Animal Source Foods: importance nutritionally &

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February 9, 2017

TOPS Program
Nutrition/Food Technology Task Force &
Agriculture/Natural Resource Task Force
1) **Animal source foods: vital role in human nutrition**
   - Stunting & hidden hunger
   - ASF matrix - bioavailability of critical nutrients

2) **Eggs, Milk, and Fish: research**
   - Egg nutrition among indigenous groups – Ecuador
   - Milk nutrition among pastoralists – Kenya
   - Fish nutrition - Haiti

3) **TOPS Program**
   - Nutrition/Food Technology Task Force
   - Agriculture/Natural Resource Management Task Force
Undernutrition in first 1,000 days…

- **Undernutrition** in young children $<$ 5 yrs
  - 164.8 million stunted (25.7%)
  - 100.7 million underweight (15.7%)
  - 51.5 million wasted (8%)

- **Hidden hunger** – micronutrient deficiencies
  - 33% children vitamin A deficient
  - 18% children anemic (some iron deficiency)
  - 17.3% world zinc deficient; 28% world iodine deficient

3.1 million (45%) of deaths to children $<$ 5 yr (2013)

140.5 million (35%) of DALYs for children $<$ 5 yr and 10% of global DALYs (2008)
Prevalence of Stunting

Next 3,000 days: ASF for healthy brains

Sensitive periods and the developing brain

HUMAN BRAIN DEVELOPMENT
Synapse formation dependent on early experiences

- Sensory Pathways (vision & hearing)
- Language
- Higher Cognitive Functions

Cell division and migration

THE LANCET
Advancing Early Childhood Development: from Science to Scale
### Global Nutrition Targets 2025

#### ASF CONTRIBUTION

1) **Stunting**: 40% reduction in the number of children under 5 who are stunted. Baseline 2012: 162 million, Target for 2025: ≈100 million

2) **Anemia**: 50% reduction of anaemia in women of reproductive age. Baseline 2012: 29%, Target for 2025: 15%

3) **Low birthweight**: 30% reduction in low birth weight. Baseline 2012: 15%, Target for 2025: 10%

4) **Childhood overweight**: No increase in childhood overweight. Baseline 2012: 7%, Target for 2025: ≤7%

5) **Exclusive breastfeeding**: Increase the rate of exclusive breastfeeding in the first 6 months up to at least 50%. Baseline 2012: 38%, Target for 2025: ≥50%

6) **Childhood wasting**: Reduce and maintain childhood wasting to less than 5%. Baseline 2012: 8%, Target for 2025: <5%
Food Matrix & Evolutionary Basis

RATIONALE FOR ANIMAL SOURCE FOODS
Essential Nutrients

• Constituents in the diet required for growth, health, and survival, not sufficiently produced endogenously.
  
  – Macronutrients – protein/amino acids, carbohydrates, lipids/fatty acids, fiber

  – Micronutrients
    • Vitamins (organic) – A (β-carotene, retinol), B (thiamin), riboflavin, niacin, pyridoxine, cobalamin, pantothenic acid, folate), C (ascorbic acid), D (calciferol), E (α-tocopherol), K, choline

    • Minerals/elements/trace minerals (inorganic) – calcium, iron, zinc, iodine, selenium, copper, fluoride, phosphorus, magnesium, manganese

  – Water & electrolytes – sodium, chloride, potassium, inorganic sulfate
Historical origins
- Nutrient discoveries in relation to disease – scurvy (vit C), beri beri (thiamine), rickets (vit D), goiter (iodine)
- Technologies that enable supplementation, fortification and biofortification

Global nutrition programming and policy
- Vitamin A supplementation
- Fortification (iodized salt, folic acid in wheat) and biofortification (golden rice, orange flesh sweet potatoes)

What is the harm?
* Potential for overload
* Physiology not constituted for single nutrients
Food matrices: it’s all in the packaging

Limiting nutrient | ASF matrix | ASF: plant form absorption rate
--- | --- | ---
Vit A → | ![Vitamin A molecule](image) | 12-24x (ug)
Iron → | ![Iron complex](image) | 2x (mg)
Zinc → | ![Zinc complex](image) | 2x (mg)
Choline → | ![Choline molecule](image) |
Global distribution of eggs, milk, & fish availability (FAO data 2011)
Evolutionary basis: anthropology of anthropometry

- **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

- **Genome-Nutrition Divergence**
  - *Discordance theory* (Konner & Eaton 1985) Human genome evolve to adapt to conditions that no longer exist. Mismatch is causing chronic diseases
Over thousands of years…

1) nature perfected the nutritional composition

2) crafted to sustain early life, completely

3) economically affordable and environmentally sustainable
Eggs: provides >50% of nutrients (++) and 20-50% (+) for breastfed infants 7-12 mo

Iannotti et al. Nutrition Reviews 2014
Lulun Egg Project – Ecuador

G. Reinhart photo, Mathile Institute
Lulun Egg Project

• **Objective:** Test the efficacy eggs introduced early in complementary feeding period on growth and nutrient biomarker outcomes (n=163)

  – **Primary outcomes:** biomarkers of choline, vitamin B$_{12}$, and fatty acids, anthropometry/growth

  – **Secondary outcomes:** acceptability, dietary intakes, and morbidities
Lulun Egg Project

• RCT (Mar–Dec 2015)
  – **Cotopaxi Province** – mixed indigenous community, high baseline stunting
  – **Intervention**: 1 egg per day for 6 months (eggs purchased locally, and delivered weekly during surveillance visits)
  – **Longitudinal follow-up**: baseline (6-9 mo) and endline (12-15 mo)

• Mixed methods
  – **Quantitative**: caregiver surveys, anthropometry, GPS/GIS
  – **Biomarkers**: LC/MS/MS at Washington University in St. Louis, ELISA (vitamin B12) at NETLAB
  – **Qualitative**: grounded theory, structured observations, focus groups, and in-depth interviews
Social Marketing

- **Intent:** encourage participation with culturally inclusive messages and symbols, and create awareness about the study and its importance

- **Activities:** messaging at study site and community; workshops (egg recipes, flower arranging); sports; community events

- **Successes:** RCT individual level; high participation; only 7% losses-to-follow-up, despite Cotopaxi volcano eruption.
GLM regression models

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Endline</th>
<th>Effect size or prevalence ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control (n = 82)</td>
<td>Egg (n = 78)</td>
<td>Control (n = 73)</td>
</tr>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Length-for-age z (SD)</td>
<td>-1.71 (0.92)</td>
<td>-2.09 (1.08)</td>
<td>-1.71 (1.00)</td>
</tr>
<tr>
<td>Weight-for-age z (SD)</td>
<td>-0.40 (0.92)</td>
<td>-0.91 (1.24)</td>
<td>-0.55 (0.85)</td>
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<tr>
<td>Weight-for-length z (SD)</td>
<td>0.86 (0.99)</td>
<td>0.55 (0.99)</td>
<td>0.36 (0.81)</td>
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<tr>
<td>BMI z (SD)</td>
<td>0.80 (1.00)</td>
<td>0.42 (1.10)</td>
<td>0.64 (0.82)</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Stunted</td>
<td>26 (32%)</td>
<td>37 (47%)</td>
<td>29 (40%)</td>
</tr>
<tr>
<td>Underweight</td>
<td>4 (5%)</td>
<td>10 (13%)</td>
<td>5 (7%)</td>
</tr>
</tbody>
</table>

GLM modeling with log-binomial with robust Poisson for stunting and underweight outcomes. All models adjusted for child age, sex of the child, and baseline anthropometry for the same dependent variable.
Growth Effect:
Change in LAZ, baseline (dashed) to endline (solid)

A. Control group

B. Egg group

Kernel density estimates
Other key findings

- No allergic reactions to eggs (observed or mother-reported)

- Reduced intake of sugar-sweetened foods (PR, 0.71; 95% CI, 0.51-0.97)

- Increased concentrations of choline, betaine, and dimethylglycine
  - No effect on vitamin B12, linoleic (18:2n-6), α-linolenic (18:3n-3), or DHA fatty acids
Pastoralist milk nutrition: Kenya
Pathways to nutrition impacts

Livelihood transition: ↓ Land access & ↑ Sendentarization

2 comparable communities: livestock (Siambu); Mbaringon: cultivation

## Food source of nutrients

<table>
<thead>
<tr>
<th></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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<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>
</tr>
<tr>
<td>Potatoes</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>33</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Beans</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>57</td>
<td>27</td>
<td>21</td>
</tr>
<tr>
<td>Meat</td>
<td>1</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Milk</td>
<td>10</td>
<td>57</td>
<td>94</td>
<td>50</td>
<td>6</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Vegetables</td>
<td>0</td>
<td>9</td>
<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 CA 2014
Maize dependency - % daily kcals

- Maize: 52%
- Milk: 10%
- Sugar: 11%
- Fat: 10%
- Beans: 10%
- Potatoes: 4%
- Rice: 1%
- Meat: 1%
- Vegetables: 0%
Livestock ownership improves nutrient intake

- **Findings:**
  - Livestock ownership increased nutrient adequacy for vitamin A, B\textsubscript{12}, and zinc (adj R\textsuperscript{2}=.06-.16; P<.001) (Iannotti and Lesorogol CA 2014)
  - Milk consumption increased BMI z scores among youth (P<0.001) (Iannotti and Lesorogol AJPA 2014)
  - Cattle and chicken ownership increased dietary diversity (adj R\textsuperscript{2}=.33; P<.001)

- **Conclusion:**
  - Support livestock development among pastoralist households for child milk consumption and nutrition

- **Next steps:**
  - Intervention study to examine improved breeds and managements of goats on: milk production and poverty reduction; milk consumption, nutrition, and health; and gender empowerment.
Fish nutrition: Haiti
Environment & nutrition

• **Low fish consumption in Haiti**
  – Stunting 20.9% < 5 years
  – Fish source of DHA, n-3 fatty acids
  – ↓Fish consumption per capita, 2.8-4.8 kg/yr

• **Mangroves & other environmental Issues**
  – Mangroves cut down for impounding land, charcoal, and fire wood
  – Overfishing, depletion of coastal waters; barrier reef destruction erosion
  – Juvenile fish and conch sold in markets
Protecting the mangroves for fish nutrition

• **Haiti fish potential**
  – Island with 2 peninsula, >1700 km total coastline
  – Promote fish and mollusk consumption for young children

• **Protecting Mangroves**
  – Universite d’Etat d’Haiti – Department of Environment
  – Important marine life nurseries [mollusks/conch, crustaceans, eels, fish]

• **Formative research**
  – Data analyses of fish consumption and stunting
  – Focus groups, in-depth interviews of fisherman, market women (madan sara), and mothers
Programming Agenda

TOPS TASK FORCE
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Leverage ASF Potential

- **Nutrition/Food Technology Task Force**
  - Introduce ASF early in the complementary feeding period
  - Promote WASH in context of animal production
  - With increased income, encourage high quality foods

- **Agriculture/Natural Resource Management Task Force**
  - Small livestock and fisheries development beyond production threshold for selling
  - Protect animal health and nutrition to improve human nutrition
  - Preserve environment to protect nutrition

- **Find transdisciplinary solutions! (and evaluate for evidence base)**
THANK YOU