Transforming the food sector by integrating nutrition into LCA

Outline

- Background of problem
- Overview of nutritional-LCA (n-LCA)
- Measures of nutrition and health
- Implementing n-LCA
- Key gaps and challenges in n-LCA
- Conclusion
Production vs. Consumption Perspective
Influence of production on nutrient-contents

Background

N-LCA

Nutrition Metrics

Integration

Challenges

Conclusion

Ashley Green
**Nutritionally-responsible food production**

**Move**
Move the needle towards optimizing agriculture on a nutrient-content basis

**Help**
Help combat the homogenization of food supply

**Inform**
Inform consumers to make healthier choices

**Identify**
Identify tradeoffs and synergies to differentiate & optimize production systems

- 2 billion Micronutrient deficient
- 1.2 billion Overweight

Graph from DeFries et al 2015

Nutrient-content

Profit

Ashley Green
What is Nutritional-LCA (n-LCA)

- Quality
- Diversity
- Health
- Quantity

Environmental LCA

*Well-established*
Applications of n-LCA

- Mass or kcal

- Nutrients vs. nutrition (e.g., ECM milk)

- Single nutrients

- Human health metrics

- Nutrient metrics
Nutrient Indices

- Nutrient indices are used to rank and compare foods based on their nutrient composition
  - Explains if a population can meet nutrient requirements
  - No perfect index exists → important to understand points of differentiation

\[
NR9 = \sum_{i=1}^{n} \frac{1}{n} \left( \frac{\text{nutrient}_i}{\text{Calories}_j} \right) \frac{1}{\text{DRI}_i}; \\
i = \text{nutrient}, \\
j = \text{food item}
\]
Nutrient Indices: Selected Points of differentiation

Weighting
- Weighting basis
  - Nutritional deficiencies
  - Bioavailability
  - Health outcomes
  - Energy needs

Capping
- Capping basis
  - 100% DRI
Nutrient diversity metrics

- Nutrient diversity metrics measure the heterogeneity of diets, food supply, and production systems

- Food quantity vs. Nutrients

- Higher computational complexity

\[
\text{Rao's Quadratic Entropy} = \sum_{i=1}^{s-1} \sum_{j=i+1}^{s-1} d_{ij} p_i p_j
\]

\(i=\text{food}_n, j=\text{food}_{n+1}\), where \(p=\text{relative abundance of food item } i\) and \(d=\text{the dissimilarity between foods } i,j\) measured by differences in nutritional composition
Nutrient quality metrics

DIAAS values of selected food items

- Cheese
- Milk
- Bovine meat (beef herd)
- Tofu
- Soymilk
- Peas
- Other pulses
- Nuts
- Groundnuts

Graph adapted from: Loveday, S 2019
How do we integrate nutrition / health?
How do we integrate nutrition / health? Functional Unit

**Functional Unit**
- Definition?
- Secondary vs. Primary integration
- Disqualifying nutrients?

Diagram:
- Nutrition
- Health
- Goal & Scope
- Inventory
- Impact Assessment
- Interpretation
Nutritional-functional unit

Results change when accounting for nutrition

- Impacts change
  - Animal vs. plant-based foods on a protein-basis

- Tradeoffs change
  - Organic systems vs. conventional
How do we integrate nutrition / health? Impact phase

Nutrition → Goal & Scope → Inventory → Impact Assessment → Health

Interpretation

Background
N-LCA
Nutrition Metrics
Integration
Challenges
Conclusion
Disability-Adjusted Life Years are a common measure of human health in LCA
Challenges in n-LCA: Comprehensive nutrition and health metrics

- Increased inclusion of nutrient quality and nutrient diversity
- Enhanced metrics reflective of interaction factors, bioavailability
- Better understanding of the uncertainty in studies and metrics that rely on correlations between food and health
Challenges in n-LCA: Increased data availability and quality

- Quantify nutritional flows
- Broaden the range of environmental impacts
- Address issues of non-representativeness (e.g., globally-averaged data)
Forthcoming case study

We are finalizing a regionally-explicit case study at the country and food item levels to test the applicability of n-LCA.
Key Questions of forthcoming n-LCA case study

- Which metrics are more suitable for the functional unit and for what questions?
  
  How should metrics be applied (e.g., capping, disqualifying nutrients, weighting factors, nutrient selection)?

- How should impact results be interpreted (e.g., relative vs. absolute measures)?

- How do environmental impacts of food items or the food supply change when evaluated on a nutritional basis?

- How should we handle issues of scaling and normalization for different nutritional metrics, within LCA?
Discussion