Livestock-derived foods and sustainable healthy diets

Lora Iannotti, PhD
Associate Professor
Director, E3 Nutrition Lab
Washington University in St. Louis
Presentation outline

1. Introduction
   • The public discourse
   • Disparities: LDF consumption patterns

2. Health and nutrition implications
   • Nutrient bioavailability of LDFs
   • LDFs through the lifecycle

3. Sustainable production of livestock-derived foods
   • Challenges
   • Opportunities

4. Conclusions
   • Summary: Key Messages
   • Next steps for taking action
E3 Nutrition Lab

Research to identify interventions that promote healthy growth and development in the most vulnerable populations globally, with the following criteria:

- Equitably accessed
- Evolutionarily appropriate
- Environmentally sustainable

Research sites: Ecuador, Haiti, Kenya, Global

Role: scientific perspective and infuse evidence-base
The public discourse

• LDFs as relate to environment and human health have garnered the public’s attention - with some imbalance in the dialogue (Steinfeld et al. 2006)(Gerber et al. 2013)(EAT-Lancet 2019)

• Indisputable evidence that LDF production systems contribute to climate change and chronic disease burden....but they can and should play a vital role in achieving SDG2 (zero hunger), SDG12 (responsible consumption), SDG 13 climate action

• Voices unheard
  • **Children and women:** 21.3% children stunted, 5.6% overweight (SOFI 2020); 1/3 of women reproductive age are anemic; hidden hunger widely prevalent
  • **Small-holder producers:** produce estimate 51–77 % of nutrients globally (Herrero et al. 2017); disproportionately affected by climate change
  • **Resource-poor populations:** low-income countries, poor communities globally
LDF consumption disparities

World

Europe

Africa

Asia
Poultry meat consumption disparities (FAOSTAT, 2018)
Nutrition & health implications

Livestock-derived foods

Photo credit: Lulun Project (G. Reinhart)
Evolutionary importance of LDFs

• *Homo erectus* (early hominin) ~1.8 mya
  • Anatomical differences from other *hominins* (*Australopithecus garhi* & *Homo habilis*), attributed to diet changes - animal source foods in particular.

**Physical Differences**

↑ Brain size – 3x the encephalization quotient (brain mass to body mass) (Broadhurst et al. 1998)
↑ Taller height - 15% taller (Walker 1993)
↑ Larger body mass
↑ Longer legs (bipedalism)
↓ Smaller teeth
↓ Colon, ↑ small intestine (>56%)

• Systematic review child evolutionary diets from *H. erectus* through early agriculture
  • Preliminary findings: 93 studies indicating ASF always present in child diets of GHF groups, together with a diverse range of others foods depending on environment.
LDFs are nutrient-dense and bioavailable

- LDF comprise a vast array of foods, with differences in nutrient composition across/within species
  - Nutrient content may depend on animal feed and nutrition
  - Meat nutrients vary by tissue type (muscle vs organ)

- LDF nutrient composition examples:
  - **Protein**: Digestible indispensable amino acid score of eggs and milk >100%, compared to 37% rice, or 45% wheat
  - **Fatty acids**: DHA and other PUFA found in LDFs, but also saturated/trans fats
  - **Vitamins**: A, B12 and other B vitamins, D, choline
  - **Minerals**: Zn, Fe, Se concentrated in LDFs

- Bioactive factors linked to health outcomes
  - >26,000 distinguishable compounds in food (Barabasi et al. 2020)
  - TMAO in LDFs linked to mortality in adults with CVD
## Nutrient matrix: bioavailability of LDFs

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>LDF Matrix</th>
<th>ASF vs PSF absorption rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vit A</td>
<td><img src="image1.png" alt="Vitamin A" /></td>
<td>12-24x (µg)</td>
</tr>
<tr>
<td>Iron</td>
<td><img src="image2.png" alt="Iron" /></td>
<td>2x (mg)</td>
</tr>
<tr>
<td>Zinc</td>
<td><img src="image3.png" alt="Zinc" /></td>
<td>2x (mg)</td>
</tr>
<tr>
<td>Choline</td>
<td><img src="image4.png" alt="Choline" /></td>
<td>-</td>
</tr>
</tbody>
</table>

*Image: ILRI (A. Slater)*
Epidemiology of LDFs → human health

• **Adults**
  - **Processed meats** linked to colorectal/other cancers, cardiovascular disease, and diabetes
  - Prospective studies in high-income countries showed ↑ all-cause mortality rates associated with **high red and processed meat** compared to low quantities; **no association or inverse for poultry** (Godfray et al. 2018)
  - **Red meat consumption** ranks toward bottom of DALYs, compared with other dietary risk factors (such as high sodium, low fruits and low grains), but evidence is still limited (GBD 2017)

• **Infants and young children**
  - Cochrane review five studies **ASF in 6-24 mo increased HAZ** (Eaton et al. 2019)
  - Systematic review ASF showed **reduced stunting in one RCT** and one cross-sectional study (Shapiro et al. 2019)

• **School-age children**
  - **Cognitive function improved** in meat group compared to milk & control groups; **improved growth** in both the milk and the meat groups (Neumann et al. 2007)
  - Children < 18 yrs from Asia showed meat consumption **increased risk of overweight/obesity** (Yang et al. 2012)

• **Pregnant and lactating women**
  - **Limited evidence on LDFs only.** Fish intake during pregnancy studied to compare risks of contamination vs no intake on offspring neurodevelopment (Starling et al. 2015)
  - Maternal supplementation with animal protein **increased birth weight** (Pimpin et al. 2019)
  - Poultry production modest **benefits on anemia** in women and children (Lambrecht et al. 2019)
LDFs through life course

Nutrient adequacy, proper growth & neural development and healthy birth weight

Mother

Infant

School Age Child

Adolescent

Adult

Pregnancy

Elderly

Memory & cognitive preservation, bone health & muscle mass maintenance, immune system functioning

Bone preservation, lower risk of infection and adequate breast milk supply

Vitamin B12, Choline, Iron, Zinc, Vitamin A, Calcium, DHA

Adequate bone growth & cognitive development, vision health and immune system functioning

Obesity, cardiovascular disease, diabetes, cancer

Adequate growth & catch up, reproductive maturation, normal cognitive development and neuroplasticity

Cognitive maintenance and adequate nutrient levels

Overconsumption

Vitamin B12, Zinc, iron

Calcium, Iron, Zinc, Vitamin B12

Normal cognitive functioning & brain development, adequate growth and immune system functioning
Sustainable livestock production

Livestock-derived foods
LDF production ↔ environment and climate

**CHALLENGES**

- **GHG emissions**: LDF production ~14.5%; food systems ~30% (Clark et al. 2019)(Gerber et al. 2013)
  - Feed production, enteric fermentation by ruminants, manure-storage and processing, transport
- **Fresh water use**: 87.2% green, 6.2% blue, and 6.6% grey
- **Biodiversity losses**: feed production, loss of top predators, extensive grazing in systems, narrowing of local livestock species/breeds

However, numbers are controversial...

- Data largely from OECD production systems
- Production, processing and supply-chain environments vary
LDF production ↔ environment and climate

OPPORTUNITIES

• **Mixed production systems**: produce half of the world’s food
  - In these systems, livestock provide draft power and manure to enrich soil biomass; inedible crop parts used for animal feed

• **Efficiencies improved through**: feed-conversion rates in chickens and pigs; animal health; quality feed; and herd management

• **Appropriate animal breeds**: local breeds adopted to local environments

• **Protecting animal health**: One Health approach to combat zoonotic disease and enhance animal health
Conclusions

Livestock-derived foods
Summary – Key Messages

• Implications of LDFs depend on: 1) context, 2) life course phase, and 3) production system

  • Nutrition inequities prevail globally, notable LDF apparent dietary intake patterns
  • LDFs provide critical nutrients in bioavailable matrices. Thus LDFs can have vital impacts on human health, both in abundance and in scarcity
  • Ensure LDF access for children, pregnant/lactating women, and elderly
  • LDF production has serious impacts on the environment but opportunities exist to mitigate climate change and environment impacts

• Rebalance food systems and support sustainable, mixed production systems to safeguard human, animal, and planetary health
Taking action: enabling environment

• Equitable Food Systems
  • Food systems should espouse fair trade principles, sound environmental practices and access to diverse and high-quality diets for all.
  • Economic and political strategies: protect the affordability of LDFs in some populations and create disincentives to overconsume in others.

• Policies & Programs
  • Policies should ensure that people have access to LDFs at critical stages of life course.
  • Social and behavioural change strategies to increase awareness of the importance and risks associated with LDFs.
  • Food-based dietary guidelines set appropriate quantities of LDFs, drawing on locally available, biome-based foods.
Taking action: planetary health

• Mitigating environment impacts of LDF production
  • Support mixed farming systems that embrace circular bioeconomy and pastoral systems.
  • Production systems adapted to local contexts and ecosystems
  • Transition some systems to more sustainable animal types (such as monogastric animals) and products (such as eggs or dairy).

• One Health principles
  • Small- and medium-scale producers should be integral to solutions, and women farmers focus for production inputs (animal health, credit and extension services).
  • Efficiencies could be gained through improved feed-conversion rates and the use of local breeds that have adapted to the environment.

Photo credit: Lulun Project (G. Reinhart)
Taking action: research and institutions

• Research: evidence-base for LDF in sustainable healthy diets
  • Test LDF interventions and health across all vulnerable groups.
  • Investigate approaches to optimizing biodiversity and dietary diversity, blending disciplines of ecology and public health nutrition.
  • Explore the bidirectionality of climate change and LDF production.

• Institutional commitments
  • UN Nutrition to play a leading role in orchestrating a concerted effort among Members, to achieve policy coherence and innovation.
  • ILRI and others in the CGIAR system committed to UN Decade on Nutrition and working to ensure availability, access and affordability of LDFs globally.
Thank you

• UN Nutrition – Stineke Oenema
• E3 Nutrition Lab – Mary Kate Cartmill
• ILRI coauthors – Shirley Tarawali, Isabelle Baltenweck, Polly Ericksen, Bernard Bett, Delia Grace Randolph
• UN Nutrition members – Joyce Njoro and Antonio Rota (IFAD), Saskia De Pee and Becky Ramsing (WFP), Nancy Aburto, Trudy Wijnhoven and Johanna Schmidt (FAO), Marzella Wustefeld, Lina Mahy, Carmen Savelli and Stephane De la Rocque (WHO)

• Poilin Breathnach, editor, and support from Sadia Mohamoud and Jessie Pullar (UNSCN). Faustina Masini, graphic design