Agriculture and Nutrition: From New Research to New Policies

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https://www.ifpri.org/project/advancing-research-nutrition-and-agriculture-arena

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54th Annual Conference and 2018 Future Leaders Forum
For those suffering from caffeine deficiency....
... some takeaway messages

Agriculture can do a lot to solve malnutrition, for 2 sets of reasons

Poverty & undernutrition still remain predominantly rural problems

1. Many of the world’s undernourished live in rural areas
2. Those rural poor would benefit from ag productivity gains
3. They would benefit from improved access to basic services, improved hygiene (rural services, ag & health extension)

“Agriculture” can improve diets for rural and urban populations

1. Nutritious foods very expensive in poor countries (relative prices)
2. The high cost of nutritious food constraints dietary diversity, even among infants/young children
3. Food policies can alter those relative food prices
Agriculture and nutrition in development have largely evolved independently, and only recently become more integrated. Worth reflecting on the evolution of these two fields, and asking what the current state of knowledge is.
A short history of agriculture & development

- **1950s**: rapid population growth: specter of Malthus!
- **1960s**: raising yields of staple cereals: Green Revolution
- **1974**: 1st global food crisis & formalization of CGIAR
- **1970s-present**: Promoting Green Revolution in Africa
- **1980s-present**: Food system diversification in Asia, LAC
- **2008**: 2nd global food crisis & improved agricultural funding
- **2008-now**: tradition income focus augmented by nutrition

*Income-nutrition tradeoffs?*
A short history of nutrition & development

1950s: Protein-malnutrition (Kwashiorkor) main concern
1955: Protein Advisory Group
1950-1974: Protein-rich foods
1968: Protein Crisis report
1974: “Great Protein Fiasco” protein deficiency oversold
1975: Micronutrient councils
1977: Protein group dissolved
1990s: Micronutrient scale-up
2000s: Revisionism & debate: supplements, biofortification, diets (role of protein & ASFs)?
Advancing Research on Nutrition and Agriculture (ARENA) Project

**Geography:** Global; South Asia & Africa; Ethiopia & Bangladesh

### Demographic Health Surveys + GIS data
- DHS linked to data on agriculture, infrastructure, agroecology, climate, etc
- 60 countries, most SSA & SAS
- Anthropometric data >1m kids
- Data on diets for 300K children aged 6-23 months

### Economic & Agricultural Surveys
- IFPRI Feed-the-Future surveys in Ethiopia & BGD
- LSMS-ISA
- Detailed agric. production & marketing data
- Special livestock & nutrition modules

### Consumer Price Surveys
- ICP price data for 180 countries, 2005, 2011
- ICP price data for 30 countries from 1970-2011
- Consumer price survey, Ethiopia: monthly data for 120 markets, 2001-2016

### Economywide Simulation Models
- CGE models link households to macroeconomy
- Ex ante & ex post assessments of food policies
- Allows spillovers of investments on prices, wages, etc
- Cost-benefit analysis
- Distributional implications

**Scientific publications:** American J. of Ag Econ., J. of Nutrition, Agricultural Systems, Econ. & Human Biology, Agricultural Economics, World Development, Global Food Security, etc
The problem of rural malnutrition
Stunting rates by livelihood: Africa

Stunting rates among children 24-59m, by father's occupation, location and wealth score: 22 Africa countries (SSA)

Large rural-urban wealth gap explains stunting gap?
Stunting rates among children 24-59m, by father's occupation, location and wealth score: 4 South Asian countries
Why are rural children so much worse off?

Explaining the rural-urban stunting gap in Africa

- Parent's Education: 20%
- Household Assets & Nonfarm work: 39%
- Mother's Characteristics: 8%
- Health / Infrastructural Services: 11%
- Unexplained: 22%
Reducing the harm of agricultural livelihoods

- Agricultural households face other disadvantages from living and working on farms:
  - strenuous labor, exposure to chemicals, poor WASH conditions
- In ARENA, we focused on animal WASH issues
- SHINE project: young children found consuming dirt & chicken feces
- Impacts on diarrhea & environmental enteropathy (gut damage) and also respiratory infections (Avian flu, sub-clinical infections)?

<table>
<thead>
<tr>
<th></th>
<th>Rural</th>
<th>Urban</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Saharan Africa (27)</td>
<td>52.6</td>
<td>20.0</td>
<td>41.6</td>
</tr>
<tr>
<td>South Asia (5)</td>
<td>27.1</td>
<td>7.0</td>
<td>20.8</td>
</tr>
<tr>
<td>Other LDC (14)</td>
<td>46.3</td>
<td>9.6</td>
<td>28.8</td>
</tr>
<tr>
<td>All 46 countries</td>
<td>35.0</td>
<td>10.7</td>
<td>26.9</td>
</tr>
</tbody>
</table>

Major concern: poultry are the most widely owned livestock!
Reducing the harm of agricultural livelihoods

In rural Ethiopia, livestock ownership is almost universal (93%), and 45% keep at least 1 animal in the main house overnight.

<table>
<thead>
<tr>
<th>Livestock type</th>
<th>Owns Livestock (% of households)</th>
<th>Corralling animals in the main house overnight (% owners)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poultry</td>
<td>48%</td>
<td>48%</td>
</tr>
<tr>
<td>Cattle</td>
<td>58%</td>
<td>23%</td>
</tr>
<tr>
<td>Goats, sheep</td>
<td>52%</td>
<td>31%</td>
</tr>
<tr>
<td>Pack animals</td>
<td>42%</td>
<td>18%</td>
</tr>
</tbody>
</table>

Animal feces observed in 40% of compounds in 3 countries

<table>
<thead>
<tr>
<th></th>
<th>Bangladesh</th>
<th>Ethiopia</th>
<th>Vietnam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal feces in compound (%)</td>
<td>41%</td>
<td>38%</td>
<td>42%</td>
</tr>
<tr>
<td>Human feces in compound (%)</td>
<td>5%</td>
<td>16%</td>
<td>1%</td>
</tr>
<tr>
<td>No toilet³ (%)</td>
<td>4%</td>
<td>16%</td>
<td>5%</td>
</tr>
</tbody>
</table>
Reducing the harm of agricultural livelihoods

In Ethiopia owning poultry predicts greater child growth (HAZ), but only if poultry are kept out of the house (away from children)

<table>
<thead>
<tr>
<th></th>
<th>Simple test: owning poultry</th>
<th>Adding “Poultry in house”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owns poultry</td>
<td>0.168**</td>
<td>0.291***</td>
</tr>
<tr>
<td>Poultry in house</td>
<td></td>
<td>-0.250**</td>
</tr>
</tbody>
</table>

Observed animal feces in compound negatively associated with child growth (HAZ) in Bangladesh & Ethiopia, but not Vietnam

<table>
<thead>
<tr>
<th></th>
<th>Bangladesh</th>
<th>Ethiopia</th>
<th>Vietnam</th>
<th>Pooled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal feces</td>
<td>-0.13*</td>
<td>-0.22*</td>
<td>0.03</td>
<td>-0.11**</td>
</tr>
</tbody>
</table>
Do Green Revolutions improve nutrition?

- Given how much the poor depend on agriculture, growth in agricultural productivity should improve nutrition via income gains.
- More income means more expenditure on nutritional goods.
- Intuitive, but no previous evidence from the Green Revolution.
- We looked at Bangladesh 1996-2011: a late Green Revolution.
- Rice yields grew by **70% over 1996-2011**.
- Synthetic district panel: mix nutrition & agricultural surveys.
- Allows us to do difference-in-difference regressions:
  - net out time-invariant confounding factors (e.g. ecology)
- Test whether changes in rice yields predict changes in nutrition.
- Simple statistical approach, but very novel in the literature.
Cereal yields and child nutrition

Growth in rice yields in Bangladeshi districts has significant associations with weight gain, but not with linear growth

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HAZ score</td>
<td>Moderate</td>
<td>Severe</td>
<td>WHZ score</td>
<td>Mild</td>
<td>Moderate</td>
</tr>
<tr>
<td>Rice yields</td>
<td>-0.14</td>
<td>0.18</td>
<td>-0.05</td>
<td>0.79**</td>
<td>-0.23*</td>
<td>-0.15</td>
</tr>
<tr>
<td></td>
<td>(0.34)</td>
<td>(0.16)</td>
<td>(0.10)</td>
<td>(0.30)</td>
<td>(0.12)</td>
<td>(0.14)</td>
</tr>
<tr>
<td>Age control</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Time effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.42</td>
<td>0.35</td>
<td>0.41</td>
<td>0.28</td>
<td>0.33</td>
<td>0.41</td>
</tr>
<tr>
<td>Sample size</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>109</td>
</tr>
</tbody>
</table>

HAZ: Height-for-Age Z-score
WHZ: Weight-for-Height Z-score

** Significant at the 0.01 level
* Significant at the 0.05 level
Growth in rice yields has significant associations with timely introduction of complementary foods, but not diet diversity.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Complementary foods (%)</td>
<td>Minimum dietary diversity (%)</td>
<td>Dairy consumption (%)</td>
</tr>
<tr>
<td>Rice yields</td>
<td>0.47*</td>
<td>-0.04</td>
<td>-0.17</td>
</tr>
<tr>
<td></td>
<td>(0.25)</td>
<td>(0.13)</td>
<td>(0.17)</td>
</tr>
<tr>
<td>Child age controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Time varying controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Time effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.87</td>
<td>0.88</td>
<td>0.44</td>
</tr>
<tr>
<td>Sample size</td>
<td>109</td>
<td>89</td>
<td>109</td>
</tr>
</tbody>
</table>

Growth in yields may have led to earlier introduction of solid foods (mainly rice); May explain weight gain.

Dietary diversity & dairy consumption were associated with stunting, but growth in rice yields did not directly improve dietary diversity.
• Young children have high calorie requirements, but also need a wide range of micronutrients
• Protein quality hypothesis: animal sourced foods provide essential amino acids not easily obtained from vegetal foods (MN-rich too)
• Infants and young children need especially nutrient-dense foods because of small stomachs
Dietary patterns in developing countries

**T1. What did 130,432 young children in 49 countries eat yesterday?**

<table>
<thead>
<tr>
<th></th>
<th>Latin America &amp; Caribbean</th>
<th>N. Africa &amp; West Asia</th>
<th>Asia (south, central, SE)</th>
<th>Africa, West &amp; Central</th>
<th>Africa, South &amp; Eastern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fortified cereals</td>
<td>8.8%</td>
<td>9.4%</td>
<td>14.5%</td>
<td>6.8%</td>
<td>8.4%</td>
</tr>
<tr>
<td>Cereals, roots, tubers</td>
<td>89.8%</td>
<td>78.8%</td>
<td>76.8%</td>
<td>72.2%</td>
<td>71.3%</td>
</tr>
<tr>
<td>Legumes/nuts</td>
<td>46.3%</td>
<td>24.1%</td>
<td>16.9%</td>
<td>20.5%</td>
<td>24.1%</td>
</tr>
<tr>
<td>Vit A-rich fruit/veg</td>
<td>55.1%</td>
<td>28.5%</td>
<td>41.0%</td>
<td>40.9%</td>
<td>53.6%</td>
</tr>
<tr>
<td>Dark green fruit/veg</td>
<td>18.8%</td>
<td>15.4%</td>
<td>28.6%</td>
<td>30.9%</td>
<td>43.0%</td>
</tr>
<tr>
<td>Other fruit &amp; veg</td>
<td>51.4%</td>
<td>34.8%</td>
<td>24.6%</td>
<td>18.1%</td>
<td>20.0%</td>
</tr>
<tr>
<td>Dairy</td>
<td>57.5%</td>
<td>64.9%</td>
<td>38.4%</td>
<td>20.8%</td>
<td>18.7%</td>
</tr>
<tr>
<td>Eggs</td>
<td>47.3%</td>
<td>30.9%</td>
<td>15.8%</td>
<td>12.2%</td>
<td>13.0%</td>
</tr>
<tr>
<td>Meat/fish</td>
<td>56.3%</td>
<td>30.9%</td>
<td>23.2%</td>
<td>39.7%</td>
<td>33.6%</td>
</tr>
<tr>
<td>White/red meat*</td>
<td>53.1%</td>
<td>24.1%</td>
<td>13.6%</td>
<td>15.5%</td>
<td>17.1%</td>
</tr>
<tr>
<td>Fish*</td>
<td>NA</td>
<td>8.0%</td>
<td>12.8%</td>
<td>31.5%</td>
<td>21.1%</td>
</tr>
</tbody>
</table>
Animal sourced foods (ASFs) & stunting

- ASFs rich in high quality protein, micronutrients & other growth-inducing nutrients
- Different ASFs have different nutrient profiles, suggesting they may be complements
- e.g. milk rich in calcium, b12, but has no iron
- Controlling for lots of things, we see large impacts of consuming 2+ ASFs daily
- Not shown: fruit consumption also a robust predictor of stunting reduction (~2%)
Why are diets so poor in poor countries?

- **Economists**: Poor people are poor! Raise incomes! (agriculture?)
- **Nutritionists**: Nutritional knowledge is poor!
- Could **high relative food prices** present an additional constraint?
- Do relative prices dictate specific pathways of diet diversification?
- Are some foods more/less expensive in low income countries?
- To capture this we come up with a novel measure of relative prices:
  - *Ratio of 1 calorie of a given food (e.g. eggs) to 1 calorie of cheapest cereal*
- Motivations for staple cereal calories as a basis of comparison:
  - *Poor people care about calories: hunger is a strong motivator*
  - *Cereals are a universally important calorie-dense staple*
  - *Cereals are tradable, so prices influenced by international productivity*
High prices constrain dietary diversification

Table 3. Cereal-relative calorie price ratios for various foods, by region

<table>
<thead>
<tr>
<th>Region</th>
<th>Roots &amp; tubers</th>
<th>Legumes</th>
<th>Cow's milk, fresh</th>
<th>Cow's milk, Proc.</th>
<th>Chicken eggs</th>
<th>Meat</th>
<th>Fish</th>
<th>Fortified baby cereal</th>
</tr>
</thead>
<tbody>
<tr>
<td>High income countries</td>
<td>1.6</td>
<td>1.2</td>
<td>3.2</td>
<td>2.2</td>
<td>3.0</td>
<td>2.0</td>
<td>4.3</td>
<td>5.0</td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>1.2</td>
<td>2.2</td>
<td>3.9</td>
<td>3.0</td>
<td>4.9</td>
<td>3.2</td>
<td>3.4</td>
<td>9.6</td>
</tr>
<tr>
<td>North Africa &amp; Western Asia</td>
<td>2.1</td>
<td>2.1</td>
<td>10.1</td>
<td>3.1</td>
<td>6.1</td>
<td>6.2</td>
<td>6.0</td>
<td>16.1</td>
</tr>
<tr>
<td>South, Central &amp; South-East Asia</td>
<td>1.5</td>
<td>2.0</td>
<td>7.8</td>
<td>3.8</td>
<td>6.2</td>
<td>6.5</td>
<td>5.3</td>
<td>16.4</td>
</tr>
<tr>
<td>Western &amp; Central Africa</td>
<td>1.0</td>
<td></td>
<td>16.5</td>
<td>4.0</td>
<td>9.9</td>
<td>5.3</td>
<td>5.0</td>
<td>23.4</td>
</tr>
<tr>
<td>Eastern &amp; Southern Africa</td>
<td>1.7</td>
<td></td>
<td>13.9</td>
<td>5.8</td>
<td>9.1</td>
<td>5.6</td>
<td>6.1</td>
<td>18.6</td>
</tr>
</tbody>
</table>
Constraints to ASF consumption: Eggs

Fig 1. Predictors of 24-hr recall egg consumption among kids 6-23m

- Halve own price*: 15%
- Double cereal yields*: 2%
- Double GDP per capita*: 2%
- Double urbanization*: 8%
- Peace to Conflict*: 6%
- Lowest to richest wealth tercile: 3%
- Give mother 9+ years schooling: 0%
- Give father 9+ years schooling: 3%
- Universal to zero open defecation: 3%
- Switch to universally improved water: 1%
- Stop breastfeeding: 1%
- Urban to rural: 3%
- No access to hospital/clinic access: 3%

Halving relative egg price predicts a 15-point increase in egg consumption among young kids.
Constraints to dietary diversification

- Poor people face a double economic burden: poverty & high prices
- Why are nutrient-rich foods so expensive?

- Highly perishable; difficult to trade long distance
- Limited trade means relative prices largely set by local productivity levels
- Productivity is low in poor countries: e.g. backyard poultry very widespread, but children don’t eat eggs
- Egg prices are lower when poultry is commercialized

**F1. Egg prices & share of chickens in intensive systems**

- Linear fit: coef = -0.08 [CI -0.10-0.07]; R-sq = 0.60
Research & Policy Implications: Major findings

Agriculture must play a critical role in solving rural malnutrition

1. Many of the world’s undernourished live in rural areas
2. Those rural poor would benefit from ag productivity gains
3. They would benefit from improved access to basic services
4. Benefit from more concerted efforts to reduce the hazards of agricultural living: chemical input exposure, strenuous labor, animal WASH

Agricultural and food policies can play a critical role in driving down the prices of nutrient-rich foods:

- Many current ag-nutrition projects too small & too local
- Biofortification
- Commercialization essential to increase productivity in perishables
- Trade policies important: Import chickens but produce eggs yourself
- Learn from diversification success stories: e.g. milk in Asia
• Thank you
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