In Honor of Per Pinstrup-Andersen:

The Micronutrient Deficiencies Challenge in African Food Systems

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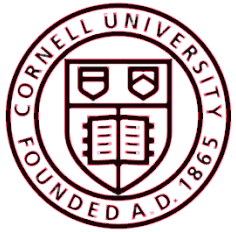
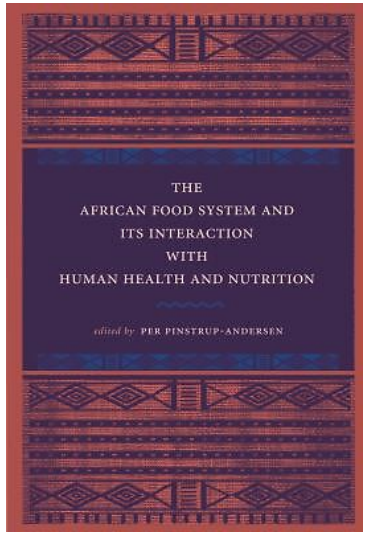
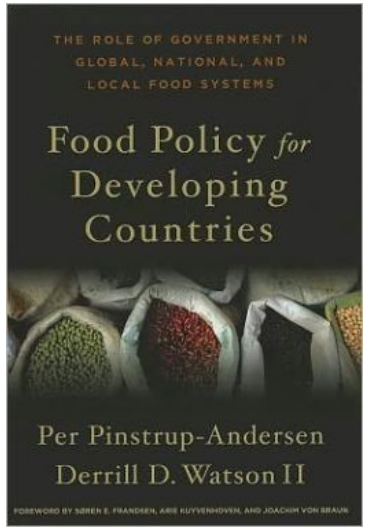


Two of Per's (many) major contributions …



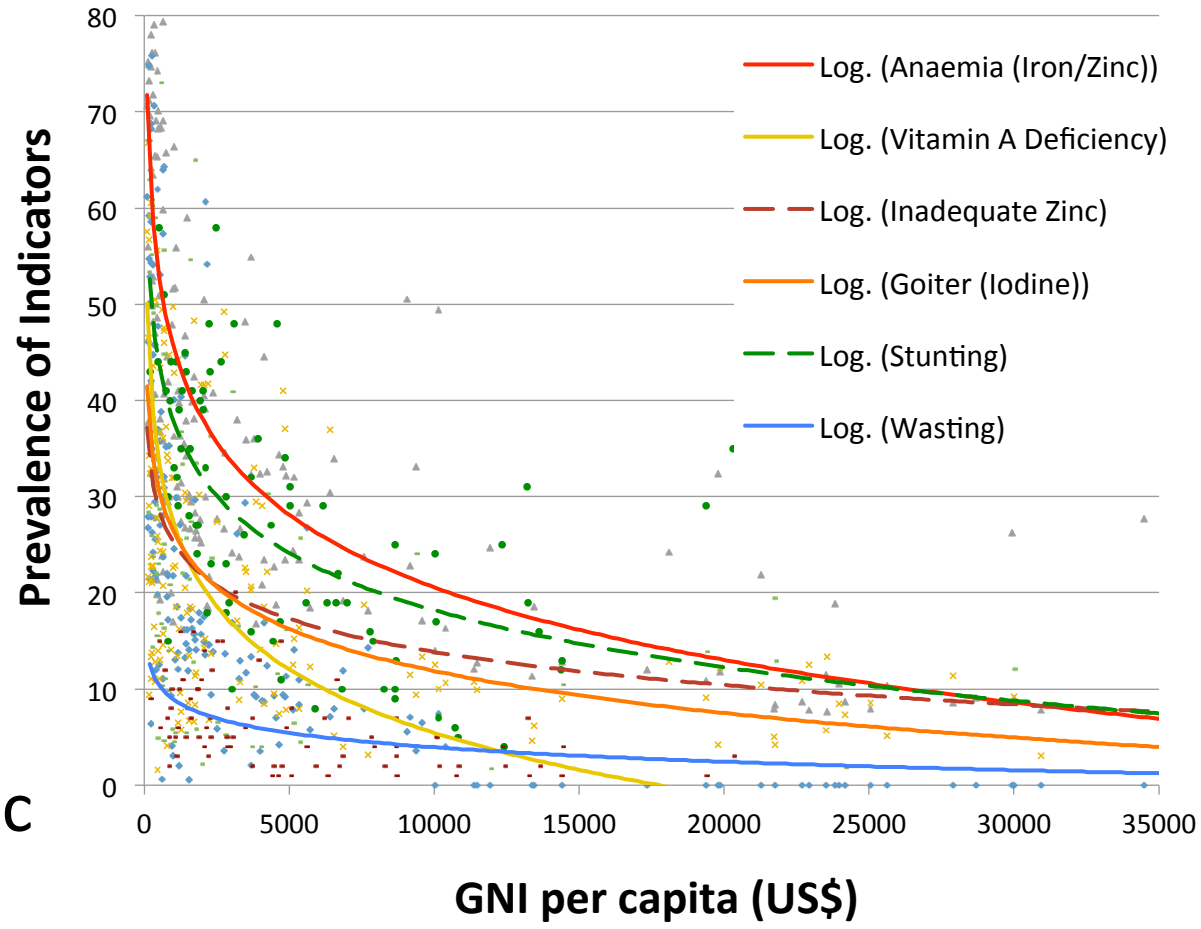


1. A holistic focus on food systems and systems-based approaches to policy analysis and design

2. Calling high-level policy and research attention to the 'triple burden' of malnutrition, including often-overlooked micronutrient deficiencies

Persistent, severe micronutrient deficiency

- 25% of the global population suffers from anemia
- 1/3 of school age children suffer from iodine deficiency
- 21% of children under 5 suffer from vit A deficiency
- 1/3 of the global population suffers from zinc deficiency



MN deficiencies deeply problematic b/c of irreversible cognitive/ physical effects … nutritional poverty traps

A foods systems approach

- Why do MN deficiencies decline so slowly with increasing income?
- Answer requires a food systems approach: interlinkages between producers, consumers and market intermediaries
  - Consumers: information problems, nutritional transition, urbanization, prices
  - Food market chains: perishability, food processing, fortification
  - Production: cropping choices, agricultural practices, MN deficiencies in soil, biofortification

Consumer demand patterns

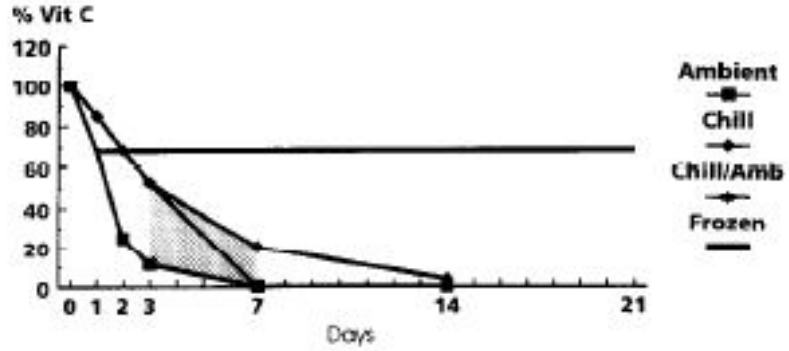
- Information: mild MN deficiencies rarely manifest in obvious sensory ways
  - Does education / increased information about micronutrients decrease MN deficiency?
- Rising GNI is associated with a "nutritional transition"
  - ↓ consumption of traditional staples, ↑ consumption of refined grains
  - ↑ consumption of animal-sourced food – ↑ intake & bioavailability of zinc and iron
- Urbanization
  - Increased opportunity cost of women's time leads to > intake of fast food, street food
  - Much of this food relies on refined wheat or rice, fats, oils, salt, sugars

The Food Value Chain (FVC)

- Perishability: foods loose vitamins over time, especially at ambient temperatures. Vitamin C & B vitamins are especially unstable.
- Increased processing of grain often removes bran and germ - including much of the Fe, Zn, Ca, vitamins, phytate, and protein

Crop	Milling fraction	Iron (µg/g)	Zinc (µg/g)
Maize	Whole grain	23	21
	Degermed grain	11	4
Rice	Brown rice	16	28
	Polished rice (90% extraction)	5	17
Sorghum	Whole grain	179	54
	Refined flour (64% extraction)	36	10
Wheat	Whole wheat flour	36	26
	White flour (70% extraction)	12	7

Miller & Welch 2012 Food Policy, Welch & Graham 1999 Field Crops Research



Spinach (Favell 1998 *Food Chemistry*)

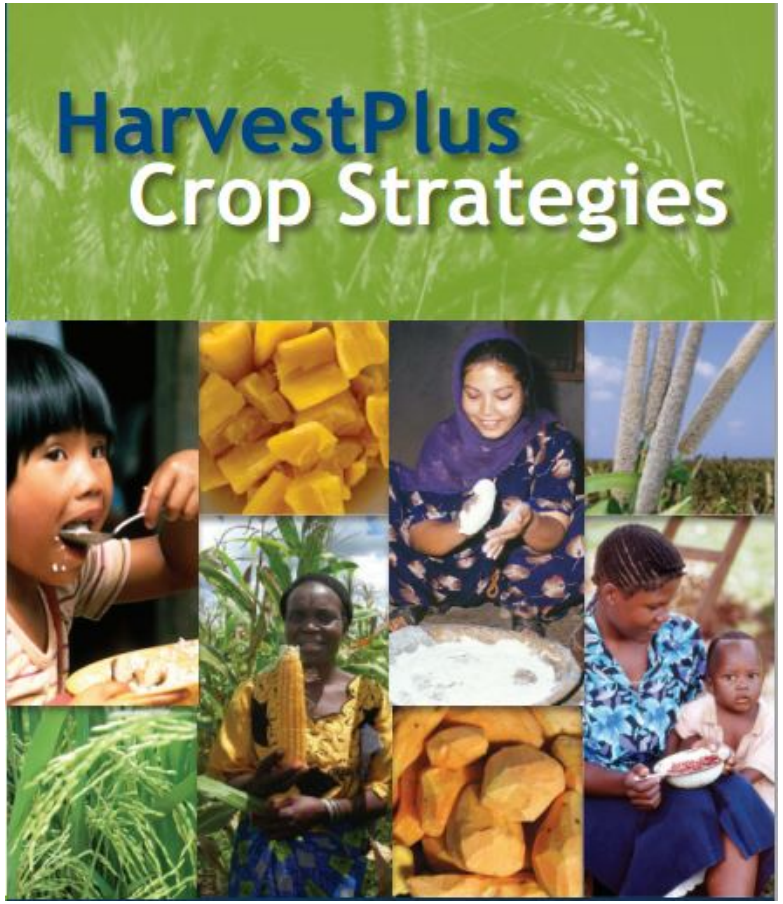
- Food fortification (e.g. milk, sugar, oils, salt) can increase levels of MNs, but success depends on large processing plants, government oversight, and consumer WTP

Producer decisions

- Micronutrient-deficient soils lead to MN-deficient crops and humans
  - Selenium deficient soils in Malawi cause low selenium intake; can be remedied with selenium-enriched fertilizers (Chilimba 2012 *Field Crops Research*)
- Green Revolution technologies increases cereal mono-cropping while decreasing production of iron- and zinc-rich legumes
  - South Asia experienced 200% (400%) increase in rice (wheat) production, a decline in diet iron density and a marked increase in anemic women in the 30 years following the Green Revolution (United Nations ACC SCN 1992)
- Increased fertilizer use affects micronutrient levels in plants
  - Excessive application of NPK fertilizer decreases vitamin C in horticulture, decreases uptake of zinc and iron in grains (Gao et al. 2011 *Field Crops Research*, Panda et al. 2012 *Comm Soil Sci Plant Anal*, Harris & Karmas 1975)

Producer decisions

- Biofortification targets poor, agrarian populations. Success depends on adoption, marketability, & longevity of MN density.



HarvestPlus Crop Strategies Brochure 2013

Looking forward

The stubborn persistent of micronutrient deficiencies clearly arises at multiple levels of food systems.

Forward-looking policy research and action must:

- Identify where MN deficiencies are severe and widespread
- Determine the root sources of those deficiencies for distinct groups
- Evaluate the cost-effectiveness of options comparatively, across the food system
- Develop useful rules of thumb for targeting interventions to those groups

Thank you, Per (and all)