Meat on Mondays:
animal source food nutrition and market implications

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Meat on Mondays: ag-nutrition strategy

• *Meatless Mondays* Campaign dating back to WWI
  – rationing strategy

• Center for Livable Future at JHSPH revived in 2003
  – environment strategy

• Change to *Meat on Mondays*
  – ag-nutrition strategy!
  – If the world consumes the per capita supply of eggs & milk 1x per week, EXCEED the DRI for vitamin A, B12, iron, zinc, etc. men 19-30 yr and lactating women
1) Rationale: invest in ASF nutrition & markets
   1) Biology: evolutionary basis for ASF
   2) Mathematics: food matrix advantages
   3) Economics: micronutrient nutrition

2) Livelihood transitions: intersection of small livestock development & nutrition
   1) Pastoralist milk nutrition – Samburu, Kenya
   2) Egg nutrition – Pastocalle, Ecuador

3) ASF in the Ag-Nutrition Agenda
   1) Exploiting nature’s technology – the egg pill & milk solution
   2) Ag-nutrition synergies – multiplying effects
Leveraging Nature's Technology: eggs & milk

Over thousands of years…
1) nature perfected the nutritional composition
2) crafted to sustain early life, completely
3) economically affordable and environmentally sustainable

• What potential lies in small livestock development to improve nutrition through synergistic impacts on poverty, availability/access to high quality foods, and women’s empowerment?
• Are ASFs more cost-effective for improving nutrition than fortified foods & supplements?
• Can we responsibly promote ASF in vulnerable populations, without crossing the threshold into chronic disease risk, and achieve more equitable distribution in world markets?
Invest in ASF nutrition & markets

RATIONALE
Evolutionary basis: anthropology of anthropometry

- Last common ancestor with other primates

- Homo erectus (2.6 mya)
  - Differed from Australopithecus garhi & Homo habilis
  - Bigger brain & body
  - Smaller intestine & teeth

- Agriculture (10,000 ya)
  - Mobility no longer necessary
  - Homo sapiens shorter
Evidence-based Paleo Diet

- **Discordance theory** (Konner & Eaton 1985)
  - Human genome evolve to adapt to conditions that no longer exist. Mismatch is causing chronic diseases

- **Plant-animal ratios** (Cordain et al. 2000)
  - Ethnographic evidence from 229 hunter-gatherer societies
  - Proportion of energy intakes: animal foods (45-65%)

- **“Meat made us human”** (Bunn 2007)
  - Plio-Pleistocene Era East African Rift Valley - Mary Leakey discoveries
  - In-tact carcasses & flaked stone tools

![Pie chart showing gathered plants (26-35%) and hunted & fished animals (66-75%)](Cordain et al. AJCN 2000)
Plasticity & right conditions enable rapid adaptations to diverse environments

- Large, transient populations: \( \uparrow \) rate + \( \uparrow \) effectiveness

- Lactase persistence (LP):
  - Single nucleotide variant (T 13910 allele) associated with lactose tolerance
  - Milk consumption 11,500 ya, and dairying 7,500 ya and allele dates 5-12,000 ya. LP phenotype prevalent within 1-2000 years (Hawks et al. 2007)
## Food matrices: it’s all in the packaging

<table>
<thead>
<tr>
<th>Limiting nutrient</th>
<th>ASF matrix</th>
<th>ASF: plant form absorption rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vit A →</td>
<td>[Chemical structure of Vit A]</td>
<td>12-24x (ug)</td>
</tr>
<tr>
<td>Iron →</td>
<td>[Chemical structure of Iron]</td>
<td>2x (mg)</td>
</tr>
<tr>
<td>Zinc →</td>
<td>[Chemical structure of Zinc]</td>
<td>2x (mg)</td>
</tr>
<tr>
<td>Choline →</td>
<td>[Chemical structure of Choline]</td>
<td>?</td>
</tr>
</tbody>
</table>
Economics of micronutrients

GUATEMALA
Guatemala: food prices and income linked to nutrients in ASF

• Hypothesis: rising food prices and increased poverty will reduce consumption of “luxury” animal source foods leading to increased probability of inadequacy for the vitamins A, B$_{12}$, and folate and minerals iron and zinc.

• Washington University and IFPRI/Markets, Trade, and Institutions (Iannotti, Robles et al. *J. Nutr* 2013)

- Energy/nutrient intakes and adequacy levels
  - 116 food items reported by households; ProPAN & USDA National Nutrient Data-base
  - Intake levels & probability of intakes

- Income-nutrient relationships
  - Disparities in intakes: concentration curves
  - Income-nutrient elasticities
  - Modeling nutrient intakes by reductions in income

- Price-nutrient relationships
  - price-nutrient elasticities
  - Modeling 2 price scenarios: food price crisis 2007–2008; standardized 10% increase across all food groups
FIGURE 1  Lorenz (income) and concentration (nutrient) curves for vitamin A (A), vitamin B-12 (B), folate (C), iron (D), and zinc (E) in a Guatemalan sample. Income (per capita expenditure) share is sorted from lowest to highest on the x-axis and plotted with the cumulative proportion of per capita expenditure [Lorenz curve] and nutrient intakes (concentration curve) on the y-axis. The curves visually illustrate the distance from the imaginary line of equality at the 45° angle.
Income-nutrient elasticities
Key findings (Iannotti, Robles, et al. J. Nutr 2012)

- Evidence for economic determinants of micronutrient nutrition

- Income most closely associated with vitamin A and vitamin B_{12}
  - Intake disparities with vitamins B_{12} & A, comparable to income

- Food prices more closely associated with zinc and folate intakes
  - Greatest increase in probability of inadequacy: zinc showed 6-8 ppt increase in poorest two quintiles; folate 6-7 ppt increase

Relevance: these nutrients found in ASF are closely linked to poverty & markets
Intersection of small livestock development & nutrition

LIVELIHOOD TRANSITIONS
Pastoralist milk nutrition: Samburu, Kenya

• Livelihood transition:
  – ↓ Land access (adjudication frequent droughts)
  – ↑ Sendentarization (policies, mandatory education, poverty)

• 2 comparable communities
  – Siambu: cultivation
  – Mbaringon: livestock

• Longitudinal data
High levels of nutrient intake inadequacy for pastoralists

Iannotti and Lesorogol *Current Anthropology* 2014
Milk, 10% energy intake, is a critical source of other nutrients

<table>
<thead>
<tr>
<th>Food Group</th>
<th>Energy</th>
<th>Vitamin A</th>
<th>Vitamin $B_{12}$</th>
<th>Vitamin C</th>
<th>Folate</th>
<th>Iron</th>
<th>Zinc</th>
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</thead>
<tbody>
<tr>
<td>Maize</td>
<td>49</td>
<td>34</td>
<td>0</td>
<td>0</td>
<td>27</td>
<td>60</td>
<td>51</td>
</tr>
<tr>
<td>Rice</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>5</td>
<td>13</td>
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<tr>
<td>Potatoes</td>
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<td>33</td>
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<td>3</td>
<td>1</td>
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<tr>
<td>Beans</td>
<td>11</td>
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<td>0</td>
<td>0</td>
<td>57</td>
<td>27</td>
<td>21</td>
</tr>
<tr>
<td>Meat</td>
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<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Milk</strong></td>
<td><strong>10</strong></td>
<td><strong>57</strong></td>
<td><strong>94</strong></td>
<td><strong>50</strong></td>
<td><strong>6</strong></td>
<td>2</td>
<td><strong>11</strong></td>
</tr>
<tr>
<td>Vegetables</td>
<td>0</td>
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<td>0</td>
<td>17</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Fat</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sugar</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Iannotti and Lesorogol *Current Anthropology* 2014
Livestock ownership improves nutrient intake adequacies and milk consumption BMI\textsubscript{z}

- Livestock ownership increased nutrient adequacy for vitamin A, B\textsubscript{12}, and zinc (adj $R^2=.06-.16; P<.001$)
  - Milk consumption increased BMI\textsubscript{z} scores among youth ($P<0.001$). (Iannotti and Lesorogol AJPA 2014)

- Cattle and chicken ownership increased dietary diversity (adj $R^2=.33; P<.001$)

- Conclusion: Support livestock development for households and milk consumption among pastoralist children

- Next steps: Intervention study to examine improved breeds of goats on milk production, consumption, and nutrition
Egg nutrition – Pastocalle, Ecuador
Egg study – Pastocalle, Ecuador

• RCT to test effects of daily egg consumption among children 6-8 mo for six months (n=180)

• Eggs purchased from local producers

• Outcomes: anthropometry, biomarkers of choline, vitamin B$_{12}$, lipids and amino acids
The egg pill & milk solution

ASF AG-NUTRITION AGENDA
Opportunities: the ASF potential

1) Evolutionary basis for “periodic” ASF

2) ASF-nutrient matrices more efficient than plant or supplement forms

3) ASF closely linked to income, prices, livelihoods, and markets

4) Eggs and milk are nature’s perfectly crafted technology to sustain early life, completely

5) Eggs and milk can be more economically affordable and environmentally sustainable than other ASF
Challenges: Ag-nutrition synergies

- What is the minimum ASF needed to sustain nutrition in vulnerable populations without crossing the threshold for increased chronic disease risk?
  - Can we responsibly promote ASF in vulnerable populations to achieve more equitable distribution in world markets?
  - Would Meat on Mondays work to improve nutrition for all?

- What potential lies in small livestock development to improve nutrition through synergistic impacts on poverty, availability/access to high quality foods, and women’s empowerment?
  - School-based ASF interventions that support local economic development
  - Household level ASF interventions targeting young children
Challenges: leveraging nature’s technology

• Can low-cost, “renewable” ASF (eggs & milk) improve nutrition in vulnerable groups?
  - Are ASF more cost-effective for improving nutrition than fortified foods & supplements?

• Will poor households reserve eggs and milk for vulnerable groups, while selling others for livelihood?
  - What health and nutrition messages are needed?
  - Can hygienic practices with livestock production mitigate child diarrheal disease

• Improve design and methods of nutrition & livestock intervention studies