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Agroscope

Using nutritional-LCA to support a more sustainable future

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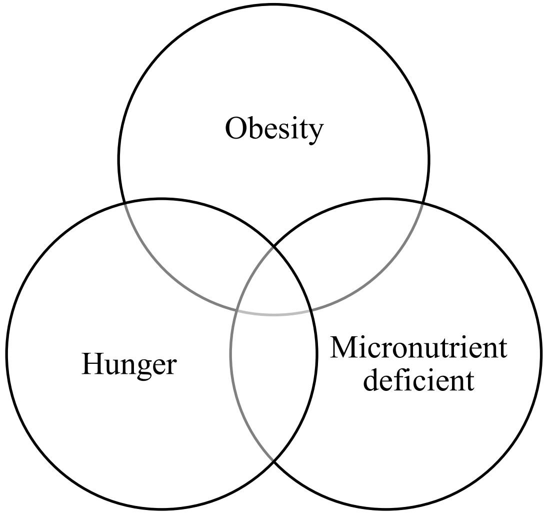
MULTIDISCIPLINARY FOOD SYSTEM CHALLENGES

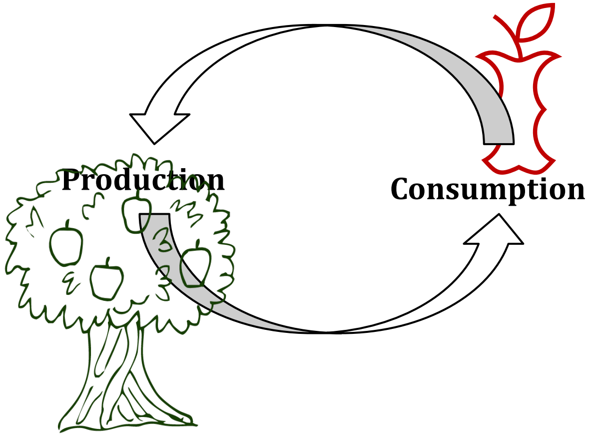
Need for stronger collaboration between nutritional/health and environmental fields for foods



Lacking nutritional adequacy:
Triple burden of malnutrition affects billions of people

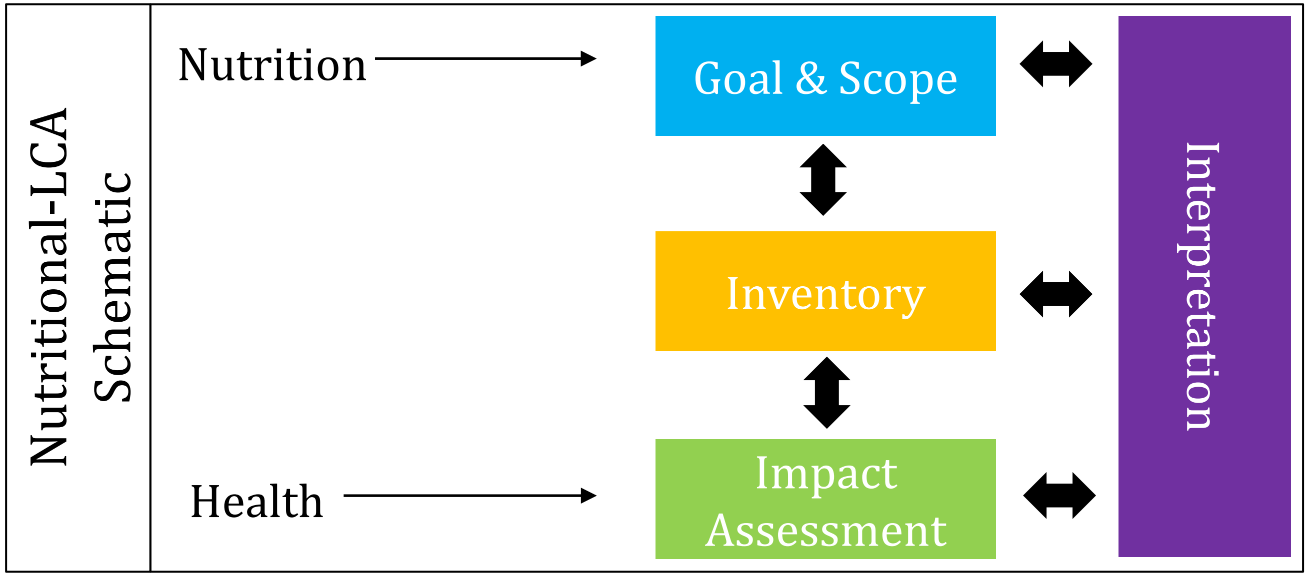
Lack of nutrient diversity:
Leading to dietary risks or agricultural resilience challenges

Environmental degradation:
Food production threatens multiple planetary boundaries



Perspectives are interlinked:
Increasing nutrient contents while decreasing environmental impacts of food can facilitate sustainable dietary choices

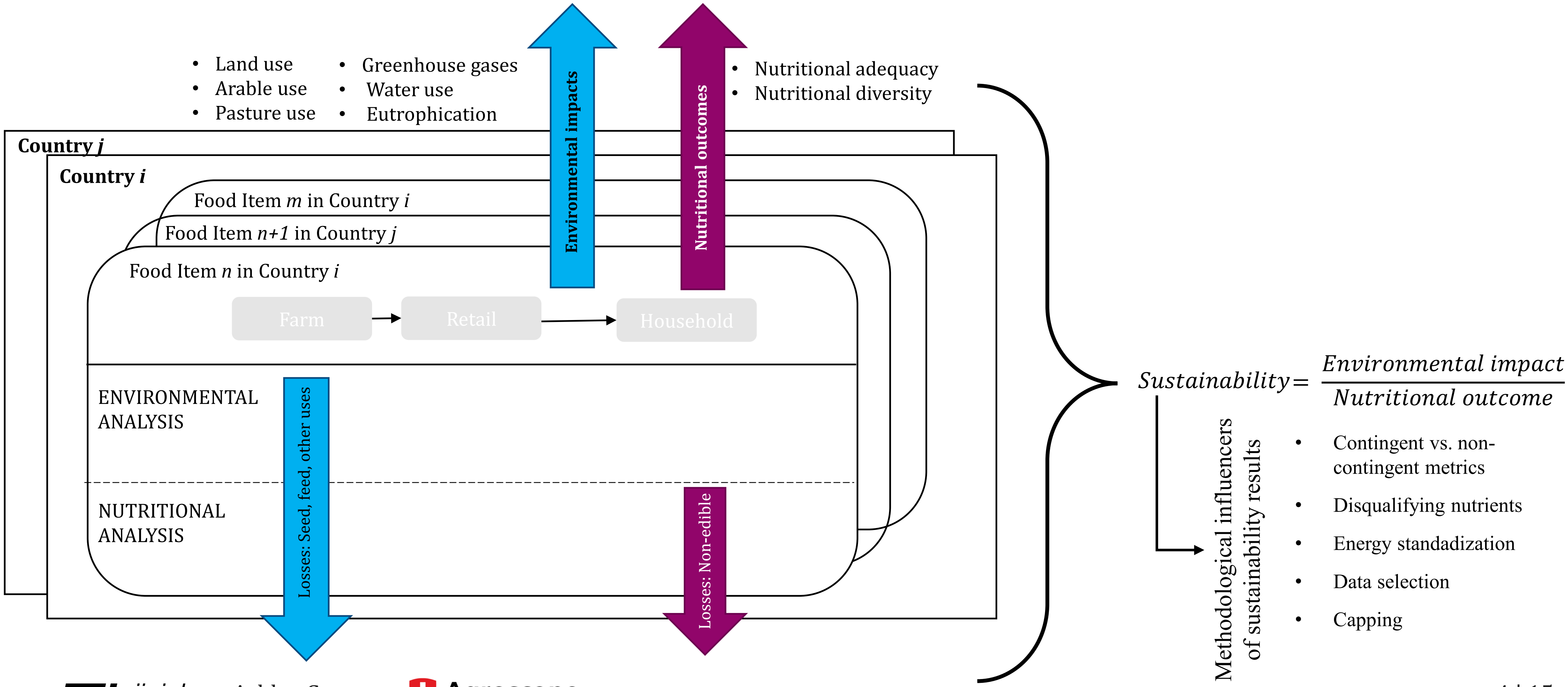
NUTRITIONAL-LCA (N-LCA)



- What happens when the nutritional value of food is used to assess environmental impacts?
- What is the optimal manner for this integration?
  - Which is the best nutritional profiling algorithm to use?
- How do we interpret n-LCA results? Due to complexity, interpretation phase is critical.

REGIONALLY EXPLICIT CASE STUDY TO TEST N-LCA

- Used regionally-explicit environmental and nutritional data



NUTRIENT ADEQUACY METRICS: NUTRIENT INDICES

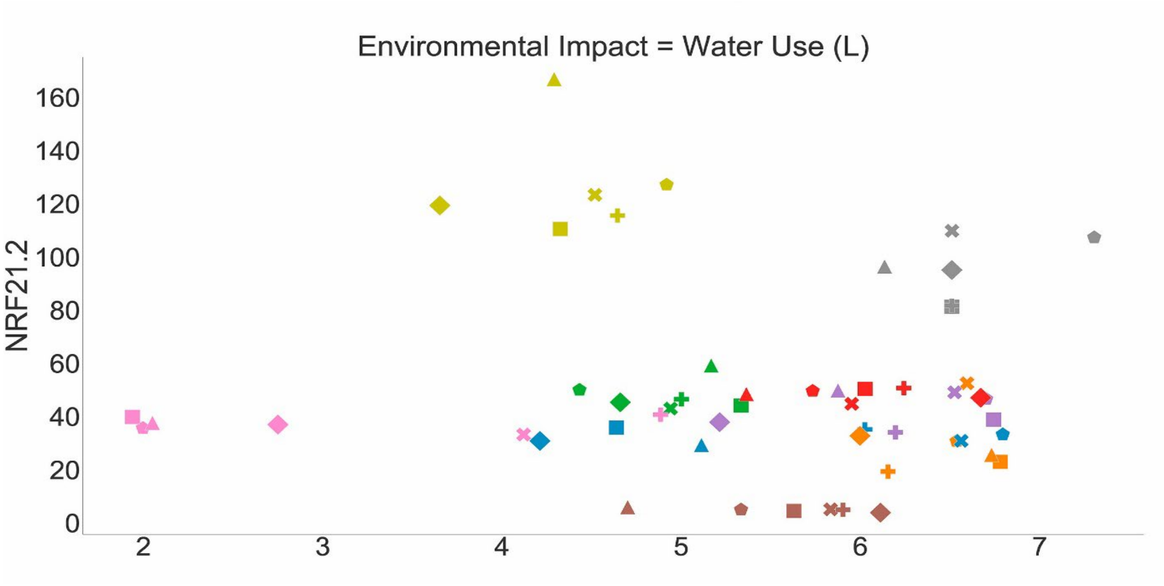
- Used to rank and compare food items
- Nutrient contents measured against daily recommended intake values
- Often developed by nutritionists but applied by LCA practioners

- NRF21.2
  - Across-the-board metric
- NRFprotein-sub
  - Group-specific metric
  - Reflective of the dietary context

NRF21.2

Protein, Calcium, Zinc, Folate, Vitamin C, Iron, Vitamin A, Carbohydrates, Potassium, Phosphorus, Copper, Fiber, Riboflavin, Vitamin B6, Thiamin, Niacin, Vitamin B12, Polyunsaturated fat, Choline, Manganese, and Magnesium, Sodium, Saturated fat.

REGIONAL DIFFERENCES: FOOD ITEMS



*impacts are measured on a natural log basis. FU=kg

- Fruits, roots & tubers, and vegetables, on average, had the lowest footprints across all impact categories
- Strong regional variation in cereals and roots & tubers
- Targeted food substitution, adoption of agricultural practices such as mineral fertilizer, can improve nutrient densities and environmental profiles

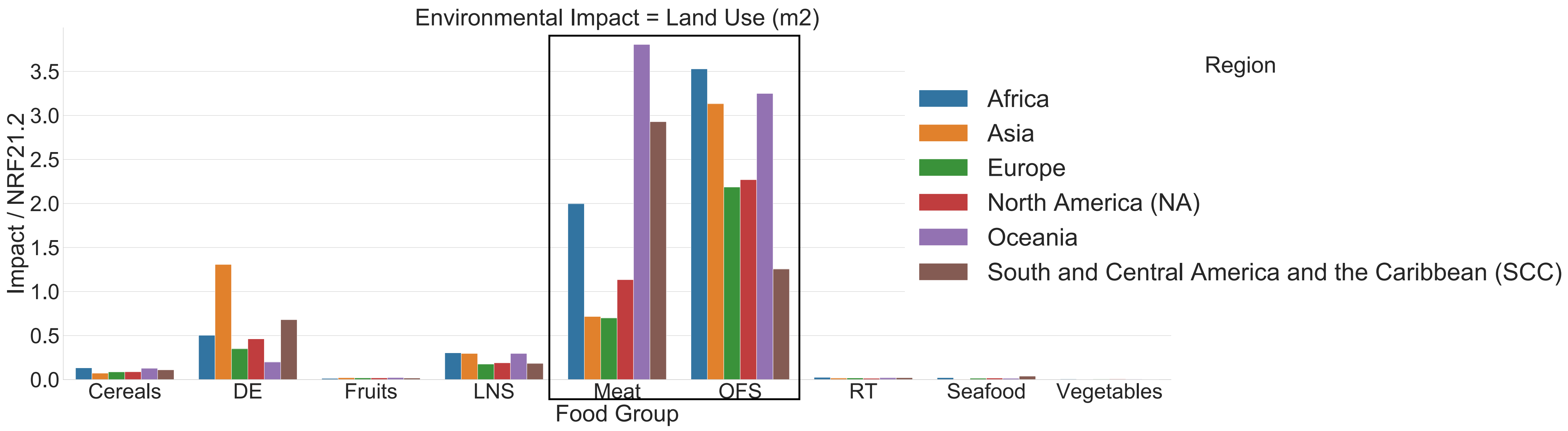
CHANGE IN RELATIVE SUSTAINABILITY RANKINGS WITH A nFU

	GHG❐ ($kg\ CO_2eq$)		Water Use❐ (L)		NRF_{scaled}
Food group	**kg**	**NRF_{food}**	**kg**	**NRF_{food}**	
Vegetables	0.059 (7)	0.021 (9)	0.197 (8)	0.069 (8)	**2.84**
Seafood	0.301 (2)	0.137 (4)	1.178 (2)	0.536 (6)	**2.20**
Legumes, nuts, and seeds (LNS)	0.09 (6)	0.084 (6)	0.727 (6)	0.677 (5)	**1.07**
Fruits	0.033 (8)	0.031 (7)	0.223 (7)	0.208 (7)	**1.07**
Meat	1 (1)	1 (2)	1 (3)	1 (4)	**1.00**
Roots and tubers (RT)	0.024 (9)	0.029 (8)	0.036 (9)	0.045 (9)	**0.81***
Dairy and eggs (DE)	0.279 (3)	0.371 (3)	1.651 (1)	2.193 (2)	**0.75***
Cereals	0.096 (5)	0.131 (5)	0.923 (4)	1.257 (3)	**0.73***
Oils, fats, and sugars (OFS)	0.21 (4)	1.866 (1)	0.834 (5)	7.427 (1)	**0.11***

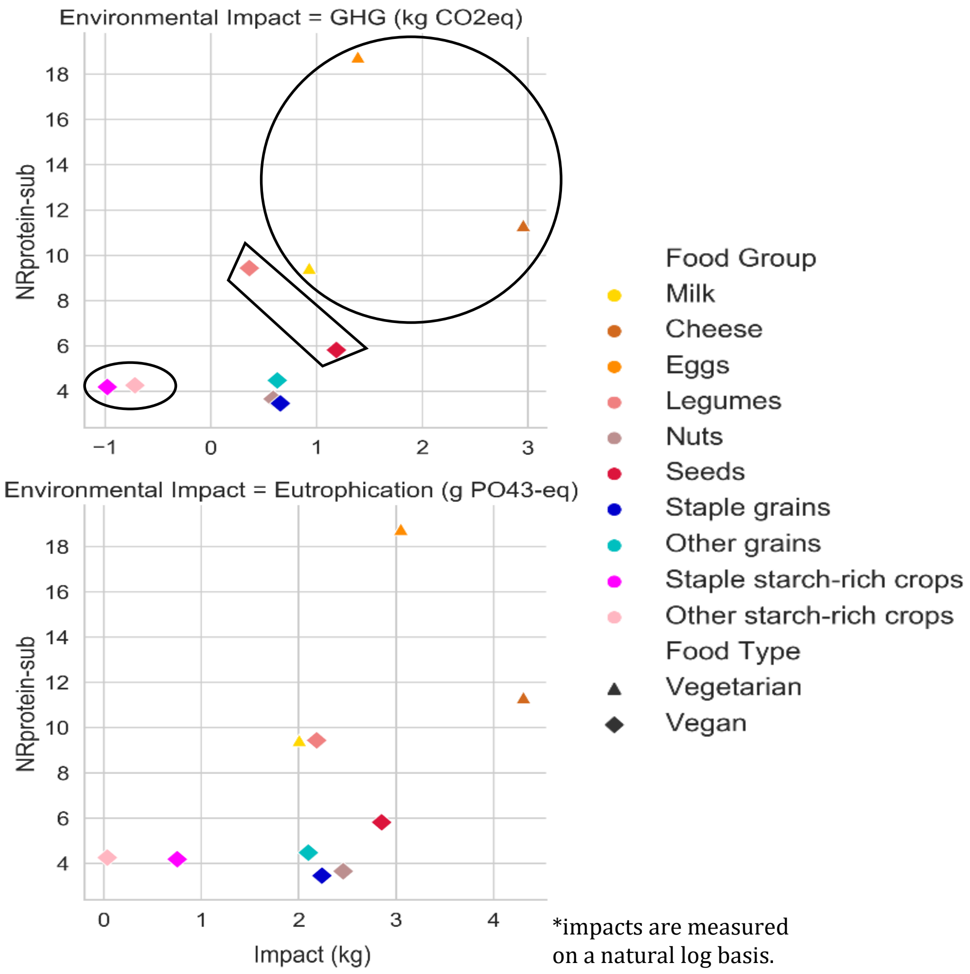
❐Impacts are scaled against meat *NRF values were scaled after calculations, for visualization purposes.

- Environmental impacts of meat are only slightly better on a nutritional basis
- OFS have moderate impacts on a mass basis but the highest impacts with a nFU
- Nutrient dense foods such as seafood, are more sustainable on a nutritional basis

REGIONALLY-EXPLICIT DIFFERENCES IN NLCA RESULTS



$NRF_{PROTEIN\text{-}SUB}$: REFLECTING THE DIETARY CONTEXT IN THE FU



*impacts are measured on a natural log basis.

- Developed for protein-rich food alternatives
- Reflective of dietary context: composed of iron, vitamin B12, calcium, riboflavin, saturated fat
- Vegetarian foods do well nutritionally but less well environmentally
- Of vegan foods, legumes and seeds do the best nutritionally but starches have the lowest footprints

NUTRITIONAL DIVERSITY OF FOOD SUPPLY

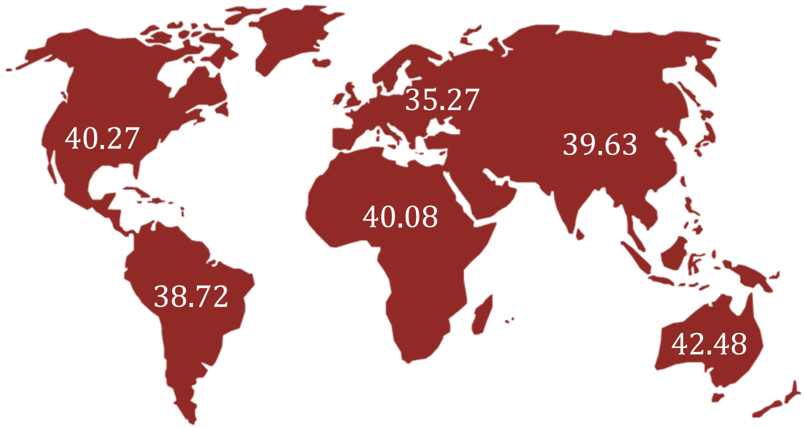
Nutrient diversity metrics

- Measure the heterogeneity of diets, food supply, and production systems
- More complete picture: Reflects differences in nutritional differences

Rao's quadratic entropy (Q) = $\sum_{i=1}^{s-1} \sum_{j=i+1}^{s-1} d_{ij} p_i p_j$; *i= foodn, j=foodn$_{+1}$ where p=relative abundance of food item i and d = the dissimilarity between foods i,j measured by differences in nutritional composition*

Q stratified by income and region

High Income	Upper-Middle Income	Lower-Middle Income	Lower Income
38.72	38.7	37.38	42.56



- No clear trends: drivers of nutrition operate at more localized scales
- As a FU, diversity metrics change relative country sustainability rankings

METHOD ASSUMPTIONS BEHIND METRICS INFLUENCE OUTCOMES

- Points of differentiation can affect nutrient index scores

1. Capping
2. Nutrient selection
3. Weighting
4. Across-the-board vs. Group-specific

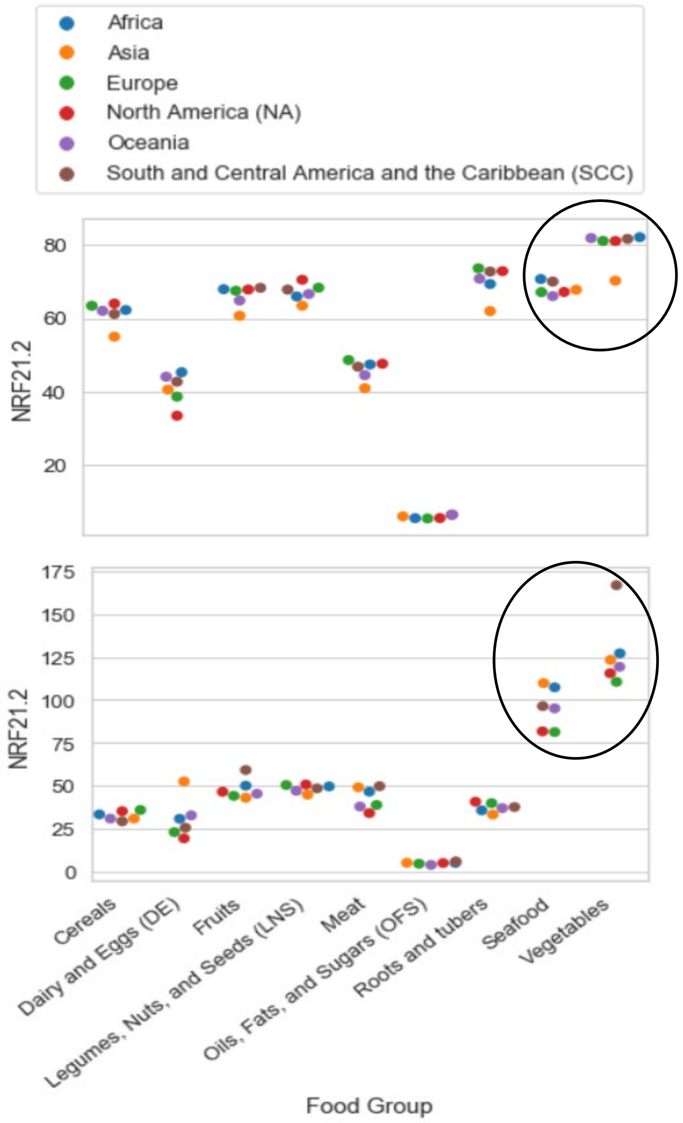
- Points at which methodological application of the same nutrient metric can diverge (e.g., capping vs. not capping)
- Often not explicitly considered in studies

CAPPING

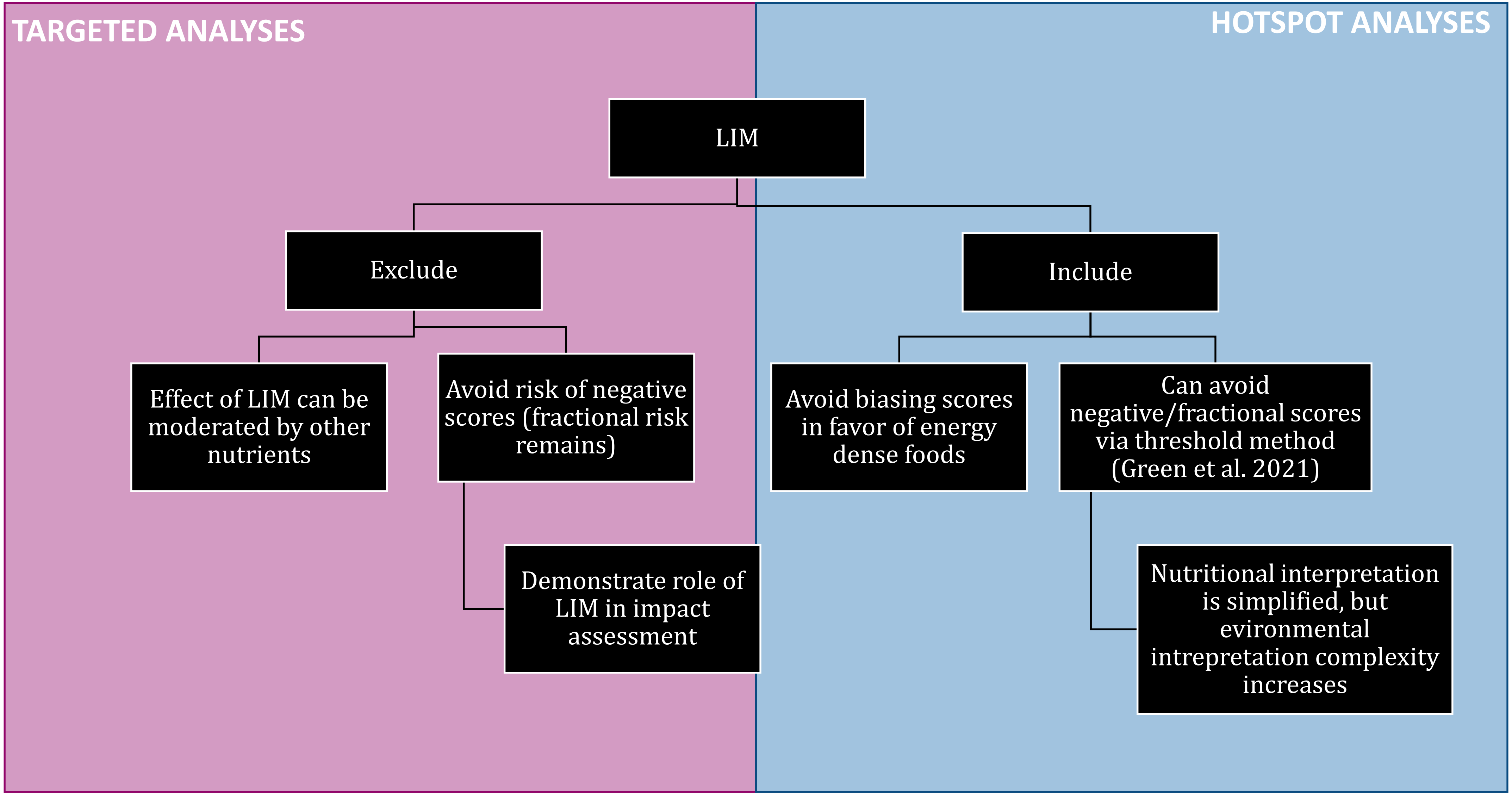
Capping

- Capping: capping nutrients at 100% of recommended nutrient intakes
  - Diet/supply: capped
  - Food: uncapped

- Foods excessively high in one nutrient will receive higher NRF scores:
  - Largely relevant if deficient in that nutrient



NUTRIENTS TO LIMIT (LIM) IN THE FU



GAPS AND LIMITATIONS

Gaps to be addressed

- Lack of bioavailability and interaction factor data for nutritional profile algorithms
- Limited nationalized environmental LCA data
- Need more accessible LCA data for other impact categories (e.g., biodiversity data, antibiotic use, animal welfare, etc.)
- Need context specific metrics reflective of local micronutrient deficiencies
- Need stronger collaborations between nutritional and environmental experts

SOURCES & DISCUSSION

Contact:
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Green, Ashley, Thomas Nemecek, Sergiy Smetana, and Alexander Mathys. **"Reconciling regionally-explicit nutritional needs with environmental protection by means of nutritional life cycle assessment."** *Journal of Cleaner Production* (2021): 127696.