Biofortification for healthy diets

A nutritional perspective

Carl Lachat, PhD Department of Food Technology, Safety and Health Carl.lachat@ugent.be

Is biofortification not addressing an outdated paradigm?

GHENT UNIVERSITY

My perspective

Nutritional epidemiology – Dep Food tech, safety and health

Mytox South ITN https://mytoxsouth.org

Advisor to WHO/UNICEF/FAO on diet diversity metrics

Part of my salary is paid by the Bill & Melinda Gates foundation

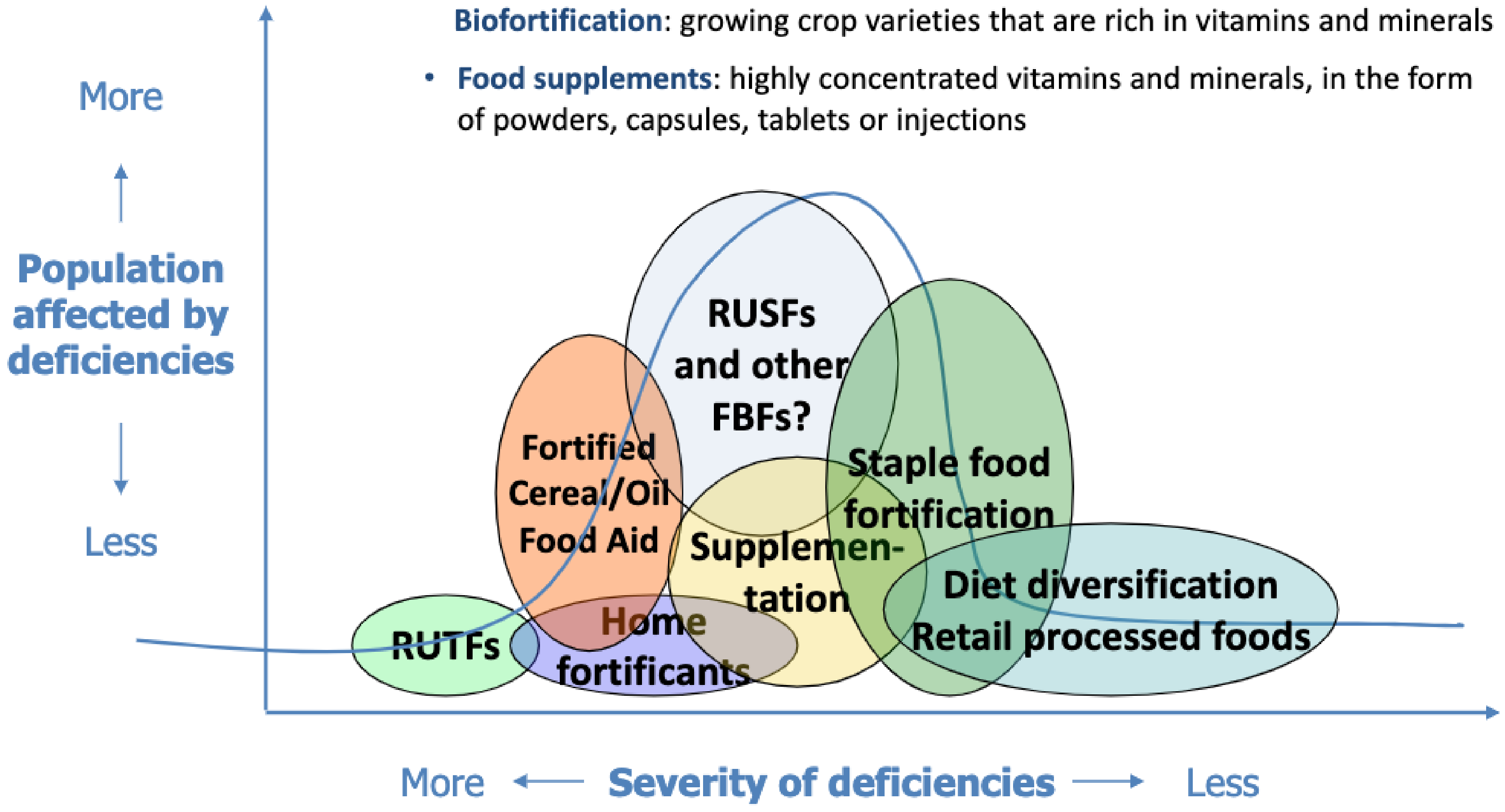
Second Copenhagen Consensus: Biofortification Best Practice, Meenakshi

By J.V. Meenakshi

Biofortification was ranked fifth by the Expert Panel at Copenhagen Consensus 2008. A diverse diet rich in micronutrients is out of reach of many of the world's poor. Because foods that are high in micronutrients such as vegetables, fruits, dairy, and meats are expensive, resource-poor people rely primarily on a few starchy staples that are rich in energy, but not in micronutrients. By enhancing the micronutrient content of these energy-rich staples, micronutrient intakes in general, and among the poor in particular, can be increased.

1.4 Types of products: spectrum of nutritional use (P. Webb, 2008)

- **Dietary diversification**: balanced diet by diversifying food cultivation and selecting foods with a high vitamin and mineral content available
- **Food fortification (enrichment)**: direct addition of nutrients to foodstuffs
  Biofortification: growing crop varieties that are rich in vitamins and minerals
- **Food supplements**: highly concentrated vitamins and minerals, in the form of powders, capsules, tablets or injections



D. Bounie, University of Lille - MSc Nutrition and Rural Development, Gent, April 2021

Alleviation of micronutrient deficiencies

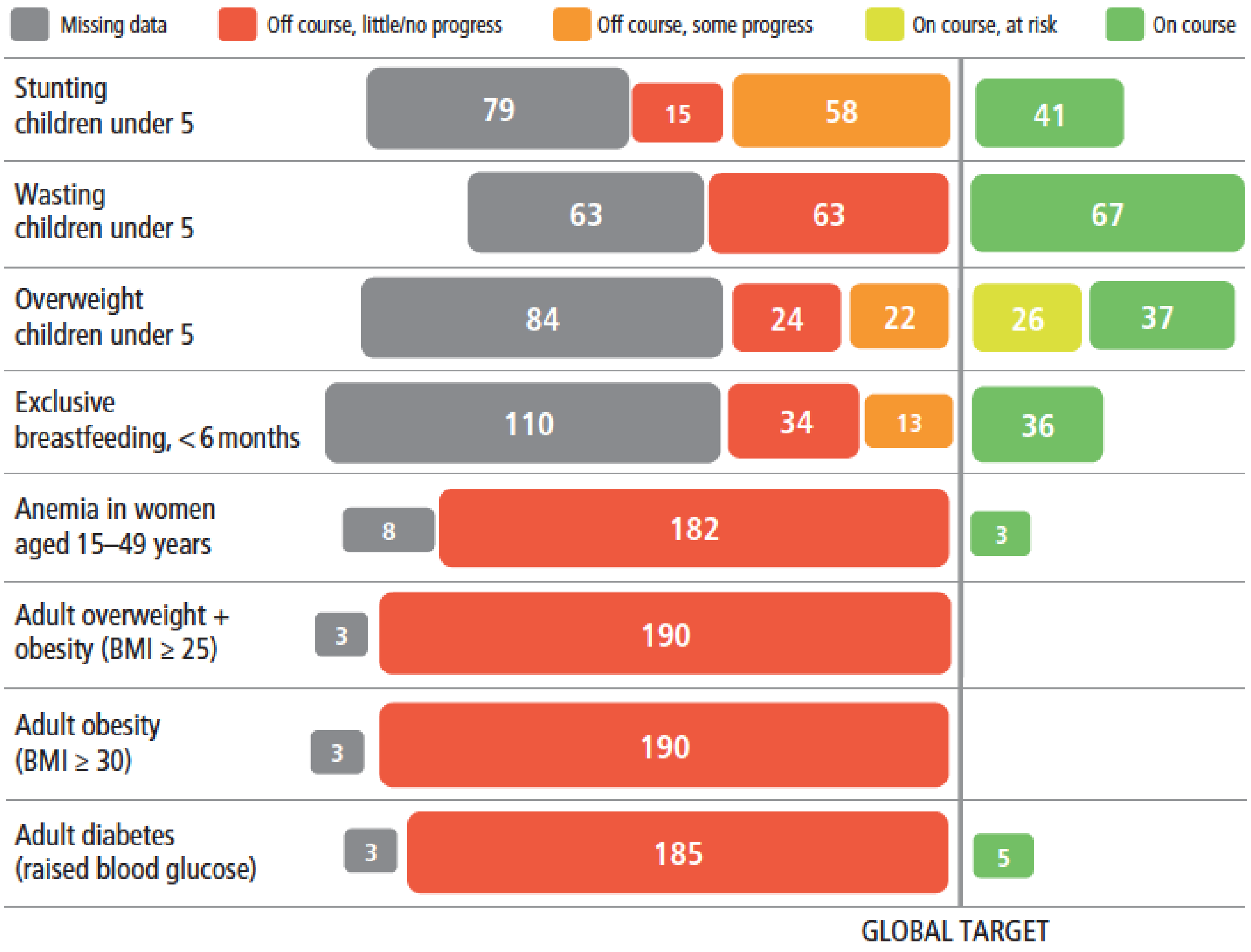
A Both sexes

Leading risks 1990
1 Child wasting
2 Short gestation for birthweight
3 Low birthweight for gestation
4 Smoking
5 High systolic blood pressure
6 Unsafe water source
7 Household air pollution
8 Child underweight
9 Unsafe sanitation
10 Vitamin A deficiency
11 High fasting plasma glucose
12 No access to handwashing facility
13 Child stunting
14 Alcohol use
15 High LDL cholesterol
16 High body-mass index
17 Ambient particulate matter
18 Low whole grains
20 Low fruit
30 Unsafe sex

Leading risks 2007	Mean percentage change in number of DALYs, 2007–17	Mean percentage change in all-age DALY rate, 2007–17	Mean percentage change in age-standardised DALY rate, 2007–17
1 High systolic blood pressure	22·0	-2·8	-19·4
2 Short gestation for birthweight	-24·2	-39·6	-24·2
3 Smoking	10·3	-12·1	-25·8
4 Child wasting	-47·7	-58·3	-47·9
5 Low birthweight for gestation	-22·5	-38·2	-22·7
6 High fasting plasma glucose	51·4	20·7	0·8
7 High body-mass index	66·2	32·5	11·7
8 Alcohol use	37·4	9·5	-2·9
9 Unsafe water source	-38·2	-50·7	-41·8
10 Unsafe sex	302·2	220·6	187·4
11 High LDL cholesterol	17·2	-6·6	-22·8
12 Household air pollution	-37·1	-49·9	-47·0
13 Ambient particulate matter	17·3	-6·5	-8·8
14 Low whole grains	23·4	-1·6	-17·0
15 Unsafe sanitation	-41·2	-53·1	-44·6
16 Low fruit			
17 Child underweight			
18 High sodium			
19 No access to handwashing facility			
20 Impaired kidney function			
21 Vitamin A deficiency			
23 Child stunting			

Leading risks 2017	Mean percentage change in number of DALYs, 2007–17	Mean percentage change in all-age DALY rate, 2007–17	Mean percentage change in age-standardised DALY rate, 2007–17
1 High systolic blood pressure	20·0	6·3	-8·0
2 Smoking	8·2	-4·1	-16·4
3 High fasting plasma glucose	25·5	11·2	-3·2
4 High body-mass index	36·7	21·1	6·8
5 Short gestation for birthweight	-21·3	-30·3	-24·0
6 Low birthweight for gestation	-21·8	-30·8	-24·7
7 Alcohol use	5·5	-6·6	-13·1
8 High LDL cholesterol	17·2	3·8	-9·3
9 Child wasting	-40·1	-46·9	-43·1
10 Ambient particulate matter	12·8	-0·1	-9·3
11 Low whole grains	15·5	2·3	-9·7
12 High sodium	22·7	8·7	-5·9
13 Low fruit	7·7	-4·6	-15·7
14 Unsafe water source	-29·1	-37·2	-35·7
15 Impaired kidney function	20·3	6·6	-5·4
16 Household air pollution			
17 Unsafe sex			
20 Unsafe sanitation			

FIGURE 2.3 Number of countries at various stages of progress against the global targets on nutrition



Source: Authors, based on data from Stevens et al. (2013), UNICEF (2016b), UNICEF, WHO, and World Bank (2015), and WHO (2015a).

The rise and fall of paradigms

- The vitamin deficiency paradigm (<1950)
- The protein deficiency paradigm (1950-1974)
- The multisectoral nutrition planning paradigm (1974-1980)
- The national nutrition policy paradigm (1980-1990)
- The community-based nutrition paradigm (1985-1995)
- The micronutrient malnutrition paradigm (1995-2005)
- A period of paradigm crisis (2005-present)

Jonsson U. The rise and fall of paradigms in world food and nutrition policy. (Commentary). *World Nutrition* June 2010, 1, 3: 128-158

UNITED NATIONS

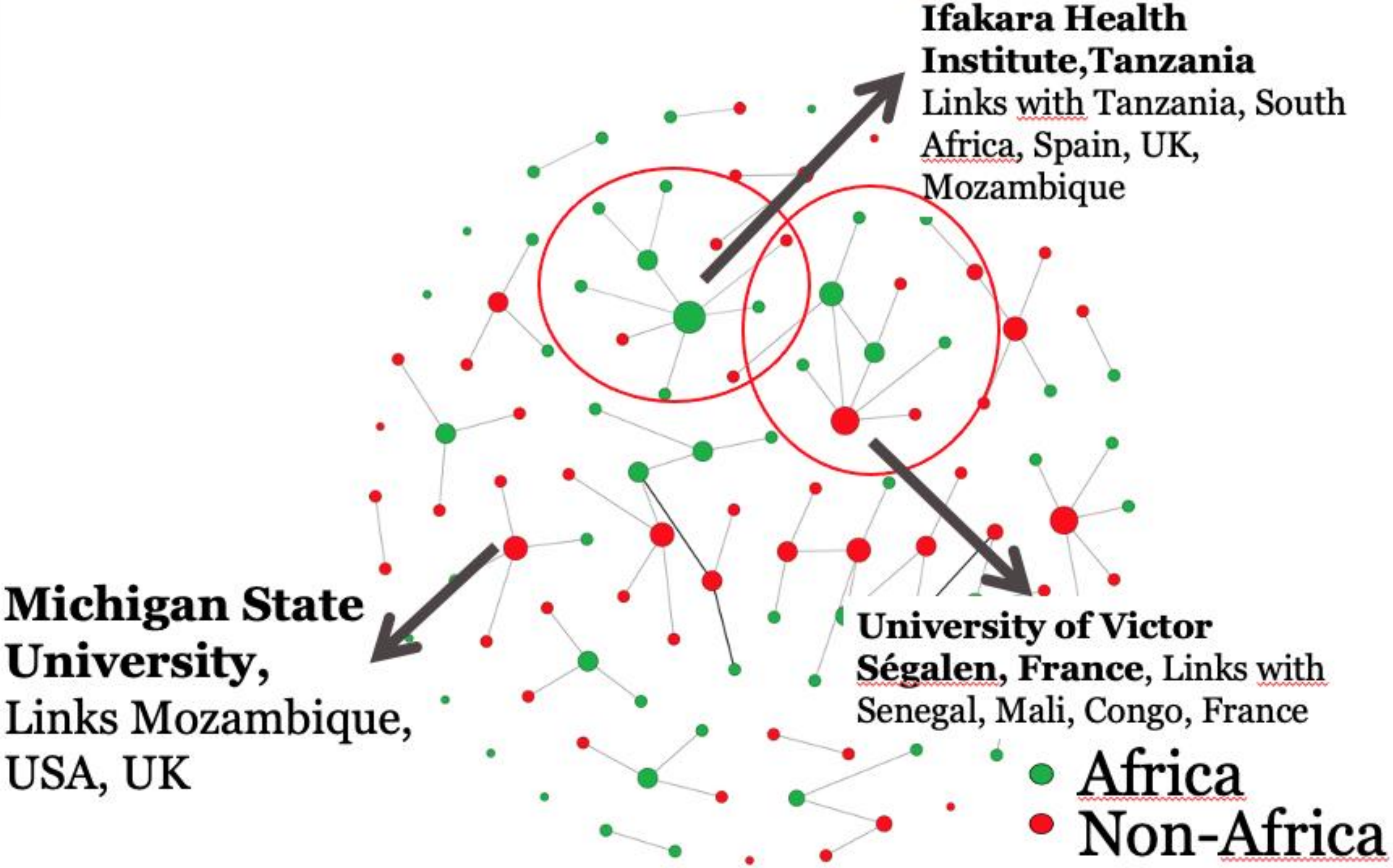
FOOD SYSTEMS SUMMIT 2021

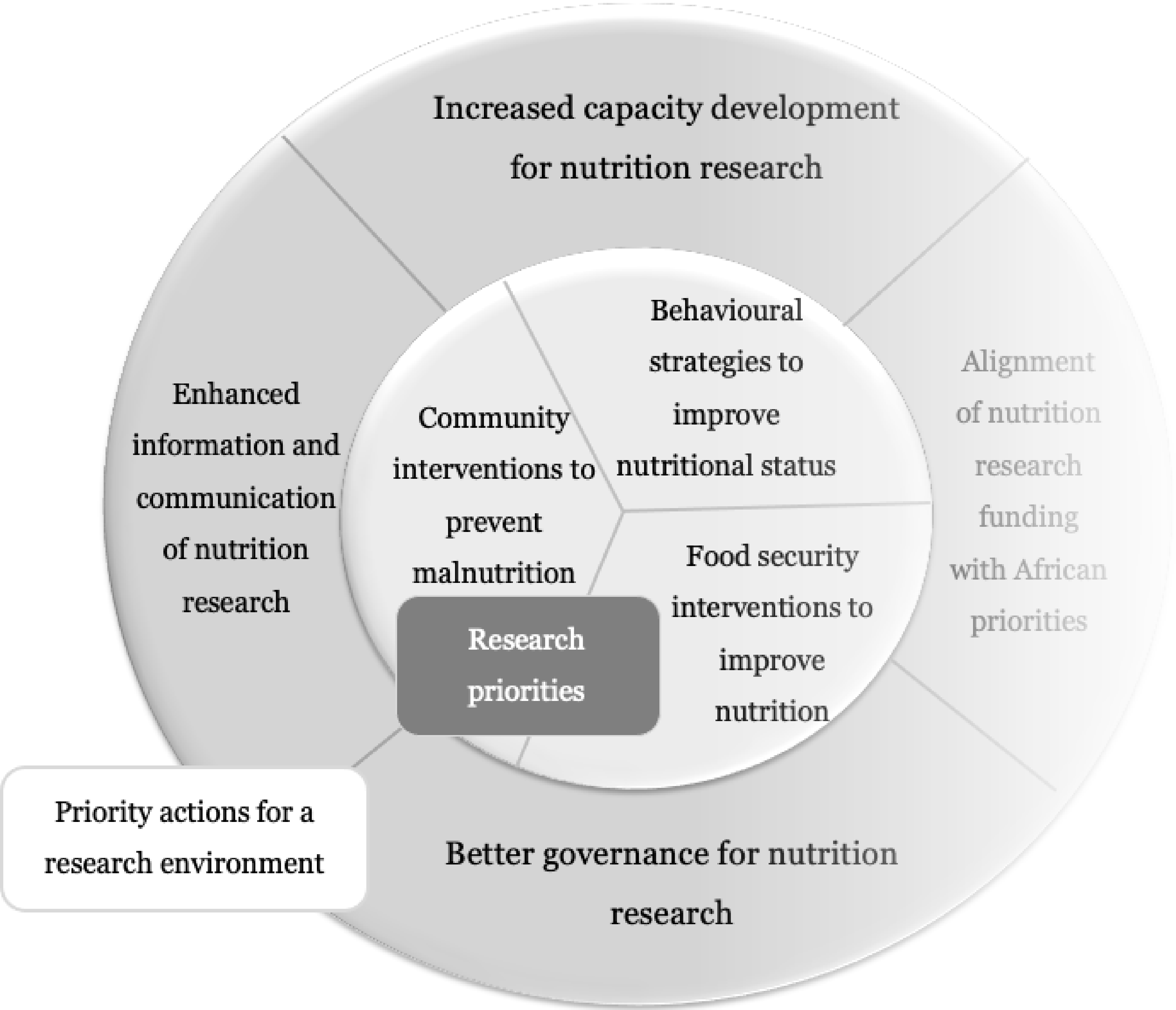
Who's interest are we addressing?

SUNRAY

Sustainable Nutrition Research for Africa in the Years to come

Vitamin A deficiency





Lachat et al Developing a Sustainable Nutrition Research Agenda in Sub-Saharan Africa—Findings from the SUNRAY Project (2014). PLoS Med 11(1): e1001593

Global tracking of progress in diets

- From reductionist “nutrient” focus to dietary patterns and diversity
- Focus on “whole of diet” approaches

- Eg Minimum diet diversity score for women (MDD-W)
    - *Application at scale*
    - *Mainstreaming in agriculture, fisheries…*

Dietary species richness as a measure of fo
biodiversity and nutritional quality of diets

Carl Lachat[a,1,2], Jessica E. Raneri[a,b,1], Katherine Walker Smith[a], Patrick Kolsteren[a], Patrick Van Damme[c], Daniela Penafiel[c,e], Wouter Vanhove[c], Gina Kennedy[b], Danny Hunter[b], Francis Oduor Odhiambo[b], Gervais Ntandou-Bouzitou[b], Bernard De Baets[f], Disna Ratnasekera[g], Hoang The Ky[h], Roseline Remans and Céline Termote[b]

[a]Department of Food Safety and Food Quality, Faculty of Bioscience Engineering, Ghent University, 9000 Ghent, Belgium; [b]Healthy Diets Food Systems Initiative, Bioversity International, 00057 Maccarese (Rome), Italy; [c]Laboratory of Tropical and Subtropical Agronomy and Faculty of Bioscience Engineering, Ghent University, 9000 Ghent, Belgium; [d]Department of Crop Sciences and Agroforestry, Faculty of Trop Czech University of Life Sciences Prague, 165 21 Prague 6, Suchdol, Czech Republic; [e]Rural Research Center, Faculty of Life Sciences, Nutri Superior Politecnica del Litoral, Guayaquil, 090608 Ecuador; [f]KERMIT, Department of Mathematical Modeling, Statistics, and Bioinformati Bioscience Engineering, Ghent University, 9000 Ghent, Belgium; [g]Department of Agricultural Biology, Faculty of Agriculture, University of Matara, Sri Lanka; and [h]HealthBridge Foundation of Canada, 10000 Hanoi, Vietnam

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Biodiversity is key for human and environmental health. Available dietary and ecological indicators are not designed to assess the intricate relationship between food biodiversity and diet quality. We applied biodiversity indicators to dietary intake data from and assessed associations with diet quality of women and young children. Data from 24-hour diet recalls (55% in the wet season) of $n = 6{,}226$ participants (34% women) in rural areas from seven low- and middle-income countries were analyzed. Mean adequacies of vitamin A, vitamin C, folate, calcium, iron, and zinc and diet diversity score (DDS) were used to assess diet quality. Associations of biodiversity indicators with nutrient adequacy were quantified using multilevel models, receiver operating characteristic curves, and test sensitivity and specificity. A total of 234 different species were consumed, of which <30% were consumed in more than one country. Nine species were consumed in all countries and provided, on average, 61% of total energy intake and a significant contribution of micronutrients in the wet season. Compared with Simpson's index of diversity and functional diversity, species richness (SR) showed stronger associations and better diagnostic properties with micronutrient adequacy. For every additional species consumed, dietary nutrient adequacy increased by 0.03 ($P < 0.001$). Diets with higher nutrient adequacy were mostly obtained when both SR and DDS were maximal. Adding SR to the minimum cutoff for minimum diet diversity improved the ability to detect diets with higher micronutrient adequacy in women but not in children. Dietary SR is recommended as the most appropriate measure of food biodiversity in diets.

sustainable diets | diet quality | malnutrition | biodiversity | food biodiversity

Food systems are a key driver of biodiversity loss worldwide (1). Globally, key drivers of food system transformations include climate change, population growth, economic development, urbanization, globalization, and production system intensification and homogenization (2–4). As a result, human diets that used to be composed of a wide variety of plants and animals have gradually shifted to a diet composed of mostly processed foods and comprising a limited number of species (5). While an estimated 300,000 edible plant species are available to humans, more than half of the global energy need is currently met by only four crops: rice, potatoes, wheat, and maize (6).

Low-quality diets are the leading risk factor for ill health worldwide (7) and are determined by socioeconomic and political factors including income, education, social cohesion, gender empowerment, and inequality (8). The diversity of species used in agricultural and livelihood systems is essential for human nutrition and sustainable food systems (9). Agricultural biodiversity contributes to farm resilience, particularly in the face of shocks such as climate change, disease outbreaks, and market price fluctuations (10). Wild food diversity, obtained in or around agricu or extracted from forests and other natural landscapes, ditional source of resilience in the food system, in particu the lean season (9). Adequate management and use of bi can help to restore ecosystems and address micronutri ciencies in vulnerable populations (11).

Surprisingly, the world's wild and agricultural biodivers spots often coincide with low-income areas with high p levels, ecosystem degradation, and malnutrition (12, 13) duced biodiversity of both wild and agricultural species can detrimental effects for diet quality and environmental sus ability by reducing availability and access to nutritious, seas foods and loss of ecosystem functions (14). Sustainable r agement of food biodiversity—the diversity of plants, anim

Significance

Current research linking biodiversity and human diets has use metrics without justification from a nutritional point of view Diet species richness, or a count of the number of differen species consumed per day, assesses both nutritional adequac and food biodiversity of diets for women and children in rura areas. The positive association of food species richness wit dietary quality was observed in both the wet and the dry season Food biodiversity contributes to diet quality in vulnerable pop ulations in areas with high biodiversity. Reporting the number o species consumed during dietary assessment provides a uniqu opportunity to cut across two critical dimensions of sustainab development—human and environmental health—and comp ments existing indicators for healthy and sustainable diets.

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Data deposition: Anonymized individual-level data and protocols for ac publicly available (https://dataverse.harvard.edu/dataverse/DietarySpec sR

[1]C.L. and J.E.R. contributed equally to this work.

[2]To whom correspondence should be addressed. Email: carl.lachat@ ge

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Renewed focus on agro-biodiversity

- Healthy diets as an ecosystem service
- Agro-biodiveristy and NUS

Poor diets as an outcome of a failing food system

- Focus action upstream
- Diet-based approach to address multi-nutrient deficiencies
- Cannot ignore overnutrition