THE EFFECT OF PRICE RISK AND MARKET PARTICIPATION ON THE DEMAND FOR NUTRITION AMONG AGRICULTURAL HOUSEHOLDS IN BANGLADESH

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Integrating Gender and Nutrition within Agricultural Extension Services

Motivation

- Food security
  - Availability, access, and **utilization**

- 795 million people "undernourished" globally despite technological advancements in agriculture
  - Undernourished: unable to meet the dietary energy requirements for a healthy and active life

- High rates of micronutrient deficiencies exist due to low dietary diversity
  - Vitamin A, iron

Pathways from Agriculture to Nutrition
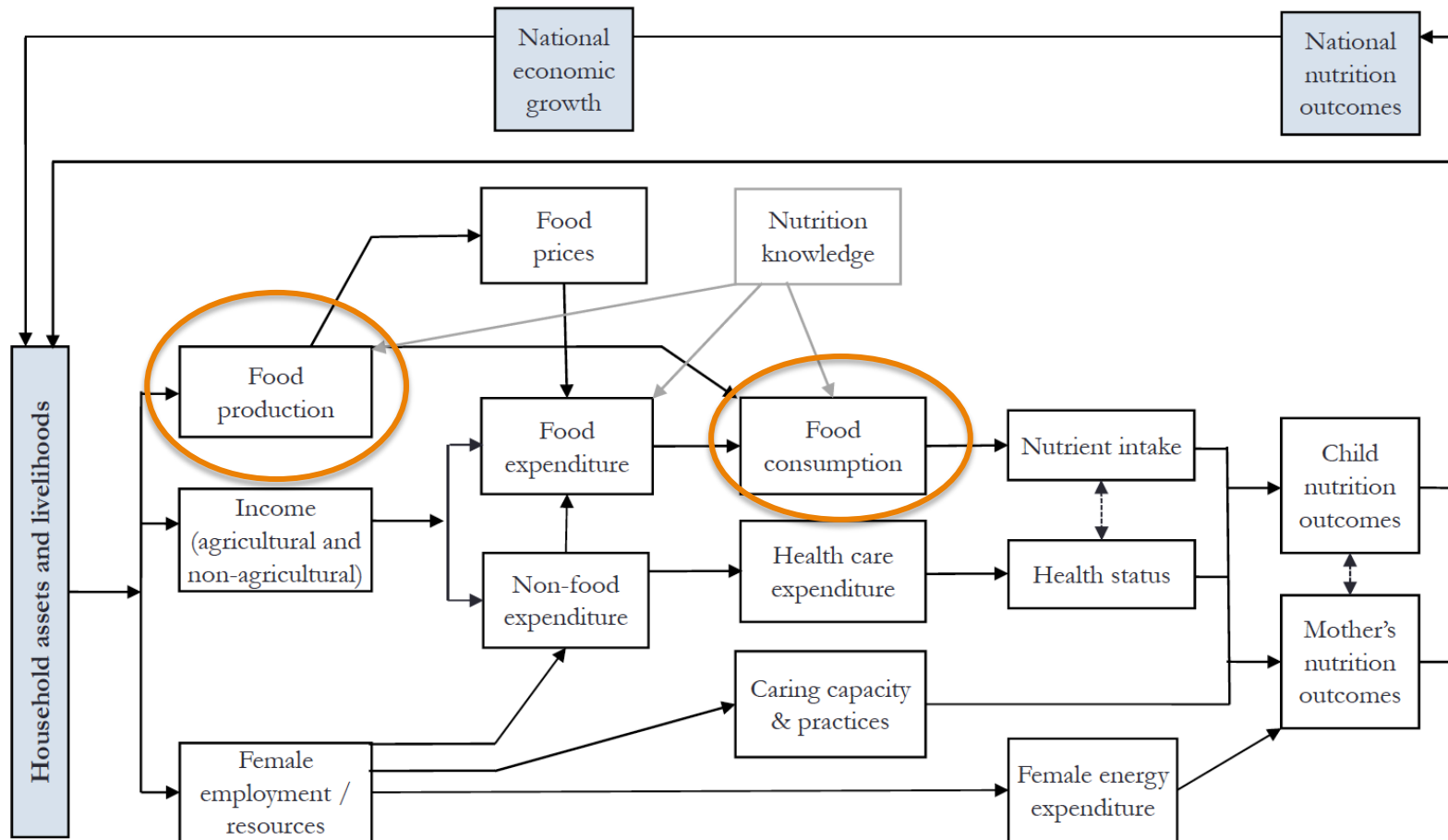
Source: Harris and Herforth (2013) From Agriculture to
      Nutrition: Pathways and Principles Feed the Future
      Nutrition Global Learning and Evidence Exchange

Research Objectives

- To develop an economic framework for linking nutrition and agriculture
  - Health and nutrition in the agricultural household model
    - Barnum & Squire (1979); Singh et al. (1986); Becker (1965); Behrman (1988)
  - Market participation and price risk
    - Barrett (2008); Bellemare, Barrett and Just (2013)
  - What is the trade-off between the production and consumption of nutrients such as protein, vitamin A and iron?

- To empirically model the relationship between dietary diversity, production diversity, and market participation in Bangladesh using household survey data

Bangladesh

- Micronutrient deficiency in Bangladesh
  - 40% of population is malnourished
  - 33% of children under five low height for age (stunting)
  - 36% of children under five low weight for age (wasting)
- Low dietary diversity
  - 70% of energy intake from rice
- Higher rates of malnutrition in rural areas
  - 35.3% of households in rural areas are food-energy deficient (IFPRI, 2013)
    - Cannot afford adequate diet to supply 2,122 kcal/person/day

Findings

- Participation in markets for selling agricultural products improves farm diversity but decreases dietary diversity
  - Farmers may have more incentive to sell nutritious food items (fruits and vegetables) and purchase rice from the market

- At the same time, farm diversity improves dietary diversity – possible endogeneity issue?
  - In further analysis we plan to take an instrumental variable approach

- Engaging in the buyers' market for food improves dietary diversity

- There is a stark difference in consumption patterns and agricultural production between districts
  - Weather risk, market access, price volatility

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Agricultural Household Model with Health, Nutrition and Market Participation

$$Max\ E(U) = E\left[U\left(H(.),C(.),\ell,\mu\right)\right]$$

$$s.t.\ F_j = F_j(X,L)\quad \forall\ j$$

$$T = L_f + L_w + \ell$$

$$\sum_{j=1}^{J} q_j M_j^B = \sum_{j=1}^{J} p_j M_j^S + wL_w - p_x X$$

Agricultural Household Model with Health, Nutrition and Market Participation

$$\mathcal{L} = E\Big[U\big(C,H,\ell\big) + \lambda\big[pF\big(X,L\big) - pC + wL_w - p_x X - qM^B\big(F,C\big) - w\ell\big]\Big]$$

N = Nutrients (carbohydrates, fats, proteins, vitamins, minerals)

α = Other attributes

$$\text{where } H = H\big(C(.),\eta\big)$$

$$C_j = C_j\big(\text{N},\alpha\big) \ \forall \ j$$

$$M_j = \begin{cases} M_j^S \ if \ \big(F_j - C_j\big) > 0 \\ M_j^B \ if \ \big(F_j - C_j\big) < 0 \end{cases} \forall \ j$$

$$\big(q_j - p_j\big) = \tau_j\big(A,G,W,M_j,V,\Omega\big)$$

Methodology

- How does participation in buyer and seller markets affect household consumption and production of nutrients?
  - Production of nutrients is a function of market participation, household and farm characteristics

  - Household demand for nutrients such as protein, vitamin A, and iron is a function of farm diversity, market participation, household and farm characteristics

- Market participation reflects the consideration of price risk in nutrition decisions

- Nutrients are defined by FAO food group classification

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15 Food Groups (FAO Dietary Diversity)

- Tropical fruits (vitamin A)
- Fruits
- Meat
- Fish and seafood
- Eggs
- Legumes, nuts, seeds
- Milk and milk products
- Oils and fats
- Sweets
- Spices, condiments and beverages

- Cereals
- White tubers and roots
- Vegetables
- Orange vegetables (vitamin A)
- Leafy green vegetables

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Empirical Model

$$D_i = \alpha_0 + \alpha_1 Z_i + \alpha_2 M_i + \alpha_3 U_i + X_i' \alpha_4 + \varepsilon_i$$

- Logit regressions
  - Household production of food groups
  - Household consumption of food groups

- OLS regressions
  - Household dietary diversity score (HDDS)
  - Farm diversity score by food group

- Covariates of interest
  - Participation in markets
    - Buying food
    - Selling agricultural products

  - Farm diversity (count of food groups produced) as a covariate in consumption models

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Data

- Household survey data (n = 1,149)
  - Agricultural production
  - Market participation
  - Food consumption (24 hour household dietary diversity)

- Two districts of Bangladesh
  - 53% Mymensingh (North-central)
  - 47% Borguna (South)

Variable	All	Borguna	Mymensingh
Summary Statistics, Covariates by District			
Religion (Muslim = 1)	0.95	0.91	0.99
Household monthly income (USD 1 = BDT 79)	10913.09	6208.52	15098.37
Household food insecurity access score (HFIAS)	1.92	3.50	0.52
Male-headed household	0.86	0.76	0.94
Household head education primary school	0.33	0.44	0.23
Household head education junior secondary school	0.11	0.06	0.15
Household head education secondary school	0.06	0.02	0.10
Household head education SSC pass	0.05	0.01	0.10
Household head education postsecondary school	0.07	0.00	0.12
Age of household head	45.20	44.56	45.76
Household size	4.63	4.16	5.06
Poverty score	46.88	37.66	55.11
Total ag land (decimals)	73.41	50.03	94.25
Farm diversity (count of food groups produced)	5.34	2.11	4.40
Buy food at the market	0.40	0.62	0.20
Sell food at the market	0.47	0.30	0.63

Differences in Production Diversity and Consumption Diversity by District
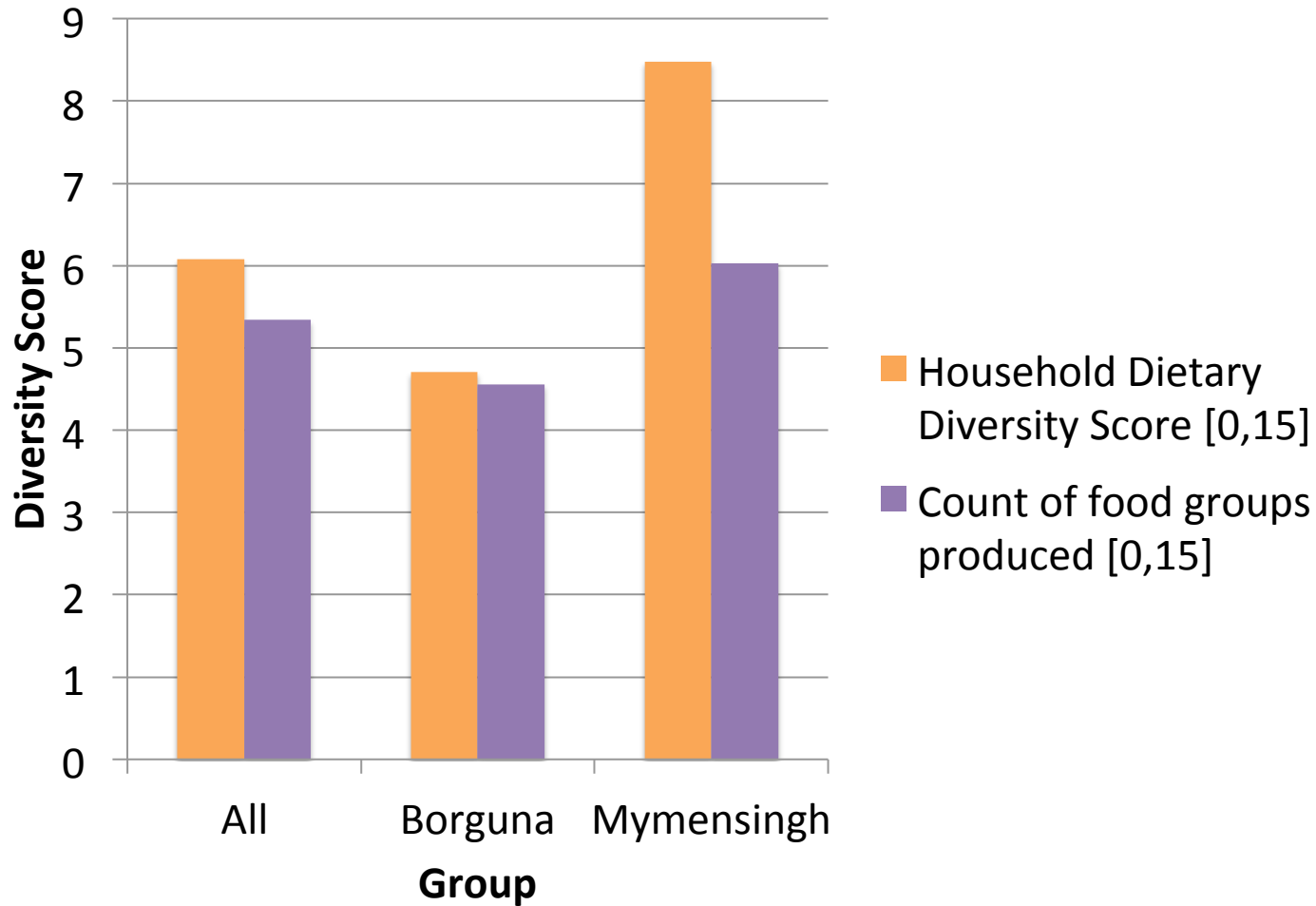
Food Group	HH Consumption (Mean)			HH Production (Mean)		
	All	Borguna	Mymensingh	All	Borguna	Mymensingh
Cereal	0.90	0.81	0.98	0.63	0.47	0.78
Tubers	0.70	0.54	0.84	0.12	0.02	0.21
Vitamin A rich veg	0.17	0.14	0.19	0.35	0.15	0.53
Leafy veg	0.47	0.40	0.54	0.26	0.09	0.40
Other veg	0.50	0.19	0.78	0.89	0.89	0.88
Vitamin A fruit	0.06	0.02	0.09	0.78	0.76	0.79
Other fruit	0.24	0.13	0.33	0.91	0.88	0.94
Meat	0.30	0.17	0.43	0.31	0.19	0.42
Eggs	0.21	0.14	0.28	0.57	0.46	0.67
Fish	0.68	0.46	0.87	0.27	0.08	0.23
Pulses	0.48	0.26	0.67	0.19	0.05	0.00
Dairy	0.20	0.06	0.32	0.90	0.86	0.93
Fat and oil	0.82	0.67	0.95	0.07	0.13	0.02
Sugar	0.22	0.06	0.35			
Spices	0.66	0.57	0.75			

Variable	All	Borguna	Mymensingh
Regression results: count of food groups produced			
District (Mymensingh = 1)	1.33***		
Religion (Muslim = 1)	-0.33	-0.49**	0.56
Household food insecurity access score (HFIAS)	-0.06***	-0.03**	-0.14***
Household monthly income (USD 1 = BDT 79)	0.00	0.00	0.00
Male-headed household	-0.19	-0.12	-0.12
Household head education primary school	-0.01	-0.14	0.08
Household head education junior secondary school	0.26	-0.03	0.39**
Household head education secondary school	0.17***	0.20	0.20
Household head education SSC pass	0.56**	-0.94	0.76***
Household head education postsecondary school	0.25	1.95*	0.30
Age of household head	0.01***	0.00	0.01**
Household size	0.11***	0.14***	0.10**
Poverty score	0.01***	0.02***	0.00
Total ag land (decimals)	0.00***	0.00***	0.00***
Buy food at the market	0.09	-0.08	0.34*
Sell food at the market	0.95***	0.91***	1.04***
	N = 1,124 Adj. R^2 =0.42	N = 527 Adj. R^2 =0.22	N = 597 Adj. R^2 =0.23

Regression results: household dietary diversity score (HDDS)			
Variable	**All**	**Borguna**	**Mymensingh**
District (Mymensingh = 1)	3.93***		
Religion (Muslim = 1)	0.00	0.06	-0.63
Household food insecurity access score (HFIAS)	-0.08***	-0.10***	0.00
Household monthly income (USD 1 = BDT 79)	0.00**	0.00	-0.05
Male-headed household	0.06	0.11	-0.81
Household head education primary school	-0.50**	-0.55**	0.07
Household head education junior secondary school	-0.15	-1.05**	0.71
Household head education secondary school	-0.26	0.00	0.01
Household head education SSC pass	-0.23	-0.06	0.12
Household head education postsecondary school	0.30	-1.34	0.60
Age of household head	-0.01	0.00	-0.02
Household size	-0.14**	-0.20**	-0.05
Poverty score	-0.01*	-0.03**	0.00
Total ag land (decimals)	0.00	0.00	0.00**
Farm diversity (count of food groups produced)	0.38***	0.39***	0.34***
Buy food at the market	1.59***	2.25***	0.14
Sell food at the market	-0.53***	-0.72***	-0.50*
	N = 740 Adj. R^2 =0.43	N = 472 Adj. R^2 =0.25	N = 268 Adj. R^2 =0.08

Results: Consumption of food groups (odds ratios)

	Cereal	Tubers	Fish
Mymensingh district	**95.227*****	**6.859*****	**13.553*****
Muslim	1.628	0.806	**1.953*****
Household monthly income (USD 1 = BDT 79)	1.000	1.000	1.000
Male-headed household	0.808	0.984	**0.927*****
Household head no education	1.223	0.887	0.897
Household head junior secondary school	0.533	**1.555*****	1.261
Household head secondary school	1.111	**1.759*****	0.812
Household head SSC pass	0.605	1.200	1.320
Household head postsecondary education	4.929	1.409	0.948
Age of household head	0.986	1.615	1.049
Household size	**0.833*****	0.997	**0.988*****
Household food insecurity access score (HFIAS)	0.950	0.966	0.923
Poverty score	**0.961*****	**0.988*****	**0.987*****
Total ag land (decimals)	1.001	1.000	0.999
Farm diversity (count of crops and livestock)	0.995	1.016	**1.037*****
Buy food at the market	**32.535*****	**2.128*****	**2.107*****
Sell food at the market	0.733	1.009	**0.682*****
Constant	17.628	1.420	1.072

Consumption of food groups (odds ratios)

	Vit A vegetables	Leafy green veg	Other veg
Mymensingh district	**1.925***	**1.983***	**24.133***
Muslim	**0.235***	0.841	1.080
Household monthly income (USD 1 = BDT 79)	1.000	1.000	**1.000***
Male-headed household	0.991	**0.951***	**0.923***
Household head no education	**1.664***	0.920	1.322
Household head junior secondary school	1.273	1.129	**1.386***
Household head secondary school	1.331	0.862	1.343
Household head SSC pass	0.892	0.844	1.013
Household head postsecondary education	0.485	1.210	**2.232***
Age of household head	0.981	1.204	1.242
Household size	1.001	0.994	1.004
Household food insecurity access score (HFIAS)	0.997	0.953	**0.902***
Poverty score	1.004	**0.988***	**0.985***
Total ag land (decimals)	**1.001***	1.001	1.000
Farm diversity (count of crops and livestock)	**0.937***	**1.024***	**1.061***
Buy food at the market	1.206	**1.353***	**2.646***
Sell food at the market	1.269	0.809	**0.521***
Constant	0.528	1.413	0.102

Summary of results

- Market participation influences decisions surrounding the production and consumption of nutrients
  - Incentive to participate in markets is likely driven by price volatility and transaction costs
  - Buyer market participation increases consumption diversity
    - Access to food groups
  - Participation in seller markets increases production diversity but decreases consumption diversity

- Participants in the northern district of Bangladesh have more farm and dietary diversity
  - Climate, soil
  - Market access? Extension?
  - Poverty score and farm diversity

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Going forward

- Further investigation into the trade-off between consuming own production vs. selling nutrient-rich foods
  - Are households really selling eggs and mangos to purchase more rice?
  - If so, how do seasonality, price volatility, etc. influence household nutrition decisions?
- Use instrumental variables to predict market participation
  - GPS distance from the household to the market
  - Mode of transportation used to access the market

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This presentation was produced as part of the United States Agency for International Development (USAID) and US Government Feed the Future project "Integrating Gender and Nutrition within Extension and Advisory Services" (INGENAES) under the Leader with Associates Cooperative Agreement No. AID-OAA-LA-14-00008. The University of Illinois at Urbana-Champaign is the prime awardee, and partners with the University of California-Davis, the University of Florida, and Cultural Practice, LLC. www.ingenaes.illinois.edu

The research and this report were made possible by the generous support of the American people through USAID. The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States government.

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