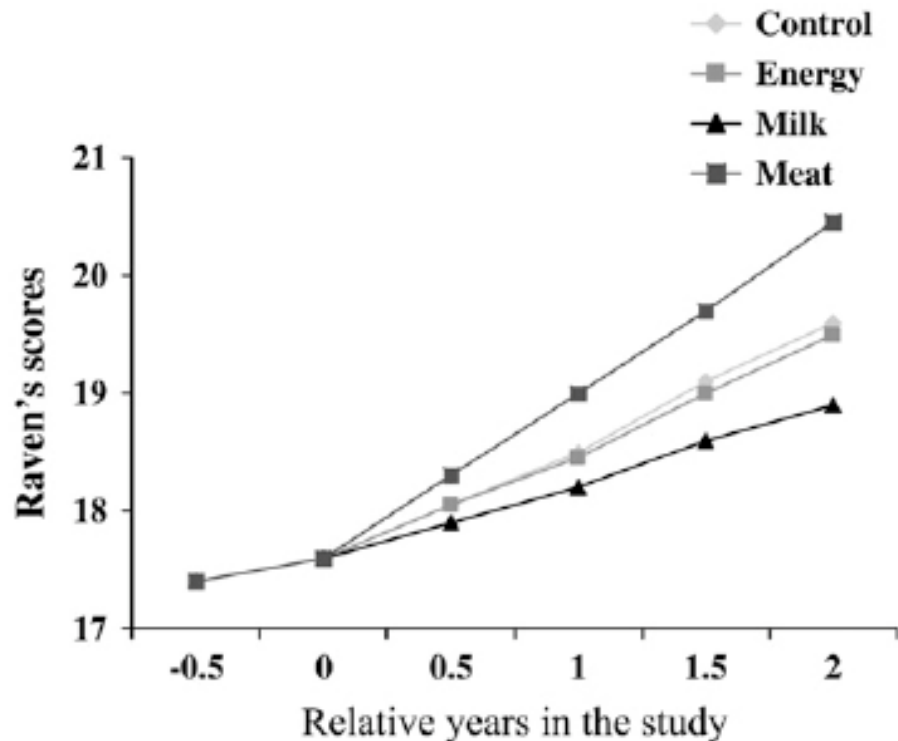


Figure 1 Raven's scores over time by intervention feeding group. From Neumann et al. (28). Reproduced with permission of author, who holds copyright.

1. Control: no food supplement provided;
2. Energy supplement: a food supplement based on a local dish of maize, beans and vegetables (githeri);
3. Milk supplement: githeri plus a glass of milk (200ml); and
4. Meat supplement: githeri cooked with 60g of minced beef.

n= 900 children, 12 schools
(3 schools per group)



MEAT VERSUS MILK

- Meat: Improved cognitive performance, higher levels of PA, increased initiative and leadership behaviors, increased mid upper arm muscle area (lean mass)

Vitamin B12, iron and zinc

- Milk: improved linear growth in younger and already stunted children



A SOURCE OF ENERGY AND MULTIPLE NUTRIENTS

- Both weight and height gain: predicted by intakes of energy, iron, vitamin A, calcium and vitamin B12 from the provided animal source foods (Meat and Milk)
- Negative predictors were total energy and nutrients that are contained in high amounts in plant foods.
- Indicative of the importance of source of energy and micronutrients for growth and development of young children



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Universidad San Francisco de Quito | Washington University in St. Louis
Pan American Health Organization | University of California, Davis | The Mathile Institute

RCT conducted in Cotopaxi, Ecuador

Children aged 6-9 months randomly assigned to treatment (1 egg per day for 6 months, $n=83$) or control (no intervention, $n=80$). Both arms received social marketing messages.

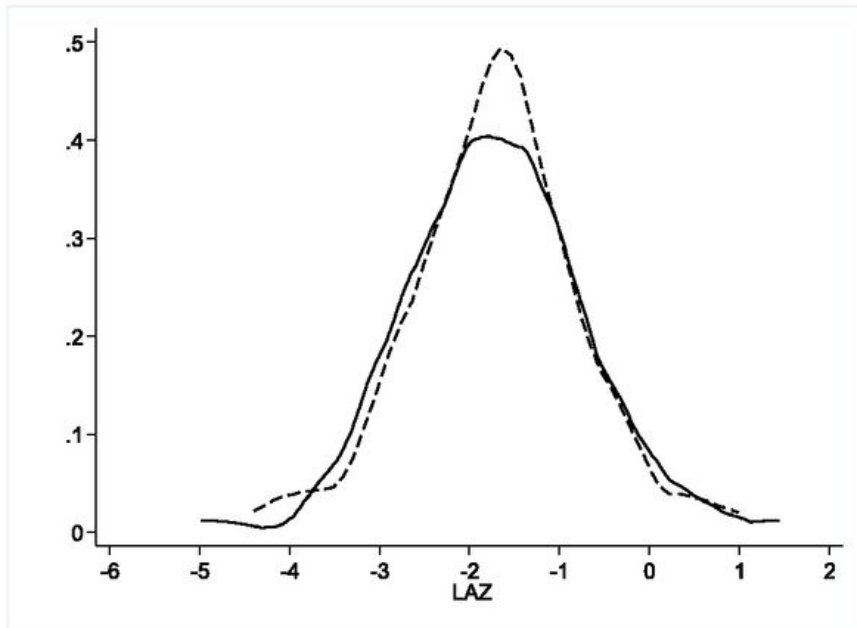
Households visited once per week to monitor morbidity, distribute eggs, monitor egg intakes

Anthropometry, diet intake, morbidity

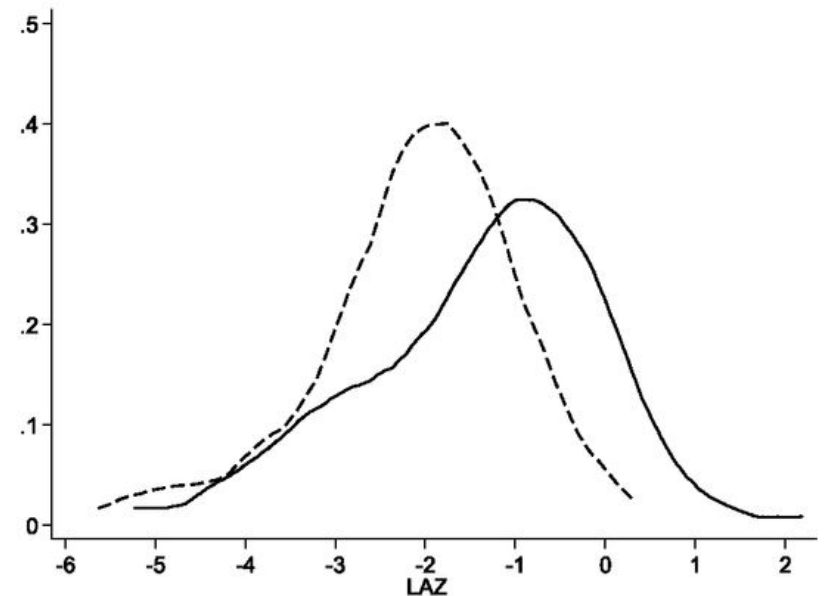


Change in LAZ distribution at baseline (dashed) and at end point (solid).

A



B

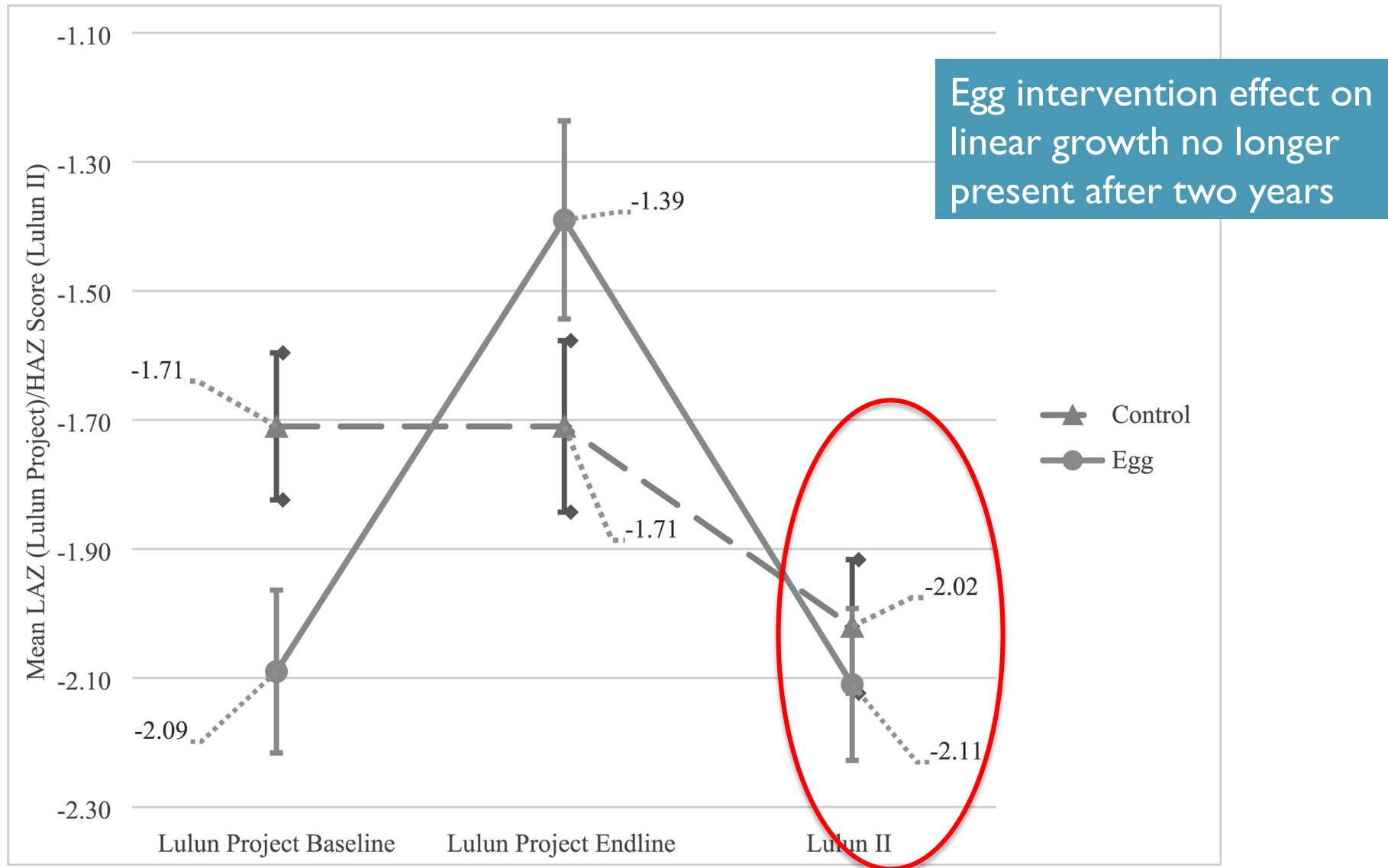


	<i>n</i>	Mean change (SD)	95% CI
A. Control group	73	0.04 (0.08)	-0.11 to 0.19
B. Egg group	75	0.68 (0.10)	0.49 to 0.88
<i>t</i> test <i>P</i> < .001			



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EGGS AND GROWTH

- Lulun II : Current egg consumption to be associated with lowered growth faltering (Iannotti et al 2020)
- The Mazira project in Malawi (Stewart et al 2020) provided the same intervention as Lulun (n=660 infants)
- No effect of egg provision on LAZ
- Significant improvement in head circumference for age

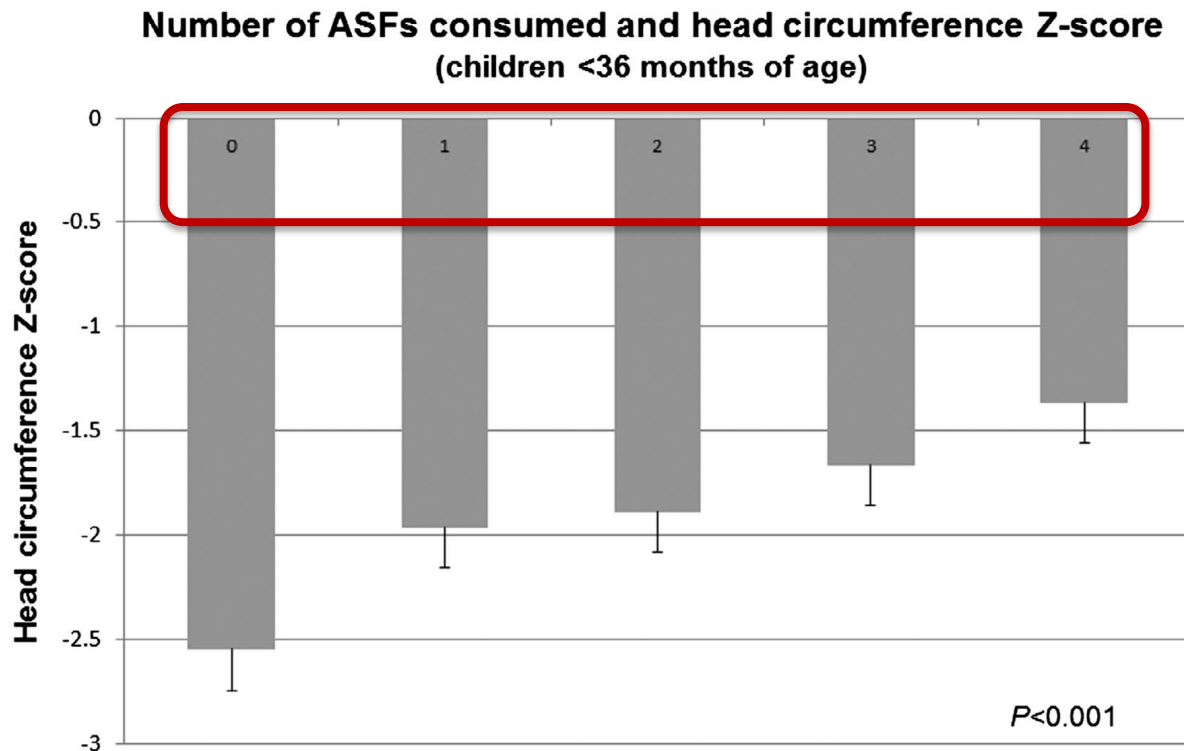


MULTIPLE ASFS

- Bangladesh Environmental Enteric Dysfunction (BEED) study (Mahfuz et al 2020)
- 472 children received 1 egg and 150 ml milk daily for 90 days with a micronutrient mix for 60 days. (174 comparison 12-18-month-old children)
- Change in LAZ in the intervention group of +0.23 (95% CI: 0.18, 0.29; $P < 0.05$), the effect was largest in children that were stunted



Rural Chitwan, Nawalparasi, Nuwakot



Miller et al 2017

Nepal (v)

48m longitudinal study

$N = 600$ children
(3,652 observations)

Head circumference associated with more ASF intake in children <3y not >3y



HEAD CIRCUMFERENCE Z-SCORE AND TYPE OF ASF (PAST 7 DAYS)

Type of ASF in the past 7 days	Unadjusted	Adjusted
Meat	0.003 (0.05)	-0.012 (0.05)
Chicken	0.309 (0.04)**	0.277 (0.04)**
Eggs	0.019 (0.04)	0.031 (0.04)
Milk/Yogurt/Whey	0.194 (0.03)**	0.150 (0.03)**
Fish	-0.136* (0.12)	-0.139* (0.11)

Mixed Effects Linear models

Adjusted for time point of measurement, wealth index, gender of child, low birth weight and age

** $p < 0.01$, * $p < 0.05$

Pooled data: Infants 6-12 months, $n = 1670$

Ghosh et al 2018

Nepal Aflacohort Study
 $N = 1,670$ mother/child pairs



ASFS DO MATTER

- Causal nature of these relationships is contextual
 - Number of ASFs may be a function of total quantity consumed
 - Type of ASF may be a function of geographic location, cultural and dietary preferences in the introduction of certain ASFs over others
 - Gaps remain in our understanding of
 - Timing and age of introduction,
 - Length of time of consumption
- Lagged impacts of consumption of ASFs (single or multiple)**



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Young Children Who Eat Animal Sourced Foods Grow Less Stunted: Findings of Contemporaneous and Lagged Analyses From Nepal, Uganda and Bangladesh

Sonia Zaharia^{1,2}, Shibani Ghosh^{1,2}, Robin Shrestha^{1,2}, Swetha Manohar^{2,3},
Andrew L Thorne- Lyman^{2,3}, Bernard Bashaasha^{2,4}, Nassul Kabunga², Sabi
Gurung^{2,3}, Grace Namirembe^{1,2}, Katherine Heneveld^{1,2}, Lichen Liang^{1,2}, and
Patrick Webb^{1,2}

1. Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA, USA
2. Feed the Future Innovation Lab for Nutrition
3. Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA
4. Makerere University, Kampala, Uganda



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OBJECTIVE

Study the link between anthropometric outcomes (length-for-age z-scores and stunting) of children between 6 and 24 months old and their contemporaneous, as well as past consumption of animal sourced foods (ASFs)



DATA

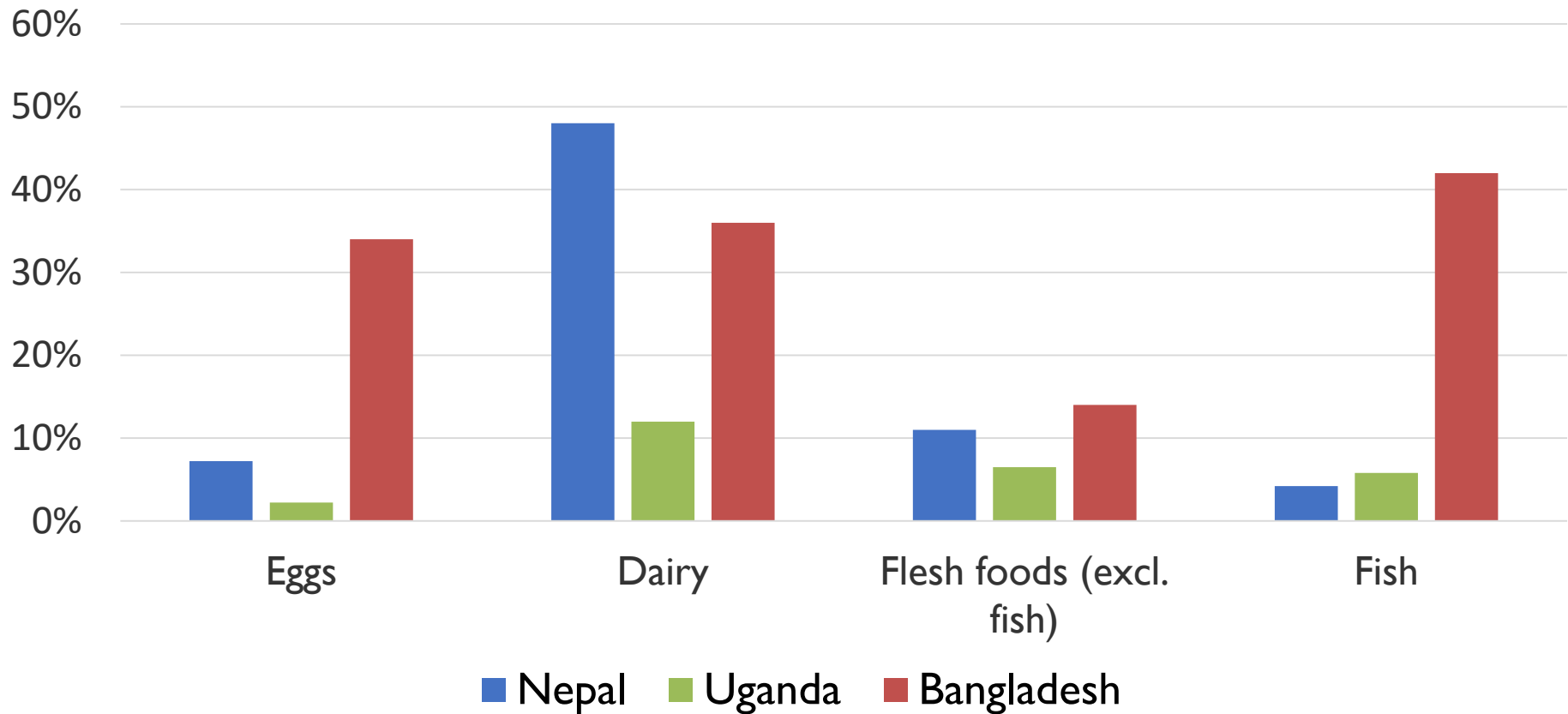
- Nepal (N=1564 children)
 - 4 annual, nationally representative surveys (2013-2016)
- Bangladesh (N=2413 children)
 - 3 bi-annual surveys (2016-2017) from south-western Bangladesh
- Uganda (N=2370 children)
 - 3 biennial surveys (2012-2016) from northern and south-western Uganda
- 24h diet recall



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Share of children in the sample who consumed a given ASF type in their daily diet

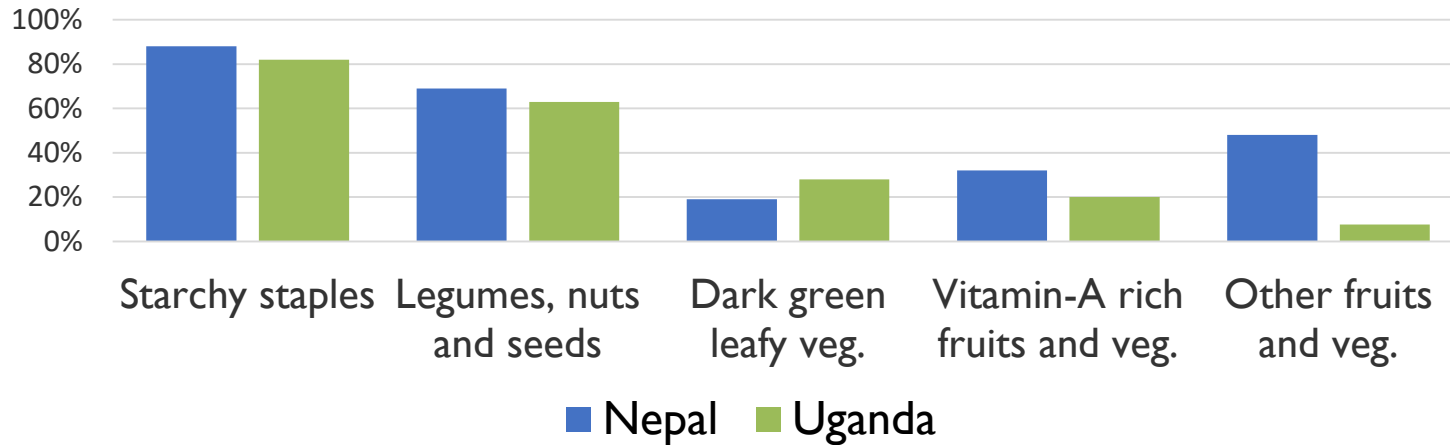




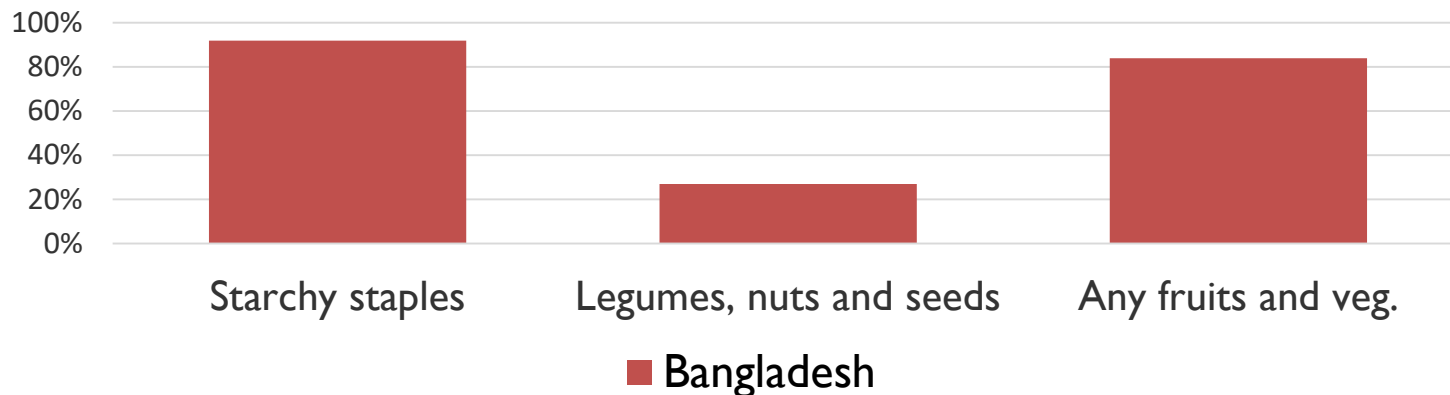
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Share of children in the sample who consumed foods from a given food group in their daily diet



Share of children in the sample who consumed foods from a given food group in their daily diet





METHOD

- Outcomes of interest:
 - Length-for-age z-score (LAZ)
 - Child is stunted (binary variable, equals 1 if LAZ < -2)
- Variables of interest:
 - Child consumed any ASF
 - Consumed 1 type of ASF; Consumed 2 or more types of ASF
- Estimation strategy:
 - Fixed effects panel regressions
 - Unit of observation: child i at time t

$$\begin{aligned} & \text{Child outcome}_{i,t} \\ &= \beta_1 \text{ASF consumption}_{i,t} \\ &+ \sum_j \gamma_j \text{Consumption of foods from group } j_{i,t} + \mathbf{z}'_{i,t} \delta + \lambda \Phi_{d,t} + \varepsilon_{i,t} \end{aligned}$$



Higher LAZ in children who consume ASFs in their daily diet, in particular for children consuming 2 or more types of ASFs

Length-for-age z-score	Nepal (N=1564)		Bangladesh (N=2413)		Uganda (N=2370)	
Child consumed any ASF	0.120*		0.116***		0.138*	
	(0.063)		(0.033)		(0.072)	
Child consumed 1 type of ASF		0.092		0.039		0.099
		(0.066)		(0.041)		(0.076)
Child consumed 2 or more types of ASF		0.258***		0.241***		0.467***
		(0.070)		(0.048)		(0.145)

Reported estimates are from fixed effects panel regressions. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Control variables (not shown):

- Consumed starchy staples, consumed any fruit and vegetables, consumed legumes nuts and seeds, age, age², age³, gender, child had diarrhea in the past 2 weeks, caregiver's education (years), caregiver's height, whether household has an improved latrine.
- Regressions include district x survey round fixed effects



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Length-for-age z-score	Nepal (N=1564)	Bangladesh (N=2413)	Uganda (N=2237)
Flesh foods (excl. fish)	0.128** (0.047)	0.089 (0.076)	0.110 (0.108)
Eggs	0.018 (0.093)	0.135* (0.067)	-0.497*** (0.186)
Dairy	0.118** (0.050)	0.133** (0.049)	0.211** (0.098)
Fish	0.019 (0.117)	0.037 (0.040)	0.166 (0.135)
Starchy staples	0.035 (0.150)	0.157* (0.076)	-0.088 (0.088)
Legumes nuts and seeds	0.146** (0.053)	0.008 (0.052)	0.079 (0.067)
Dark green leafy vegetables	0.185** (0.075)		0.117* (0.068)
Vit.A rich fruit and vegetables	0.111** (0.037)		0.096 (0.068)
Other fruit and vegetables	0.144 (0.116)		0.095 (0.101)
Any fruit and vegetables		0.063 (0.090)	

Reported estimates are from fixed effects panel regressions. * p<0.1; ** p<0.05; *** p<0.01.

Children's past ASF consumption matters for higher LAZ in Nepal and Bangladesh

Length-for-age z-score	Nepal (N=787)		Bangladesh (N=1381)	
Consumed any ASF in her daily diet last year (Nepal) or 6 months ago (Bangladesh)	0.257**		0.140***	
	(0.093)		(0.049)	
Consumed 1 type of ASF in her daily diet last year (Nepal) or 6 months ago (Bangladesh)		0.254**		0.095
		(0.102)		(0.061)
Consumed ≥ 2 types of ASF in her daily diet last year (Nepal) or 6 months ago (Bangladesh)		0.283		0.231***
		(0.162)		(0.048)

Reported estimates are from fixed effects panel regressions. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Control variables (not shown):

- Consumed starchy staples, consumed any fruit and vegetables, consumed legumes nuts and seeds, age, age², age³, gender, child had diarrhea in the past 2 weeks, caregiver's education (years), caregiver's height, whether household has an improved latrine.
- Regressions include district x survey round fixed effects

Children's past ASF consumption matters for lower stunting rates in Nepal and Bangladesh

Child is stunted	Nepal (N=787)		Bangladesh (N=1381)	
Consumed any ASF in her daily diet last year (Nepal) or 6 months ago (Bangladesh)	-0.099**		-0.033	
	(0.034)		(0.024)	
Consumed 1 type of ASF in her daily diet last year (Nepal) or 6 months ago (Bangladesh)		-0.092**		-0.001
		(0.039)		(0.029)
Consumed ≥ 2 types of ASF in her daily diet last year (Nepal) or 6 months ago (Bangladesh)		-0.159***		-0.099***
		(0.036)		(0.019)

Reported estimates are from fixed effects panel regressions. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Control variables (not shown):

- Consumed starchy staples, consumed any fruit and vegetables, consumed legumes nuts and seeds, age, age², age³, gender, child had diarrhea in the past 2 weeks, caregiver's education (years), caregiver's height, whether household has an improved latrine.
- Regressions include district x survey round fixed effects



CONCLUSION

- Contribution:
 - Use longitudinal data
 - Look at contemporaneous and **past** ASF consumption
 - Fixed effects regressions to account for changing local conditions
- Findings:
 - ASF consumption is associated with higher LAZ and lower stunting rates
 - Association is stronger if more ASF types are consumed
 - Past ASF consumption matters in addition to, and sometimes more than, contemporaneous ASF consumption



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Can agricultural or multisector interventions improve intake of animal source foods where diets are currently lacking diversity?

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IMPROVED DAIRY CATTLE AND CHILD MILK CONSUMPTION

Uganda national cross-section [n=2,975 households]

- HHs adopting improved dairy cows increase milk yield*** (>200% on average); higher milk sales and higher milk consumption.
- **Yes, higher sales raised food expenditures by 16%.**
- Improved cows associated with less child stunting.
- **But...adoption far higher in large farms.**



RESEARCH ARTICLE

Does ownership of improved dairy cow breeds improve child nutrition? A pathway analysis for Uganda

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¹ International Food Policy Research Institute (IFPRI), Kampala, Uganda, ² Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA, United States of America

* n.kabunga@cgiar.org



Abstract

The promotion of livestock production is widely believed to support enhanced diet quality and child nutrition, but the empirical evidence for this causal linkage remains narrow and ambiguous. This study examines whether adoption of improved dairy cow breeds is linked to farm-level outcomes that translate into household-level benefits including improved child nutrition outcomes in Uganda. Using nationwide data from Uganda's National Panel Survey, propensity score matching is used to create an unbiased counterfactual, based on observed characteristics, to assess the net impacts of improved dairy cow adoption. All estimates were tested for robustness and sensitivity to variations in observable and unobservable confounders. Results based on the matched samples showed that households adopting improved dairy cows significantly increased milk yield—by over 200% on average. This resulted in higher milk sales and milk intakes, demonstrating the potential of this agricultural technology to both integrate households into modern value chains and increase households' access to animal source foods. Use of improved dairy cows increased household food expenditures by about 16%. Although undernutrition was widely prevalent in the study sample and in matched households, the adoption of improved dairy cows was associated with lower child stunting in adopter household. In scale terms, results also showed that holding larger farms tends to support adoption, but that this also stimulates the household's ability to achieve gains from adoption, which can translate into enhanced nutrition.

OPEN ACCESS

Citation: Kabunga NS, Ghosh S, Webb P (2017) Does ownership of improved dairy cow breeds improve child nutrition? A pathway analysis for Uganda. *PLoS ONE* 12(11): e0167816. <https://doi.org/10.1371/journal.pone.0167816>

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Source: Kabunga et al. 2017. *Plos One*.



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CAN CROPPING DIVERSITY INCREASE WOMEN'S DIET DIVERSITY?

Uganda pooled panel (3 rounds; n=3,600 households)

- **Yes**, linked to better 'diet diversity' scores.
- **Yes**. Cropping diversity (promoted by Uganda Community Connector Project) correlated with more veggies and **meat** intake by women.

Food category	Effect in 2014 (over 2012)	Effect in 2016 (over 2012)
Cereals	-	-
Tubers/roots	-	-
Legumes	-	-
Oilseeds	-	-
Vegetables	**	-
Fruits	-	-
Meats	-	*
Dairy	-	-
Fats/oils	**	*

Source: Kabunga, Liang, Bashaasha et al.



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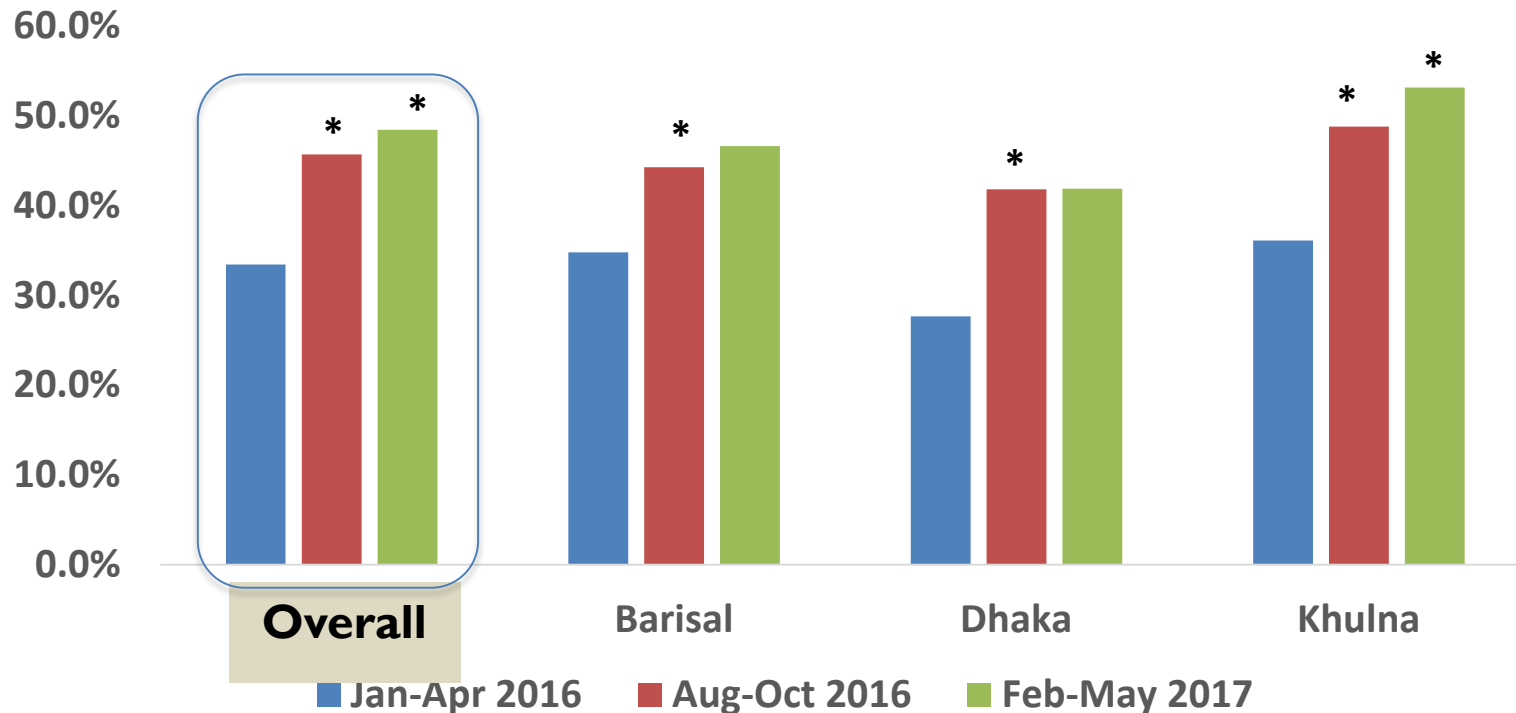
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Can *Aquaculture Promotion* Raise Fish intake for Children >24m

Bangladesh (southwest), 3 rounds, 3000+ households

* Significantly higher compared to Round 1
p<0.05 (logistic regression, controlling for wealth, education, gender of head, etc.)





CHANGE IN *SMALL FISH* CONSUMPTION

Bangladesh (southwest), 3 rounds, 3000+ households

Diff R3-R1 (grams)	Child	Female caregiver
No USAID program exposure	Reference	Reference
Exposed to one USAID program	-0.308	0.154
Exposed to multiple USAID programs	3.736*	7.041*
N	2791	2801

β -coefficients are shown in the table above; * $p < 0.05$

Models adjust for engagement in aquaculture and horticulture, baseline fish consumption, female caregiver's education level, HFIAS



HOUSEHOLD DIETARY IMPACTS

Bangladesh (southwest), 3 rounds, 3000+ households

	Total household expenditure	Household food expenditure	Household diet diversity
<i>Neither aquaculture nor horticulture</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
<i>Either aquaculture OR horticulture</i>	0.040	0.024	0.139
Aquaculture AND horticulture	0.348**	0.366*	0.246*
N	2802	2800	2800

β -coefficients are shown in the table above; * $p < 0.05$; ** $p < 0.01$

*Models adjust for baseline expenditure, household diet diversity, education, household food insecurity and access score (HFIAS).

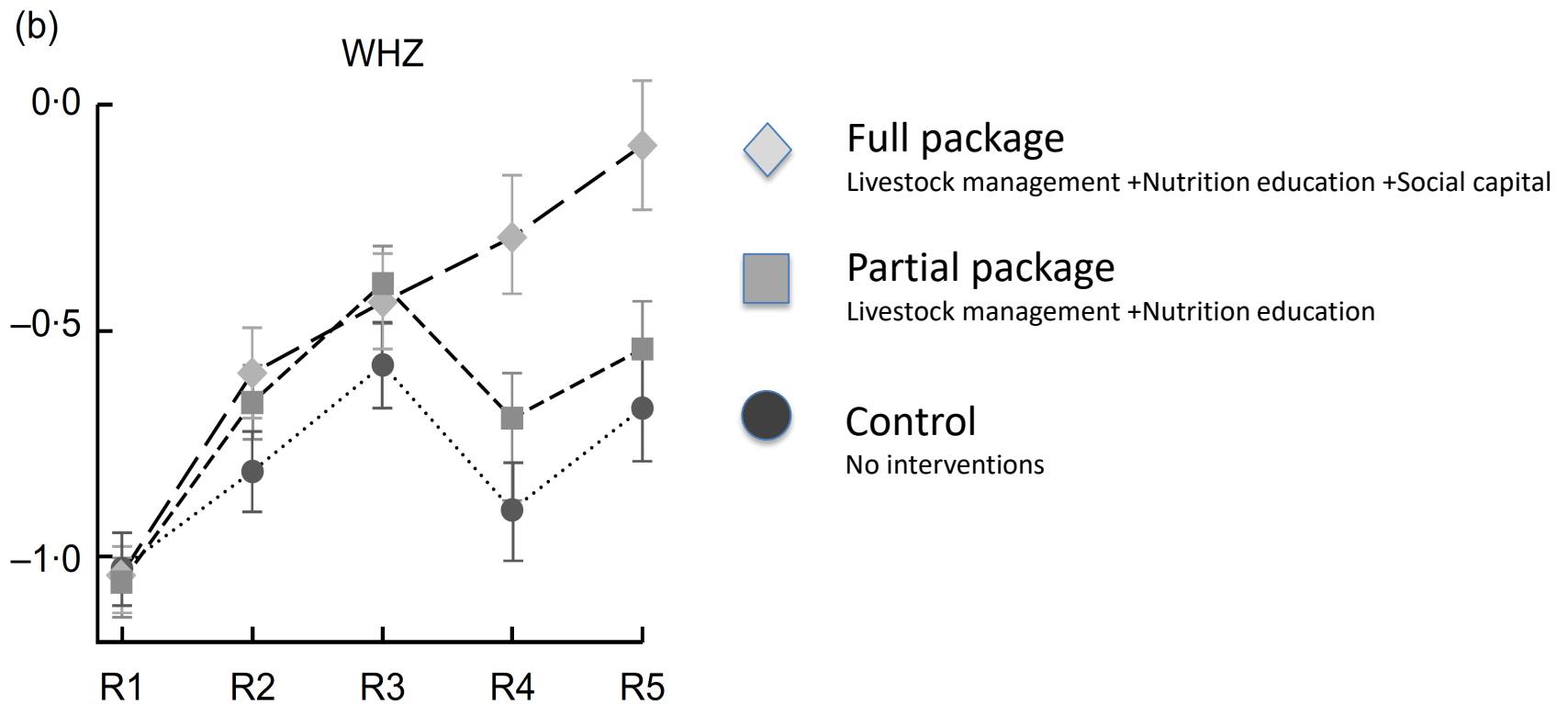


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3-ARM RCT IN NEPAL

5 rounds of data collection (N = 974 HHs, 1,333 children)



PRODUCING **EGGS** (PROMOTED BY SUA AHARA) ASSOCIATED WITH HIGHER CHILD INTAKE, IN NEPAL ESPECIALLY IN POOREST HHS

Repeat nationally representative panel (3 rounds); N=3,500+ HHs

	(1) All regions	(2) Mountains	(3) Hills	(4) Terai
HH produces egg	1.064*** (0.27)	3.865*** (0.86)	1.865*** (0.43)	0.691** (0.28)
Wealth quintile	0.226*** (0.06)	0.624*** (0.15)	0.513*** (0.14)	0.183*** (0.06)
Produce egg X Wealth quintile	-0.107 (0.08)	-0.748*** (0.19)	-0.353*** (0.08)	0.037 (0.08)
Land rented (hectares)	-0.021** (0.01)	0.040*** (0.01)	-0.020 (0.01)	-0.273 (0.21)
Land owned (hectares)	-0.008 (0.01)	-0.025** (0.01)	0.000 (0.01)	-0.212 (0.20)
Child's age (months)	0.095*** (0.01)	0.022 (0.04)	0.104*** (0.02)	0.108*** (0.01)



CONCLUSIONS

1. Yes, agriculture and multisector interventions *can* increase output and intake of ASFs among women and children of producing households.
2. Some increased dietary intake is from own production, much from market purchases.
3. Access to markets key to both productivity and dietary gains.



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Q&A



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