



# Transforming the food sector by integrating nutrition into LCA

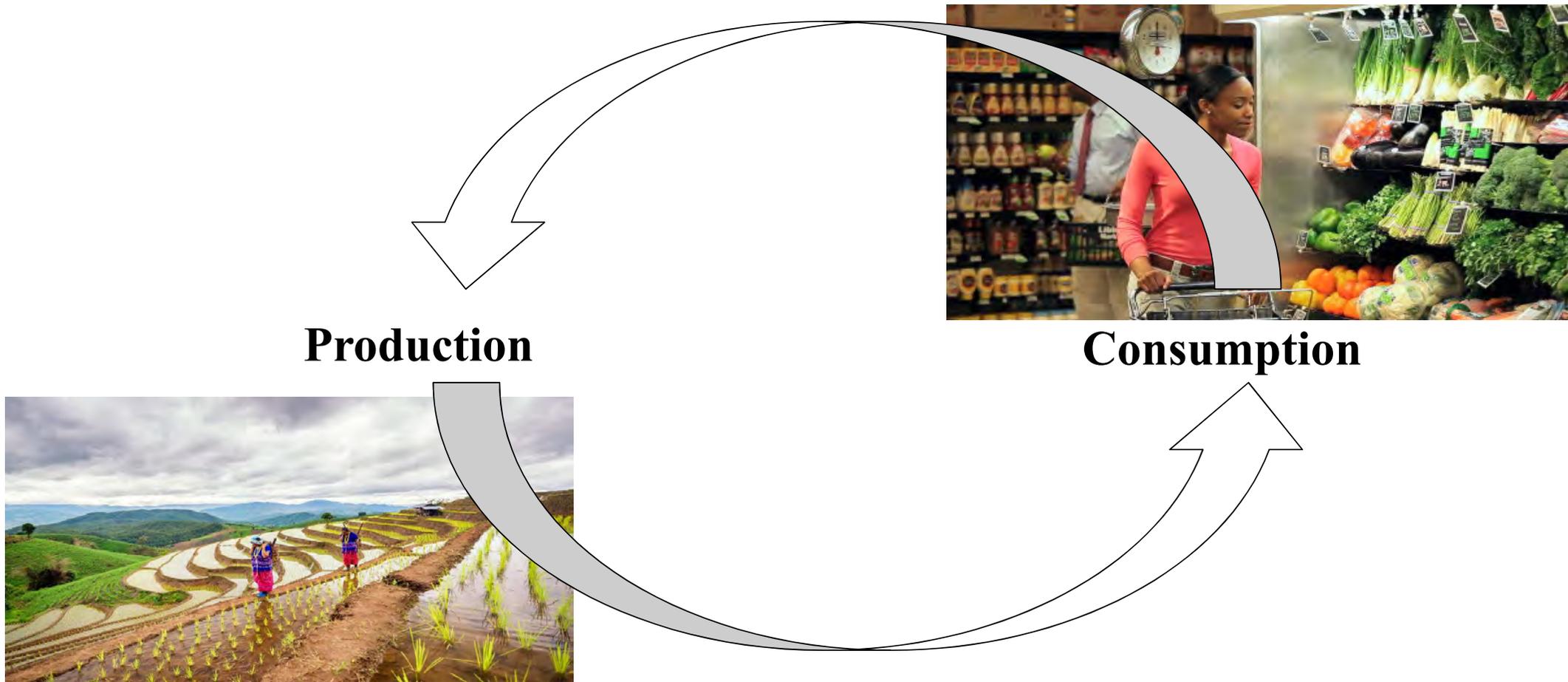
<https://planasa.com/en/adelita-queen-raspberries/>



# Outline

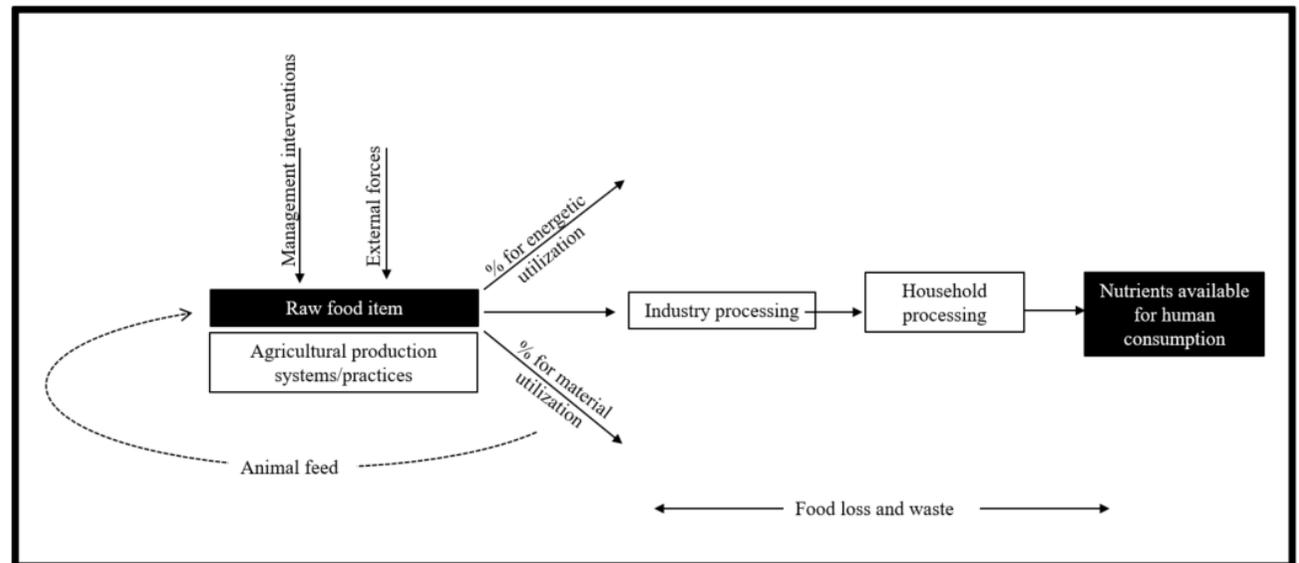
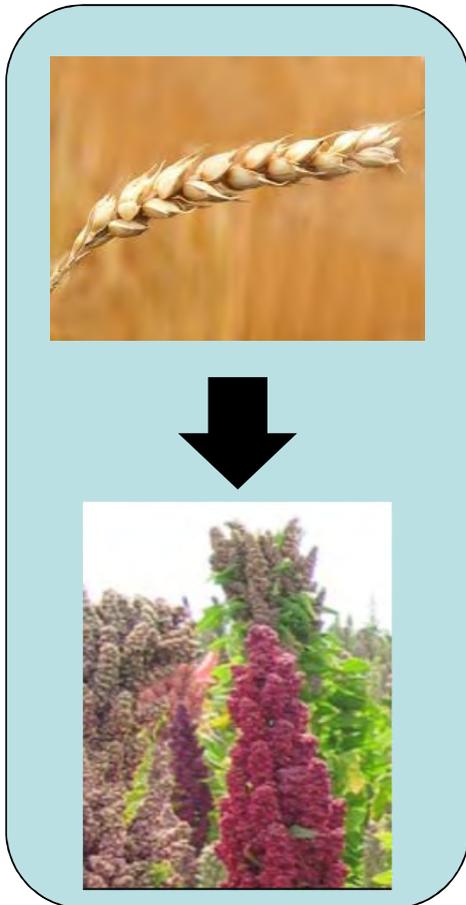
- Background of problem
- Overview of nutritional-LCA (n-LCA)
- Measures of nutrition and health
- Implementing n-LCA
- Key gaps and challenges in n-LCA
- Conclusion

# Production vs. Consumption Perspective



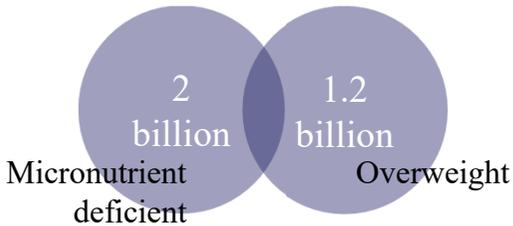
Ashley Green

# Influence of production on nutrient-contents



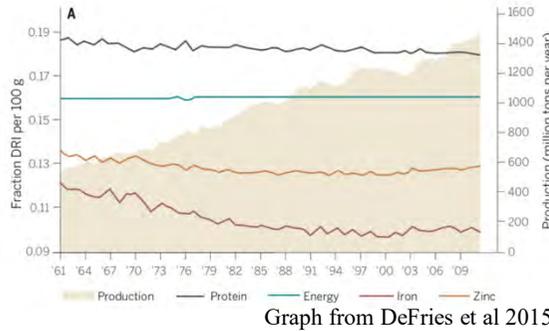
Ashley Green

# Nutritionally-responsible food production



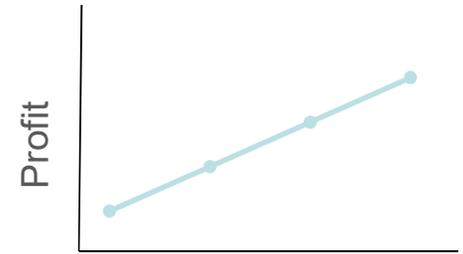
## Move

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



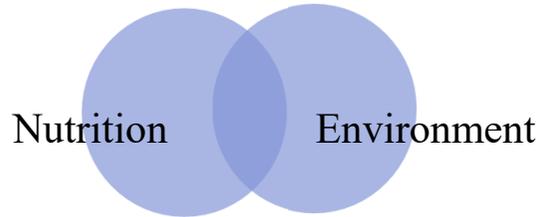
## Help

Help combat the homogenization of food supply



## Inform

Inform consumers to make healthier choices

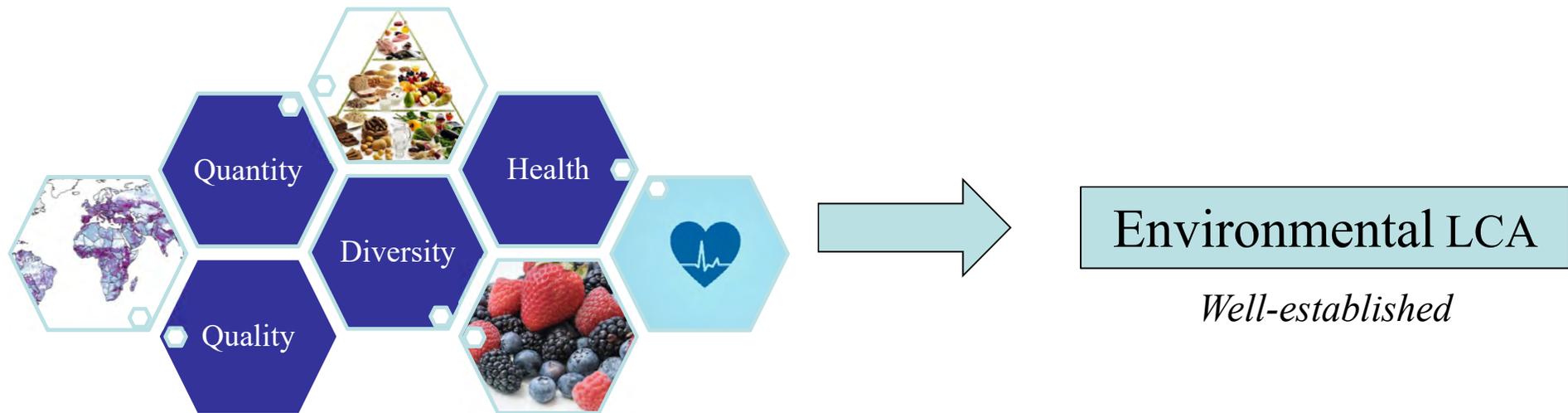


## Identify

Identify tradeoffs and synergies to differentiate & optimize production systems



# What is Nutritional-LCA (n-LCA)





# 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

$$NR9 = \sum_{i=1}^n \frac{1}{n} \frac{\left( \frac{\text{nutrient}_i}{\text{Calories}_j} \right)}{DRI_i};$$

*i = nutrient,*  
*j = food item*

Qualifying Nutrients	Disqualifying Nutrients
Protein	Added sugar / Total sugar
Fiber	Sodium
Vitamin A	Saturated Fat
Vitamin C	
Vitamin E	
Calcium	
Potassium	
Iron	
Magnesium	



# 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

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

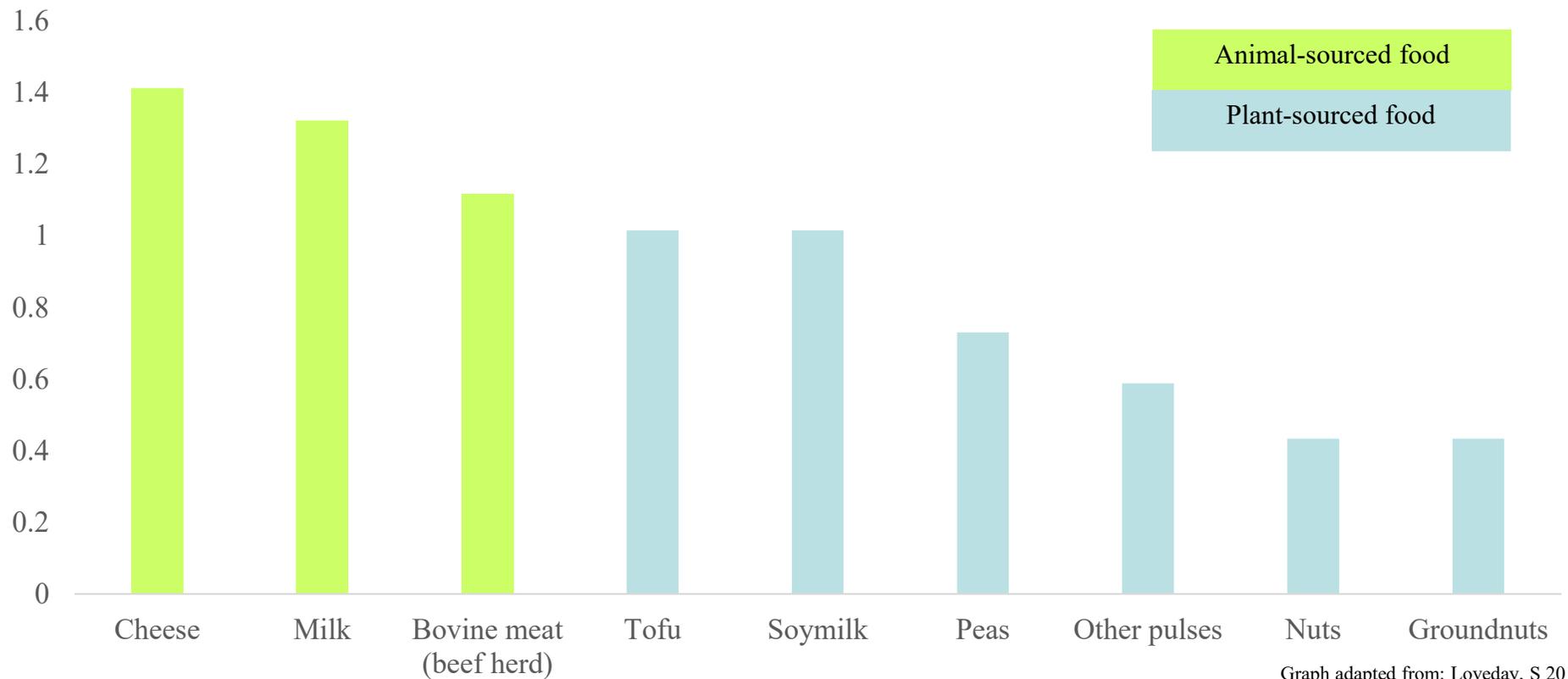


$i = \text{food}_n, j = \text{food}_{n+1}$  where  $p = \text{relative abundance of food item } i$  and  $d = \text{the dissimilarity between foods } i, j \text{ measured by differences in nutritional composition}$



# Nutrient quality metrics

DIAAS values of selected food items

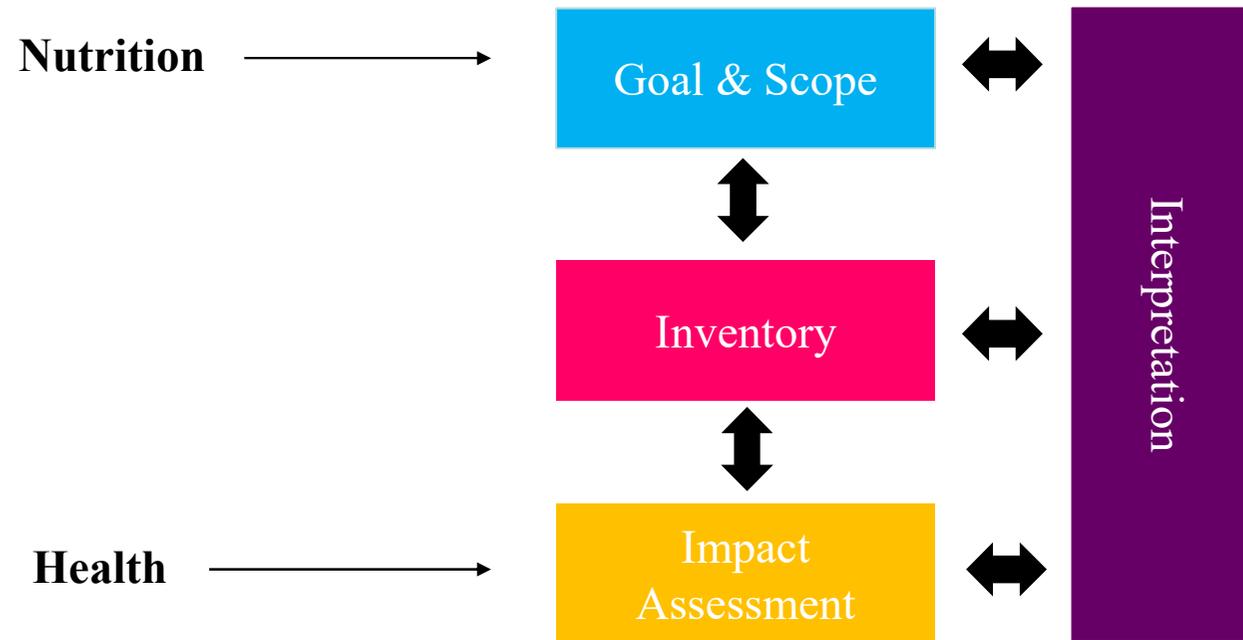


Graph adapted from: Loveday, S 2019

Ashley Green



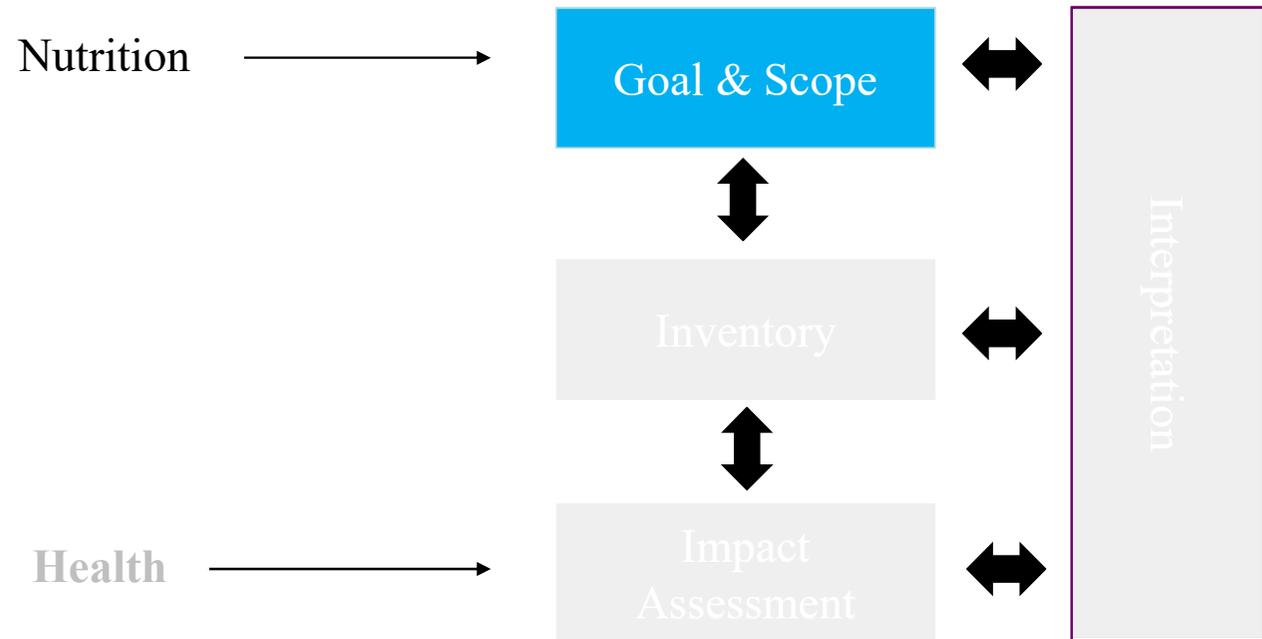
# How do we integrate nutrition / health?



# 📄 🇨🇭 How do we integrate nutrition / health? Functional Unit

## Functional Unit

- Definition?
- Secondary vs. Primary integration
- Disqualifying nutrients?





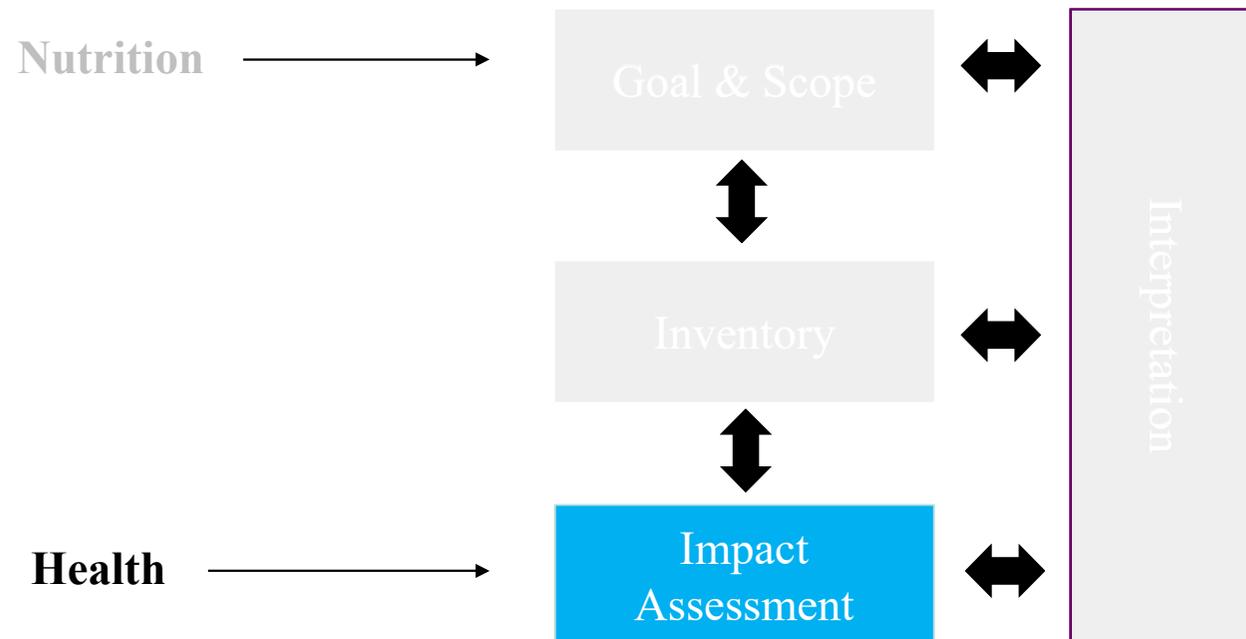
# Nutritional-functional unit

## 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





# Human health metrics & Impact Phase

*Disability-Adjusted Life Years are a common measure of human health in LCA*

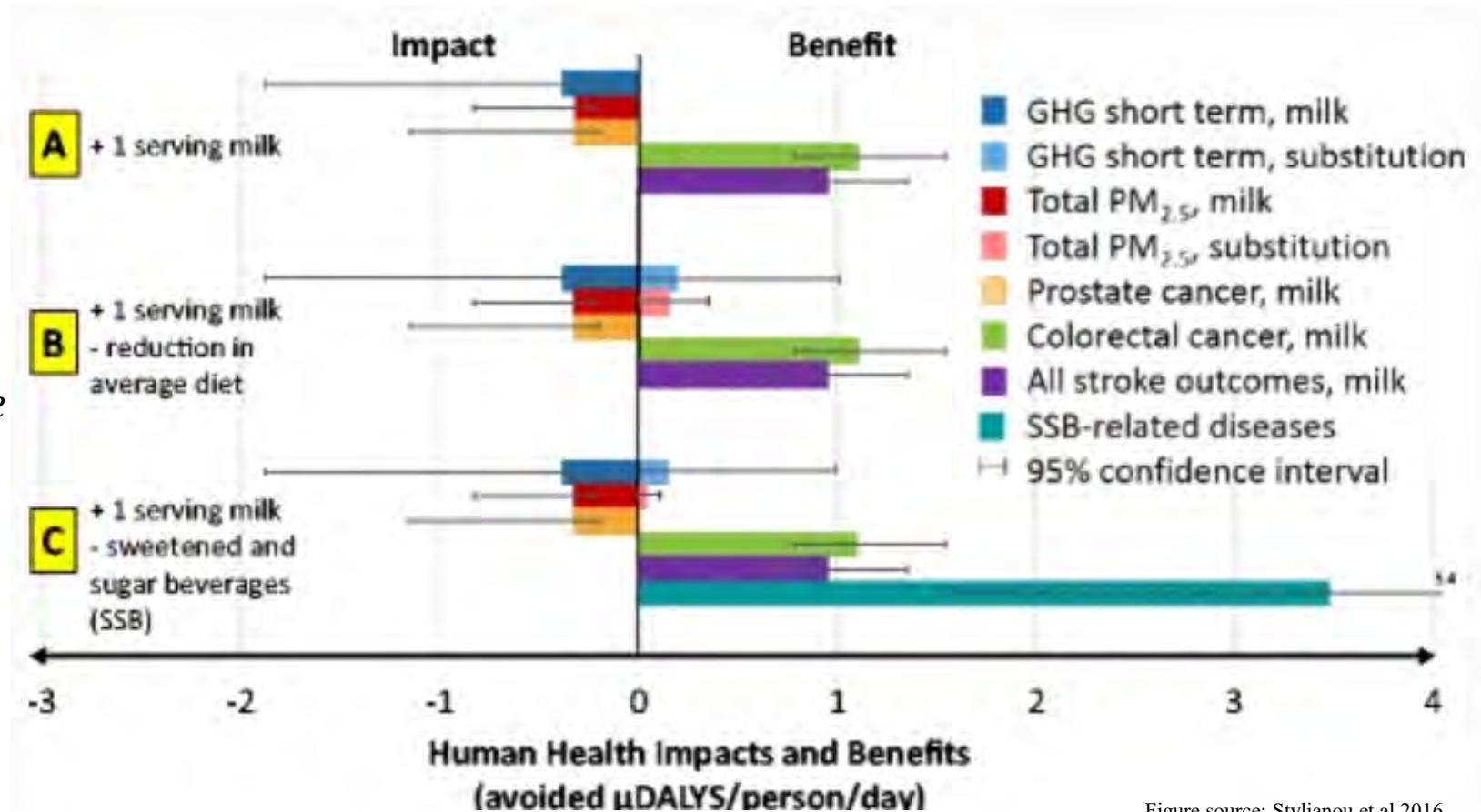


Figure source: Stylianou et al 2016

Ashley Green



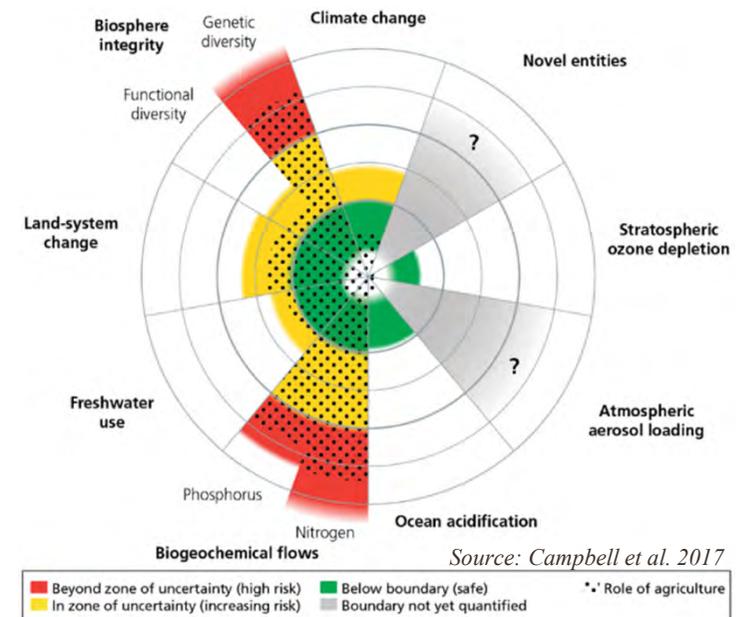
## Challenges in n-LCA: Comprehensive nutrition and health metrics

- 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

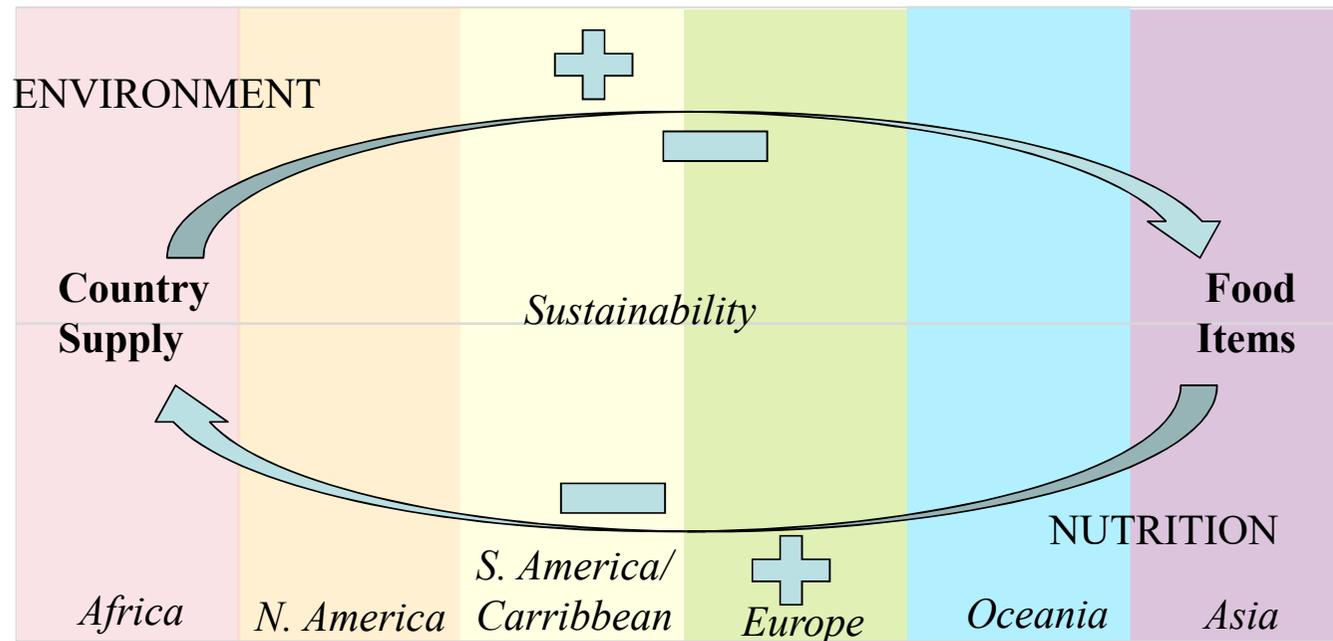
- Quantify nutritional flows
- Broaden the range of environmental impacts
- Address issues of non-representativeness (e.g., globally-averaged data)





## 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



<https://www.cirad.fr/en/news/all-news-items/articles/2017/science/breedcafs-new-coffee-varieties-for-agroforestry>



<https://www.thelocal.ch/20130920/swiss-farmers-milk-worlds-highest-subsidies>

Ashley Green