The Interconnection of Food
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• **Marshall Burke**, Environmental Earth System Science, Center on Food Security and the Environment

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The food – conflict nexus

Marshall Burke

Dept. of Earth System Science, and Center on Food Security and the Environment Stanford University
Conflict prone countries are more food insecure
Conflict prone countries are more food insecure

Data: World Bank, PRIO
But which way does causal arrow go?

Food → Conflict
Conflict → Food
Conflict ↔ Food

Why does it matter?
And how can we figure it out?
Norway: food secure, peaceful
Nigeria: food insecure, conflict-prone

Conclude: food insecurity → conflict?

Better research design:
Compare Nigeria to itself over time,
Norway to itself over time

Look for “natural experiments”
CONFLICT ➔ FOOD INSECURITY

Conflict:

• Inhibits food production and trade
• Destroys productive assets
• Worsens access to health facilities
Rwandan civil war and child height

Akresh et al 2011

Civil war starts

unaffected regions

affected regions

height-for-age (z score)

Month & Year of Birth
Broader economic effects also not good

Figure 2. Protracted Civil Wars

Cerra and Saxena 2008
Maybe this is good news?
Problem: conflict hasn’t fallen much (recently)

Civil conflict, all countries

Data: Uppsala/PRIO
Problem: conflict hasn’t fallen much (recently)

Civil unrest in Africa

Data: SCAD
Problem: conflict not the only factor
FOOD INSECURITY ➔ CONFLICT

Economists view:
Joining a conflict is a cost/benefit calculation.

“Grievance” view:
Insecure access to food is breach of social contract.
Grievances on display

Food price spikes and riots

Iagi et al. 2011
An (unfortunate) natural experiment

External price spikes $\rightarrow$ less food security $\rightarrow$ local conflict (?)
An (unfortunate) natural experiment

External price spikes $\rightarrow$ less food security $\rightarrow$ local conflict (?)

**FINDING:**

1 standard deviation increase in food prices $\rightarrow$ 10% increase in conflict events

*Effect is twice as big in cities*

*Burke and McGuirk 2015*
Another natural experiment: the weather

Dry/hot year $\rightarrow$ lower agricultural production $\rightarrow$ local conflict (?)
**FINDING:**

1 standard deviation increase in temperature

→ **10% increase in conflict events** (again!)
The food ↔ conflict nexus

1. Conflict important, but probably not most important, factor in food insecurity
2. Food insecurity/ poverty is likely an underappreciated factor in conflict

Investments in food security could pay double.
Food and Health Nexus

Steve Luby, MD
Connecting the Dots
Stanford University
April 17, 2015

Photo: Nazmun Nahar
Global trend in child under nutrition

Adapted from Stevens GA, Lancet. 2012 Sep 1;380(9844):824-34
WHO Multicentre Growth Reference Study

• Design
  – 8440 children from affluent families
  – Brazil, Ghana, India, Norway, Oman, US
  – 21 measurement visits from to age 24 months

• Results
  – Length of the children strikingly similar among the 6 sites
  – Variability
    • 3% due to inter-site differences
    • 70% due to individual differences by site

Mugsy Bogues

- 5’ 3”
- Shortest player ever in the NBA
- Drafted 12th overall
- Played 14 seasons
- Blocked 39 shots
- 6726 assists

Shawn Bradley

- 7’ 6”
- Amongst the tallest players in the NBA
- Drafted 2nd overall
- Played 14 seasons
- Blocked 2110 shots
- 573 assists

Why worry about stunting?
Why worry about stunting?

When entire communities are short, this is a marker of chronic undernutrition.

1.4 million child deaths annually attributable to undernutrition.  
(Lancet 2012; 380: 2224–60)

- Malnourished children also face:
  - cognitive impairment
  - decreased wages
  - increased chronic diseases

http://printablecolouringpages.co.uk
Critical period for growth faltering

The first 1000 days

- Maternal nutrition
- Early child nutrition
- Key area for
  - Research
  - Interventions

Slide from Christine Stewart

Adapted from Victora CG, Pediatrics March; 125(3):e473-480
If children are malnourished

• Feed them more
  – But more calories are insufficient
  – need nutrient dense food

• Supplement with nutrient dense foods
  – only correct 1/3 of growth faltering
  
  (Dewey K. *Matern Child Nutr* 2008, 4 Suppl 1: 24--85 )
If lack of food is not the sole common underlying sufficient cause of stunting, what else is driving this?
Healthy Thriving Communities

www.healthcosmic.com

www.precisionnutrition.com

www.priyo.com
• 98% of fecal sludge in Dhaka, Bangladesh is discharged untreated into the environment

• The poor have limited ability to secure
  – clean water
  – nutrient dense food
  – clean energy
“Hunger reduces one to an utterly spineless, brainless condition, more like the after-effects of influenza than anything else. It is as though one had been turned into a jellyfish, or as though all one's blood had been pumped out and luke-warm water substituted. Complete inertia is my chief memory of hunger.”

George Orwell
Impoverished households are risk averse

• Non-cereal crops in Bangladesh
  – Provide better nutrition
  – Generate more earnings

• Bangladeshi farmers prefer to grow rice (Rahman S, *Asian J Ag Dev* 2008)
  – They are more familiar and know better what to expect with rice
Healthy Thriving Communities

www.priyo.com

www.healthcosmic.com

www.precisionnutrition.com
Leveraging the nexus going forward:
Ending extreme poverty

Source: USAID
Global deaths for children under 5

- Moving from a focus on child survival to child thriving
- Supporting a healthy planetary biome to support thriving societies

Source: Institute for Health Metrics and Evaluation
Risks looking forward

- Non-sustainable pressure on global resources
- Shocks
  - Volcanic eruption
  - Regional nuclear conflict
  - Pandemic

What can we do?

• Raising livestock accounts for
  – 30% of total human water use
  – 55% of erosion
  – Water pollution
    • 33% of nitrogen and phosphorus
    • 37% of pesticides
    • 37% of heavy metals
    • 50% of antibiotics
The World’s Second Food Security Challenge

or

The Food Security Roots of the Middle Income Trap:

Scott Rozelle, Senior Fellow
Food Security and the Environment
Freeman Spogli Institute
The World’s Second Food Security Challenge

Middle income trap

– When developing countries hit middle income (between US$5,000 to US$12,000 per capita), growth stagnates and in some cases economies collapse
  • Many different possible (theorized) sources (in past):
    – misdirected investment strategies;
    – interest groups that keep key infrastructure investments/policy changes from happening
  • One additional possible source (foreshadowing what we will examine in this presentation) is:
    – poor health and education due to systematic and chronic deficiencies in the foods that provide the nutrients needed for this stage of development ➔ poor health and education ➔ because jobs in a middle income country require health and educated individuals, many will be polarized out of the labor force ➔ high cost to maintain the population / high crime / reduced investment ➔ stagnation (yes: “caught in a trap”)

Goal
explore if there is a Second Food Security Challenge (when countries are in the Middle Income staged of Development) and try to understand how it occurs and what can be done to avoid it.

Plan
1. Background: Traditional Food Security Problem
   – Briefly review this in order to set up the contrasts and connections with the Second Food Security Challenge

2. Second Food Security Challenge
   • Economic Context
   • The Problem
   • The Reason
   • Policy Options

3. Summary and Conclusion

Will use some examples from China, a middle income country that I study, but, I believe this story is more generally true
2. Traditional Food Security: in Phase I of development

- The context: Countries at start of Phase I of Economic Development ➞ poor, malnutrition, food deficit, high prices, access is difficult,
Definition: Traditional Food Security

• Food Security is:
  – having adequate supplies of affordable food (calories/protein);
  – for each household (a nation’s population) throughout the year;
  – to ensure a healthy and productive life (economic growth path)
Food Security and Development Link:

[In the case of Poor Countries]

- Insufficient calories / protein (macro-nutrients)

- Without enough calories ➔
  - Poor health
  - Increased morbidity
  - Stunting / wasting / chronic diseases
  - Negatively affects income ➔ poverty/low income trap
Source of the problem for households

• The problem is one of “economic access”

• Economic access for the rural poor depends on income and food prices

• When prices are low, even those with low levels of income are typically able to access food in quantities enough to escape malnutrition (from the lack of calories)

• When prices are low and incomes are rising, food is even more affordable
Phase I: route to success (part a)
(this is how the Green Revolution jump starts economic growth when countries are poor)

- Increasing Incomes (in part with investment into Ag)
  - Rising Consumption
- Falling prices (in part with investment into Ag)
  - More Rising Consumption

- Falling Morbidity / Basic Education

- Stage I of Transformation of the Economy
  - Industrialization (phase I ➔ low wage mfging)
  - Urbanization (phase I ➔ temporary / permanent for some)

- Increasing Incomes [wages constant / more off-farm employment opportunities]
- Rising Consumption

[virtuous cycle begins ➔ pushes economy to middle income]
Phase I: route to success (part b)
(Green Revolution is trigger / also need other policy efforts and economic transitions)

- Increasing Incomes (in part with investment into Ag)
  - Rising Consumption
- Falling prices (in part with investment into Ag)
  - More Rising Consumption

[virtuous cycle begins ➔ pushes economy towards middle income]

- Falling Morbidity / Healthy Labor Force (other policies: Basic Education)

- Stage I of Transformation of the Economy (also need good industrial and trade policies)
  - Industrialization (phase I ➔ low wage mfging)
  - Urbanization (phase I ➔ temporary / permanent for some)

- Increasing Incomes [wages constant / more off-farm employment opportunities]
- Rising Consumption
Metric for success: Traditional Food Security Policies

• Sufficient, low-priced calories / protein → macro nutrients is enough for most of the population
  – Those working in factories and constructions sites are healthy and strong
  – Those left working on the farm (larger farms) are healthy and strong

This is why producing lots of cheap calories and vegetable proteins is important … Food Security with Phase I characteristics is an important part of development strategy when countries are just beginning their development push … when they are poor people need sufficient macro nutrients
Food security success in Middle Income Countries
(Kcal for 2009)

• Brazil:  3173
• China:   3036
• Mexico:  3146
• Thailand: 2862
• Turkey:  3666

FAOSTAT (2010)
2. World’s Second Food Security Challenge

a. The Context: The Economic Setting of Middle Income Countries

[the context is important to understand as it explains how malnutrition can coexist with rising incomes

caution: the context can be complicated]
World’s Second Food Security Challenge is different in (rapidly growing) middle income countries.

The context: Countries in Phase II of Economic Development.

Economic Development is the process of transforming from poor to rich, but, in fact, it happens in TWO PHASES.
Who is in Phase II?

• Countries with income per capita levels between $5,000 to $12,000 US dollars / capita

– And a lot of other similar characteristics
Middle Income Countries Aspirees for High Income Status

- Argentina
- Brazil
- Chile
- Costa Rica
- Malaysia
- Mexico
- Russia
- Thailand
- Tunisia
- Turkey
- Uruguay
- Venezuela

China
Who is in Phase II?

- Countries with income per capita levels between $5,000 to $12,000 US dollars / capita

- Countries that also share a lot of other characteristics
Phase II countries are in new stage of transition

- In phase II (especially for rapidly growing countries), economic dynamic of a country is different from those in phase I:
  - Wages rising
  - Rapid, permanent urbanization
  - Low wage manufacturing / subsistence agriculture disappearing
  - Re-industrialization ➔ high-value, innovation-based industries and service sector
  - High premium on education/health (need to have skills in math / science / language / foreign language / etc. to get a job – at the high and rising wage rate)
Phase II countries are in new stage of transition

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  - High premium on education/health (need to have skills in math / science / language / foreign language / etc. to get a job – at the high and rising wage rate)

What were the types of jobs that people had in South Korea during the 1990s?
Phase II countries are in new stage of transition

• In phase II (especially for rapidly growing countries), economic dynamic of a country is different from those in phase I:
  – Wages rising
  – Rapid, permanent urbanization
  – Low wage manufacturing / subsistence agriculture disappearing
  – Re-industrialization ➔ high-value, innovation-based industries and service sector
  – High premium on education/health (need to have skills in math / science / language / foreign language / etc. to get a job – at the high and rising wage rate)

What are the types of jobs that people have in Mexico today?
All of this, of course, takes place in an environment that is NOT that of a fully developed country

• Characterized by underdeveloped (less than perfect) economic and social institutions:

  – Less than perfect credit markets (have to save for everything – housing / education / etc)
  – Less than perfect health insurance
  – Less than perfect social security
  – Less than perfect welfare systems

[that is these countries typically only have a low and permeable safety net]
YET: Another common characteristic:

Aspirees (middle income countries) almost all middle income countries are countries with **high levels of Inequality** (gini ratios)

- Argentina (46)
- Brazil (54)
- Chile (52)
- Costa Rica (50)
- Malaysia (46)
- Mexico (52)
- Russia (42)
- Thailand (42)
- Tunisia (41)
- Turkey (43)
- Uruguay (42)
- Venezuela (44)

China: 50
Implications of high inequality:

Although average per capita income rising & absolute grinding poverty is disappearing ➔ still many “near-poor” people

China: 150 million people < $2 / day
300 million people < $3 / day

[although most billionaires in the world!]
Food security in the Middle Income World

• Not macro nutrient deficiency:

• Micro nutrient deficiency!
  – Hidden hunger:
    • Iron
    • Zinc
    • Vitamin B
    • More
As we have seen:
There are few calorie deficiencies (Kcal for 2009)

- Brazil: 3173
- China: 3036
- Mexico: 3146
- Thailand: 2862
- Turkey: 3666

FAOSTAT (2010)
Food security in the Middle Income World

- Not macro nutrient deficiency:

- Micro nutrient deficiency!
  - Hidden hunger:
    - Iron
    - Zinc
    - Vitamin B
    - More
2b. What is evidence of micronutrient deficiencies in middle income countries?

- Whole World
- Case Study of China
### Scope of problem (% with iron-deficient anemia)

<table>
<thead>
<tr>
<th>Country</th>
<th>Pre-school</th>
<th>Pregnant Women</th>
<th>Reproductive-aged Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>55</td>
<td>29</td>
<td>23</td>
</tr>
<tr>
<td>Mexico</td>
<td>30</td>
<td>26</td>
<td>21</td>
</tr>
<tr>
<td>Thailand</td>
<td>25</td>
<td>22</td>
<td>18</td>
</tr>
<tr>
<td>Turkey</td>
<td>33</td>
<td>40</td>
<td>26</td>
</tr>
<tr>
<td>China</td>
<td>20</td>
<td>29</td>
<td>20</td>
</tr>
<tr>
<td>US</td>
<td>3</td>
<td>5</td>
<td>7</td>
</tr>
</tbody>
</table>
And infants and school-aged children (in China):
First: infants ...
What is the quality of China’s youngest babies?

• Testing ≈2000 babies and their Mom’s in Southern Shaanxi (these areas are 2 to 3 hour drive from Xi’an – one of China’s fastest growing cities)
Malnutrition during the first 1000 days

• Of the 1960 babies tested (in 2013)

  ➔ 862 of them are malnourished

  > 40 percent of infants are sick with iron deficient anemia
What are the Cognitive Consequence of Malnutrition?

All babies are being given an Infant IQ test (Bayles test)
Cognitive Consequence of Malnutrition

- Around 40 percent of infants also FAILED their baby infant IQ tests (highly correlated with anemia rates)

- Malnutrition ➔
  - Sub-normal cognition
  - Sub-normal motor skills

We actually just did our fourth follow up survey (2015) and about 50% are failing the toddler IQ tests
Ultimate Consequences:

If the micronutrient deficiencies of infants / toddlers are not corrected before baby is 30 months old ➔

• Life time effects on:
  – IQ
  – Mental health
  – Height
  – Weight
  – Health
What does this mean?

In harshest terms:

Nearly 20 to 25 percent of China’s future population (100s of millions of people) are in danger of becoming PERMANENTLY physically and mentally HANDICAPPED
... and school-aged children (in China):

Between 2008 and 2013 we tested nearly 60,000 students across China for iron-deficiency anemia
In fact, anemia is all over China

<table>
<thead>
<tr>
<th>Total</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaanxi—2008 (Dataset 1)</td>
<td>37.5</td>
</tr>
<tr>
<td>Shanxi—2009a (Dataset 2)</td>
<td>31.6</td>
</tr>
<tr>
<td>Gansu—2010 (Dataset 3)</td>
<td>31.2</td>
</tr>
<tr>
<td>Qinghai—2009 (Dataset 4)</td>
<td>51.1</td>
</tr>
<tr>
<td>Ningxia—2009 (Dataset 5)</td>
<td>25.4</td>
</tr>
<tr>
<td>Sichuan—2010 (Dataset 6)</td>
<td>24.8</td>
</tr>
<tr>
<td>Guizhou—2010 (Dataset 7)</td>
<td>33.1</td>
</tr>
</tbody>
</table>

Children with anemia (≈ 33%) are estimated to have anemia.
Anemia also can have severe effects on children populations.

- Anemia affects:
  - School performance
  - Attendance
  - IQ
  - Health
  - Behavior

Anemia poor educational and cognitive performance / Stoltzfus et al. 2001 (in developing countries); Bobonis et al. 2006 (in India); Halterman et al. 2001; Nokes et al. 1998 (US)
Does Addressing Anemia Really Lead to Better Educational Performance?
Our In-the-field Experiment
Will iron supplements $\rightarrow$ less anemia?

Lower anemia $\rightarrow$ Better school performance?

---

Stage 1

Baseline survey $\rightarrow$ POLICY EXPERIMENT RCT’s $\rightarrow$ Evaluation survey
Start with 60 RANDOMLY SELECTED sample schools in Shaanxi Province
Using Hemocue 201+ technology measures Hb levels (Oct. 2008)
Baseline TIMMS test
(October 2008)
All fourth grade students
flipping a coin ...

“heads” is treatment school (●) ...

… “tails” ➔ is control class (○)
Locations of sample schools in Shaanxi Province

(●) Treatment Schools

(○) Control Schools
Pre-balanced at the baseline between 30 Treatment (T) Schools and 30 Control (C) Schools
Prebalancing ensures that schools in treatment groups and schools in control groups are statistically identical prior to the intervention (like identical twins).

Therefore, after the intervention, we can interpret any differences to the outcome variables (Hb levels, anemia, test scores) to be due to the intervention.
Stage 2 ➔ The Intervention
Will iron supplements ➔ less anemia?

Lower anemia ➔ Better school performance?

Stage 2

Baseline survey ➔ POLICY EXPERIMENT ➔ Evaluation survey

Treated

CONTROL

RCT’s
School Type A
(30 schools)

“Centrum / Day”

Give students one multi-vitamin with iron per day (5 mg of iron) … from November 2008 to May 2009 (≈4 US cents/day) …
30 control schools

Zero: no vitamins
Our In-the-field Experiment
Will iron supplements \(\Rightarrow\) less anemia?

Lower anemia \(\Rightarrow\) Better school performance?

Baseline survey \(\rightarrow\) POLICY EXPERIMENT RCT’s \(\rightarrow\) Evaluation survey

Stage 3
Evaluation survey (J)

Re-taking the standard academic tests …

… after 5 months of written letter to parent.
Re-taking the Hb Test (June 2009) Still anemic or not?
Results
Impact of daily vitamin on students:

**Hemoglobin**

- Control: 0
- Daily Vitamin: 3

**Anemia (%)**

- Control: 0
- Daily Vitamin: -30

**Math Test Scores (std. dev.)**

- Control: 0.1
- Daily Vitamin: 0.4
Other interventions

Intervention Two: 1 egg/day + vitamin
Intervention Three

Chewable Vitamin per Day
Intervention Four

Vita Meal (vitamin fortified porridge)
Impact of vitamin supplementation on students

Hemoglobin

Anemia (%)

Math Test Scores (std. dev.)
Does Addressing Anemia Really Lead to Better Educational Performance?

Answer: Yes …

&

Implications: if anemia rates are high, students are underperforming
Summary: Longer-run Implications for Economy / Society

- 100s of million of children are cognitively impaired
- They are not competitive in school system
- Do not learn / Drop out
  - It is ok at first … wages are rising … still low wage, unskilled jobs [this actually exacerbates the drop out problem … victim of own success]
- Low wage jobs disappear … only high wage jobs left … employers will not hire someone for a high wage if they can barely read and write (no math / no science / no language skills ➔ no formal job)
- Polarization of the labor market:
  - Half in high wage sector (rich get richer)
  - Half in informal sector … or drop out all together (gangs / organized crime)
- Society has to spend more and more on police / crime / security … large part of labor force is unproductive (or counter-productive … investment falls as uncertainty rises) ➔ VICIOUS CYCLE and STAGNATION
c. Explanation for the causes of the Second Food Security Challenge
Real Question: What is going on?

- Countries are growing and growing fast
- Wages are rising
- There are a lot of poor people, but, not extreme poverty

→ So, why don’t families invest in their:
  - Babies?
  - Children?
Two reasons

REASON ONE:

The Price of Food:

- Victim of their success in Phase I …
- Investments in agriculture / open door policies ➔ are behind growth …
  ➔ contributed to alleviation of worst poverty
  ➔ and: made price of food low …

• Cheap calories (from staples) raise demand for staples by those in the lower end of the income distribution (even though they could afford more)
Many reasons for not spending more on diversified diet

i. Real cost of meat and fruits and vegetables is not only relatively expensive, they are absolutely expensive (in real terms)
   – Need refrigeration
   – Need markets close by
     • Need time if markets not close by
   – More expensive to prepare
ii. Many competing uses for extra income

- There is extra income …
- But, as DuFlo and Banerjee point out:
  - There are many competing uses for the income of families in developing countries (especially in countries with underdeveloped economic and social institutions – which as we see characterizes middle income countries)
    - Saving for marriage
    - Saving for housing
    - Saving for retirement
    - Saving for catastrophic illnesses/injuries
    - Temples; celebrations; and more
    - Etc / etc / etc
  - Why spend additional money on higher-priced, more varied diet
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    - Etc / etc / etc
  - Why spend additional money on higher-priced, more varied diet

In short, this is often called:

“the battle for the wallet”
REASON TWO: absence of knowledge

- Hidden hunger: no outside symptoms
- Slow and imperfect correlation between nutrition intervention and anemia status and behavior/performance/physical status
- With high rates of migration, caregiving is being done by Grandma: “I never ate meat, and aren’t I ok?” …
- Time inconsistency between demand for skills and need to invest in skills: Current health and cognitive skills are fine for now; but, not sufficient for 10 to 20 years from now
- Lack of any formal nutrition education/training.
Empirical evidence

• The most educated person in a rural community is often the principal of the school:
  – But: only 1 out of 20 even know what “anemia” is
  – Principals believed that only 3% of their students were nutritionally deprived (actual number is more than 33%)

• Only 2 out of 100 caregivers have had any formal education/training in nutrition …

• MORE (from our study on infants) ➔
Survey of 2000 caregivers (Moms and Grandmas in rural China, 2012)

Percent of women that know that human babies require micronutrients:

- Yes: [Diagram]
- No: [Diagram]

Percent of women that know that baby pigs require micronutrients:

- Yes: [Diagram]
- No: [Diagram]