

FOOD  
SYSTEMS

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# Sight and Life

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# Some food-related idioms ...

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**“Grist to the mill”**

*Something that can be used to bring advantage*

**“Two peas in a pod”**

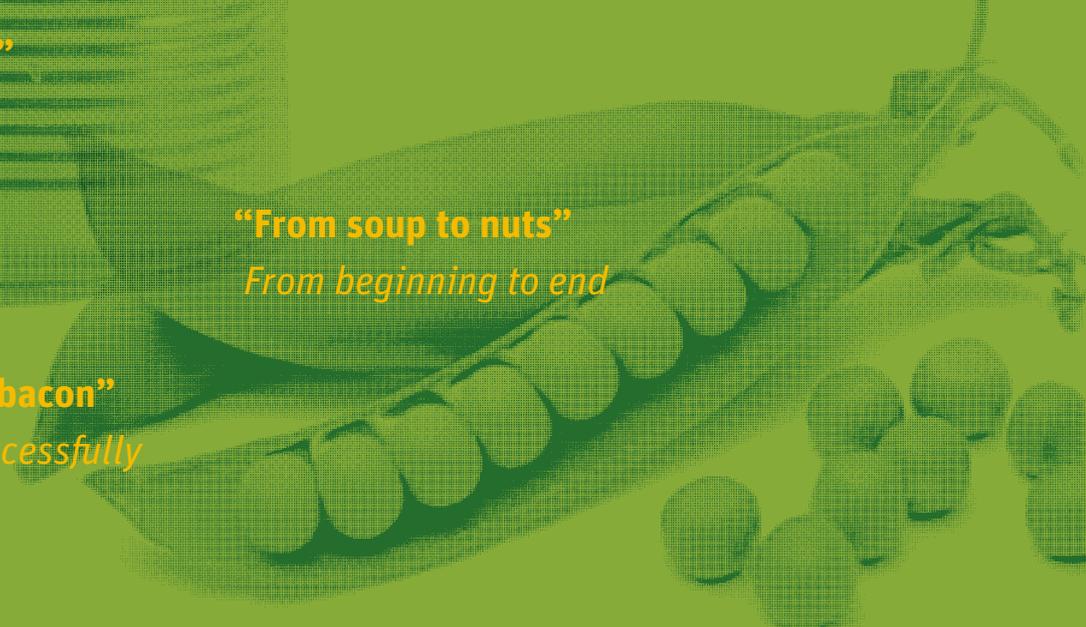
*Very close, intimate*

**“Fine kettle of fish”**

*A mess, an unsatisfactory situation*

**“To cut the mustard”**

*To succeed*



**“From soup to nuts”**

*From beginning to end*

**“To bring home the bacon”**

*To do something successfully*





# Welcome

## Kalpana Beesabathuni

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On April 1, 2016, the United Nations General Assembly proclaimed a UN Decade of Action on Nutrition, to run from 2016 to 2025. The resolution calls for collaboration between a wide group of actors. In this spirit, we are delighted to collaborate with the World Food System Center at ETH Zurich for this edition of *Sight and Life* magazine to **bring grist to the mill** – that is, perspectives from thought leaders belonging to two traditionally distinct camps: agriculture and health. These perspectives are here brought to bear on the common theme of “food systems for improved nutrition.”

We all connect over food so much that food-related phrases are an integral part of our daily conversations, across languages and cultures, as you will also see in this editorial. With this edition, we hope to shed some light on the potential offered by food-systems approaches to address food and nutrition security, including both quantity and quality. Quantity and quality are like **two peas in a pod**: they are intimately connected and must be considered together.

It is undeniable that great progress has been made in addressing certain food and nutrition security challenges globally. However, as we try to tackle the multiple health burdens of malnutrition at a time when the environmental basis for food production is a **fine kettle of fish**, it is necessary to disrupt current approaches and **to cut the mustard** with new ways of thinking and working.

A food system considers the multiple activities, resources and actors engaged in producing, processing, distributing and consuming food. These are all shaped by, and interact with, **everything from soup to nuts** – i.e., all the environmental, social,

political and economic boundary conditions that determine what type of food can be produced where, how it is used, and by whom. All these elements are strongly influenced by global change drivers such as population growth, changing consumption patterns, biodiversity loss, and climate change. Given that our food systems are already struggling to **bring home the bacon** (i.e., to deliver on their intended outcomes of global food and nutrition security) these increasing pressures will catapult our tasks **out of the frying pan and into the fire**.

**“A food system considers the multiple activities, resources and actors engaged in producing, processing, distributing and consuming food”**

In order to ensure food and nutrition security for all, it is important to look at the issues in an integrated manner. This of course does not exclude the essential need for expert knowledge, but it does suggest that we need to spend more time understanding how issues are connected, their root causes, and where critical leverage points might be. This calls for greater exchange across disciplines, sectors and scales, and for new ways of thinking and working. We are grateful to the contributors to this issue for providing some **food for thought** about such approaches.

**“We need to spend more time understanding how issues are connected”**

The infographic at the beginning of this edition is from the prestigious journal *The Lancet* and captures a **seed change** in thinking about how governments can support healthy food preferences. Designing policies for food systems with the indi-

vidual at the core is a welcome change. This issue of our magazine starts with two articles that provide an overview of the concepts of “sustainable” and “resilient” food systems. John Ingram explores the question “What are sustainable food systems for a healthy world?” considering our understanding of the relationships between food systems and environmental and human health. Jonas Jörin and co-authors elaborate further on these concepts to define food system resilience – an important approach, as we face the prospect of increasing shocks and unexpected disturbances that will further challenge food systems and their capacity to deliver food and nutrition security. **In a nutshell**, both highlight the need for new approaches to help us to navigate complexity and work with a variety of different stakeholders and interests.

For that to happen, Jess Fanzo provides a **fresh** insight into how food and health systems need to work synergistically in order to bring about effective change for health, nutrition and well-being. Jess discusses the steps taken by the SDGs to include the pressing global burden of obesity and non-communicable diseases (NCDs), and outlines how to fill the important gaps. Shauna Downs builds the argument further through her analysis of food-system drivers and solutions. Tackling the nutrition transition in Latin America is no **piece of cake**, but Diana Parra sheds some light on the approaches that have been used in Colombia so far, and makes suggestions for integrated interventions and policies for the future that can effectively tackle the double burden of malnutrition and at the same time build sustainable food systems.

Scientists from CGIAR and McGill University **whet our appetite** about how two of their pioneering initiatives are bringing forward intersectoral collaborations on convergent innovation platforms, while Tom Gill and Rickey Yada bust common myths associated with food processing.

**The best thing since sliced bread** in this issue is a set of tools, models and frameworks by a number of authors for practitioners in the food and nutrition ecosystem. John Fiedler emphasizes the data deficit for measuring programs and explains how household surveys, which are already popular in many countries, can be made practical and be triangulated with other measurement tools. And co-authors provide a framework for assessing and enhancing food-systems resilience, and apply it to a case study on *tef* in Ethiopia. The article on innovative financing captures an overview of promising models and instruments for bringing in funds from untapped sources or for maximizing impact for investors. Corey Luthringer and Greg Garrett share lessons in building national premix supply systems to ensure a sustainable supply of premix for food fortification.

**A new crop of ideas** emerges in the articles on protein and crop yields. With protein back in the spotlight, Gilbert Weber addresses how to sustainably meet the global demand for animal-

sourced foods. Simon Billing maps the global protein system and identifies six areas of innovation that need to be nurtured through a full systems approach. Leslie Ziegler, a food entrepreneur committed to sustainability, shares her thoughts on using more water-efficient protein ingredients such as cricket flour for cookies and chips. Marco Ferroni reminds us of the crucial role of smallholders in farming, especially in low- and middle-income countries, and discusses how we can support them to improve crop yields. Jennifer Baxter explains how engineering systems can be used to both reduce food waste and provide heat and power to communities.

We are **sure as eggs is eggs** that collaborative partnerships across disciplines and sectors are the way to build sustainable and resilient food systems. We hope that this edition will give you some **food for thought** about these approaches, and we look forward to hearing your perspectives!

Sincerely,

Kalpna Beesabathuni and Michelle Grant

*Kalpna Beesabathuni*

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# ... and their meaning

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**“Out of the frying pan and into the fire”**

*To go from bad to worse*

**“Food for thought”**

*An idea or issue to ponder*

**“Seed change”**

*A dramatic change or departure from the status quo as a means of solving a problem*

**“In a nutshell”**

*In brief*

**“A piece of cake”**

*Very easy*

**“To whet one’s appetite”**

*To stimulate one’s interest*

**“The best thing since sliced bread”**

*A notable new idea*

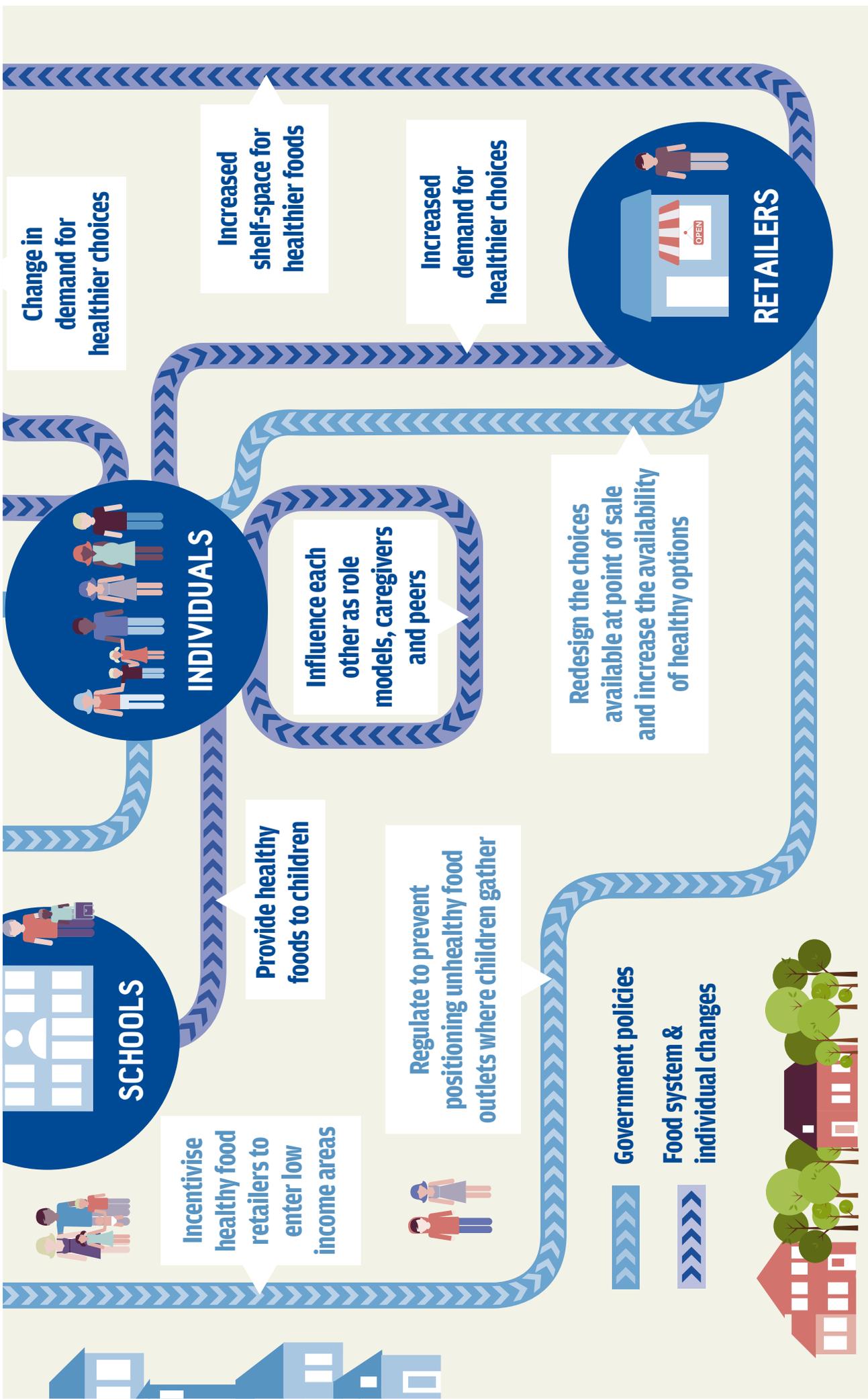
**“Sure as eggs is eggs”**

*Absolutely certain*

# HOW CAN GOVERNMENTS SUPPORT HEALTHY FOOD PREFERENCES?

The food system is an interconnected network of producers, industry, and institutions. But at its heart is the individual. Policy can affect all parts of the network, influencing a cultural shift towards healthier food preferences.





For further information on the obesity series or to read the full report, visit [www.thelancet.com/series/obesity-2015](http://www.thelancet.com/series/obesity-2015)  
 Source: Hawkes C, Smith TG, Jewell J, et al. Smart food policies for obesity prevention. *Lancet* 2015; published online Feb 19.  
[http://dx.doi.org/10.1016/S0140-6736\(14\)61745-1](http://dx.doi.org/10.1016/S0140-6736(14)61745-1)

# Making Stunting a Development Indicator

**Klaus Kraemer**

*Sight and Life*, Basel, Switzerland

At the 2012 World Economic Forum (WEF) in Davos, Dr David Nabarro – now Special Adviser on the 2030 Agenda for Sustainable Development – was presented with the inaugural *Sight and Life* Nutrition Leadership Award on behalf of the Scaling Up Nutrition (SUN) Movement. Accepting the award, Dr Nabarro stated that “Nutrition on its own should become a new development goal as we look beyond 2015.” The word “development” is significant here. Dr Nabarro was looking forward to the coming era of the Sustainable Development Goals (SDGs). Indeed, nutrition has an important place within the overall framework of the SDGs, with a central role in Goal 2 (Zero Hunger). We have even gone further and put **nutrition** at the heart of achieving all 17 SDGs,<sup>1</sup> but in the widest definition of the word – not in the narrow sense in which many define it.

## Stunting: the universal nutrition target

In recent years, stunting (low height for age, linear growth failure, <-2 SD of the WHO Child Growth Standards median) has come to be seen as the universal nutrition target (in addition to anemia, low birth weight, exclusive breastfeeding, and wasting). A stunting target was initially endorsed by the 2012 World Health Assembly (WHA) and is now also anchored in Sustainable Development Goal (SDG) 2 – probably for its importance during the first 1,000 days of life and its lifelong influence on health and prosperity. In an earlier commentary in *Sight and Life*, **The stunting enigma**,<sup>2</sup> I quoted the president of the World Bank Group, Jim Yong Kim, as observing that: “This [stunting] is the face of poverty.”

For me, this is *the* most powerful description of the tragedy of stunting. It acknowledges the multifactorial etiology of stunting (chronic malnutrition), as was so aptly illustrated in the UNICEF conceptual framework by the late Urban Jonsson (to whom we pay tribute in an obituary in this issue). Studies in The Gambia<sup>3</sup> have

shown that > 40% of stunting can be attributed to environmental enteric dysfunction (EED) – i.e., chronic exposure to pathogenic bacteria, viruses, and parasites due to poor hygiene, contaminated water and open defecation causing epithelial atrophy, malabsorption and inflammation. As a consequence, nutrients are lost and diverted to immune responses rather than to growth. Moreover, in a recent publication we demonstrated (applying a sophisticated metabolomics platform) that all nine essential amino acids were significantly lower in stunted children than in non-stunted children.<sup>4</sup> You might think such a result predictable, but there has in fact been a lack of interest in protein (research) on the part of the nutrition community since the mid-1970s. This was the direct consequence of Donald McLaren’s influential commentary in *The Lancet*, “The Great Protein Fiasco,” that led to a flurry of micronutrient research, with protein left out in the cold.<sup>5</sup> As a result of the recent publication, Richard Semba and I posed the question in a Huffington Post blog, “Have we been hooked on micronutrients in our search for the solution to stunting?” We believe that over the last decades we have neglected the importance of good-quality protein and other nutrients essential for growth.<sup>6</sup>

“There has been a lack of interest in protein (research) on the part of the nutrition community since the mid-1970s”

## The accelerant of a good start in life

Roger Thurow writes in his new book *The First 1,000 Days*<sup>7</sup> that “Good Nutrition is the indispensable fuel of growth and development, particularly in the 1,000 days; it is the accelerant of a good start in life.” Thurow goes on: “They [The Lancet series] concluded that if the world was to launch an effective assault on stunting, it would need to attack the problem along a wide front stretching across multiple sectors of development – agriculture,



Ricardo  
7 years old

Manuel  
7 years old



**PREVENT STUNTING  
GROW THE FUTURE!**

**PREVENTING  
ADVANCING CA  
SUSTAINABLE**

nutrition, health care, water, sanitation, education, communications and behavior change.”

This view is underlined by the authors of the most recent issue of the *European Journal of Clinical Nutrition*.<sup>8</sup> This special issue, which is edited by Guest Editor and leading auxologist Prof. Michael Hermanussen from Kiel University in Germany, points out that: “Growth and height have been within the focus of medical research for many centuries and are included in the political agenda of the WHO and UNICEF, as they are measures of *poverty, chronic illness* and malnutrition”. Fascinatingly, Prof. Hermanussen argues that: “Evidence that body height is determined by socioeconomic circumstances can be traced back to Louis René Villermé (1782–1863), a French hygienist who used data collected by the military services of the French army in 1812 and 1813, and the report to the Minister of War in 1817.” *Plus ça change, plus c’est la même chose* – if only we would pay full attention to the evidence before our eyes.

Speaking of important recent publications, the Maternal and Child Nutrition supplement “Stop Stunting in South Asia. Improving Child Feeding, Women’s Nutrition and Household Sanitation,”<sup>9</sup> could not have been timelier, too. In its accompanying editorial by Victor Aguayo (UNICEF) and Purnima Menon (IFPRI), Shawn Baker of the Bill & Melinda Gates Foundation is quoted as saying, “It will be essential to define the roles and responsibilities of each sector in reducing child stunting and, importantly, to co-locate the interventions of all sectors.”

I can only concur with Baker, but I have a burning question: Who is going to coordinate this multi-sectoral approach to eradicating the glaring injustice of stunting? Will it be Nutrition? Health? Agriculture? Education? Or possibly even the infrastructure sector? Who will be held accountable, and how?

## “Who is going to coordinate this multi-sectoral approach to eradicating the glaring injustice of stunting?”

The nutrition community is clearly interested in reducing stunting, but what interest has the infrastructure sector in investing in improved water and sanitation *with reduced stunting as an outcome*? The SUN Movement clearly supports the national implementation of cross-sectoral teams, but there is still a significant functional and technical capacity gap at different levels within governments, NGOs, businesses, and academia. Who will take the lead and invest in creating these capabilities? Transformational leadership skills to forge effective teams – the type of “soft skills” taught by the African Nutrition Leadership Programme<sup>10</sup> – are lacking, and are an expensive investment with a long-horizon return. It isn’t a quick fix!

The stakes are high. We **must** make good progress in stunting reduction. Nutrition has never been higher on the development agenda, and it will not get a second chance. Yet the reality, according to the 2013 *Lancet* series, is that stunting can only be reduced by about 20% through applying, at scale, the 10 evidence-informed nutrition-specific interventions.<sup>11</sup> The other 80% of the problem is barely under the control or influence of nutrition.

I fully support tracking stunting as a development – **not nutrition** – indicator. It accumulates all the insults that can occur during a child’s development, determining the child’s health and a country’s health and economic wellbeing. Such an approach would, I believe, raise levels of accountability within governments, and thus would more effectively facilitate the multi-sectoral approach that is so essential for success. History teaches us that the Nutrition sector has traditionally lacked a real home, being always prone to fall between the cracks of Agriculture and Health. Little has changed. We must move stunting out of Nutrition and establish an accountability framework across sectors and stakeholders that really works to the benefit of the children, their families and countries. If we do not, then history will repeat itself, with tragic consequences.

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interventions to improve lives.



# Household Consumption and Expenditure Surveys

A tool for bringing more evidence and accountability to food and nutrition programs and policymaking

**John Fiedler**

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**BOX 1:** Introductions to HCES and key issues in their use in food and nutrition analyses

**Key messages**

- > Food consumption and nutrient intake data are essential for identifying and assessing diets, monitoring diet quality, designing nutrition programs and informing food and nutrition policies.
- > Household consumption and expenditure surveys (HCES) are increasingly being turned to as a source of food consumption data.
- > A typical HCES collects data on household composition, socioeconomic behaviors and food acquisition and consumption data from a sample of households that is representative at the region, state or district level and comprises about 75,000 individuals.
- > HCES have proven to be of particular importance in designing and monitoring fortification programs.
- > HCES has become a standard tool in the continuing fight against global food insecurity and malnutrition.

Topical Area	References
1. An HCES primer	1
2. A guide to using HCES to measure food security	2
3. A guide and criteria for selecting among HCES, Food Balance Sheets, 24-Hour Recall and Food Frequency methods for obtaining data to design and monitor fortification programs	3
4. Descriptions of how to use HCES together with food composition table data to develop estimates of nutrient availability	4, 5
5. A comparative analysis of the costs of HCES and 24-Hour Recall	6
6. General reviews of HCES that also lay out a global strategy for strengthening HCES for undertaking food and nutrition analyses	7, 8
7. An assessment of the relevance and reliability of HCES based on a review of 100 countries' questionnaires	9
8. A case study of how to use HCES to conduct an <i>ex ante</i> assessment of biofortification	10
9. A case study of how to use HCES to monitor population diet quality and nutrition status	11

**Introduction**

Food consumption and nutrient intake data are essential for identifying and assessing diets, monitoring diet quality, designing nutrition programs and informing food and nutrition policies. Household consumption and expenditure surveys (HCES) are in-

creasingly being turned to as a source of food consumption data. HCES are a collection of multi-purpose surveys that collect a variety of data, including information about food consumption and acquisition. HCES include: **1)** household budget surveys; **2)** living standards measurement study; **3)** household income and expenditure surveys and **4)** integrated household surveys. The more than 125 countries that routinely conduct HCES have undertaken an average of seven surveys, with rounds, performed at 3–5 year intervals, consisting of interview data from a sample of about 15,000 households. **Box 1** lists papers providing general introductions to HCES and guides to using them in food and nutrition analysis. Although HCES have been done in most countries for more than three decades, food and nutrition analysts have only recently become familiar with them because they have traditionally not been widely accessible. The surveys are designed, financed and conducted by central bank or ministry of finance macroeconomists to collect the data they require to construct consumer price indices and estimate labor force participation rates, gross domestic product and other economic indicators, and they generally have not shared them with others. Now, however, sparked by the need to track the Millennium Development Goals and their successors the Sustainable Development Goals, HCES have come to be an increasingly common source of data with which to devise evidence-based policies and to address growing demands for increased accountability.<sup>12</sup> With HCES expected to play a prominent role in monitoring the Sustainable Development Goals,<sup>13</sup> they are poised to become an increasingly familiar go-to source for population-based food and nutrition information, much as the Demographic & Health Surveys (DHS) have become for health and nutrition data.

.....

**“HCES have come to be an increasingly common source of data with which to devise evidence-based policies and to address growing demands for increased accountability”**

.....

The empirical basis of most nutrition work has long been constrained, because most nutritionists have chosen to rely exclusively on 24-hour recall or observed-weighted food record survey data, both of which are in exceedingly short supply. Nutritionists have regarded these data as indispensable because of their relatively greater precision and reliability. The high costs and administrative demands of these surveys, however, have proven to be insuperable obstacles: the few that have

**BOX 2:** Food insecurity and nutrition-related applications of HCES data

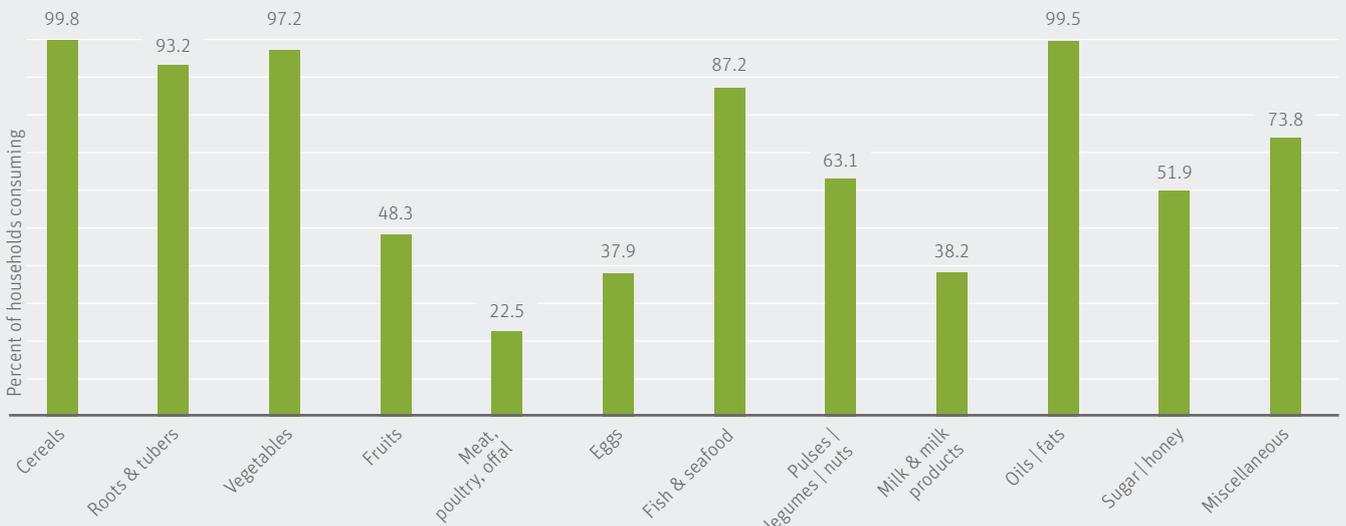
Application	References
1. Conducting subnational food security analysis	14, 15, 16, 17
2. Assessing diet quality and dietary change	3, 16, 18, 19, 20, 21, 22, 23
3. Assessing the diversity of food supplies	11, 24
4. Analyzing the nutrient availability of the domestically produced food supply	11, 24
5. Assessing dietary diversity	11, 23, 24
6. Analyzing the relationship between household food expenditure and malnutrition	25
7. Estimating sodium intakes	26
8. Identifying and monitoring the prevalence of overweight and obesity	27, 28
9. Assessing the consumption of snacks and soft drinks by babies	29
10. Estimating nutrient intakes and the prevalence of inadequate nutrient intakes	4, 5, 30, 31
11. Identifying the most common food sources of specific nutrients	5, 11, 24
12. Designing and modeling the impact of fortification programs	3, 4, 16, 22, 30, 31, 32, 33, 34
13. Designing and modeling the impact of biofortification programs	35, 36, 37, 38, 39
14. Conducting feasibility and cost-benefit analyses of fortification, biofortification and supplementation program portfolios	33, 34
15. Nutrition epidemiological analysis	40, 41
16. Developing a global fortification strategy	42
17. A book and software to facilitate and standardize the analysis of food security and nutrition issues using HCES	43

been funded have generally been small-scale and not nationally representative. The result has been to hobble the planning and effectiveness of nutrition programs. As the food and nutrition community is becoming increasingly familiar with HCES, this information gap is being addressed by means of these alternative data sources. At the same time, these data have spawned the use of these surveys in ways not considered when the surveys were originally designed. **Box 2** lists some of the newer food security and nutrition applications of HCES.

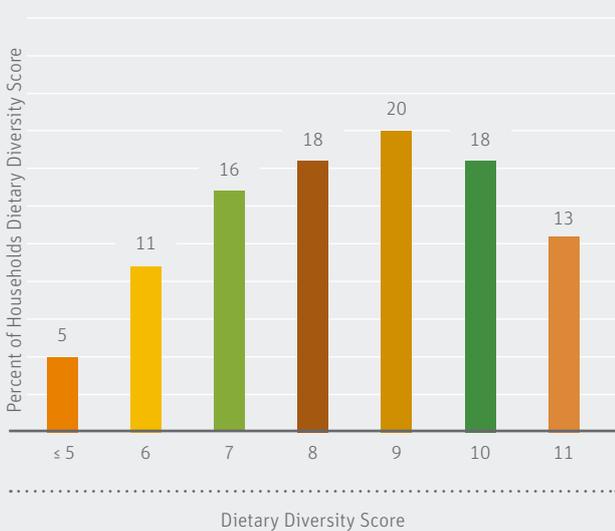
While there remain issues and concerns about the quality of HCES, a number of factors have contributed to their growing use in an increasing variety of applications, including:

- > growing global and country-specific efforts to improve their quality;<sup>7,8,9,12,13,44,45</sup>

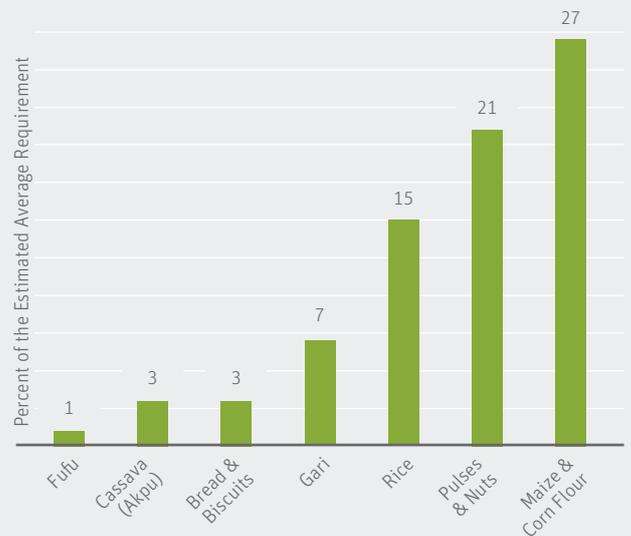
**FIGURE 1:** Analyzing the food group composition of the Bangladesh diet



**FIGURE 2:** Bangladesh households' dietary diversity scores



**FIGURE 3:** The most important food sources in Nigeria



- > recognition that they are heterogeneous and that there is a need to be selective – that some of the surveys are sound, while others are of unacceptable quality for use in many nutrition applications;<sup>6,7,8,9</sup>
- > acknowledgement that some applications are less demanding in terms of the quality of the data they require;<sup>6</sup> and
- > the growing practice of triangulating different sources of data to enable the bracketing of plausible estimates and the reduction of uncertainties.<sup>6,34</sup>

**HCES: a window into population-based dietary patterns**

A typical HCES collects data on household composition, socio-

economic behaviors and food acquisition and consumption data from a sample of households that is representative at the region, state or district level and comprises about 75,000 individuals. On average, a predefined list of roughly 125 food items is used to collect the quantity and value of food acquired and/or consumed during the recall period (commonly the last 7 to 14 days), and identifies how each food item was acquired – i.e., whether it was purchased, sourced from own production or received as a gift or in-kind payment. Some HCES collect a mix of purchase and consumption data; some collect only consumption data. **Figures 1–3** exemplify some of the types of basic, population diet quality analysis that HCES can support.

### Dietary assessment methods using HCES

Assessing the adequacy of a household's consumption requires comparing its consumption to its nutritional requirements over a given time period. For most HCES, because no data are collected on food stocks, it is customary to assume that all of the food acquired during the recall period is consumed during the recall period. (This assumption may distort consumption profiles when, for instance, households purchase large quantities of a staple or do not purchase any of a staple during the recall period because the household already has plenty available and it draws down stocks during the recall period.)

First, the household's reported food acquisition and consumption over the recall period are used to develop an estimate of the household's usual daily intake. Each food item in the HCES is matched to a food composition table entry to identify each food's nutrient content per 100 grams (net of non-edible portions). Next, the nutrient content level of each food is multiplied by the reported quantity of the food to provide an estimate of the total nutrient availability or apparent nutrient intake from the food in question. The same procedure is followed for each of the food items in the HCES food list, and the apparent nutrient intake of all of the items is summed and then divided by the length of the recall period to provide the household's estimated total apparent daily nutrient intake. The use of the qualifier "apparent" acknowledges that these totals do not take into account waste and that some of the food is given to persons other than household members or to animals. (Some analysts assume a portion (e.g., 10–15%) of the household's food is wasted. The daily food quantities are sometimes referred to as "available" food rather than "apparent consumption.")

The adequacy of the household's apparent food consumption is measured by estimating the age- and gender-specific estimated average requirement (EAR) of each nutrient of interest for each household member and summing. For any given nutrient, the household's total EAR is compared to its estimated apparent intake of the nutrient. It is assumed that if the household's total apparent nutrient intake is less than the household's EAR, then the household is at risk of inadequate intake; i.e., it suffers from food insecurity.<sup>46</sup>

.....

**“It is assumed that if the household's total apparent nutrient intake is less than the household's EAR, then the household suffers from food insecurity”**

.....

### BOX 3

#### Information requirements for designing a fortification intervention

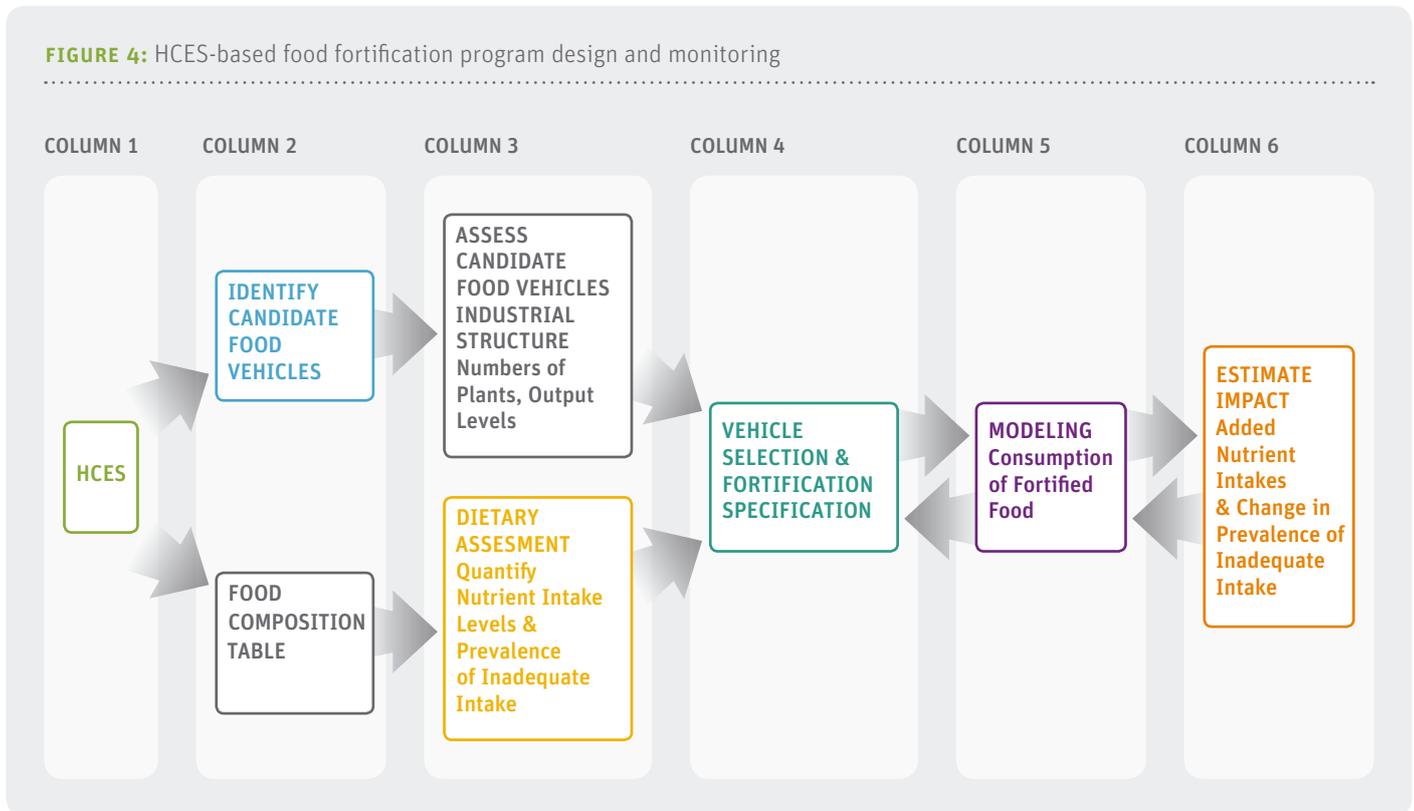
1. Which potentially fortifiable foods are being consumed in the country?
2. What proportion of this consumption is obtained through the purchase of centrally processed foods (amenable to large-scale fortification)?
3. How have these consumption patterns changed over time?
4. What proportion of the population purchasing these foods has inadequate intake of a micronutrient that can be added to this food vehicle?
5. What is the size of the nutrient gap, considering all sources of consumption and other micronutrient interventions?
6. How is the intake gap distributed in the population?
7. What quantities of the potential food vehicle are being consumed?
8. How is the consumption of the food distributed in the population?
9. How bioavailable are the nutrients that will be used in the fortification formulation?
10. At the proposed fortificant levels, does the fortification program put individuals at risk of excess intakes?

In the case of standard food security analysis, the calculations end here, with a household level measure of the adequacy of energy availability or apparent energy intakes. For fortification, however, it is necessary to conduct the analysis at the individual level so that fortificant levels which are safe, but which, at the same time, maximize the public health impact of fortification, can be approximated.

### Designing and monitoring fortification programs with HCES

HCES have proven to be of particular importance in designing and monitoring fortification programs. **Box 3** identifies the food-consumption-related information requirements essential to design and monitor a fortification program. **Figure 4** presents an overview of how HCES can be used to provide much of the required information, as well as to monitor the program and simulate its impact.

HCES collect household level data. To analyze individual household members' nutrient intakes, it is necessary to know, or to assume, how the household's food is distributed among its members. Most commonly it is assumed that households distribute food in direct proportion to each household member's proportionate share of the household's total adult male consumption equivalents (AME).<sup>47</sup> Using the AME to distribute the household's usual daily intake among its members yields individual apparent nutrient intakes. Comparing those levels to each individual's EAR provides a dietary assessment indicator (**Figure 4**, column 3, row 2). It is assumed that if the individual's apparent nutrient intake is less than the his/her age- and

**FIGURE 4:** HCES-based food fortification program design and monitoring

gender-specific EAR, then the individual is at risk of inadequate intake; if it is greater than his/her EAR, then his/her intake is adequate. The percentage of persons at risk of inadequate intake of a particular nutrient is the prevalence of inadequate intake – a proxy measure for the prevalence of nutrient deficiency. (The methodology described here is the cut point method, a shortcut derived from the probability method which can be used to estimate adequacy when certain conditions are met, as they are for zinc, vitamin A, calcium, and most other micronutrients. In the case of iron, however, it is necessary to use the probability method.<sup>46</sup>) **Table 1** presents an example, analyzing vitamin A intakes (in retinol equivalents, REs) in Zambia.

### “Fortification program impacts may be modeled as the change in nutrient intake status”

One of the first steps in designing or monitoring a fortification program is to quantify the coverage and quantities of each food vehicle apparently consumed (**Figure 4**, column 4, and **Figure 5**). It is often assumed that only the portion of a food item that is purchased is fortifiable (i.e., that which is consumed from home production or received in-kind or free-of-

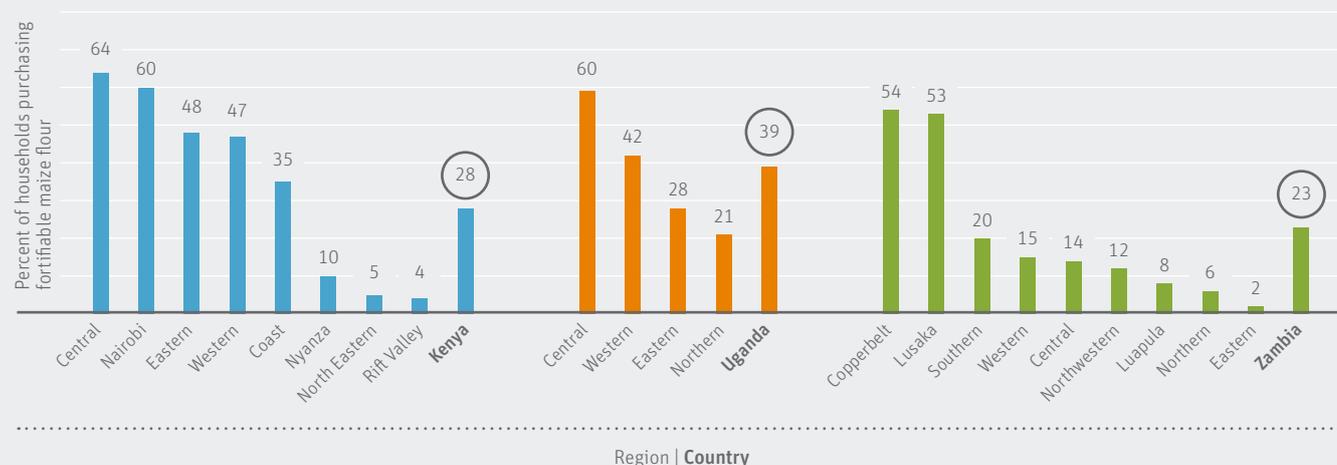
charge/gifted is not). The additional nutrient intake from each fortifiable food is modeled (**Figure 4**, column 5) as the individual’s estimated apparent “usual intake” of the food in question, multiplied by the relevant fortification standards (or, alternatively, exploratory fortificant levels might be simulated). In the absence of data, it is generally assumed that all of the fortifiable food item that was purchased was fortified and that the companies producing the fortification vehicle(s) were compliant with existing fortification regulations. These assumptions provide an optimistic, best-case scenario. Alternative sets of assumptions may be adopted to examine other possibilities, and alternative fortification program portfolios may be modeled (as in **Figure 6**) to assess alternative food vehicles and combinations of vehicles. Fortification program impacts may be modeled as the change in nutrient intake status; i.e., as the individual’s baseline nutrient intake level minus endline intake level, and/or as the individual’s baseline EAR gap minus endline EAR gap (**Figure 4**, column 6, and **Figure 7**).

### Conclusion

The growing use of HCES to analyze food and nutrition issues together with the growing interest in issues around food prices, food production and food policy, has prompted a spate of efforts to strengthen and standardize HCES’ collection of food consumption data.<sup>48,49,50</sup> Among the more telling and forward-looking of these efforts has been the FAO-World Bank publication of ADePT-Food Security Module, an open-access, user-friendly

**TABLE 1:** Daily intake of vitamin A and prevalence of inadequate vitamin A intake, Zambia 2013

Province   Domain	Percent Population		Mean Vitamin A Intake (RE)	Prevalence of Inadequate Vitamin A Intake	Children 12–59m		Women (15–49y)	
	Urban	Rural			Mean Vitamin A Intake (RE)	Percent of EAR	Mean Vitamin A Intake (RE)	Percent of EAR
Central	22%	78%	110	95.5	58	26%	121	24%
Copperbelt	79%	21%	148	97.3	66	30%	144	29%
Eastern	8%	92%	68	99.0	35	16%	73	15%
Luapula	12%	88%	848	41.2	441	199%	890	179%
Lusaka	85%	15%	167	96.7	78	36%	172	35%
Northern	16%	84%	454	67.7	221	100%	479	96%
Northwestern	15%	85%	389	78.6	188	84%	419	84%
Southern	21%	79%	65	99.6	29	13%	74	15%
Western	14%	86%	336	83.1	140	63%	304	61%
<b>National</b>	<b>35%</b>	<b>65%</b>	<b>248</b>	<b>87.2</b>	<b>128</b>	<b>58%</b>	<b>250</b>	<b>50%</b>
Urban	100	na	158	96.0	82	37%	168	34%
Rural	na	100	268	82.5	146	66%	302	61%

**FIGURE 5:** Coverage of fortifiable maize flour by region and nationwide in Kenya, Uganda and Zambia

software that combines HCES with food composition table data to produce a wide range of food consumption and nutrition-related national and subnational indicators and analyses.<sup>43</sup> With version 2 soon to be released, it is evident that HCES have become a standard tool in the continuing fight against global food insecurity and malnutrition.

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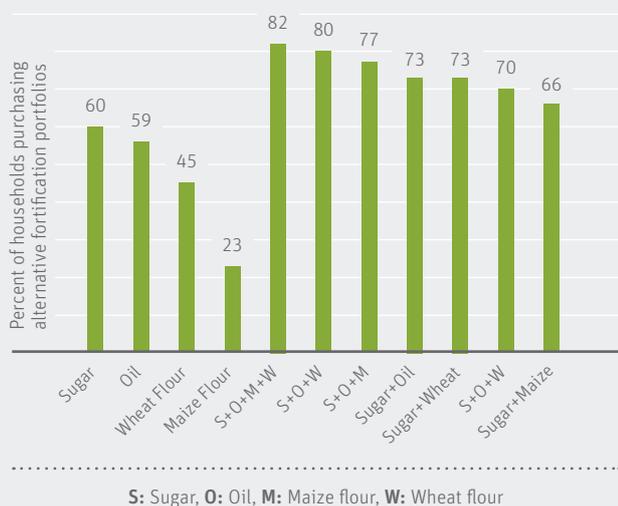
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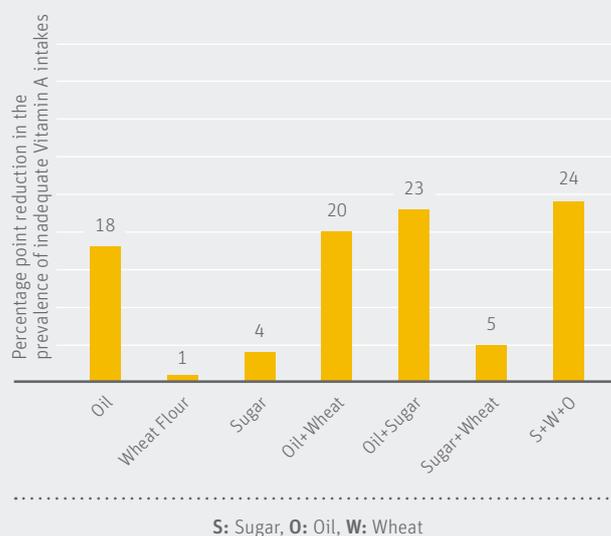


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**FIGURE 7:** Simulating alternative fortification program portfolio impacts, Bangladesh



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# Resilience in Food Systems

## The case of *tef* in Ethiopia

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### Key messages

- > Well-functioning food systems are essential to ensure that people do not suffer from malnutrition.
- > Food systems must be resilient to shocks in order to minimize the negative impacts on food and nutrition security, environmental quality and social well-being.
- > The resilience of food systems can be analyzed by breaking them down into individual value chains of commodities.
- > Our project has developed an initial set of guidelines which proposes a suite of methods, techniques and tools to assess and build resilience in food systems. They are structured into four iterative steps, which are: 1) problem identification and framing, 2) definition of the system, 3) resilience assessment, and 4) interventions for resilience building.
- > Understanding the resilience of individual value chains is a crucial first step for assessing entire food systems.

### Challenged food systems

Well-functioning food systems are essential to ensure that people do not suffer from malnutrition. Today, malnutrition is visible both in form of undernutrition (including hunger and inadequate nutrition) and overnutrition (including overweight and obesity).

Among many institutions, the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) advocate improving the functioning of food systems in order to provide sufficient, safe, high quality and accessible food for all people. However, the increased occurrence of shocks (unexpected disturbances) is making it increasingly difficult in all parts of

the world to provide food and nutrition security for everyone and at all times.

A shock – for example, in the form of a bad harvest that is caused by a plant disease – not only directly impacts the affected farmers, but also leads to indirect consequences for all the actors involved (e.g., input suppliers, processors, retailers, and consumers) who are associated with the affected crop. In other words, a shock creates challenges which affect the proper functioning of many elements of a food system. Hence, food systems must be resilient and able to anticipate and respond in a timely manner to shocks in order to minimize the negative impacts on outcomes such as food and nutrition security, environmental quality and social well-being.

**“The increased occurrence of shocks is making it more and more difficult to provide food and nutrition security for everyone at all times”**

In our research project on “Enhancing Resilience in Food Systems,” a flagship project of the World Food System Center at ETH Zurich, we define food system resilience as “the capacity over time of a food system and its units at multiple levels to provide sufficient, appropriate, and accessible food to all, also in the face of various and even unforeseen disturbances.”<sup>1</sup> This definition takes into account the complexity of food systems as well as growing pressures from various risks. Climate change, political tensions, sudden economic changes are just a few examples of risks that can trigger shocks which ultimately affect the functioning of food systems. Addressing this complexity requires an understanding of the human/environmental interactions at multiple levels and scales<sup>2-4</sup> and a consideration of the potential feedback effects that result in complex and often non-linear dynamics.<sup>5, 6</sup> It also calls for the inclusion of emerging trade-offs of one set of services (for example, food production) at the cost of another (for example, cleaner water).<sup>7-9</sup> Dealing scientifically with the complexity of food systems calls for the adoption of holistic research approaches which reflect the interdisciplinary and systemic nature of the problem. Systems science offers a large range of tools that make

**TABLE 1:** Structure of guidelines

#	Stage	Steps
1	Problem identification and framing	<ul style="list-style-type: none"> <li>&gt; Literature review</li> <li>&gt; Interviews, consultation</li> </ul>
2	Definition of the system	<ul style="list-style-type: none"> <li>&gt; Value chain analysis</li> <li>&gt; Drivers of change</li> <li>&gt; Material flow analysis</li> <li>&gt; Stakeholder analysis</li> </ul>
3	Resilience assessment	<ul style="list-style-type: none"> <li>&gt; Data collection (survey, interviews, secondary data)</li> <li>&gt; Data analysis</li> </ul>
4	Interventions for resilience building	<ul style="list-style-type: none"> <li>&gt; Formulation of interventions based on resilience assessment</li> <li>&gt; Formulation of interventions through stakeholder consensus (workshops)</li> </ul>

is possible to assess complexity in food systems.<sup>3</sup> Another aspect to be considered in this discourse is the linkage between sustainability and resilience, which are seen as distinct concepts but which are at the same time complementary, as they each support the development of greater strength within systems for coping with unexpected changes.<sup>1</sup>

“Our long-term goal is the development of a comprehensive resilience framework for assessing and building resilience within food systems”

#### Towards a resilience framework for food systems

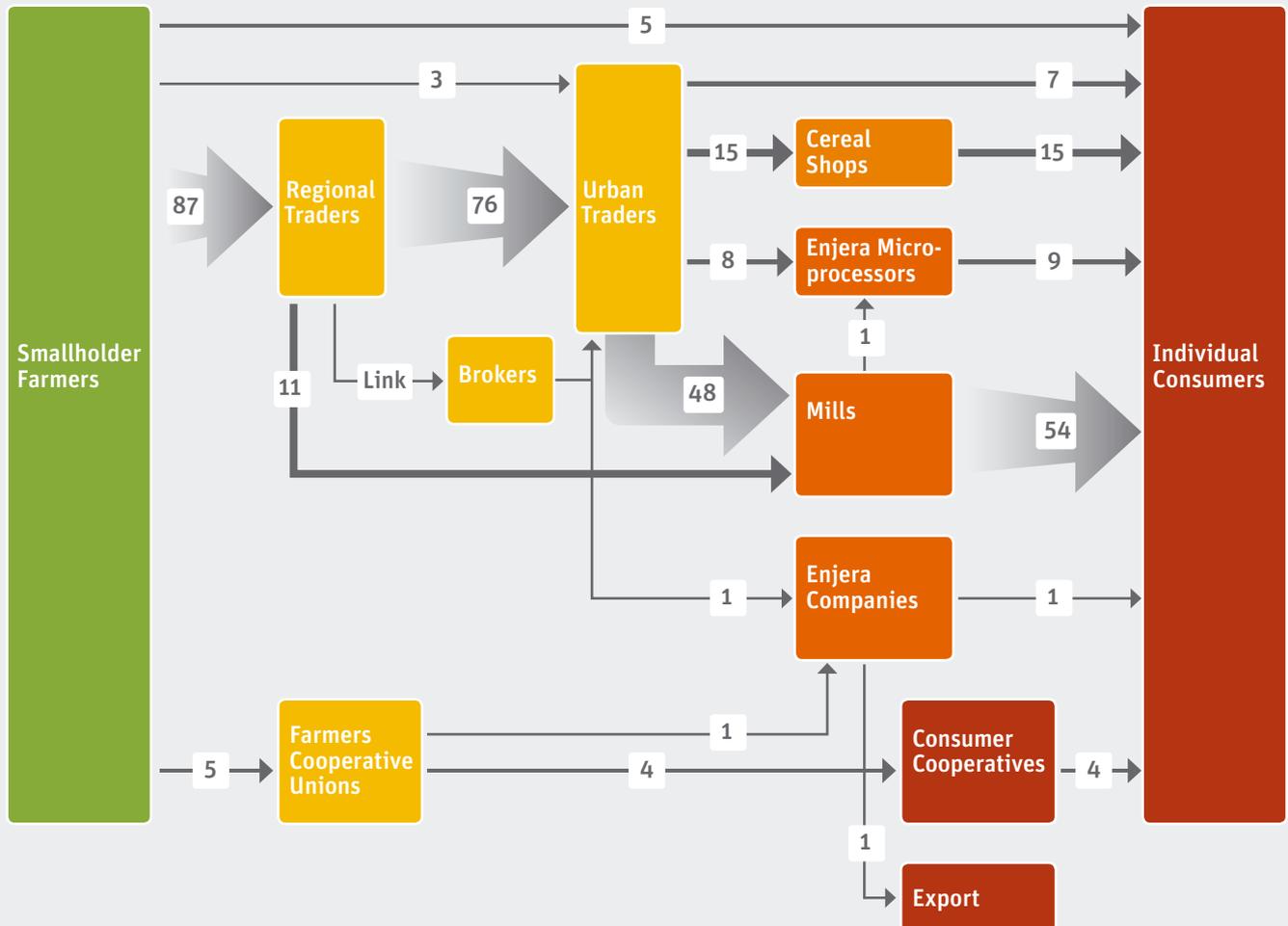
To assess and enhance resilience in food systems, we start by disentangling their complexity and breaking them down into individual value chains of commodities. These value chains constitute subsets of food systems. Throughout the resilience assessment process, we remain aware of the fact that food systems include multiple value chains that are interconnected, and that those value chains provide multiple outcomes.<sup>1</sup> Analyzing individual food value chains does, however, serve our primary objective, which is

to understand what kind of indicators (e.g., availability of stocks, response mechanisms against shocks, etc.) define resilience in food systems. This supports our long-term goal, which is the development of a comprehensive resilience framework for assessing and building resilience within food systems.

Currently, our project has developed an initial set of guidelines which synthesize the relevant literature and propose a suite of methods, techniques and tools to assess and build resilience in food systems. The guidelines are designed to help governmental and non-governmental stakeholders to assess resilience in food systems. They are structured into four iterative steps, which are: **1)** problem identification and framing, **2)** definition of the system, **3)** resilience assessment, and **4)** interventions for resilience building (see Table 1). In order to assess food system resilience (step 3), we draw on a set of indicators and corresponding analytical questions that cover the major attributes characterizing systems with a high level of resilience. These include: buffering capacity; diversity; connectivity; capital (economic, financial, environmental, social, physical); exposure to pressure; profitability; self-organization; governance capacity; transformability; transparency and information availability; learning capacity; and equitability.<sup>1</sup>

These guidelines account for realities in an operational context, including situations with low availability of data and

The *tef* value chain

**FIGURE 1:** Material flows for the post-production steps. Material flows in % of total marketed *tef*.

Source: Authors' calculations based on <sup>12, 13</sup> and expert interviews.

resources. We do not propose a single procedure with fixed methods, but rather allow for differences in context, availability of data and expertise, and engagement of stakeholders. Hence, our guidelines consist of a stepwise approach ensuring that important issues are systematically identified and analyzed, while supporting a flexible combination of appropriate qualitative and quantitative methods.

#### Case Study: Resilience of the *tef* value chain in Ethiopia

The aforementioned guidelines have been recently applied to the *tef* value chain in Ethiopia in partnership with the Ethiopian Institute of Agricultural Research in Debre Zeit. In a first step of the guidelines, we framed the *tef* value chain. *Tef* is a primary staple food in Ethiopia. It is deeply rooted in Ethiopian culture as a preferred food ingredient for making *enjera*, a fermented flatbread present in most Ethiopian meals (Figure 1). It has

great nutritional value (see Table 2) and is suitable for people with gluten intolerance.<sup>10</sup>

In the second step of the guidelines, we looked at the structure of the *tef* value chain. Until recently, 99% of the global *tef* production took place in Ethiopia, making the *tef* value chain localizable.<sup>14</sup> The export of non-processed *tef* has been banned since 2006 in an attempt to keep domestic prices low,<sup>14</sup> although with little effect, as domestic *tef* prices continue to rise every year due to increasing demand from a growing urban population.<sup>13</sup> Around 36% of *tef* has been marketed in 2013<sup>15</sup> – hence it can be regarded as a food security crop; however, the share of *tef* that is marketed is growing year by year. So far, the majority of *tef* is consumed by subsistence farmers, especially by those located in remote areas of Ethiopia. For the 36% of *tef* which is marketed, regional traders collect 87% from farmers. From the regional traders, the majority of *tef* goes to urban

**TABLE 2:** Nutritional characteristics of *tef* grain

<i>Tef</i> grain (per 100 g)		
Energy	kcal	367
Protein	g	13.3
Total lipid (fat)	g	2.38
Ash	g	2.37
Carbohydrate, by difference	g	73.13
Fiber, total dietary	g	8
Sugars, total	g	1.84
Calcium, Ca	mg	180
Iron, Fe	mg	7.63
Magnesium, Mg	mg	184
Phosphorus, P	mg	429
Potassium, K	mg	427
Sodium, Na	mg	12
Zinc, Zn	mg	3.63
Copper, Cu	mg	0.81
Manganese, Mn	mg	9.24
Selenium, Se	mg	4.4
Thiamin	mg	0.39
Riboflavin	mg	0.27
Niacin	mg	3.363
Pantothenic acid	mg	0.942
Vitamin B <sub>6</sub>	mg	0.482
Choline, total	mg	13.1
Betaine	mg	2.3
β-Carotene	μg	5
Vitamin A	IU	9
Lutein + zeaxanthin	μg	66
Vitamin E (α-tocopherol)	mg	0.08
β-Tocopherol	mg	0.02
γ-Tocopherol	mg	5.04
δ-Tocopherol	mg	0.07
Vitamin K (phylloquinone)	μg	1.9
<b>Lipids</b>		
Fatty acids, total saturated	g	0.449
Fatty acids, total monounsaturated	g	0.589
Fatty acids, total polyunsaturated	g	1.071
Amino acid composition	g	12.597

**Source:** USDA National Nutrient Database for Standard Reference (2015)

*Tef* is also native to Ethiopia, making it more resistant to local pests and locally occurring diseases.<sup>11</sup> Compared to other major food staples, such as wheat and maize, *tef* can better sustain extreme heat and water-logging.



*Enjera* (Ethiopian flatbread) made from *tef*

traders, who then distribute it among various mills, *enjera* processors and cereal shops before it reaches the consumers. The consumers then either make *enjera* themselves from *tef* flour or else buy the ready-made *enjera*. The demand for ready-made *enjera* is growing rapidly in urban areas due to lifestyle changes and the associated need for convenience products.

In line with the third step of the guidelines, we assessed the ability of different stages of the *tef* value chain to deal with shocks. Based on a literature review, interviews (n=57) with actors from all stages of the value chain, and available secondary data, scores were assigned qualitatively (Table 4) for each resilience attribute (Table 3).

#### Key findings are as follows:

- The supply system for unimproved inputs (seeds and traditional farm implements) is more resilient than the one for improved inputs (fertilizer, pesticides, improved seeds and farm implements). Since unimproved seeds are produced by the farmers themselves, they are widely available, and are used by around 90% of all farmers. Improved inputs are relatively expensive, are supplied by only a handful of providers, and are not widely available.
- Although *tef* is resistant to extreme weather events (e.g., drought, water-logging) and is little affected by diseases, its production contributes to soil degradation (extremely fine seedbed required) and relies on extensive use of fertilizer. Even with high use of fertilizer, *tef* yields (between one and two tons per hectare) are still comparatively low compared with other (food security) crops.
- There are a large number of small, diversified businesses which produce *enjera* products. Big *enjera* producers are rare. Despite a growing availability of *tef*-based *enjera*, especially in urban areas, it is gradually becoming more expensive due to rising prices, making it less and less affordable for medium- and lower-income households.
- Overall, the *tef* value chain suffers in all stages from a

**TABLE 3:** Interventions to build resilience against droughts (numbers show priorities)

Intervention	Process						
	Input supply	Production			Trade	Processing & Retail	Consumption
		Farmers	Cooperatives	Experts			
Alternative income sources	1	4	1	4		7	1
Savings	3		2	2		3	5
Stocks		1		3		1	2
Insurance		2			2		4
Water harvesting techniques	7	5	3	5			
Drought resistant varieties		3	4	1			
Government support					3	5	3
Early warning systems					1	4	6
Self-organisation and trust	4					2	
Ability to express diverse opinions	5					6	
Promotion of improved technology	6						
Infrastructure quality	2						

lack of information and capacity to evolve. This is widely attributed to the dominant role of the government. For example, the government largely runs the improved input supply system as well as the information flow to farmers through its own extension services. Furthermore, a lack of available financial capital and insurance solutions hampers the ability of all actors across the *tef* value chain to transform themselves into more shock-resistant entities.

- On the positive side, the endemic, nutritious and profitable characteristics of *tef* make it a highly suitable commodity to be produced, processed and sold both within and outside Ethiopia.

Following the resilience assessment, the guidelines aim to develop interventions for building resilience. For this, stakeholders (n=26) across the *tef* value chain were invited to participate in a workshop to discuss how the *tef* value chain could become more resilient to shocks, in particular a drought scenario.

Interestingly, experts and farmers thought similarly about the type of interventions that would increase the resilience of the *tef* production. However, experts prioritized introducing drought-resistant varieties, whereas farmers saw the provision of stocks and insurance solutions as primary needs for building up resilience. This example highlights how consulting directly with relevant stakeholders leads to contrasting conclusions compared to what scientists and governmental actors may think are suitable interventions for building resilience. It also shows that interventions need to be tailored to particular stages of the value chain.

.....  
 “Stakeholders across the *tef* value chain were invited to participate in a workshop to discuss how the *tef* value chain could become more resilient to shocks”  
 .....

**Next steps and way forward**

Understanding the resilience of individual value chains is a crucial first step for assessing entire food systems. Apart from looking at *tef*, we are also currently assessing the resilience of the cocoa value chain in Ghana. In this case, we are dealing with a cash crop, which requires a different approach and understanding of food systems resilience. Next steps also include studies in Switzerland on key value chains, such as milk, beef, potato, etc. Once we have applied our guidelines to a number of case studies in very different contexts, we expect to know better what kind of indicators are needed to a) understand individual value chains and b) obtain insights into how they interact with each other from a systems perspective. This will support the development of a quantitative resilience framework for food systems in the coming years.

Such a framework must look at what kind of trade-offs and synergies arise between various food system outcomes, and between food system outcomes and resilience. For instance, do

**TABLE 4:** Resilience scores for all stages of the *tef* value chain. Orange is very low, yellow is low, light yellow is medium, light green is high, dark green is very high.

Attribute	Value chain step					
	Improved inputs	Unimproved inputs	Production	Trade	Processing & Retail	Consumption
Buffering capacity	Orange	Dark Green	Yellow	Light Yellow	Light Yellow	Yellow
Environmental capital	Yellow	Light Yellow	Orange	Light Yellow	Light Yellow	Light Green
Connectivity	Orange	Dark Green	Light Yellow	Yellow	Light Green	Dark Green
Diversity	Orange	Dark Green	Dark Green	Light Yellow	Dark Green	Dark Green
Equitability	Yellow	Light Green	Yellow	Light Yellow	Light Green	Light Yellow
Exposure to pressure	Light Yellow	Light Green	Light Green	Light Green	Yellow	Light Green
Governance capacity	Light Yellow	Light Yellow	Light Yellow	Light Green	Light Yellow	Light Yellow
Information, learning	Light Yellow	Light Yellow	Orange	Orange	Yellow	Yellow
Profitability & financial capacity	Orange	Light Green	Dark Green	Dark Green	Light Yellow	Orange
Self-Organization	Yellow	Dark Green	Light Yellow	Light Green	Light Green	Light Green
Transformability	Orange	Light Yellow	Light Yellow	Yellow	Light Yellow	Yellow

possible interventions actually achieve the desired effects? Are food systems flexible enough to manage sudden and frequent changes of external conditions, such as impacts of climate change, changes in nutrient cycles, and social and political disruptions? Such questions are absolutely critical to ensure food and nutrition security for a growing global population in the face of mounting and combined shocks.

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# Sustainable Food Systems for a Healthy World

## John Ingram

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### Key messages

- > The physical and mental health of the human population is inextricably linked with the state of the environment.
- > The environment is affected significantly by the food systems that play such an important part in human health and well-being.
- > A “food system” approach helps relate all food system activities to the outcomes of these activities not only for food security, but also for the environment and enterprise.
- > The food system approach thereby provides a framework for the systematic analysis of synergies and trade-offs among food security, environment and enterprise outcomes of possible policy, financial, social and/or technical interventions. It also helps identify the right people to engage in such analyses.

### Definitions

What are “sustainable food systems for a healthy world”? This question of course involves three concepts, all warranting discussion: “sustainable,” “food systems” and “healthy world.” I feel it helps to address them in reverse order, dealing first with the concept “healthy world” – arguably the ultimate goal.

Many concerned with global environmental change, whether as academics or as the “interested public,” may first think of biological, biogeochemical and/or biophysical parameters to define the concept “healthy world.” Much has been published

on the “state of the planet” in this vein, with recent major works by international bodies such as the IPCC on climate and UNEP’s International Resource Panel on natural resources. These have been accompanied by numerous major papers in the academic literature which introduced, for instance, the concepts of “Planetary Boundaries” and a “Safe Operating Space for Humanity.”<sup>1,2</sup>

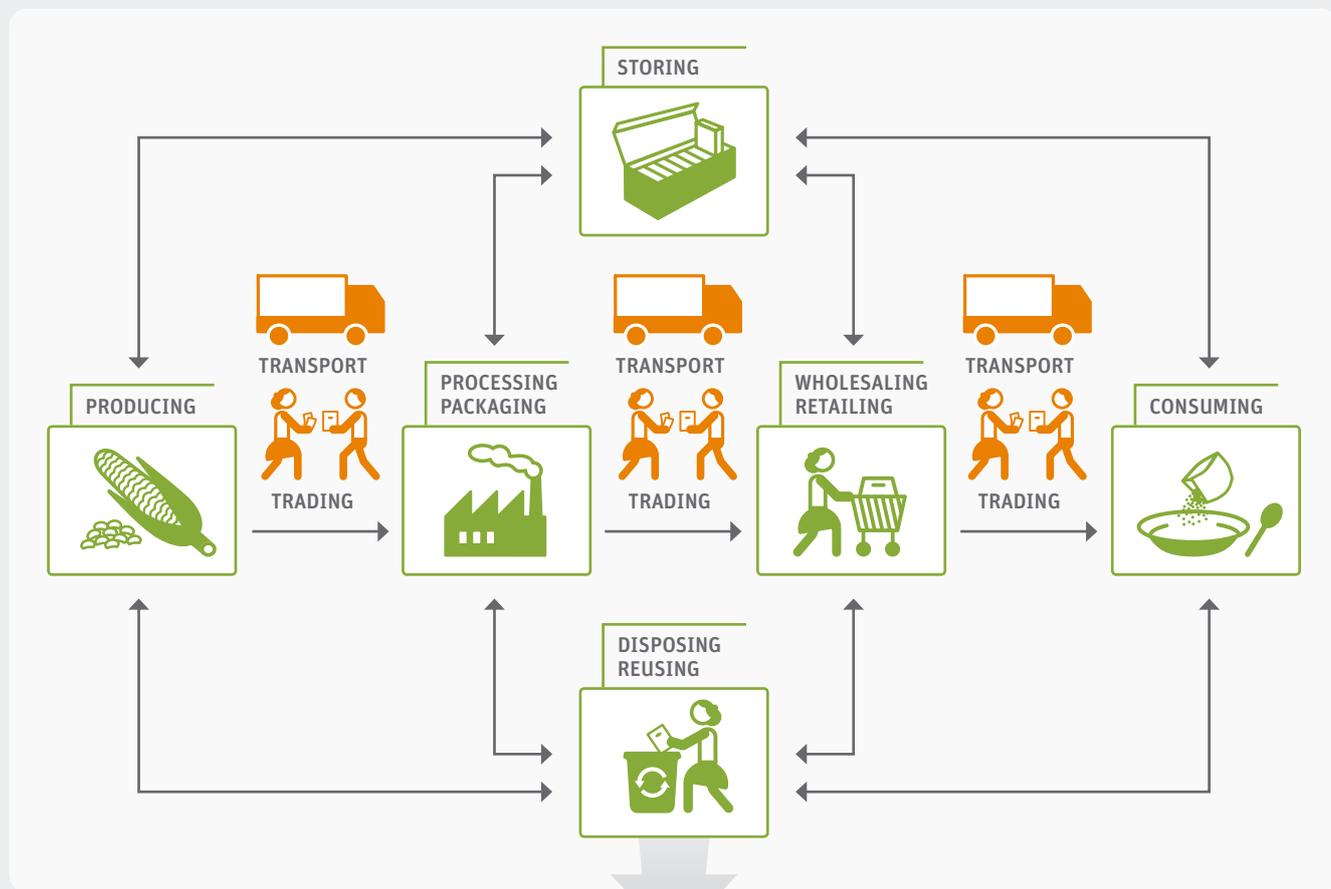
Environmental concerns are clearly important, but only represent one view of a “healthy world.” Another relates to the health of the human population, which has risen dramatically in recent decades. This is partially due to increased longevity – a development which few would argue is a bad thing. Further, the fact that now more than six billion people – or approximately 80% of the world’s population – do not suffer from inadequate calorie intake is a remarkable human achievement; some 50 years ago, this proportion was approximately 65%.<sup>3</sup> But we should not be complacent: today some one billion people do not have access to sufficient calories<sup>4</sup> and at least two billion people lack sufficient micronutrients,<sup>5</sup> while – paradoxically – over two billion people consume too many calories.<sup>6</sup> This under- and over-consumption has led to a growing “triple burden” of malnutrition. Different, overlapping forms of malnutrition are the “new normal”;<sup>7</sup> some people consume too little, while others – sometimes in the same community or even household – consume too much.

## “Different, overlapping forms of malnutrition are the ‘new normal’”

Set against this backdrop is the fact that the global human population is expected to reach approximately nine billion people by 2050.<sup>8</sup> Furthermore, food consumption patterns are changing rapidly as average wealth increases (especially in the case of the emerging “middle class” in much of the world<sup>9</sup>), leading to many people consuming more food overall and more meat in particular.<sup>10</sup> This change in diet (coupled with an increase in

**FIGURE 1:** Food Systems Activities and Outcomes (adapted from Ericksen<sup>19</sup> and Ingram<sup>20</sup>)

### Food Systems Activities



### Food System Outcomes



sedentary lifestyles) is leading to a pandemic of overweight and obesity,<sup>11</sup> which is bringing with it an increase in diet-related diseases such as type 2 diabetes.<sup>12</sup> At the other extreme is the major concern of insufficient nutrients for many, resulting in, for example, childhood stunting<sup>13</sup> and blindness.<sup>14</sup>

### A “healthy world”

What, then, is a “healthy world”? From the viewpoint of the current human condition overall – and certainly looking forward – environmental and human health aspects are equally important. The environment underpins our food systems, clean air and fresh water, and a range of cultural and esthetic considerations;<sup>15</sup> a healthy environment is inextricably linked with physical and mental health of the human population. But it is also affected by the food systems that play such an important part in human health and well-being.

### “Food systems”

The concept of “food systems” (as distinct from “food production systems”) is not new: driven by social and political concerns, rural sociologists promoted this approach well over 20 years ago.<sup>16,17</sup> Several authors have since put forward frameworks for analyzing food systems, but Sobal et al<sup>18</sup> noted that few existing models broadly described the system, as most focused merely on one disciplinary perspective or one segment of the system.

Sobal et al identified four major types of model: food chains, food cycles, food webs and food contexts, and developed a more integrated approach including nutrition. One particular approach has emerged strongly over the last decade, substantially based on work in the global environmental change community.<sup>19,20</sup> In essence it relates all the food system activities (growing, harvesting, processing, packaging, transporting, marketing, consuming, and disposing of food and food-related items) to the outcomes of these activities not only for food security and other social issues, but also for the environment and enterprise. The food security outcomes are grouped into three components (Availability, Access and Utilization), each of which comprises three elements (Figure 1). All nine elements are either explicit or implicit in the widely cited FAO food security definition “when all people, at all times, have physical, economic and social access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life”; all nine have to be satisfied and stable over time (other than increasing, if too low) in order for food security to be met.

The concept also recognizes the motives of different food system “actors” and the range of policy, market, social, technological and biophysical environments that influence their actions. The food system approach thus allows the food chain activities

to be linked to their social, economic and environmental context (Figure 2). Moreover, as actors in each section of the food chain affect each other’s behavior, two-way linkages are taken into account. This food system concept has proved useful in a number of ways – for example, in helping define international, climate change/food security agendas;<sup>21</sup> in assessing sustainable nutrition security;<sup>22</sup> in futures thinking;<sup>23</sup> and in international and national assessments.<sup>24</sup>

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**“The food system approach allows food chain activities to be linked to their social, economic and environmental context”**

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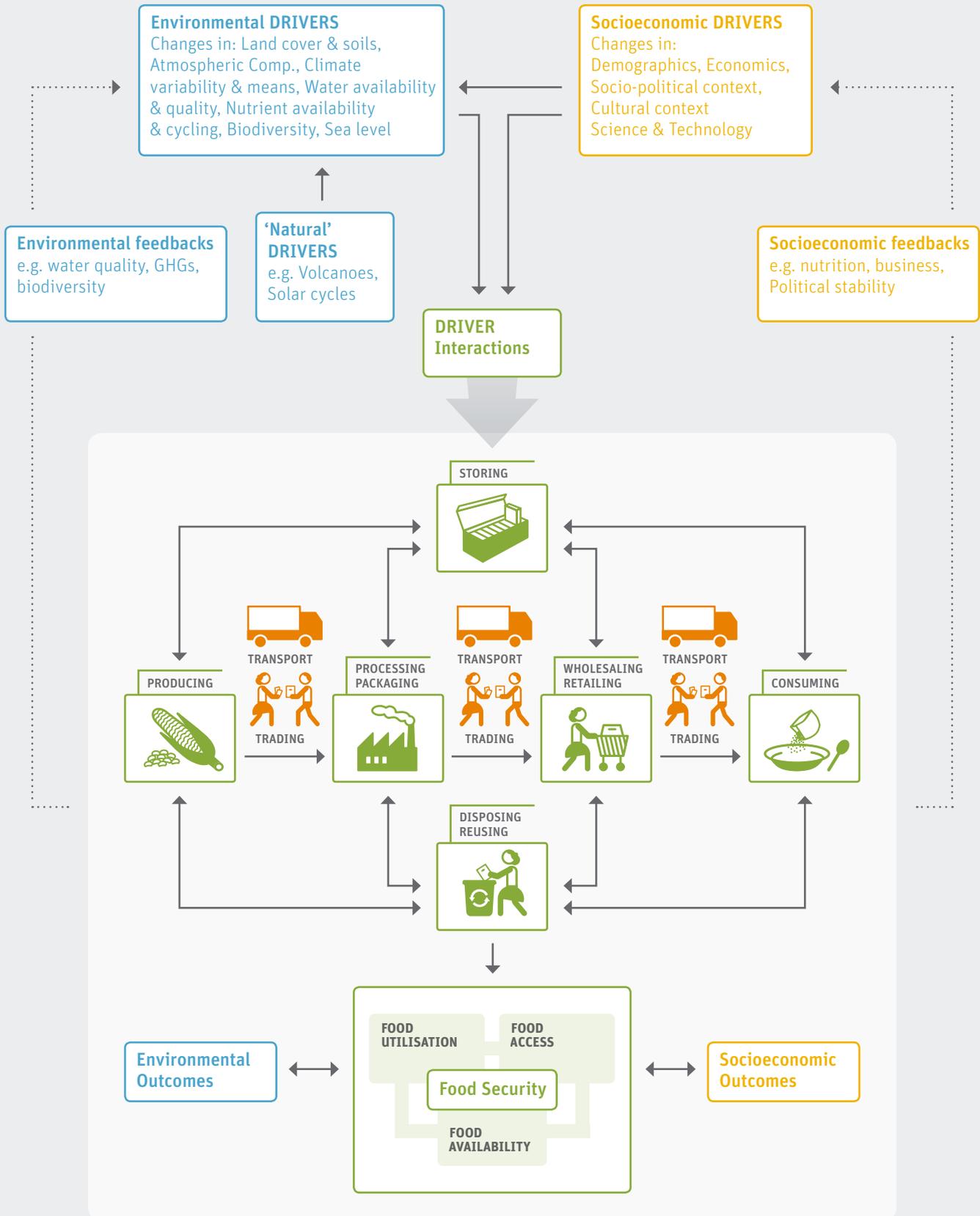
The food systems approach helps to engender discussion of adaptation options to improve outcomes across the full set of food system activities (i.e., along the length of the food chain) rather than just, say, in the agricultural domain. It also provides a framework for systematic analysis of synergies and trade-offs of possible interventions, balanced across a range of societal goals (Figure 2). Further, it serves as a “checklist” to ensure that the right people are engaged in discussion and that the right range of outcomes (some hitherto unforeseen) is being considered by those planning and/or implementing adaptation.<sup>20</sup> This is particularly valuable for considering how to improve health and well-being using an “Innovation System” perspective, as this recognizes that need for multiple dialogues among stakeholders.<sup>25</sup>

### “Sustainability”

Finally, then, how should the notion of “sustainable” be considered? There is increasing societal, political and business pressure to develop more “sustainable” food systems. This is driven by the need to satisfy the growing demand for food anticipated over the coming decades, coupled with the already well recognized deleterious environmental impacts of the ways in which we produce and consume food. Sustainability is traditionally conceived of in terms of three “pillars”: **1)** environmental, **2)** economic, and **3)** social.

With the increasing concerns about climate change, biodiversity loss and other aspects of environmental degradation, environmental issues often dominate debates around “sustainable” food production, and the term is often used synonymously with overall sustainability. However, in the context of a sustainable food system, the “social” and “economic” pillars are of equal importance – even more so if they are conceived in broad terms: “social” should include, at least, nutrition and health outcomes,

**FIGURE 2:** Food systems *Drivers and Feedbacks* (adapted from Ericksen<sup>19</sup> and Ingram<sup>20</sup>)





Food security is underpinned by physical, social and economic access to food.

cultural diversity, and social capital. The traditional “economic” pillar should include business sustainability, i.e., the sustainability of the enterprise, be it that of an individual farmer/fisherman, an SME or a multinational corporation. These are all businesses and, as they are also actors in the food system, they have to be sustainable from a business viewpoint if they are to fulfill their role.

All three sustainability pillars apply across all food system activities. The relative importance placed on each pillar’s contribution to overall food system sustainability, however, varies depending on the sub-region, as well as on the spatial and temporal level in question. It also varies according to the viewpoint from which it is being considered; and this, in turn, may vary when contemplated from the perspective of an individual actor in the system. For instance, while fish farming in general needs to ensure high environmental sustainability when conducted over large areas, an individual fish farmer may view business sustainability as the most important factor. In contrast, for the “nutrition/health” component of social sustainability, both individual consumers and the public health community at large will most probably always consider the health pillar first.

Juggling these varied “sustainability” dimensions in food systems is not simple: the wide range of actors involved, their range of activities, incentives and barriers, and their spectrum of world views delivers a highly complex picture. But, as Ben

Ramalingam notes: “... The whole system disguises rather than navigates complexity, and it does so at various levels ... This maintains a series of collective illusions and overly simplistic assumptions about the nature of systems, about the nature of change, and about the nature of human actors.”<sup>26</sup>

Achieving “sustainable food systems for a healthy world” requires navigating this complexity. I am sure that having clearer understandings of what is ‘healthy’, how to take a ‘food systems’ approach, and what does ‘sustainable’ mean and to whom and why, will certainly help.

.....  
**“Having clearer understandings of the concepts ‘healthy,’ ‘food systems’ and ‘sustainable’ will help in the pursuit of sustainable food systems for a healthy world”**  
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# Non-Communicable Diseases, Food Systems and the Sustainable Development Goals

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- > Creating innovative ways of acknowledging and identifying nutrition issues, providing and implementing comprehensive nutrition interventions, and delivering nutrition education for preventative purposes will also be essential in order to reverse NCD trends.

## Key messages

- > During the era of the Millennium Development Goals (MDGs), non-communicable diseases (NCDs), along with overweight and obesity, increased among populations almost everywhere.
- > NCDs are currently the most common cause of death and disability worldwide, accounting for 68% of global mortality, or two out of every three deaths.
- > Connected with a rise in obesity and NCDs, we are facing an unprecedented change in demography, epidemiology and diets
- > Diet is the number one risk factor for NCD-related morbidity and mortality.
- > The health and agriculture sectors have an essential role to play in the prevention and treatment of both communicable diseases and NCDs.
- > Food and health systems need to work synergistically to bring about effective change

## The Sustainable Development Goals and inclusion of nutrition- and diet-related NCDs

A post-2015 era of development has been ushered in. With the approval of the Sustainable Development Goals (SDGs) at the UN General Assembly in New York in September of 2015, we said goodbye to the Millennium Development Goals (MDGs), assessed our past achievements, and worked towards a broader, bolder set of targets that will steer our world onto a new path of sustainable development.<sup>1</sup>

Two major goals of the SDGs directly relate to nutrition: SDG2 and SDG3, as **Table 1** illustrates. Many of the other 15 goals indirectly relate to nutrition and diet, by touching on areas such as climate change and natural resources, education, and women's empowerment, for example.<sup>2</sup>

The continued inclusion of nutrition in the SDG agenda is of critical importance to bridge the progress made during the MDG epoch. While much was achieved in the past, the MDGs fell short of achieving their objective of eradicating undernutrition. The final year (2015) of the MDGs indicated that the proportion of undernourished people in the developing regions had fallen by almost half since 1990, from 23% in 1990 to 13% in 2015, and underweight for age among children under five declined, although at unequal rates and not everywhere.<sup>3</sup>

What the MDG commitments did do was provide the momentum for countries to track progress toward globally agreed poverty reduction targets, which included reducing hunger and undernutrition.<sup>4</sup> At that time, communicable diseases were tear-

**TABLE 1:** Nutrition-related SDGs, their targets and indicators

Goal	Target Number	Target	Indicator
<b>SDG2:</b> <b>Zero Hunger</b>	2.1	By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.	2.1.1 Prevalence of undernourishment 2.1.2 Prevalence of moderate or severe food insecurity
	2.2	By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons.	2.2.1 Prevalence of stunting of children under five 2.2.2 Prevalence of weight by height of children under five (wasting and overweight)
<b>SDG3:</b> <b>Good Health and Wellbeing</b>	3.4	By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being.	3.4.1 Mortality due to CVD, cancer, diabetes or chronic respiratory disease

ing apart many of these countries. What the MDGs did not pledge to do was track more meaningful indicators of undernutrition – stunting and wasting – which are improved and more actionable indicators for tracking both chronic and acute malnutrition. As it now stands, stunting continues to wreak havoc in many nations, and 159 million children are stunted (although this figure is slowly declining).<sup>5</sup> Another 50 million children are wasted.<sup>5</sup> The SDGs have both stunting and wasting as primary indicators to be monitored over the next fifteen years.

During the era of the MDGs, slowly, and insidiously, non-communicable diseases – mainly cancer, cardiovascular disease (CVD), chronic respiratory diseases, and diabetes – along with overweight and obesity were increasing among populations almost everywhere. Virtually no country remained untouched. The burden of overweight/obesity and NCDs was completely ignored in the MDG agenda. But now, this has changed. Childhood overweight is an indicator in SDG2 and a NCD reduction target is embedded in SDG3. However – shockingly – there is still no target or indicator to track overweight and obesity in adults. The MDG agenda also allowed for significant investments in communicable diseases such as HIV/AIDS and TB, which helped bolster health systems in many low-income countries. This improvement to health systems could be seen as an opportunity for easier entry points in treating complex, chronic diseases such as NCDs.

Recognition of NCDs as part of the SDG agenda aligns well with other goal-setting agendas, including the World Health Organization’s Comprehensive Implementation Plan on Maternal, Infant, and Young Child Nutrition, as well as the six Global World

Health Assembly Targets 2025 and the nine global targets on NCDs, endorsed by the World Health Assembly in 2012 and 2013 respectively. Furthermore, in November of 2014, governments committed to ending hunger and malnutrition in all its forms at the Second International Conference on Nutrition (ICN2).

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**“The burden of overweight/obesity and NCDs was completely ignored in the MDG agenda. But now, this has changed”**  
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#### **Beast of burden**

Overweight and obesity are major risk factors of NCDs, and obesity trends are not moving in the right direction. Currently, a staggering 2.1 billion people suffer from overweight and obesity globally<sup>6</sup> and an estimated 41 million of them are overweight children under five years of age. Two-thirds of those children reside in low- and middle-income countries.<sup>5,7</sup> An updated analysis of obesity trends<sup>4,5</sup> further delineates that 266 million men and 375 million women are obese. These growing rates of overweight and obesity worldwide are linked to a rise in NCDs – life-threatening conditions that are overburdening health systems.

NCDs are currently the most common cause of death and disability worldwide, accounting for 68% of global mortality, or two out of every three deaths. Of the 38 million deaths due to

NCDs in 2012, 16 million or 42% were premature and largely avoidable – up from 14.6 million in 2000. Seventy-five percent of these deaths occur in developing countries.<sup>9</sup> CVD alone is a significant cause of premature death and the primary driver of morbidity for all NCDs, the largest burden of which occurs in low- and middle-income countries.<sup>10</sup> As for diabetes, an estimated 422 million adults were living with this condition in 2014, compared to 108 million in 1980.<sup>8</sup> NCDs are killing people at a younger age in low- and middle-income countries (LMICs), in which 30% of NCD-related deaths occur before the age of 60 (the productive age bracket) as compared to 13% in high-income countries.<sup>11,12</sup> Higher death tolls are also associated with poorly functioning health systems in many LMICs.

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**“If countries want to make a dent in the obesity and NCD pandemics and attempt to achieve the SDGs, drastic changes will need to occur”**

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If countries want to make a dent in the obesity and NCD pandemics and attempt to achieve SDG2 and SDG3 drastic changes will need to occur. These will involve cost-effective strategies that include reducing modifiable risk factors (related to tobacco smoke, alcohol, diet and physical activity), coordinating mandates between health and agriculture sectors, strengthening and connecting health and food systems, improving surveillance, and expanding coverage of essential medicines, technologies and treatments.<sup>13,14</sup>

#### Spanning systems

Connected with a rise in obesity and NCDs, we are facing an unprecedented change in demography, epidemiology and nutrition transitions globally, regionally and within nations. Dietary demands, needs and appetites are also shifting. As countries get wealthier, demand for animal-source foods, sugars, oil and fats increases. With the rise in incomes, both Engel’s and Bennett’s Laws hold true: people spend less of their income on food, and diets change towards more luxury foods, with less reliance on staple grain foods as the majority of their calories.

These transitions are driving a new demand for the way food is being grown, processed and consumed.<sup>15–17</sup> Diets are shifting towards food preferences higher in sugar and refined carbohydrates and salt. Beverages often laced with high proportions of sugar are consumed in greater amounts along with packaged, processed foods. Vegetable oil intake is on the rise, along with snacking and eating away from home. At the national scale, diets

are shifting from plant-based diets rich in fruits, vegetables, and legumes to highly refined foods, meats and dairy products in all but a few poor countries that cannot afford the shift.<sup>18–20</sup>

Diets are important when thinking about morbidity and mortality related to NCDs. Forouzanfar and colleagues<sup>21</sup> found that diet – especially diets low in fruits and vegetables, whole grains, nuts and seeds, milk, fiber, seafood omega-3 fatty acids, polyunsaturated fatty acids, and high in red meat, processed meat, sugar sweetened beverages, trans fatty acids and sodium – is the number one risk factor for NCDs (accounting for 11.3 million deaths and 241.4 million disability-adjusted life years [DALYs]). High body-mass index has significantly increased its contribution to NCD risk over the past 20 years.<sup>21</sup> Research shows that the type of diet and overall dietary patterns matter: diets heavier in meats (especially processed meats) put people at higher risk of multiple NCDs as compared to Mediterranean, pescatarian and vegetarian diets.<sup>22,23</sup>

So how do we begin to make a dent in the burden and make changes to diets and their subsequent health outcomes? Functioning, connected and strong public health and food systems are important contributors towards positive change. This will take coordinated, funded and committed leadership from health and agriculture ministries. If food systems are insufficient, effects on health can be negative. A healthy and more sustainable food system can improve the health of communities across the lifecycle through improvements in the way food is produced, processed, packaged, labeled, distributed, marketed, consumed and disposed of.<sup>24</sup> However, the globalized food system is in need of a major overhaul.<sup>25</sup> Hawkes and Popkin<sup>20</sup> call for the nutrition and NCD communities to come together to provide evidence and advocate for healthier food policies and systems. Similarly, the health sector takes the responsibility to emphasize, support and ensure health of food producers and consumers, especially women.<sup>26</sup>

.....

**“A healthy and more sustainable food system can improve the health of communities. However, the globalized food system is in need of a major overhaul”**

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The health sector has an essential role to play in the prevention and treatment of both communicable and non-communicable diseases, which can have deleterious effects on nutrition. In turn, poor nutrition can serve as a risk factor for CDs and NCDs, and compromised health can put one at risk of poor dietary intake and compromised nutritional status.<sup>27</sup> Strengthening health systems



A local food store in Nepal

is essential for building a supportive environment for nutrition assessment and monitoring, diet counseling and education, and for integrating nutrition into existing health care treatment and services.<sup>27</sup> Creating an institutional culture where health care providers in the health system value nutrition, and understand their role in providing nutrition care, will be important if we want to make a dent in the complexities of obesity and NCDs.<sup>28</sup>

Food and health systems need to work synergistically to bring about effective change. This requires thoughtful integration between interventions or approaches, especially when an already existing collection of distinct vertical programs exists.<sup>29</sup> “Every intervention, from the simplest to the most complex, has an effect on the overall system, and the overall system has an effect on every intervention.”<sup>30</sup> Services, interventions and solutions that are bundled or packaged across food and health systems can be more effective and advantageous.

Approaching nutrition through a multi-sectoral lens is – in theory – a starting point, but the realities of making that work effectively in a trans-sectoral, collaborative way is another matter altogether.<sup>31</sup> Scientific discovery and operations research have provided new ways of assimilating these sectors and systems approaches so as to incorporate nutrition, but we need more examples of how to make it work across diverse contexts. One size will not fit all.

### Optimizing opportunities

There are several opportunities that need to be harnessed in the short term. The political will and momentum are there. The ris-

ing trends of obesity and NCDs are not a secret anymore, and no country is immune. The UN General Assembly met in 2014 to discuss the burden of NCDs. The resulting NCD declaration characterized NCDs as a threat to development and a cause and consequence of poverty and inequality. It emphasized the importance of several established initiatives, including full implementation of the WHO’s Framework Convention on Tobacco Control and the WHO’s Global Action Plan for the Prevention and Control of NCDs 2013– 2020 (NCD Plan) which set out nine voluntary global targets for NCDs, including the goal of a 25% mortality reduction for key chronic conditions.<sup>44</sup> This was the first time they had met on a health-related issue after HIV/AIDS. Along with political will and commitment, targets have also been set. The World Health Assembly has recognized obesity as an issue, and the WHO has an NCD plan in place. There will be a need for countries to take on food and health system challenges and most likely to overhaul their priorities, structures and interactions across sectors. This will call for a concerted effort and unshakable political will.<sup>20</sup>

There is a need though for better target-setting. The SDGs missed the mark in that adult obesity is not tracked, nor are some of the behavioral risk factors such as poor diets. However, the buck does not stop at the global level. Countries have the option to pick the indicators that are important to them. We encourage each country to build up its information systems to track NCD behaviors and risk factors for both adults and children. Behaviors include tobacco use, physical inactivity, unhealthy diet, and the harmful use of alcohol that can lead to four risk factor changes



A young man has his blood pressure monitored in Ghana.

that are signs of early NCD development, including raised blood pressure, overweight/obesity, raised blood glucose and raised cholesterol. We also encourage countries to track dietary intake through better surveillance. Because diets are so key to NCD risk, and are a proxy of a healthy (or unhealthy) food system, we need to better understand what people are eating, how much their diet costs, where they get their foods from, and their preferences concerning how to access healthy food. Thereafter, that data should be used to drive programmatic work and localized interventions.

.....

**“We need to better understand what people are eating, how much their diet costs, where they get their foods from, and their preferences concerning how to access healthy food”**

.....

Investments in the health sector should match the current disease burden that nations face. We are seeing shifts from communicable to non-communicable diseases. While the communicable and undernutrition agenda is far from over, there needs to be some investment and ramp-up to address NCDs. Each year, more die from cardiovascular disease (30% of deaths in a given year) than from all communicable diseases combined.<sup>10</sup> And

treating NCDs is costly. Many households are forced to pay out-of-pocket costs to treat NCDs, incurring catastrophic long-term health expenditures that push them into yet deeper poverty.<sup>32</sup> We also know that obesity will generate significant health care costs. Globally, it is estimated that from 2011 to 2025, the economic burden of NCDs will be US\$7 trillion, with cardiovascular disease accounting for most of that expense.<sup>10</sup> Yet NCDs receive less than 2% of development assistance for health.<sup>33</sup>

Advocacy and grassroots movements matter. We saw this with the HIV/AIDS movement, and we are seeing stirrings of food movements that advocate changing the way our food is produced and consumed in the USA and the UK. Civil society organizations can take the lead in advocating for countries to take NCDs seriously and jumpstart childhood obesity prevention programs that bolster local food systems.

#### **Filling fissures**

Food and health systems both need strengthening to be resilient against shocks. We saw in Liberia how both systems were quickly dismantled by the Ebola crisis, following years of reconstruction in the wake of conflict.<sup>34</sup> We are certain to see more conflicts and pandemics, some more challenging than we can even imagine, and it is crucial that basic health care and ample food supplies continue to function even in these very demanding conditions.

Data gaps are hindering accountability and progress. The Global Nutrition Report called for more rigorous data collection in order to ensure accountability.<sup>35</sup> This cannot be stressed

enough. If you don't track it, the perception is that the problem "doesn't really exist."

Creating innovative ways of acknowledging and identifying nutrition issues, providing and implementing comprehensive nutrition interventions, and delivering nutrition education for preventative purposes will also be essential in order to reverse NCD trends.<sup>28</sup> The nutrition community needs a 2.0 reboot in the way we implement programs that engage and empower consumers.

## “The nutrition community needs a 2.0 reboot in the way we implement programs that engage and empower consumers”

Early testing for prevention and treatment is critical, particularly for obesity prevention in childhood.<sup>36</sup> We also need rapid diagnostic tests for NCD risk factors that can be used in low-resource settings (i.e., blood glucose and cholesterol tests).<sup>37</sup>

Capacity development will be the lynchpin if we want to focus on the prevention, along with the treatment, of complex diseases such as diabetes and cancer.<sup>38</sup> Even in the USA, which has one of the most efficient health and food systems in the world, we often focus on treating obesity and NCDs, rather than on preventing them through food-based approaches such as improving school meals, redesigning point-of-sale food placements, taxing junk food and sugar-sweetened beverages, and adjusting food labels, to name but a few possible measures.<sup>39,40</sup> Human and institutional capacity will need to be re-thought in the post-2015 world.<sup>41</sup>

We need more productive reflection and dialogue on the moral responsibilities of governments, industry and individuals. Whose duty is it to ensure we have a food and health system that promotes wellbeing? The public has the right to information and knowledge, but the food environment also needs to be just: equitable and healthier, while allowing for self-determination and liberties and minimizing non-malfeasance.<sup>42</sup>

It is essential to put in place systematized crosschecks or “watchdog” measures that ensure the SDG agenda remains equitable and doesn't simply target those who are better off.<sup>43</sup> The point is help the most vulnerable and those who are the worst off (i.e. the so-called “social lottery”), and to take into account racial, ethnic, gender, education and geography barriers to achieving progress.<sup>44</sup>

### Conclusion

No country has yet been successful in fully addressing the obesity or NCD burdens, but that doesn't mean that this is not something

that can be achieved. The SDG agenda represents an opportunity to make significant investments and formulate healthy food policies that reinvigorate food and health systems. Although there are gaps and hurdles to overcome, the opportunities are there, waiting to be harnessed.

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# The Multiple Burdens of Malnutrition

## Food system drivers and solutions

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#### Key messages

- > Although undernutrition persists in many low- and middle-income countries, rates of overweight and obesity are on the rise, particularly among women.
- > Nearly all countries in the world now experience at least one form of malnutrition.
- > Undernutrition and overweight/obesity can no longer be tackled independently of one another.
- > Many countries of the developing world are experiencing a nutrition transition characterized by an increase in the consumption of energy-dense foods of low nutritional quality as well as high intakes of refined carbohydrates, added sugars and fats.
- > The creation of a healthier food environment could lead to increased consumption of nutrient-rich foods while reducing consumption of energy-dense foods of low nutritional value.
- > To make nutrient-rich foods more available, affordable and acceptable within the current food environment, changes are needed across the full breadth of the food system.

#### Multiple burdens of malnutrition

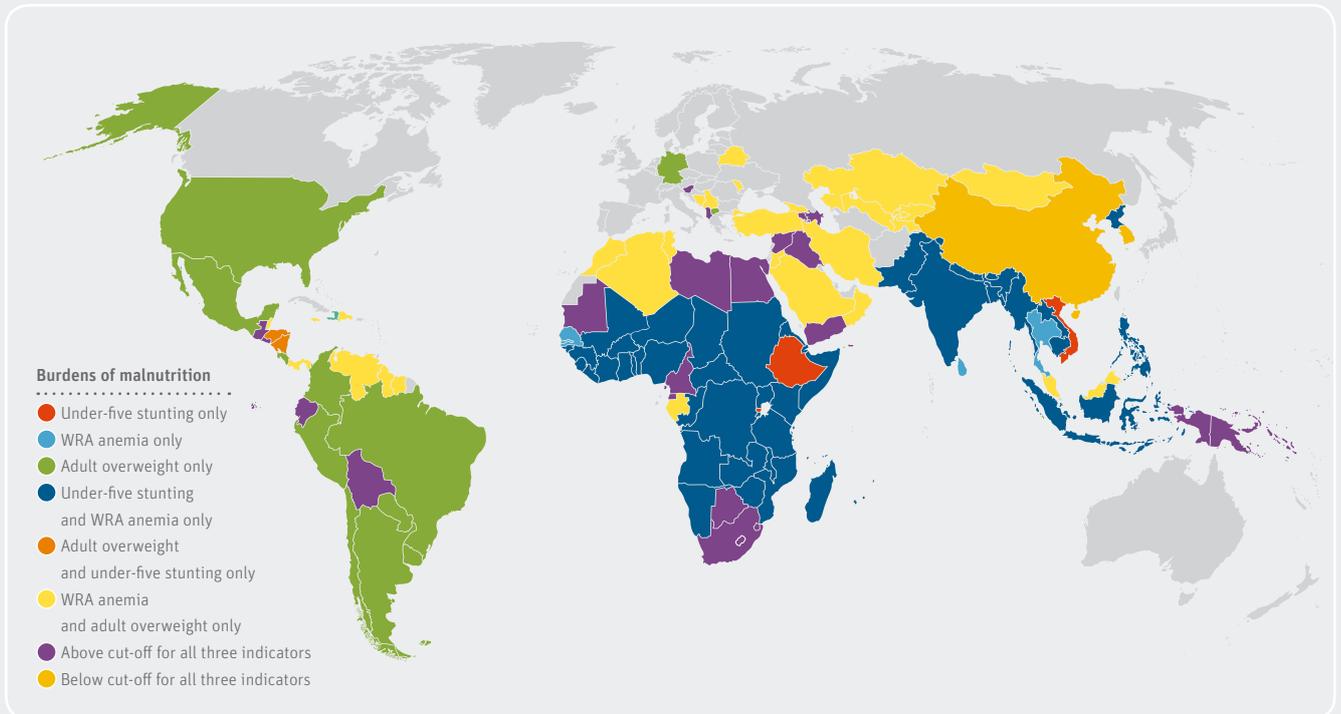
Overweight and obesity, and their associated diet-related non-communicable diseases (NCDs) including cardiovascular disease and diabetes, are no longer a problem exclusive to the developed world.<sup>1</sup> In the past, the main burden of nutrition-related

disease in the developing world was undernutrition – stunting, underweight, wasting, and micronutrient deficiencies. However, in recent decades there has been a shift in the burden of malnutrition.<sup>1</sup> Although undernutrition continues to persist in many low- and middle-income countries,<sup>2,3</sup> rates of overweight and obesity are on the rise, particularly among women.<sup>4</sup> Between 1975 and 2014, the global prevalence of underweight in women decreased from 14.6% to 9.7%, whereas the obesity prevalence increased from 6.4% to 14.9% over the same period – and the same pattern was found in men.<sup>1</sup> Alongside these increases in overweight and obesity, there have been marked increases in the global prevalence of diabetes and cardiovascular disease.<sup>5,6</sup> The global prevalence of diabetes increased among women from 5% in 1974 to 7.9% in 2014; an appalling 422 million people worldwide now have diabetes.<sup>1</sup>

**“An appalling 422 million people worldwide now have diabetes”**

Nearly all countries in the world now experience at least one form of malnutrition. Of the 122 countries examined in the 2014 Global Nutrition Report, all but two experienced high rates of at least one form of malnutrition (**Figure 1**).<sup>7</sup> Nearly half (45%) experienced at least one form of undernutrition ( $\geq 20\%$  under-five stunting and/or anemia in women of reproductive age) in combination with high levels of overweight in adults ( $\geq 35\%$ ).<sup>7</sup> In addition to the multiple burdens of malnutrition within the same country, the phenomenon has also been observed within the same household. A study conducted in urban Kenya found a large proportion of mothers who were overweight (43%) or obese (37%) had stunted children.<sup>8</sup> This is not unique to Kenya. Multiple burdens of malnutrition within the same household have been observed in other countries worldwide.<sup>9–13</sup>

It is clear that undernutrition and overweight/obesity can no longer be tackled independently of one another. Given that one of the drivers of all forms of malnutrition is the food we consume (or do not consume), addressing the way in which the food

**FIGURE 1:** Burdens of malnutrition

**Source:** Adapted from the 2014 Global Nutrition Report<sup>7</sup>

WRA = women of reproductive age

Cut-offs for placing countries in each indicator were: under-five stunting  $\geq 20\%$ , WRA  $\geq 20\%$  and adult overweight  $\geq 35\%$

Island states not included on map: Comoros ( $<5$  stunting & WRA anemia); Saint Lucia (WRA anemia and adult overweight); Maldives, Sao Tome and Principe, Solomon Islands, Vanuatu ( $<5$  stunting, WRA anemia and adult overweight)

system delivers the nutrition that is needed to promote health both in the context of undernutrition and overweight and obesity is imperative.

### Food systems in the developing world are changing

The global food system is rapidly changing. As it has become more globalized, this has led to shifts in the availability, affordability and acceptability of food.<sup>14,15</sup> A nutrition transition has coincided with these changes in many countries in the developing world. This has been associated with an increase in the consumption of energy-dense foods of low nutritional quality as well as a high intake of refined carbohydrates, added sugars and fats, along with animal-source foods.<sup>16</sup>

There are several drivers of the nutrition transition and the changes in food environments worldwide. Globalization and trade liberalization have led to an influx of highly processed foods (e.g., soft drinks, fast foods and baked goods) and an expansion of transnational food companies, making these foods more widely available and affordable.<sup>15,17</sup> Moreover, companies have marketed these foods intensely in order to generate increased consumer demand.<sup>18,19</sup> In some cases, smaller portion sizes and

packaging have been used to enable low-income consumers to purchase these products at a low price.<sup>20</sup> This has removed the price barrier, increasing access to these energy-dense foods of low nutritional value among the world's poor. At the same time, street foods and locally produced and prepared fried snacks and sweets are widely available.<sup>21,22</sup> These changes, combined with changes in physical activity patterns and an increase in sedentary behaviors, have led to the increased burden of overweight and obesity.<sup>23</sup>

.....

**“Street foods and locally produced and prepared fried snacks and sweets are widely available”**

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### Tackling the multiple burdens of malnutrition together

In order to tackle the multiple burdens of malnutrition, individual, community and broader food system changes are needed. At the individual level, addressing eating and feeding patterns in the first 1,000 days from conception until the child is

two years of age (including exclusive breastfeeding) can help reduce the risk of both undernutrition and overweight/obesity.<sup>3</sup> Providing nutritious food at the community level through school meals or food assistance can also help. However, in order to ensure that these interventions are feasible, the food system needs to be better equipped to deliver nutrient-rich foods at an affordable price, particularly for the most vulnerable populations. Addressing the set of underlying incentives and disincentives in the food system that make it difficult for people who are socioeconomically disadvantaged to access nutrient-rich foods will be necessary. Outlined below are examples of where to intervene at the individual, community and broader food-system level to address the underlying drivers of the multiple burdens of malnutrition.

### The first 1,000 days

The first 1,000 days from conception to two years is a critical period for disease risk later in life: what women eat (or do not eat) during this period has lasting and irreversible consequences for their offspring.<sup>24</sup> Insufficient nutritional intake during pregnancy triggers anatomical, hormonal and physiological changes in the fetus that enhance its survival in “resource-poor” environments.<sup>25</sup> However, when these nutritional deficits are followed by periods of “excess,” this can lead to the development of disease.<sup>25</sup> The developmental-origins hypothesis posits that the long-term risk of disease is initially induced through adaptive responses that the fetus or infant makes to cues from the mother about her state of health.<sup>26</sup> Both over- and under-eating during pregnancy can lead to accelerated weight gain in childhood and increase the offspring’s risk of NCDs later in life.<sup>26</sup> Evidence to support this hypothesis is growing, and has been identified in birth cohorts from Brazil, Guatemala, India, the Philippines and South Africa.<sup>27</sup> Although this can be viewed as a challenge to tackling the multiple burdens of malnutrition, it is also an opportunity for early prevention.

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**“Both over- and under-eating during pregnancy can lead to accelerated weight gain in childhood and increase the offspring’s risk of NCDs later in life”**

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The 2013 Lancet Series on Maternal and Child Nutrition outlines interventions aimed at improving nutrition during this critical period. If delivered at scale, these interventions have the potential to help address part of the malnutrition burden worldwide. For example, exclusive breastfeeding until the infant is six months of age promotes optimal growth and development<sup>28</sup>

while at the same time reducing the odds of type 2 diabetes and overweight/obesity in children.<sup>29,30</sup>

### School meals

Providing healthy foods in schools in all countries worldwide is vital for improving school attendance and retention, particularly among girls, improving nutritional status and cognitive development, and combating overweight/obesity; schools are an important social safety net for low-income populations.<sup>31</sup> Providing nutrient-rich foods to schoolchildren ensures that even the poorest of children have at least one healthy meal throughout the day. This is important in both a developing- and developed-world context. However, for school meals to deliver for both undernutrition and overweight/obesity prevention, they need to include fresh, minimally processed, nutrient-rich foods. Developing clear guidelines and policies for school meals could help ensure that meals meet the nutritional needs of schoolchildren. However, these guidelines need to reflect the current state of the evidence in terms of what constitutes nutritious foods – something which does not always happen at present. For example, in an effort to reduce fat consumption, the United States National School Lunch Program bans full-fat milk but allows the sugar-sweetened low-fat chocolate variety.<sup>32,33</sup> The World Health Organization’s Nutrition Friendly School Initiative is a school-based program aimed at preventing the double burden of malnutrition.<sup>34</sup> One of the components of that initiative is the development of school nutrition policies. A pilot study of the initiative conducted in Benin and Burkina Faso suggested that it had the potential to mobilize schools and communities for improved nutrition and health, but the approach would need to be adapted for local conditions with limited human and material resources in order to ensure its success.<sup>35</sup>

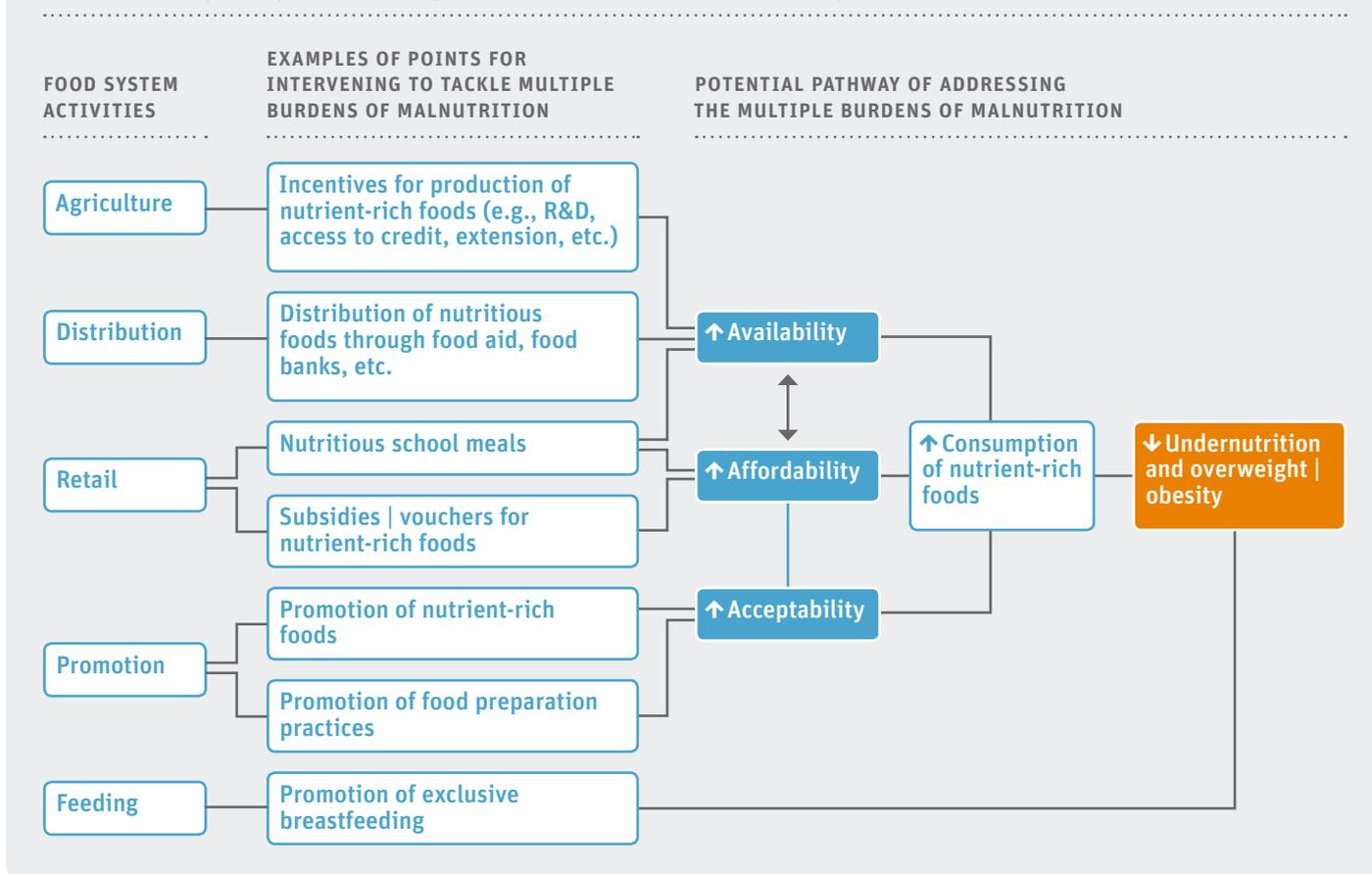
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**“For school meals to deliver for both undernutrition and overweight/obesity, they need to include fresh, minimally processed, nutrient-rich foods”**

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### Food assistance

The multiple burdens of malnutrition can exist even in the direst of circumstances. A study examining the multiple burdens of malnutrition among refugee populations in Western Sahara refugee camps in Algeria found the coexistence of undernutrition and overweight/obesity in 24.7% of households.<sup>9</sup> High levels of the coexistence of multiple burdens of malnutrition have also been found in the Gaza Strip.<sup>11</sup> Food assistance, cash transfers

**FIGURE 2:** Examples of potential food system interventions to address the multiple burdens of malnutrition

and vouchers, particularly in areas of prolonged conflict, need to deliver both in terms of energy/nutrient needs and in terms of broader food quality. Ensuring that high-quality, minimally processed foods are also available and affordable could help stave off overweight/obesity in these situations. For example, a World Food Programme (WFP) initiative in Gaza aims to address the double burden by providing vouchers that can be used to purchase fresh, nutritious produce in combination with a nutrition awareness pilot program.<sup>36</sup> The program provides interactive discussions and presentations on diet, hygiene, cooking, purchasing healthy food on a budget, and care of infants for women receiving WFP vouchers who are pregnant or have small children.<sup>36</sup>

### Creating a supportive food system

A healthier food environment (i.e., the multitude of factors that affect food access) could lead to increased consumption of nutrient-rich foods while reducing consumption of energy-dense foods of low nutritional value. However, in order to make nutrient-rich foods more available, affordable and acceptable within the current food environment, changes are needed across the full breadth of the food system. These need to take place all along the value chain, from agricultural production all the way through to consumption.

Food system incentives that favor the production of cereals and cash crops over fruits, vegetables, nuts and legumes are one of the main underlying reasons that highly processed foods (e.g., sugar-sweetened beverages, biscuits and chips) have become so cheap and widely available worldwide. For example, incentives (i.e., subsidies, research & development, and crop insurance) for the production of corn and soybean oil in the United States have distorted the price of the “ingredients” of many highly processed foods. Palm oil, which is high in saturated fat, has become the most consumed oil on the planet after investment in its production by Malaysia and Indonesia, as well as support from the World Bank.<sup>37</sup> Half of all packaged food products now contain palm oil.<sup>38</sup> This may have implications for health (although additional evidence is needed)<sup>32,39</sup> as well as for the environment, given that the promotion of palm oil production has led to substantial deforestation and loss of biodiversity.<sup>40</sup> In order to ensure better access to healthy foods (produced in a sustainable way), and in an effort to avert the multiple burdens of malnutrition, food system incentives must be realigned to support a healthier food environment, thus making it easier for individuals to make healthier choices. **Figure 2** provides examples of potential points at which to intervene in the food system to address the multiple burdens of malnutrition by improving the availabil-

ity, affordability and acceptability of nutritious foods. These examples would tackle both undernutrition and overweight/obesity simultaneously. However, as the overweight/obesity rates continue to increase worldwide, additional policy approaches such as taxation and improved labeling will be needed.<sup>41,42</sup>

### Avoiding unintended consequences

In order to make progress toward addressing the multiple burdens of malnutrition, interventions need to ensure that efforts to address undernutrition do not have negative consequences for overweight/obesity. For example, Mexico's Progresa-Oportunidades conditional cash transfer program was successful in addressing undernutrition among socioeconomically disadvantaged Mexicans. However, the program was associated with an increased body mass index (BMI), higher diastolic blood pressure, and higher prevalence of overweight and obesity in participants.<sup>43</sup> Another potential intervention aimed at tackling undernutrition that has the potential for negative unintended consequences for overweight/obesity and diet-related NCDs is the fortification of some staple foods. Although these initiatives are important for delivering key micronutrients to populations at risk of deficiency, in some cases, the vehicles for fortification could be problematic if consumed in excess. For example, consuming fortified processed foods and condiments such as fortified sugar, salt and high-sodium sauces (e.g., soy and fish sauce) will likely improve micronutrient intakes,<sup>44</sup> but could have negative repercussions for overweight/obesity and diet-related NCDs if consumed in excess. These potential unintended consequences need to be acknowledged and addressed prior to program implementation. Supplementary feeding programs need to be constantly evaluated and grounded in the needs of the targeted population to ensure that there are no negative repercussions in terms of obesity risk.<sup>45</sup>

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**“A joined-up approach to tackling all forms of malnutrition is essential”**

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### Conclusions

Most countries worldwide are now battling multiple burdens of malnutrition. In order to make progress in tackling the multiple burdens, interventions throughout the food system to ensure that nutritious foods are available, affordable and acceptable for all populations worldwide will be needed. A joined-up approach to tackling all forms of malnutrition is essential.

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# Setting New Frontiers for 21<sup>st</sup> Century Food Systems Research and Action

## Agriculture for Nutrition and Health (A4NH) and Convergent Innovation (CI)

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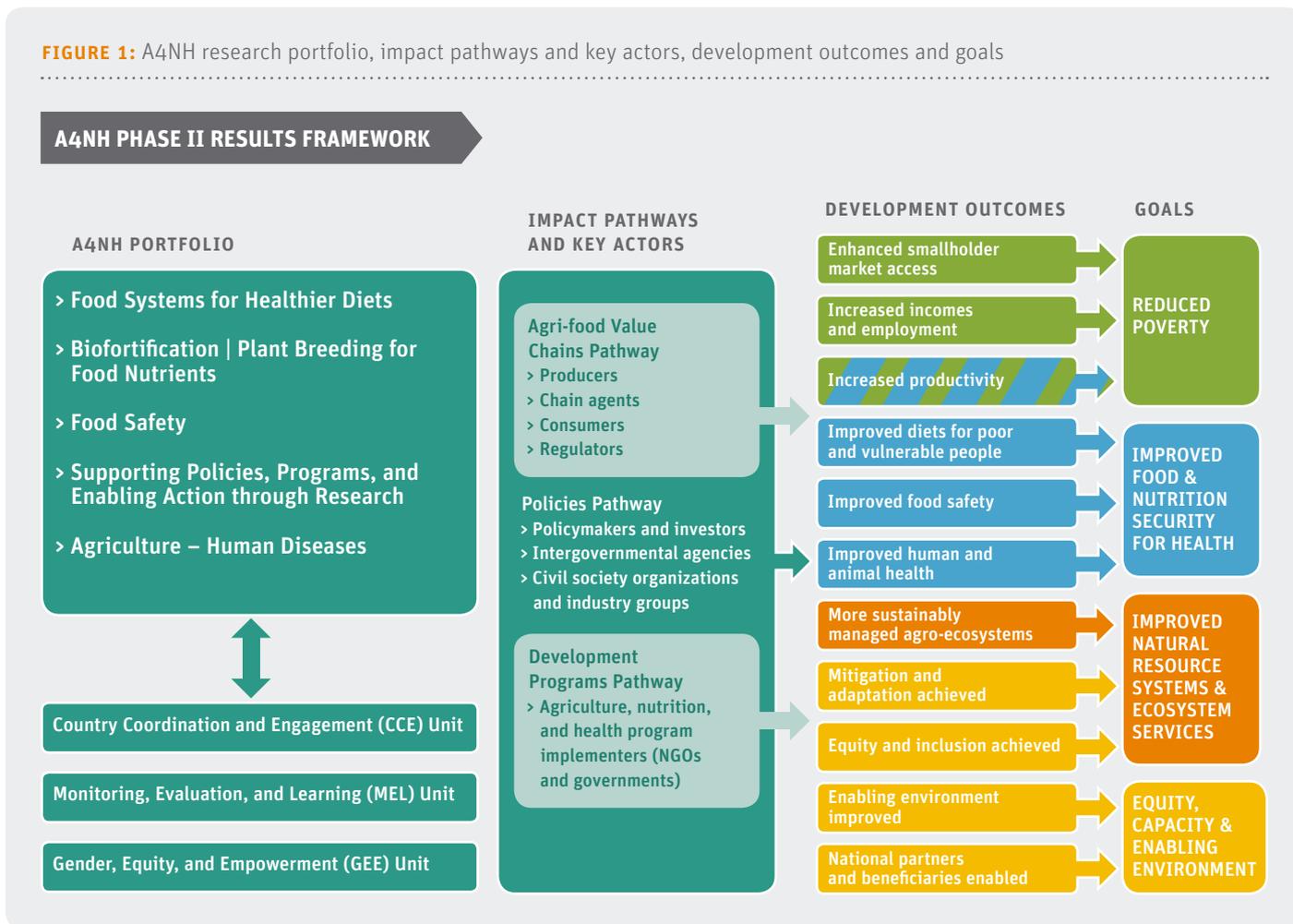
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### Key messages

- > Food systems are key to our ability to ensure sustainable development and well-being while arresting ballooning healthcare costs in industrialized and emerging economies alike.
- > Nutrition is front and center in the global development agenda, and there is growing interest in making agriculture and other large development sectors more nutrition-sensitive.
- > Low- and lower-middle-income countries are increasingly emphasizing the role of agriculture and food in their economic development plans. This requires a change in perspective – moving from a focus on agricultural production to a consideration of the entire food system.
- > Since 2012, CGIAR has increased its emphasis on how to change agricultural research to improve nutrition and health through an interdisciplinary, multisectoral research program, Agriculture for Nutrition and Health (A4NH). Compared with traditional agricultural research, the A4NH program puts more emphasis on consumption and demand, and on processing, storage and other value chain elements, beyond the farm.
- > A key transdisciplinary concept that expands on the implementation of inter-sectoral initiatives such as A4NH is Convergent Innovation. The CI ecosystem covers the full continuum from smallholder farms and community to local, state/provincial, national, and global markets.

**FIGURE 1:** A4NH research portfolio, impact pathways and key actors, development outcomes and goals



- > In low-income countries and emerging economies, CI engages food businesses on two fronts: improving food security and reducing undernutrition, and shaping the food habits of the affluent population.
- > It is our hope that across low-income, emerging, and industrialized economies alike, A4NH and CI will yield insights for other researchers, decision-makers from the private and public sector, and civil society, for a better convergence in human and economic development.

Food systems are at the core of our ability, as a 21<sup>st</sup> century society, to ensure sustainable development and well-being while arresting ballooning healthcare costs in industrialized and emerging economies alike. Food is at the nexus of the positive and negative externalities that agricultural, health, and other related systems have had on rural and urban communities worldwide since the onset of the industrial revolution. To go beyond what has been possible thus far, there is a need to reinvent food systems research and action so as to accelerate the scope and im-

port of significant sectoral and inter-sectoral investments made by governments, the private sector, civil society, and academia, for better convergence in efforts. This perspective features two pioneering initiatives in the nutrition research landscape: the CGIAR’s Agriculture for Nutrition and Health (A4NH) program, and the development and implementation of Convergent Innovation (CI) platforms.

**CGIAR’s Agriculture for Nutrition and Health (A4NH) Program**

Nutrition is front and center in the global development agenda in low-income countries and emerging economies. Although commitments to prioritize and invest in improving nutrition have soared, intent needs to be translated into successful action. Additionally, while nutrition-specific interventions, usually delivered by the health sector, have well documented efficacy, they will only reduce undernutrition by about 20%, even if implemented at scale.<sup>1</sup> Thus, there is growing interest in inter-sectoral approaches, including through making agriculture and other large development sectors more nutrition-sensitive.

Agriculture is particularly important in low-income countries, as the majority of people (typically 60–80%) and a large share

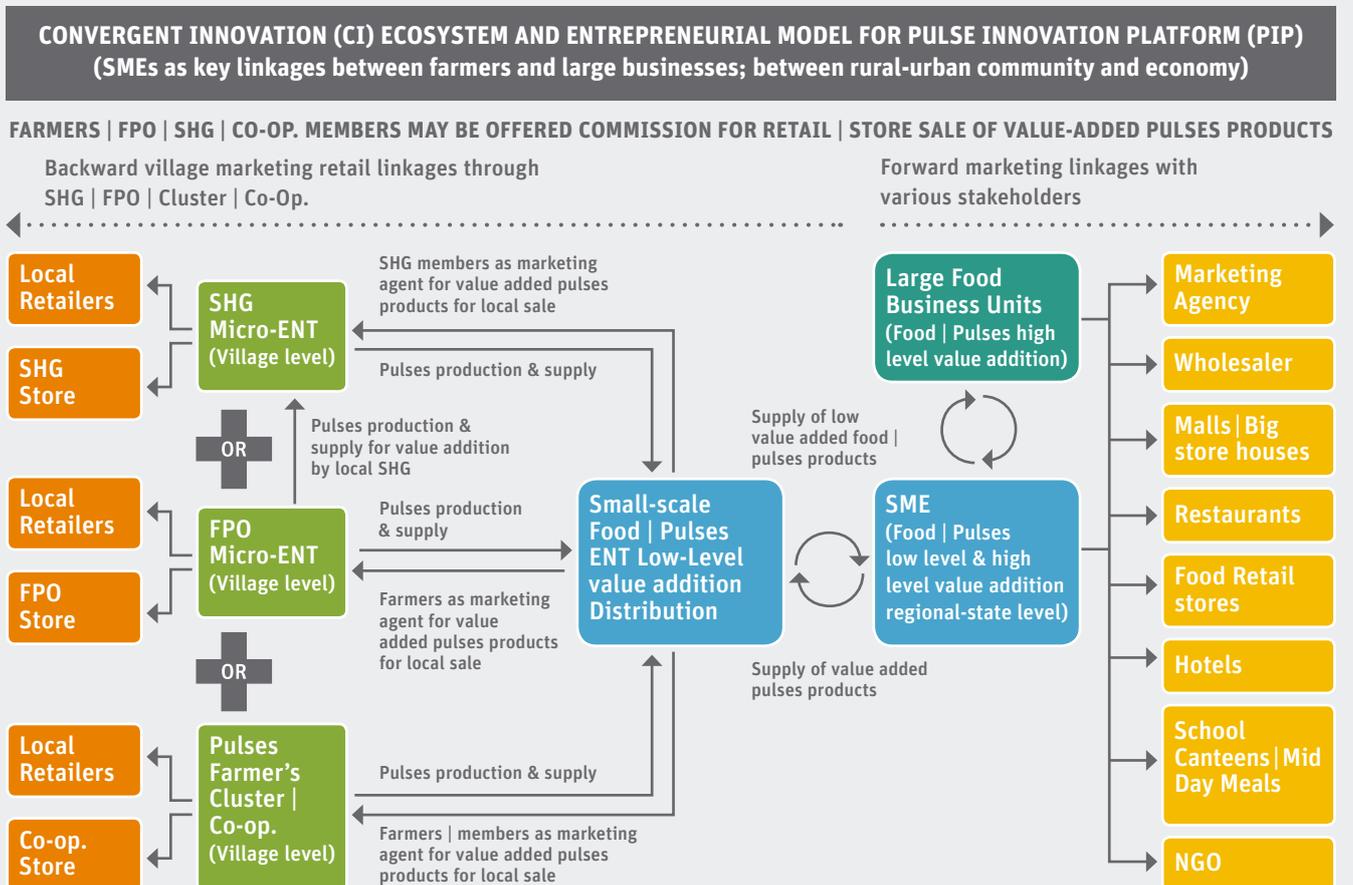
of GDP (25–40%) come from agriculture.<sup>2</sup> Agriculture is charged with providing safe, healthy, diversified, and nutritious foods at affordable prices. The diets of many people in low-income countries, especially mothers and children who are most vulnerable, often lack fruits, leafy green vegetables, pulses, seeds and nuts, and animal-sourced foods. In addition to food, agriculture contributes to nutrition through improved incomes. Attention to gender, both the role of women and of men, is critical. With a gender focus, benefits multiply, particularly where empowered mothers are more capable of raising healthy children.

“There is growing interest in making agriculture more nutrition-sensitive”

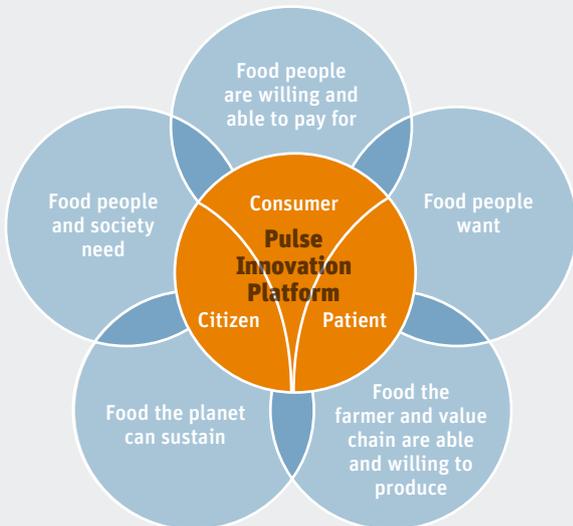
Low- and lower-middle-income countries are increasingly emphasizing the role of agriculture and food in their economic development plans. As economies develop, more people

are involved, and greater economic value is added beyond the farm. This requires a change in perspective – moving from a focus on agricultural production to a consideration of the entire food system. In low-income, agrarian countries, an obvious starting place is to invest in more efficient ways of supplying nutritious foods, such as milk, fish, and vegetables, to households, whether through their own production, or through markets. With economic growth and urbanization, agri-food systems become more complex, and investments beyond the farm, such as storage facilities and cold chains, become more important. There have been major transformations in food systems in middle-income countries in recent decades.<sup>3</sup> These transformations include changes in food supply chains, which have grown longer and more capital-intensive, with much additional processing of food products.<sup>4</sup> Even in low-income countries, there have also been dramatic changes in food consumption patterns, often driven by the rapid urbanization and improved domestic markets and some increased trade.<sup>5</sup>

FIGURE 2: Key ecosystem and enterprise considerations for pulse innovation



Terminology: FPO Farmer Producing Organization, SHG Self-Help Group, ENT Entrepreneur, SME Small and Medium-sized Enterprises, NGO Non-Governmental Organization, PIP Pulse Innovation Platform

**FIGURE 3:** Convergent Innovation “sweet spot”

We note, however, that most changes in food systems have been ad-hoc and opportunistic. If food systems are to provide healthier food both sustainably and equitably, a more systematic approach will be needed. Such an approach establishes national consensus on objectives, and considers key actors and the drivers and enablers of food system transformation. This is a major challenge for countries, as food systems must balance and resolve trade-offs between health, socioeconomic and environmental objectives, and endowments and constraints. Thus food systems research and thinking must embrace multiple technical disciplines within an overall national, socioeconomic and political economy context.

Since 2012, CGIAR has increased its emphasis on how to change agricultural research to improve nutrition and health through an interdisciplinary, multisectoral research program, Agriculture for Nutrition and Health (A4NH). Hosted by the International Food Policy Research Institute (IFPRI), the program includes reducing stunting and micronutrient deficiency on the one hand, while controlling alarming increases in obesity and non-communicable diseases on the other. **Figure 1** describes A4NH’s research portfolio, impact pathways and key actors, development outcomes and goals. Classically, the research for development pathway focuses on: identifying and developing nutrition-enhancing production technologies, knowledge and evidence; the institutional innovations that support sustainable access to and/or application of these technologies and knowledge; and policy and investment options that can increase the contribution of agri-food systems to nutrition and health. Compared with traditional agricultural research, the A4NH program puts more emphasis on consumption and demand, and on pro-

cessing, storage and other value chain elements, beyond the farm. Given the scale of nutrition and health challenges, and of urgent needs, there is also emphasis on how proven approaches to improving nutrition and health can be scaled up and sustained in specific countries and contexts.

## “Most low- and middle-income countries are undergoing unbalanced diet transitions”

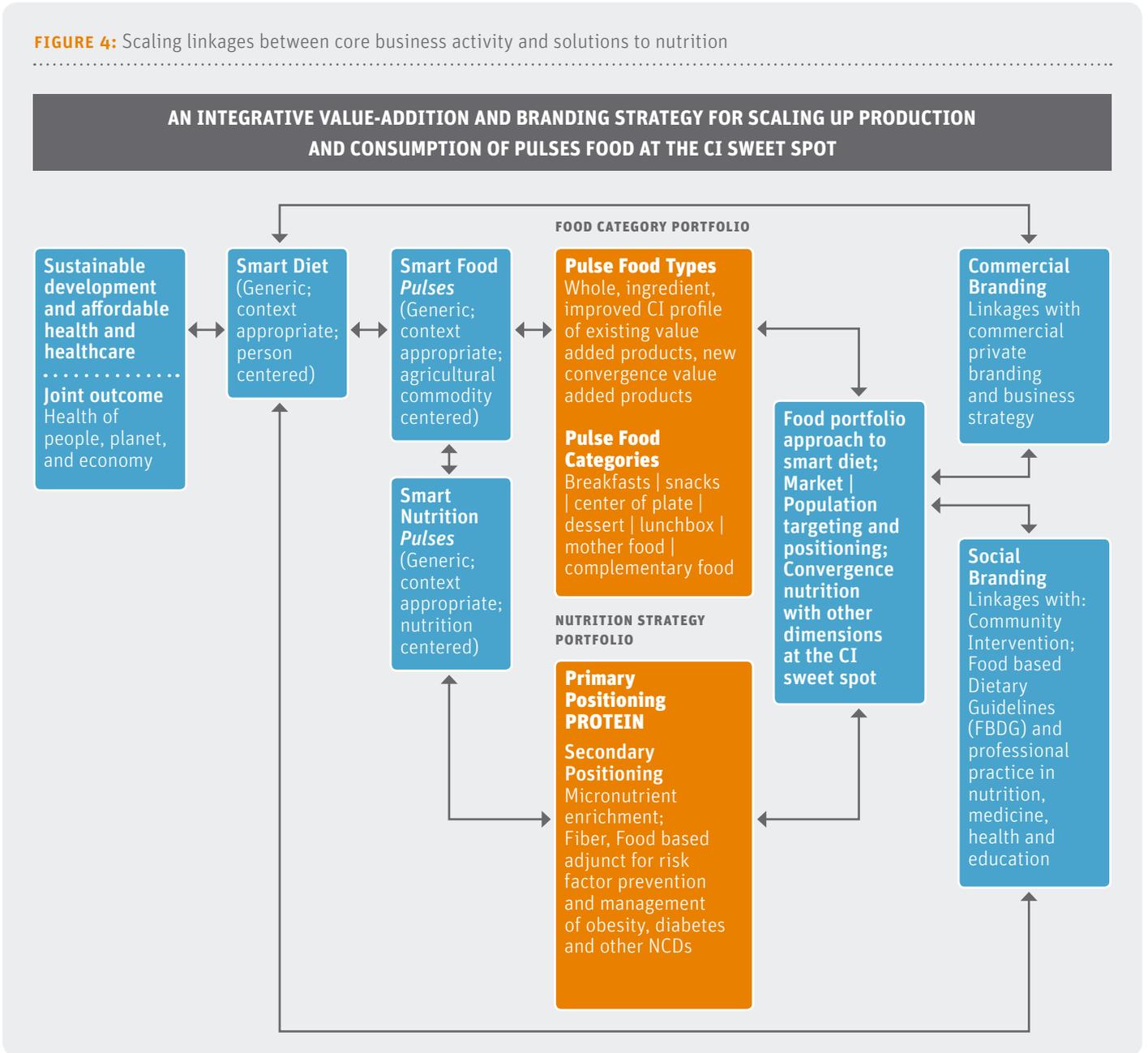
Most low- and middle-income countries are undergoing unbalanced diet transitions – too slow improvements in chronic undernutrition and micronutrient deficiencies, and rapid increases in overweight and obesity. Such countries also have strategies and plans for agri-food transformation as a key element of their economic development. For these reasons, A4NH plans much greater emphasis on food systems research through its “Food System for Healthier Diet” program. This program brings together a new partnership, led by Wageningen University Research, bringing together CGIAR Centers, national research and development partners, and private sector companies, facilitated by the Global Alliance for Improved Nutrition (GAIN), and business schools, coordinated by McGill University. The program builds on current capacities in agricultural production and value-chain innovations for nutritional quality and food safety, with greater emphasis on assessment of consumption and diet quality and on multi-chain food systems innovations and analysis. The research program will be organized in three main components:

- > Assessing regional and sub-regional drivers of food system transformation, and options and constraints for dietary change (**diagnosis and foresight**);
- > Testing concrete agri-food value chain innovations and interventions for improving diet quality and diversity (**food system innovations**); and
- > Supporting the scaling-up of successful actions through effective engagement of multi-stakeholder platforms and multisectoral mechanisms (**scaling up and anchoring**).

### Convergent Innovation (CI)

A key transdisciplinary concept that expands on the implementation of inter-sectoral initiatives such as A4NH is Convergent Innovation. The development and deployment of CI has benefited from the support of the International Development Research Centre and the Social Sciences and Humanities Research Council of Canada. CI fosters behavior change and societal transformation through instilling social and environ-

**FIGURE 4:** Scaling linkages between core business activity and solutions to nutrition



mental objectives of agriculture, food product development, nutrition, and health into business strategies, while improving the economic viability of efforts focused on social benefit. CI intertwines technological innovation, social innovation, and institutional innovation to simultaneously derive measurable economic and social benefits.

.....  
**“CI takes food as the transformational layer between agriculture and the health of people, economy, and planet”**  
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CI takes food as the transformational layer between agriculture and the health of people, economy, and planet. Research and practice based on CI focus on agricultural commodities of high strategic significance at local, state/provincial, country or global levels. The CI ecosystem covers the full continuum from small-holder farms and community to local, state/provincial, national, and global markets, with small start-ups, small and medium-sized enterprises (SMEs), and large businesses competing and collaborating in novel ways for better distributed value addition.

Pulses have served as the test bed for CI’s operational deployment through global and national innovation platforms. Over the last four years, academic, civil society, private, and public-sector partners in the Global Pulse Innovation Platform (PIP) have spearheaded a social movement that led to the UN’s

declaration of 2016 as the International Year of Pulses (IYP). The Global PIP, launched in March 2016 in Montreal, is the core food convergent innovation hub of the sector, with national platforms in development in Canada, India and Ethiopia. Some key ecosystem and enterprise considerations for pulse innovation are illustrated in **Figure 2**.

A “sweet spot” for CI is illustrated in **Figure 3** by the overlap between characteristics of safe and nutritious food that people and society need, food they want, food people are able and willing to pay for, food farmers and the value chain are able and willing to produce, and food the planet can sustain. The characteristics of food at the CI sweet spot – be they in people’s minds or in terms of actual physical characteristics – are likely to present both conflict and convergence in their contribution to the health of people, economy, and planet. CI therefore considers the diverse and dynamic nature of individual food choices, and diet, from the joint perspective of consumer, patient, and citizen. Successful 21<sup>st</sup> century food systems from this perspective are ones that can produce a rich portfolio of food at the CI sweet spot for domestic and/or international markets.

For food businesses in both traditional and industrialized contexts, scaling the linkages between core business activity and solutions to nutrition is non-trivial, and presents several challenges (see **Figure 4**). First, placing nutrition and health sensitivity as a core driver of technological innovation, product category transformation, and commercialization requires a strategic shift in mindset and activities. Second, to change product and brand portfolio in a nutrition- and health-sensitive direction, businesses have to be able to produce an appealing product that balances immediate desires (e.g. tastiness) and long-term benefits (e.g. healthiness), and can be produced at a price point that the consumer can afford and is willing to pay, without losing out on profitability.

## “CI fosters health promotion and nutrition transformation as economic development occurs”

Thus, in low-income countries and emerging economies, CI engages food businesses on two fronts: improving food security and reducing undernutrition by seeding business entrepreneurship and innovation in resource-poor communities, and shaping the food habits of the affluent population. CI fosters health promotion and nutrition transformation as economic development occurs, and sets the agri-food sector on a path to prosperity that balances tradition and modernity, and builds more rural-urban continuity. In industrialized countries, business engagement is about mainstreaming CI in innovation pipelines, business strat-

egies, and investment. CI acceleration processes combine principles and methods from multiple domains, including behavioral insights from consumer research, entrepreneurship training, and Big Data analytics. These principles and methods are applied in providing support, through training and mentorship, for small start-ups, SMEs, and large businesses, with incubation facilities being available as needed for SMEs.

### Conclusion

Research that informs, and emerges from, the CGIAR’s Agriculture for Nutrition and Health (A4NH) program and partnerships around Convergent Innovation (CI) provides opportunities for engaging agriculture, nutrition, and health researchers for sustainable development and improvements in well-being. It is our hope that across low-income, emerging, and industrialized economies alike, A4NH and CI will yield insights for other researchers, decision-makers from the private and public sector, and civil society at local, state/provincial, national, and global levels, for a better convergence in human and economic development.

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# Innovative Financing for Nutrition

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## Key messages

- > To reach the global targets for stunting, wasting, anemia in women and exclusive breastfeeding, it is estimated that an additional \$7 billion (US) per year is needed over the next ten years.
- > While the majority would come from the traditional sources represented by governments and donor organizations, the remaining gap of a little more than \$4 billion over 10 years would need to be filled by innovative financing sources and household contributions.
- > There are three reasons to be optimistic about the use of innovative finance for nutrition:
  - 1) the financial case for solving malnutrition provides a very powerful incentive for governments to invest;
  - 2) in certain cases where inefficiencies in the market are clear, innovative financing can have a positive impact; and
  - 3) there is, at least theoretically, a viable commercial market for nutrition products, even in low-income countries.
- > Innovative financing enables and rewards countries, enterprises, and NGOs with a good track record to innovate and to optimize supply and delivery models. It provides new business opportunities in emerging markets for credit, lowers risk for any single investor, and thus has the potential to improve overall efficiency, effectiveness and transparency of aid utilization.

Investments in nutrition are not comparable to the scale of the nutrition problem – on average, countries spend just 1% of their health budgets on high-impact nutrition-specific programs. At present, \$3.9 billion per year is spent on nutrition. To reach the global targets for stunting, wasting, anemia in women

and exclusive breastfeeding, it is estimated that an additional \$7 billion per year is needed over the next ten years. While the majority would come from the traditional sources represented by governments and donor organizations, the remaining gap of a little more than \$4 billion over 10 years would need to be filled by innovative financing sources and household contributions.<sup>1</sup> Additional sources of funding from areas linked to nutrition such as education, agriculture and food security, water and sanitation, gender and health promotion must also be mobilized towards achieving specific nutrition outcomes. Since 2006, innovative financing has mobilized over \$8 billion in health and \$1 billion in agriculture and food security. An additional \$18 billion and \$2.5 billion, respectively, are expected by the year 2020.<sup>2</sup> As seen in other sectors, innovative financing is the manifestation of an increased focus on programs that deliver results and, with this, public private partnerships.<sup>2</sup> This article provides perspectives of experts in innovative financing, highlights of relevant models from other sectors, and new initiatives in the nutrition sector. Joe Dougherty from Dalberg Global Development Advisors explains that: “Innovative financing is simply anything other than a traditional grant. It is of two types. One type seeks no financial returns such as performance-based contracts and the other type seeks financial returns such as debt, equity or a hybrid of the two.”

**“Current investments in nutrition are not comparable to the scale of the nutrition problem”**

## Landscape of innovative financing mechanisms

Since the creation of the Millennium Development Goals (MDG) in the year 2000, different types of innovative financing instruments (**Table 1**) have mobilized \$94 billion complementing official development assistance (ODA) in developing countries.<sup>2</sup> Guarantees, whereby the public sector has the ability to leverage capital by providing credit enhancements, and bonds, which dedicate resources to specific development goals such as low-carbon infrastructure, mobilized more than half of these funds. These are proven models (**Figure 1**) with simpler structures, fewer stakeholders to manage, and clear standards for

**TABLE 1:** Description of innovative financing instruments<sup>2</sup>

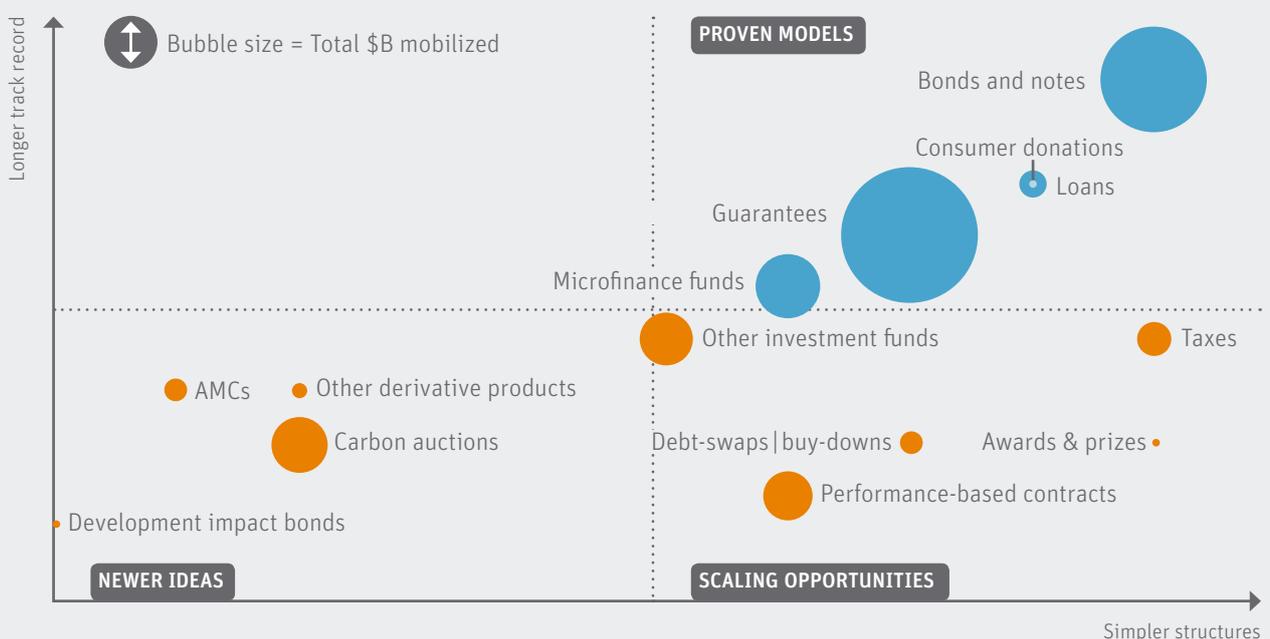
Compulsory charges	Voluntary contributions		Results-, output-, and performance-based mechanisms			
	Donations as a part of consumer purchases	Carbon auctions (voluntary market)	Debt swaps & buy-downs	Performance-based contracts	Development impact bonds	Awards & prizes
Taxes						
Specific tax imposed by government to raise funding for a specific development challenge	A percentage of each purchase of a consumer product goes to fund a designated development challenge	Voluntary participation in legally binding exchanges for trading carbon credits and reducing emissions	Developing country debt repayment obligations are transferred or reduced based on meeting development goals	Grant contracts structured to disburse based on meeting specific performance targets	Investors fund development intervention upfront, government   donors repay them with interest based on results achieved	Financial reward for development solutions in a competitive selection process

assessing risk. They are hence able to scale and to establish track records. Models that have the potential to scale, such as solidarity airline levy or performance-based contracts, are also easy to operate but would need more performance data in order to be considered mature mechanisms. Newer models such as Development Impact Bonds (DIBs; **Box 1**) are nascent and would need to be proven by traditional donors and philanthropies before they can attract private investors. A DIB would be useful for improving aid effectiveness and mobilizing private-sector resources in the nutrition sector, as nutrition has a strong financial case and there is a viable market for nutrition products (see impact investing).

“Successful financing mechanisms are focused, drive results, are effective in raising the priority of the issue, increase partnerships, and have robust accountability frameworks”

*Augustin Flory, CIFF*

**FIGURE 1:** Landscape of innovative financing mechanisms<sup>2</sup>

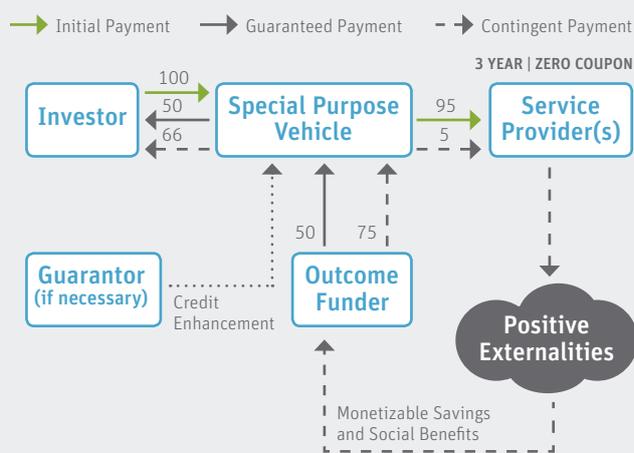
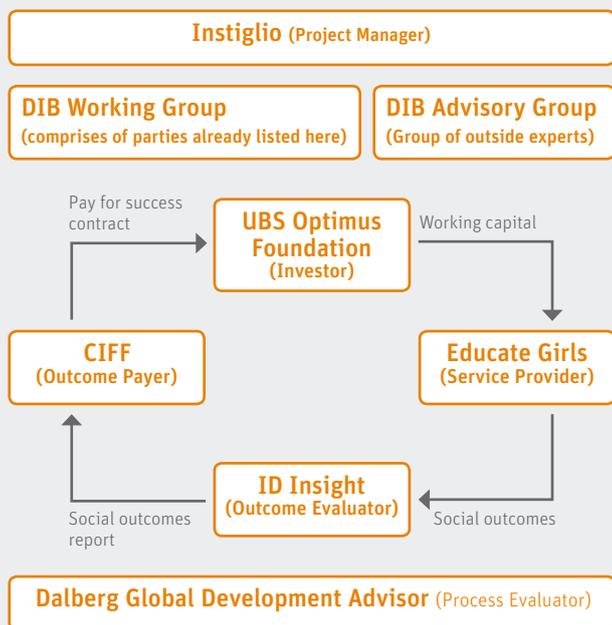


Advanced market commitments	Securities and Derivatives					
	Other Derivative Products	Other Investment Funds	Microfinance Investment Funds	Loans	Guarantees	Bonds and Notes
Commitment of funds to guarantee price   market for products once developed	Financial instrument that derives its value from performance of another asset like securities tied to residential mortgages or weather events	Investment vehicles that are structured and funded to target a specific development challenge, often blending investors with different risk   return profiles	Investment funds that finance microcredit lenders in developing countries who provide low-income and marginalized borrowers with access to finance	Loans made with concessionary repayment terms to borrowers for implementing specific development interventions like green credit lines	Financial commitment to provide payment in case of financial loss, including insurance products, that act as a risk-mitigation incentive to attract other funders	Debt financing raised in capital markets to fund development interventions like microfinance or climate change interventions

**Box 1: Development Impact Bond**

A particular class of impact investing, social impact bonds (SIB) – also called “pay for success” – has become popular in high-income countries. Private investors provide capital to fund a social intervention, and governments repay the investor only if an agreed outcome is achieved. Development Impact Bond (DIB) is similar to a SIB but implemented in low- and middle-income countries: a donor, as opposed to the government, funds the outcome.<sup>3</sup> The first and most notable DIB was started in 2014 in Rajasthan, India, and is called Educate Girls DIB.<sup>4</sup> It aims to increase enrolment and improve learning outcomes for girls. Funding is fully tied to outcomes. This DIB is a proof of concept to demonstrate both social and financial returns. In practice, it works as follows:

Educate Girls (service provider) received working capital from UBS Optimus Foundation (investor) to carry out a three-year intervention. ID Insight (outcome evaluator) will assess progress made in improving enrollment and learning outcomes and provide an evaluation report to the Children’s Investment Fund Foundation (CIFF), UBS Optimus Foundation and Educate Girls after the program ends in 2018. CIFF (outcome payer) will disburse payments to UBS Optimus Foundation according to the indicators measured for the program. A theoretical example<sup>2</sup> of cash flows in a DIB follows:



Potential Cash flows	At issue Cash flows	At maturity (guaranteed)	At maturity (If metrics are achieved)
Investor	-100	+50	+66
Outcome Funder	0	-50	-75
Special Purpose Vehicle	+5	0	+4
Projects	+95	0	+5

### New and promising models in nutrition

The share of the total ODA for basic nutrition during the MDG period (2000–2011) doubled from 0.2% to 0.4%, which is very low when compared to spend on food and agriculture. There is no information on the impact of other financial resources in nutrition. Augustin Flory from the Children’s Investment Fund Foundation (CIFF) explains, “The limited progress in nutrition during the MDG period, even in countries that had experienced high economic growth, combined with the size of the problem (nutrition is the underlying cause of 45% of under-five mortality and affects more than 40% of children in Africa and South Asia) and the exceptional cost effectiveness of the solutions brought CIFF and the governments of UK and Brazil to host the Nutrition for Growth Summit in 2013 to catalyze greater political and financial commitments for nutrition.”

“Three reasons to be optimistic about the use of innovative finance for nutrition – strong investment case for solving malnutrition, opportunity to fix certain inefficiencies in the market, and a viable commercial market for nutrition products”

*Joe Dougherty, Dalberg*

“Nutrition is chronically underfunded – a focused fund that positions and brands nutrition as a smart investment is required to attract other resources from the private sector”

*Martin Short, The Power of Nutrition*

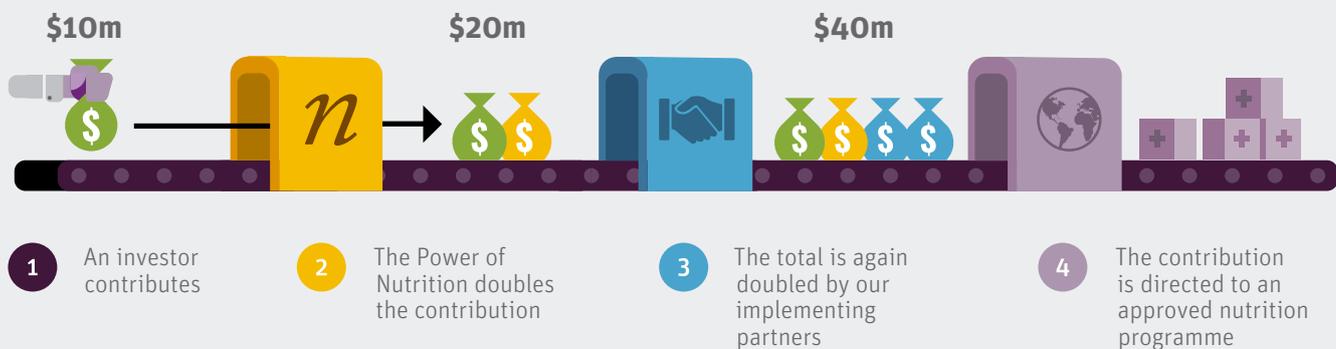
Momentum was built for tracking all forms of financing, alignment with the Sustainable Development Goals, and developing innovative financing mechanisms to bridge gaps and spark new ways of working. The need for new financing solutions was also reinforced at the Third International Financing for Development conference last year. Joe Dougherty from Dalberg provides three reasons to be optimistic about the use of innovative finance for nutrition: **1)** the financial case for solving malnutrition (e.g., the combined effects of undernutrition can cost affected countries up to 11% of GDP<sup>5</sup>) provides a very powerful incentive for governments to invest; **2)** in certain cases where inefficiencies in the market are clear (e.g., timing of payments), innovative financing can have a positive impact (**Box 2**); and **3)** unlike some other sectors, there is, at least theoretically, a viable commercial market for nutrition products, even in low-income countries (see impact investing).

Some examples of new and promising models are explained below: **The Power of Nutrition** is an independent charitable

### Box 2: Bridge Funds

Bridge funds are designed to increase the speed and efficiency of funding from international donors. Two notable examples are UNICEF’s Pledge Guarantee for Health (PGH) and the US Fund for UNICEF Bridge Fund. PGH<sup>6</sup> is a financial tool that enables governments and NGOs to obtain short-term, low-cost financing based on pending aid commitments. PGH transactions average six months in duration, allowing the \$100 million in credit from commercial banking partners to be turned over twice annually, thus reducing the time between a donor pledge and “money in the bank.” Recipients are thus empowered to use committed donor funding in advance of disbursement, resulting in higher buying power, accelerated procurement and delivery, and optimization of the supply chain.<sup>7</sup> This means that costs associated with uncertain payment timings, additional premiums, expedited production and shipment, stock-outs, wastage, and expired commodities are lowered.

Similarly, the Bridge Fund pools capital in the form of 3-year or 5-year fixed-rate loans to speed the delivery of life-saving commodities and assistance to children in need. For example, a single net worth grant of \$1.4 million allows the Bridge Fund to borrow, or leverage, \$5 million, which is 3.5 times as much capital. If this bridges just two transactions per year (\$10 million), that net worth investor has already achieved seven times the impact of the original investment. After five years, a grant-maker can achieve up to 35 times (\$50 million) the impact of the original investment. In three years, a total of \$101 million of social investment capital was mobilized to accelerated delivery of school supplies to 45,000 Syrian children and anti-malarial commodities to three countries; it sped the procurement of more than 100 million polio vaccinations in Nigeria and the distribution of therapeutic food to 10,000 children in Burkina Faso during a nutrition crisis; it saved

**FIGURE 2:** The Power of Nutrition guarantees that every investment is multiplied four times

Source: [www.powerofnutrition.org](http://www.powerofnutrition.org)

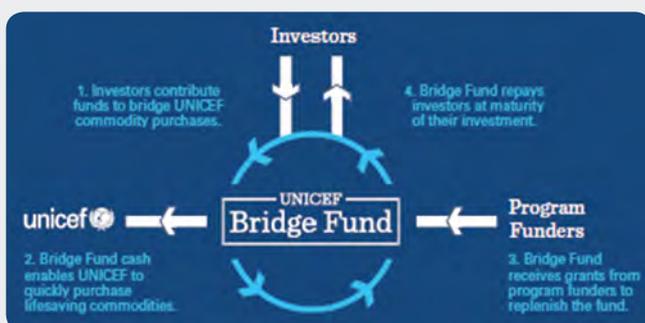
foundation that has committed to unlock \$1 billion by 2020 in new private- and public-sector financing for child nutrition that would not have been generated in its absence. Every dollar from private and other non-traditional sources of financing (such as non-OECD donors) is first matched by the UK's Department for International Development (DfID). A second match is guaranteed by the implementing partners (Figure 2). This financing is expected to drive a measurable reduction in child undernutrition by scaling up a package of evidence-based nutrition interventions in hotspot geographies in sub-Saharan Africa and Asia. Incubated by CIFF and the UBS Optimus Foundation, the Power of Nutrition was launched in April 2015 with \$200 million in signed commitments. It identified Tanzania as the first nutrition hotspot

and made a first investment to the country in partnership with the World Bank. This investment unlocks up to \$44 million to provide incentives to primary health care facilities for successful performance against nutrition indicators.<sup>4</sup> A new investment that unlocks \$10 million to tackle child undernutrition in post-Ebola Liberia has just been announced in partnership with UNICEF.

**UNITLIFE** is a model built on the solidarity levy in extractive industries started in 2014. Replicating the very successful UNITAID model (Figure 3), UNITLIFE brings together political leader commitments from seven countries in Africa to eliminate chronic malnutrition. It is estimated that \$100–\$200 million in annual revenues can be generated from a micro levy of \$0.10 on each barrel of oil sold by the state.<sup>8</sup> Benefits include substantial source of funding, low maintenance to collect once installed, ability to expand to gas and minerals, independence from annual public budgeting and discussion process in parliament, which makes the solidarity levy mechanism less volatile.<sup>6</sup> The structure of the model is currently being designed, and may look similar to UNITAID. UNITLIFE will be governed by a steering committee whose members will include contributing countries and UNICEF (as the host organization). The committee will be supported by a small technical secretariat located in Geneva. A technical advisory committee, whose members are independent, will evaluate proposals to support the implementation of nutrition-specific interventions as mentioned in *The Lancet* and to advise the steering committee.<sup>9</sup>

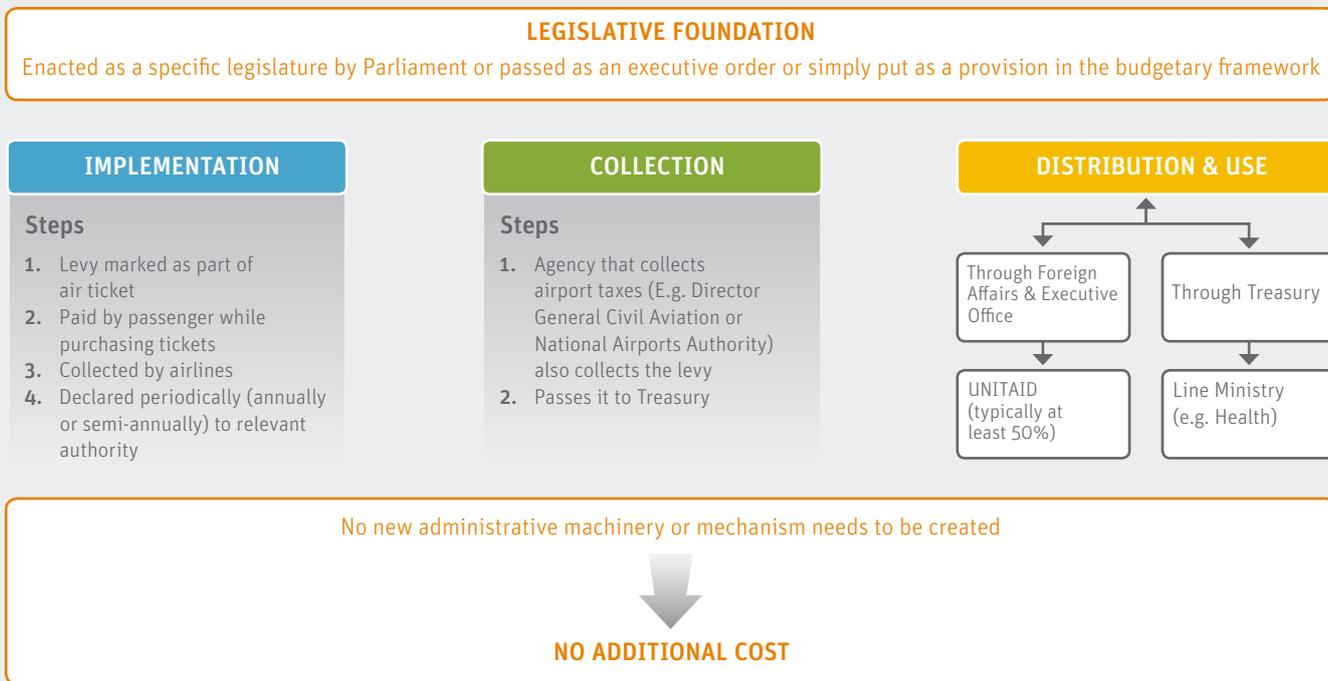
**The Global Financing Facility in Support of Every Woman Every Child (GFF)** aims to close the funding gap between resource needs and those available for reproductive, maternal, newborn, child, and adolescent health (RMNCAH). Financing is mobilized from three key sources: domestic financing from public and private sectors; GFF Trust Fund and two of the World Bank's agencies – International Development Association (IDA)

\$10 million on purchases of oral polio vaccine, and allowed more than 1.4 million children to be vaccinated in Nigeria through accelerated support from the World Bank.



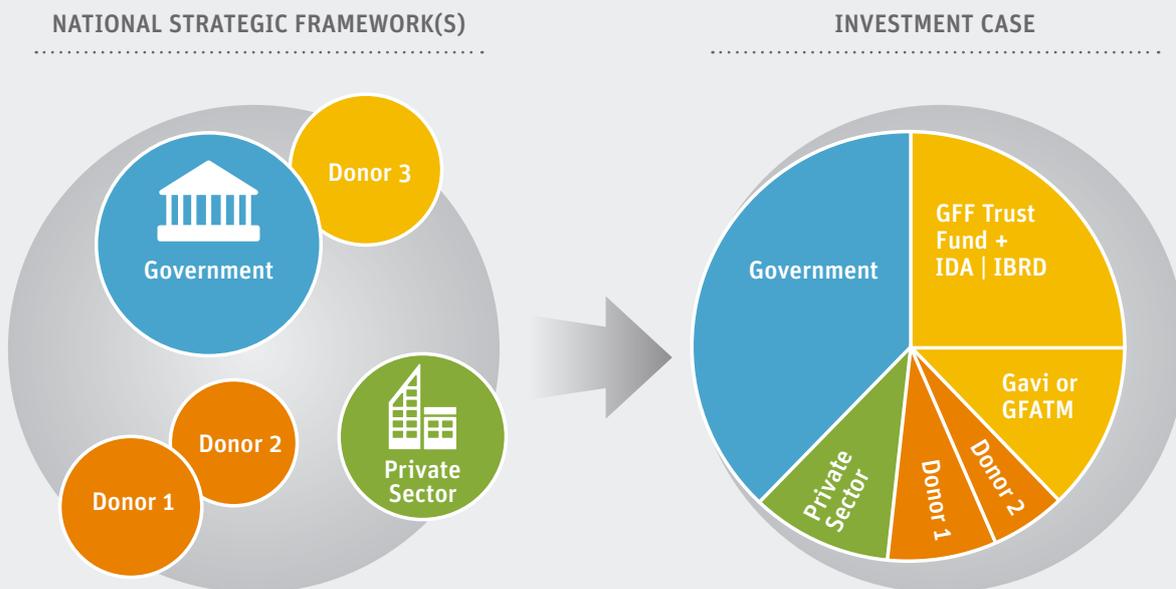
Source: Dalberg, UN Foundation – Pledge Guarantee for Health; [www.unicefusa.org/unicef-bridge-fund](http://www.unicefusa.org/unicef-bridge-fund)

**FIGURE 3:** How is the air ticket levy implemented?<sup>10</sup>



**Note:** Solidarity (e.g. air ticket) levy is a small tax added to outbound air tickets. It is applied to all airlines and therefore has no impact on competition, nor does it penalize the implementing country.<sup>11</sup> The levy is tiny relative to ticket price: rate may be flat (e.g., US \$2–4 for all) or graded (e.g., \$2 for economy class/\$40 for business class). Between 2006 and 2013, UNITAID raised \$2.2 billion. It has been used to shape markets and lower prices for antiretroviral medicines (from \$10,000 to \$100 for a year’s treatment), introduce new TB testing tools (doubled detection rates for drug-resistant TB), and expand access to new malaria drugs and diagnostics (contributing to a 50% reduction in deaths since 2000).<sup>12</sup>

**FIGURE 4:** GFF – Complementary financing of the investment case



**Note:** A country-specific investment case is at the core of the model. The Investment Case, a prioritized plan, drives efficiency by focusing on evidence-based, high-impact interventions while also improving alignment, which reduces gaps and overlaps as financiers increase funding for RMNCAH.<sup>13</sup>

**Terminology:** **GFF** Global Financing Facility, **IDA** International Development Association, **IBRD** International Bank for Reconstruction and Development, **GFATM** Global Fund to fight AIDS, Tuberculosis and Malaria, **RMNCAH** Reproductive, Maternal, Newborn, Child, and Adolescent Health

and the International Bank for Reconstruction and Development (IBRD); and other international donors. The GFF Trust Fund encourages additional allocations from IDA and IBRD – funds that are given as grants or low-interest loans to the poorest countries (Figure 4). Such a design can support GFF to mobilize more than \$57 billion from 2015 to 2030 and substantially increase domestic attention paid to nutrition programming.<sup>13,14</sup> Further scale and efficiency will come from integrated financing. Jessica Johnston, during her time at the MDG Health Alliance, provides an excellent example of how malaria and nutrition programs would benefit from such integrated approaches in select regions in Sub-Saharan Africa – the provision of nutrition screening and supplementation, co-delivered with malaria prevention, can increase the overall effectiveness of the malaria treatment, and serve as an incentive for parents to adhere to the regimen, and in turn, help reduce incidents of severe malaria and child mortality.<sup>15</sup>

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“We should move away from single-delivery platforms, it’s not how people live, and it’s a waste of resources in the long term. We need to see more investment cases for integrated approaches to delivering global health interventions, as well as seek opportunities to build or leverage innovative financing mechanisms.”

*Jessica Johnston, Office of Reid Hoffman (formerly at the MDG Health Alliance)*

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**Impact Investment** provides growth capital to companies with both a financial and a social mission.<sup>16</sup> Investments typically run for at least five years and at least provide a return of principal, with returns ranging from zero to market rate. A good example in nutrition is the loan made by LGT Venture Philanthropy, through a partnership with GAIN, to Meds & Food for Kids, a Haitian-based producer of lipid-based nutrient supplements. A loan of \$732,000 helped to set up a new production facility that now has the capacity to produce 10 times more than it did at its previous facility.<sup>17</sup> Over a period of five years, more than 100,000 children received these supplements. Such examples

are few, and funds have yet to be effectively targeted towards nutrition. This is partly due to the lack of investable companies, which are either too small or not sufficiently profitable.<sup>16</sup> However, if partnerships with the public sector are catalyzed, one can expect to see scale through impact investment, as in the case of Africa Improved Foods in Rwanda, which has a total project size of \$59 million through a mix of debt and equity from investors, private sector and the government of Rwanda. Africa Improved Foods in Rwanda aims to reach more than a million people with adequate nutrition in two years (Figure 5).<sup>18</sup>

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“A necessity for DIBs specifically, as well as impact investing more generally, is adaptive management that continually improves the scale of success. Regular progress measurement and analysis alongside a culture of performance is core to this.”

*John Fairhurst, UBS Optimus Foundation*

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**Conclusion**

It may be observed that decreases in aid budgets drive innovative financing. However, as seen in the examples provided in this article, there are several other noteworthy benefits. Innovative financing enables and rewards countries, enterprises and NGOs with a good track record to innovate and to optimize supply and delivery models. It provides new business opportunities in emerging markets for credit, lowers risk for any single investor, and thus has the potential to improve overall efficiency, effectiveness and transparency of aid utilization.

**Acknowledgements**

Romeo Frega (AB Agri) for brainstorming on relevant models and joint interviews of some experts; Jessica Johnston (Office of Reid Hoffman, formerly at the MDG Health Alliance) for her insights and guidance; Augustin Flory (formerly CIFF); John Fairhurst (UBS Optimus Foundation); Martin Short (The Power of Nutrition); and Joe Dougherty (Dalberg) for their valuable perspectives.

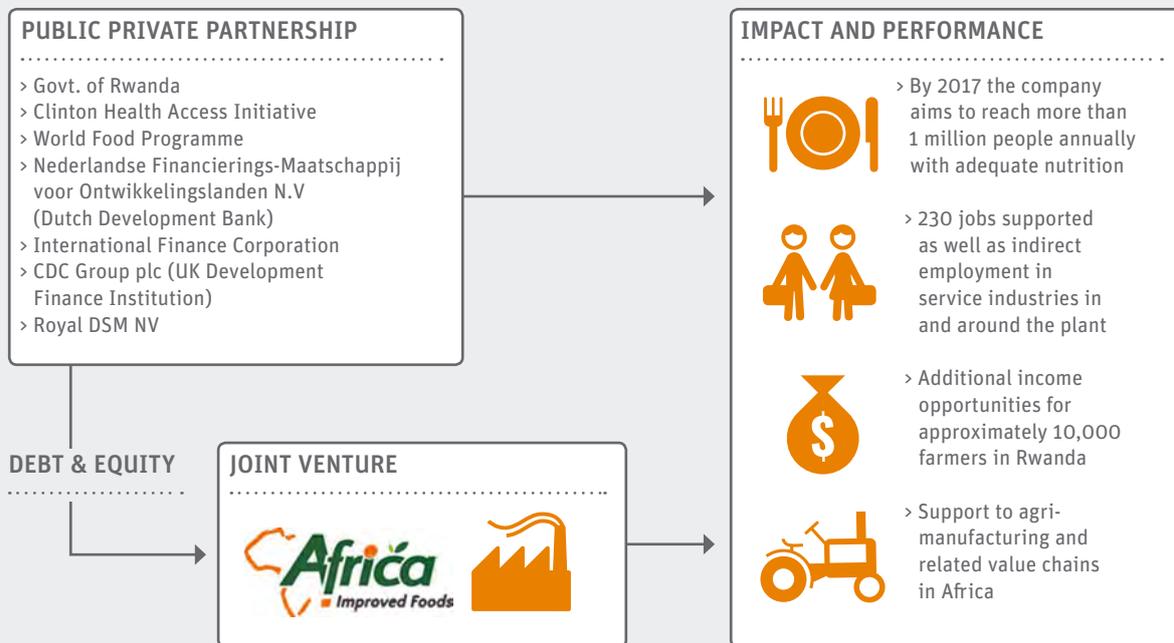
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**FIGURE 5:** Impact of investing through a public-private partnership model in Rwanda

**Note:** A 45,000 tons per year processing plant in Rwanda for fortified cereals. A significant portion of the final product will be sold to the World Food Programme, which will distribute the product in the broader region (Southern Sudan, Uganda, Burundi etc.). The Rwandan government will distribute the product at no cost to the most vulnerable populations. The processing plant will source soybeans and maize locally from Rwandan farming cooperatives, offering approximately 10,000 farmers a stable, sustainable income for a proportion of their harvest.<sup>18</sup>

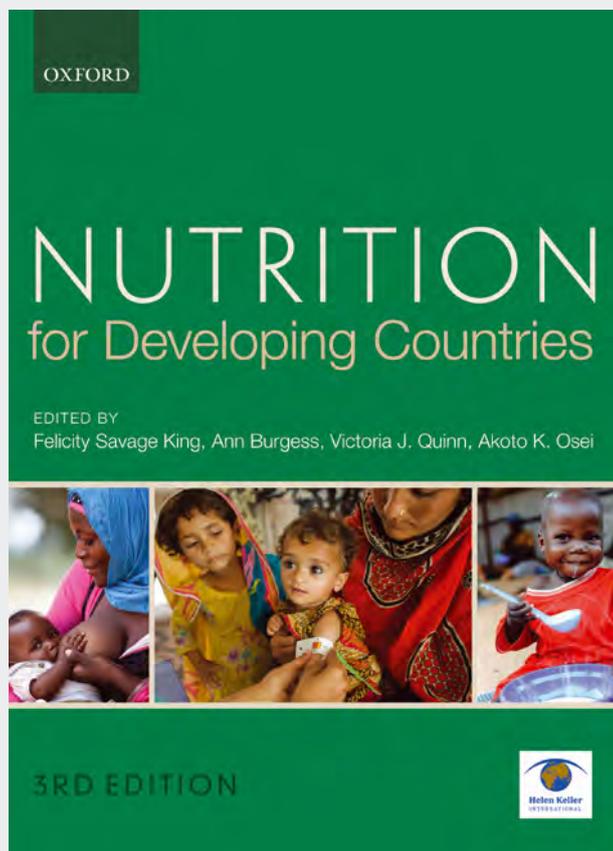
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# Improving Nutritious Food Systems by Establishing National Micronutrient Premix Supply Systems

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components: a premix supplier, a revolving fund (or a revolving fund agent), a distributor, and fortified food producers.

- > When introducing or strengthening premix procurement and distribution models, experience shows that it is important to:
  - > select the most appropriate partner executing agency;
  - > clearly communicate with all partners and stakeholders;
  - > advocate for complementary policies and programs; and
  - > support enforcement of fortification mandates.

## Key messages

- > If appropriately strengthened, food systems have the potential to deliver adequate availability, access, utilization, and supply stability of both macro- and micronutrients that contribute to food and nutrition security.
- > Large-scale food fortification has emerged as one of the most feasible, cost-effective, and sustainable evidence-based interventions to address population-level vitamin and mineral deficiencies.
- > The past decade has seen an expansion in food fortification programs in developing nations. However, timely and regular access to affordable and quality-assured vitamin and mineral premix is a barrier for a number of country programs.
- > Several interventions have led to sustainable national premix supply systems. The model typically has four key

## Making fortification programs truly sustainable

Food systems arise from the complex interactions of all the activities and actors involved in transforming environmental, agricultural, and manufacturing inputs into outcomes of food and nutrition security and health.<sup>1,2</sup> By considering the interactions of all involved sectors, food systems have the potential and capacity to deliver adequate availability, access, utilization, and supply stability of both macro- and micronutrients that contribute to food and nutrition security.

Currently, in many low- and middle-income countries, food systems deliver narrow diets of staple foods that lack key micronutrients. Large-scale food fortification has emerged as one of the most feasible, cost-effective, and sustainable evidence-based interventions to address population-level vitamin and mineral deficiencies, estimated to affect hundreds of millions of the world's population.<sup>3</sup> Food fortification also improves food and nutrition security by providing greater availability of, and access to, micronutrients necessary for health and well-being. However, in order for fortification programs to be truly sustainable, they need to be embedded within food systems along with the inputs and resources required to ensure the



Wheat flour fortification in action

quality and safety of fortified foods. This includes consistent access to quality-assured vitamin and mineral premix.

.....

**“Currently, in many low- and middle-income countries, food systems deliver narrow diets of staple foods that lack key micronutrients”**

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#### Challenges in building national premix supply systems

The past decade has seen an expansion in knowledge and scale-up of food fortification programs in developing nations. Fortification of staples and condiments with essential vitamins and minerals has gained global traction, with over 140 countries implementing salt iodization programs, 85 countries mandating at least one kind of cereal grain fortification, and dozens more rolling out large-scale programs fortifying edible oils, sauces and condiments. These figures represent tremendous success in scaling up a proven, highly cost-effective, and sustainable nutrition intervention which is embedded within food systems.

However, timely and regular access to affordable and quality-assured vitamin and mineral premix remains a barrier for a number of country programs, and is an essential component towards sustainable, nutritious food systems. In order for national programs to reach long-term viability, programs which may have relied on donated or highly subsidized premix in the past – or which are looking to procure premix for the first time – need to move to a model where the program shoulders the costs

of premix procurement, storage and distribution. This shift is a challenge for a number of reasons, especially for programs with a fragmented food processing industry.

First, micronutrient premix is one of the most significant recurring input costs for fortification programs.<sup>4</sup> The cost of premix was cited as one of the top three barriers to ensuring fortification quality and compliance by 75% of respondents (the highest percentage of all barriers reported) in a 17-country survey conducted in 2015.<sup>5</sup> Second, especially for small and medium-sized producers, there is a limited ability to accurately forecast product demand and premix needs in cases where fortified foods have not yet been mainstreamed. Thus, these producers struggle with financing an upfront purchase of premix that balances the risk of stock-out with that of premix expiration. Third, for many countries, premix must be imported, and there can be high costs associated with this, such as customs taxes, VAT, and currency exchange fluctuations. These can make it cost-prohibitive and risky to purchase premix in the relatively small volumes that such producers require. Lastly, international procurement of premix can have lead times of three months or more, which is impractical for the highly fluctuating demand requirements as dictated by changing consumer acceptance and emergency assistance programs. Thus, having a national or localized procurement, storage and distribution capacity is instrumental to achieving sustainable and timely access to premix.

#### Identifying solutions to improve nutritious food systems

To date, significant resource allocations have been focused on developing innovative models for premix procurement and distribution. For example, this has been a key component of over a dozen country fortification programs which GAIN has supported since 2002. These efforts have reviewed annual demand for fortified foods; industry makeup, organization, and capacity to fortify; and existing procurement and distribution arrangements. This has led to targeted technical assistance to fill quality control and monitoring gaps, and contributed to better forecasting for premix requirements within the sector.

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**“Having a national or localized procurement, storage and distribution capacity is instrumental to achieving sustainable and timely access to premix”**

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At the level of individual countries where food industry has struggled to procure quality-assured premix on its own, several

interventions have led to more sustainable national premix supply systems (Figure 1). The model, likened to a “revolving fund,” with full or partial cost recovery requires up to four key components but this may vary depending on context: a premix supplier, a revolving fund agent, a local distributor, and fortified food producers. The revolving fund agent manages the funds throughout the procurement process and runs competitive tenders to regularly supply a distributor’s centralized warehouse with bulk quantities of premix from certified premix suppliers. The distributor informs the revolving fund agent of the forecast demand for all fortified food producers within a country or region party to this model. Food producers can then procure premix in required quantities from the local distributor directly, reducing lead times. The distributor then delivers ordered premix amounts to food producers and concurrently works with producers to make arrangements to procure new orders. It is worth noting that depending on context, the revolving fund agent can also play the dual role of a distributor. The revolving fund agent continues to hold the risk, in particular if it offers extended credit terms or sells the premix on a consignment basis to the distributor for premix payment.

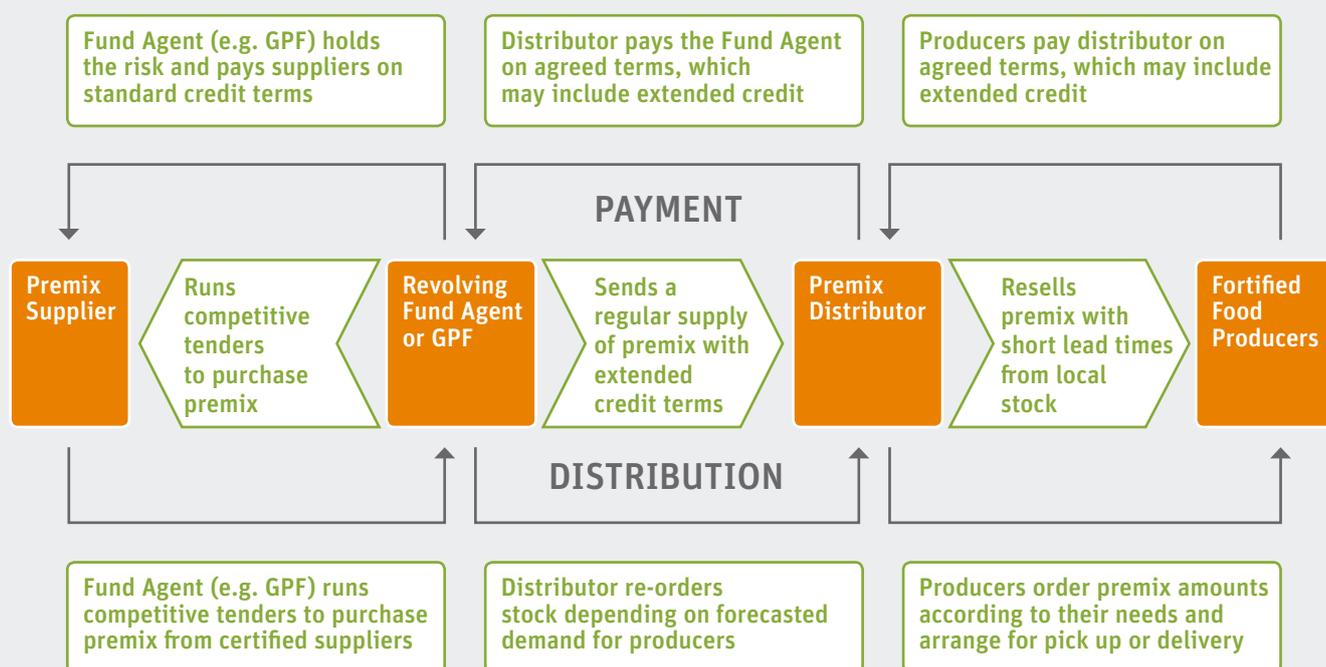
The benefits of such a premix supply system are myriad and especially pronounced for countries with small and medium-sized fortified food producers which struggle to access quality-assured premix directly. The model has been shown to work through various approaches rolled out in Ghana, Tanzania,

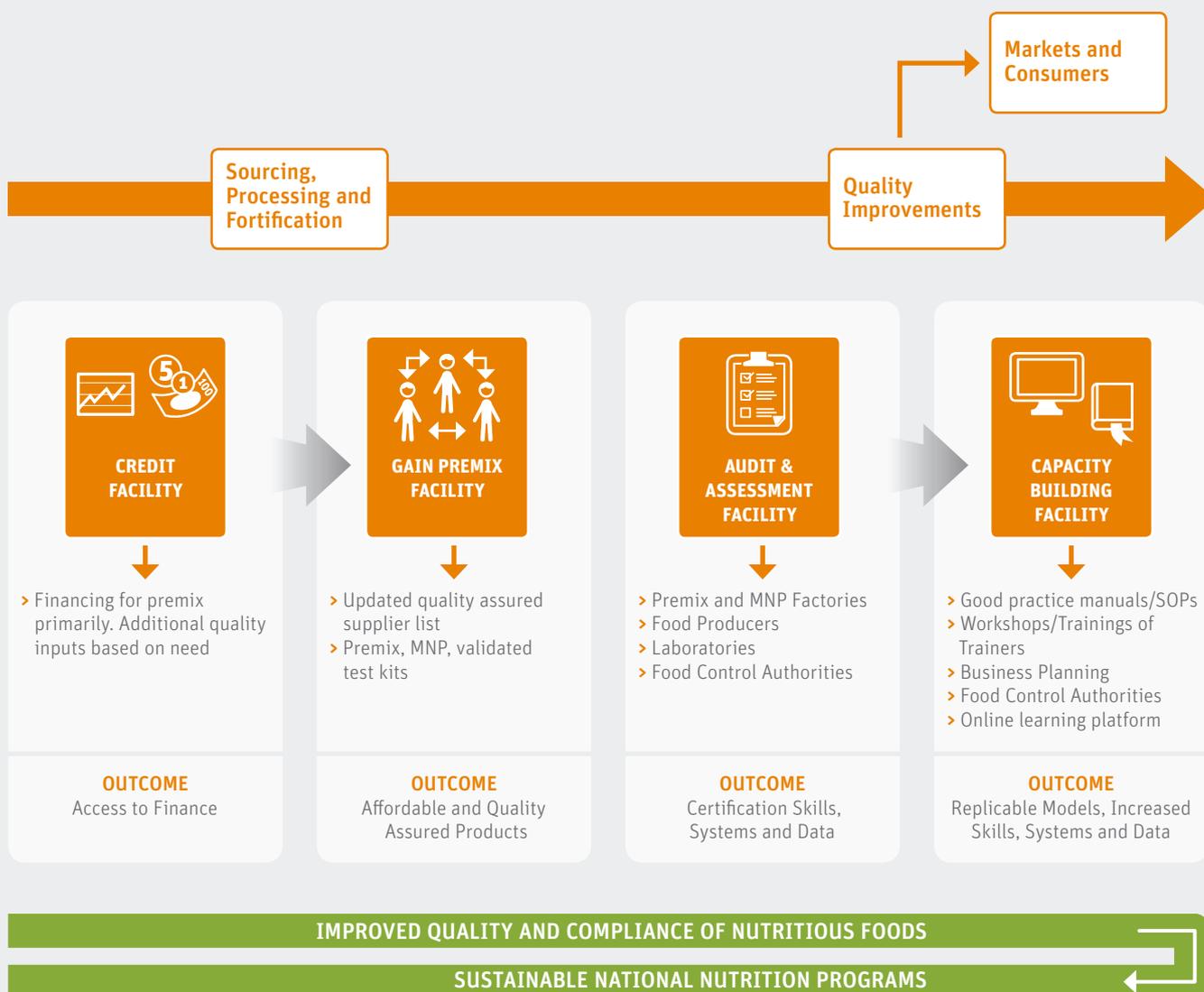


Sustainable premix supply systems can make a major contribution to improving the nutritional status of the population

Kenya, Ethiopia, and Kyrgyzstan. Boxes 1 and 2 are case studies showcasing iterations of this model in action in selected countries and highlight how the model should be customized to the operating context existing in a partner country. By consolidating the premix requirements for a large number of producers within a country, the revolving fund agent is able

FIGURE 1: Indicative national premix supply system model



**FIGURE 2:** GAIN's Platform for Quality and Safety (GPQS)

**Notes:** The GPQS offers services to government and food industry which aim to build more robust quality systems for fortification. For premix, it provides access to high-quality premix at competitive prices through procurement, credit, and audit facilities.<sup>6</sup> The audit facility prequalifies suppliers based on stringent quality criteria, monitors ongoing quality of supply as well as testing premix and fortificants. The procurement facility offers a centralized service to run competitive tenders from the certified suppliers, ensuring fair and transparent competition. The credit facility pools risk and offers extended credit terms or the option to finance on a consignment basis to pay for premix shipments. As of March 2016, the GPQS has certified 18 premix blenders and 23 micronutrient manufacturers and has sourced approximately \$56 million (US) worth of fortificants and premix across over 43 countries.<sup>7</sup> These services are available to help establish national premix supply systems.

to take advantage of the volume effect, running tenders for bulk premix orders to achieve a more competitive price than producers could each obtain individually. Through the distributor's centralized warehousing, maintenance and overhead costs are minimized, and the premix can be resold in quantities more conducive to the needs and storage capacity of individual producers. Financial risk is minimized for local distributors through access to affordable pricing by a centralized international procurement mechanism, and for local producers

as their working capital is not tied in excessive premix stock as they have access to local supply. In this way, only the revolving fund agent and/or distributor has to manage customs, import requirements, and currency exchange, which allows food producers to buy in the local currency, with minimum lead time. This procurement model is similar to the "just-in-time" supply chain management philosophy, eliminating waste by procuring only what is needed, when it is needed.<sup>8,9</sup> This allows both the distributor and food producers to optimize the amount of

### Box 1: Ethiopia's KIO<sub>3</sub> Revolving Fund: Working with a government agency and producer cooperatives

Since 2011, Ethiopia has achieved tremendous progress in improving iodine nutrition through salt iodization, increasing national iodized salt coverage from 4.2% in 2005 to over 90% in 2014, in part through improved supply chains for potassium iodate (KIO<sub>3</sub>). The KIO<sub>3</sub> supply system had been fully donor-based leading to low viability of the program especially as donors were unable to carry the increasing costs of KIO<sub>3</sub> as production volumes of iodized salt increased.

To address this, the Ethiopian government worked with GAIN to establish a revolving fund with distribution that would allow salt producers to purchase and procure KIO<sub>3</sub> directly from the government in the quantities needed. GAIN, UNICEF, and the Micronutrient Initiative capitalized this fund in 2012 with initial donations of KIO<sub>3</sub>, and GAIN worked with the Ethiopian Government to select the Pharmaceutical Fund and Supply Agency (PFSA) as a suitable candidate to host the fund. PFSA is a government agency whose mandate is to ensure the availability and affordability of quality pharmaceuticals and health equipment to all public health facilities in Ethiopia by using a revolving drug fund. Thus, PFSA was chosen because it already has experience in procurement and has the capacity to import goods on international markets for resale. PFSA also has experience in demand forecasting and revolving fund financial models, and would only need to add KIO<sub>3</sub> to its repertoire of products available.

PFSA has been able to forecast demand for KIO<sub>3</sub>; appropriately recover proceeds from sales to replenish stocks from approved KIO<sub>3</sub> suppliers; and effectively distribute stock. In some salt-producing areas of Ethiopia, producers organized themselves into associations that could better manage procurement of stock from PFSA and distribute this to small and medium-sized producers. One such producers' organization, the Afar Salt Producers Mutual Support Association (ASPMSA), even worked with the government and the individual producers to coordinate production, fix quotas, and set prices of iodized salt higher than non-iodized salt. ASPMSA also coordinated procurement and distribution of KIO<sub>3</sub> to its member producers, automatically deducting the cost of KIO<sub>3</sub> from the producers' pay, based on each producer's production quota. This method effectively removed the incentive to increase profits by not iodizing.<sup>10</sup> KIO<sub>3</sub> could then be purchased in amounts ranging from 5 to 25 kg, suitable for all sizes of salt producers, allowing for consistent recovery of the KIO<sub>3</sub> costs for the revolving fund.

The revolving fund has continued to successfully operate with minimal donor support. A total of 54 MT of KIO<sub>3</sub> has been successfully procured by PFSA, and in late 2015 a request for a fourth procurement of 40 MT was received by the Ministry of Health and will be tendered via international competitive bidding.



Bread made with fortified wheat flour in India

stock each keeps, preventing both stock-outs and expiration that would be detrimental to achieving the intended health impact of the fortification program.

“The ‘revolving fund’ model has been shown to work and to be highly replicable and customizable”

#### Lessons learned and path forward

Several lessons can be drawn from the experiences described in the boxed case studies and should be considered when introducing or strengthening premix procurement and distribution models in support of better food systems:

#### 1. Select the most appropriate partner executing agency.

The choice of revolving fund agent can determine the success or failure of the revolving fund itself. The partner agency must have the technical capacity and a strong

relationship with fortified food producers to ensure their revolving fund services will be utilized and viable. Having exclusive or preferential access to both premix suppliers and fortified food producers can help encourage the revolving fund agent to take on the risk of procuring large volumes of premix.

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**2. Clearly communicate with all partners and stakeholders.** Communication message misalignment has been a pitfall that prevents successful procurement models. Whether it is with industry, government, and private companies directly involved in the revolving fund, or external organizations and donor agencies operating parallel programs, ensuring that communications are clear and consistent on national fortification efforts and premix volumes required will encourage stakeholders to complement each other in their efforts.

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**3. Advocate for complementary policies and programs.**

Advocacy is necessary to ensure that national stakeholders understand that using a premix supply system is an effective and advantageous proposition. Advocacy with governments is necessary to facilitate premix imports and minimize taxation and import costs. Within industry, advocacy is useful to encourage larger producers, who will often procure their premix directly, to also utilize aggregate procurement mechanisms to leverage higher purchase volumes for more competitive prices for smaller producers.

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**4. Enforcement of fortification mandates is complementary to sustainably supplying premix.**

Ensuring that enforcement and inspection agencies have the capacity and political will to detect and work with non-compliant food producers is critical to successfully sustaining fortification with high-quality premix after donor support has ended. Without such enforcement and

**Box 2: Premix Hubs in Tanzania and Ghana: Building new markets through private-sector partners**

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The premix hubs in Ghana and Tanzania were designed to ensure that food producers embarking on fortification for the first time had access to high-quality premix while building their own procurement capacity.

In Tanzania, the premix hub was designed to carry multiple micronutrient premix for flour fortification and vitamin A for fortification of vegetable oil. GAIN and its partners selected Phillips Pharmaceuticals as distribution agent. (Phillips is a private company and leading importer of healthcare products with local offices in Tanzania.) This assistance ensured the proper storage conditions were available for retention of stability and quality, especially that of vitamin A, which requires appropriate storage conditions.

Premix was available to producers on a sliding subsidy basis, managed by Helen Keller International (HKI). Subsidies were agreed to start at 40% of the vitamin and premix cost to industry, tapering to 20% over six months, and finally end within one year. Throughout the lifespan of the Hub, producers were exposed to several alternative sources of premix and educated on strategic sourcing of quality premix. Internationally certified suppliers were given access to the new market by supplying the Hub and had already approached industry to market their products prior to the Hub's close in 2014. In this way, market forces were able to take over after subsidies ended and industry continues to source their own vitamins and premix as needed for fortification efforts. Smaller producers have even continued the practice of pooling their volumes to take advantage of bulk pricing.

In Ghana, GAIN and its partners invested in the procurement capacity of Environmental Processing and Associates Ltd. (EPA), a small private company that was closely involved with the President's Special Initiative on Salt. The GAIN Premix Facility acted as the revolving fund agent and agreed to supply high-quality  $KIO_3$  to EPA on consignment in small packages of 1 kg and 5 kg, suitable to the needs of small and medium-sized salt producers. Salt producers order  $KIO_3$  from EPA, who regularly distributes it upon order. The purchase price included a markup to absorb fluctuating exchange rates and port clearing expenses while covering the supply services of delivery, warehousing, and management.

This model has proven viable. In 2012, EPA supplied the equivalent of 27% of the theoretical market for  $KIO_3$ , based on annual salt consumption and industry capacity for iodization. In February 2015, EPA took on their sixth  $KIO_3$  consignment and due to its market-driven design the model has remained viable even without successfully achieving an exemption from the 27.5% customs duty and VAT imposed on  $KIO_3$ . A key success factor identified by EPA is the flexibility of supply that they offer. Salt producers can be supplied high-quality  $KIO_3$  within 24 hours of ordering, and producers can buy in small volumes as often as necessary which is particularly important in Ghana where the salt industry remains highly fragmented with numerous small producers.

engagement, some industries may seek out less expensive and lower-quality premix sources or cease fortification with premix altogether.

### Sustainably delivering micronutrients through improved food systems

Ensuring a sustainable supply of high-quality fortification premix is a necessary factor to improve the nutritious quality of food systems and achieve the intended health impact through national food fortification programs. High cost and the challenges of identifying quality premix sources and procuring via international markets present barriers to many food producers. Through the establishment of national premix supply systems which are designed for the local context, such as the procurement and distribution models described here, industries can better pool their volumes and take advantage of more competitive pricing, allowing them to access a timely supply of premix from certified suppliers. Moving forward, GAIN, through its Platform for Quality and Safety (GPQS) which includes the GAIN Premix Facility (Figure 2), is committed to providing premix services to all partners where needed to ensure sustainable national micronutrient premix systems are established or strengthened. This in turn will ensure more sustainable access to affordable and high-quality premix for fortified food producers which helps build higher quality and more nutritious food systems for all.

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# To Feed Ten Billion, Crop Yields Have to Rise

## Future food systems depend heavily on agricultural intensification by smallholders

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#### Key messages

- > The predicted surge in demand for food, feed and fiber over the next 30 years poses huge production challenges. This is particularly true in developing countries.
- > Sub-Saharan Africa cannot rely much on food trade and needs to invest in agriculture. However, governments often lack the will to do this, and foreign investment is not always managed in the countries' best interests.
- > Better farm inputs would help farmers harvest more food; improved storage and transport would keep more of the produce in a suitable condition for consumers.
- > Greater agricultural intensification is essential – and possible. However, further intensification has to be achieved sustainably.
- > Intensification requires the use of more and better farm inputs, but also improves the efficiency of their use. The scope for improvement is huge.
- > Plant breeding and genetic gain offer the main hope for much-needed step-changes in productivity.
- > As well as improving crop varieties, the management of crops also needs to improve. In smallholder settings, this means the adoption of better technology and better practices by millions of farmers.

- > New technology initially costs more than old versions. Buying seed is more expensive upfront than saving it from the previous harvest. However, the returns on investment – both in terms of food production and farmer income – can be high.

The world's population reached seven billion in 2011 and could reach almost ten billion by 2050.<sup>1</sup> Over 98% of this growth will occur in less developed regions, primarily in Africa and Asia. Most of the food production there depends on smallholder farmers.

Globally, calorie demand will increase even faster than population. As people's income grows, so does their demand for higher value food such as meat and dairy products. Satisfying the rising meat demand will require more animal feed, particularly corn and soybean. Producing one kilo of meat requires much more than one kilo of feed, so demand for these cereals will rise even faster than if *per capita* meat demand remained stable.

#### The production challenges for developing countries

The predicted surge in demand for food, feed and fiber over the next 30 years poses huge production challenges. This is particularly true in developing countries. Their populations are worse hit by food price inflation than populations in industrialized nations. Large nations such as India and China, with heavy demand relative to world markets, will need to continue producing much of their own grain. High import dependency in any country is not a practical option anyway, because world markets for staple commodities are thin. The food crisis of 2007–08 revealed the dangers of depending too heavily on trade rather than fostering domestic supply.

For several reasons, Sub-Saharan Africa cannot rely much on food trade. Infrastructure there is generally poor, incomes are low, and many countries lack both foreign currency and sea ports. In addition, increased imports – including food aid – can displace farm income.<sup>2</sup> With rapid demand growth and a large



Smallholders are faced with a huge production task, but without many of the tools and services available to commercial growers elsewhere

part of the population engaged in farming, Sub-Saharan Africa needs to invest in agriculture. However, governments often lack the will to do so, and foreign investment is not always managed in the countries' best interests. Smallholders remain faced with a huge production task, but without many of the tools and services available to commercial growers elsewhere.

Some commentators play down the difficulties, for example by pointing to current low commodity prices. The FAO food price index<sup>3</sup> in 2015 was below that of the previous six years, and in early 2016 was markedly lower than 12 months before. But this is deceptive. Production is increasingly hampered by natural resource depletion and degradation, and will be further impeded by climate change. Improvements in cereal yields are already lagging behind the likely rate of demand growth. Few countries can significantly increase suitable farmland without encroaching on valuable habitats. Overall, there is little slack in the world's food systems. Without additional intensification and therefore crop yield growth, new price increases are only a matter of time.

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**“Greater agricultural intensification is essential – and possible”**  
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#### **Demand- vs. Supply-side management**

Addressing this situation on the Demand side would be difficult: Dietary restrictions or extreme measures of population control may be undesirable or politically unfeasible. More could be done to reduce food waste; biofuel production targets could also be lowered. However, much of the focus needs to remain on the

Supply side. Better farm inputs would help farmers harvest more food; improved storage and transport would keep more of the produce in suitable condition for consumers.

Greater agricultural intensification is essential – and possible. However, further intensification has to be achieved sustainably. This does not only mean that more needs to be produced from less. It also requires a reduction in the negative environmental impacts of agriculture, and the maximization of its benefits for the countryside and biodiversity.

#### **Building natural capital**

Farming carries an environmental cost, which must be kept as low as possible. Land-clearing reduces biodiversity and increases carbon emissions. Wasteful use of farm chemicals and other unsuitable agronomic practices can cause further harm. Nitrous oxide linked to fertilization, carbon dioxide from fossil fuels, and methane from cattle or irrigated rice all raise greenhouse gas levels. Intensification based on modern management and crop varieties is the only way to mitigate these effects and feed a hungry world sustainably. Raising crop yields reduces the need to open up new land for farming.

Intensification requires the use of more and better farm inputs, but also improves the efficiency of their use. The scope for improvement is huge. There are many ways to reduce water use, for example. These include measures as varied as breeding water-efficient crops or building precision irrigation systems. Targeted pest management is as safe as possible for the environment, farmers and consumers. Breeding crops that are more resistant to pests and disease helps reduce the use of chemical treatments. Soil-testing, tailored agronomic recommendations and the availability of suitably applied fertilizers all contribute to field fertility. Crop diversity is desirable, and possible in many settings. In others, however, monocultures will continue to enable the most efficient production of food. Organic farming provides welcome business openings for some farmers. It is labor-intensive, however, which prevents smallholders from additionally pursuing other activities. Organic agriculture's low yields also waste farmland. Globally, it is not a sustainable answer to food security challenges.<sup>4</sup>

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**“Plant breeding and genetic gain offer the main hope for step-changes in productivity”**  
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Farm management can enhance or degrade ecosystems. As the largest land and water user, agriculture depends on, and generates, a wide variety of environmental processes. Paying farmers to adopt positive practices will encourage them to ensure sustain-

able, resource-efficient production. These “ecosystem services” could, for example, address landscape value additions, watershed protection, biodiversity conservation and carbon sequestration. Such services build natural capital and can open up new sources of income, not least for smallholders.

### Improving crop yields

One core element of intensification is the improvement of crop yields, as indicated above. Changes in yield are largely a function of genetic gain and crop management, which interact with each other. “Genetic gain” is the increase in plant performance attained through breeding. In sophisticated agricultural settings, it is responsible for the bulk of yield growth: 70–75% in US corn, for example, according to one long-term study.<sup>5</sup> In less advanced agriculture, management plays a proportionately greater role in yield increases. But plant breeding and genetic gain offer the main hope for much-needed step-changes in productivity. Expert assessment suggests that 50–60% of grain yield growth in developing and emerging markets by 2030 will come from improved varieties.<sup>6</sup> To achieve this, plant breeders will use conventional and, to a lesser extent, marker-assisted methods. Genetic modification will play only a small role, as many countries forbid its use.

### Improving crop management

As well as improving crop varieties, the management of crops also needs to improve. In smallholder settings, this means the adoption of better technology and better practices by millions of farmers. There are four main drivers of this process:

- > In the first place, smallholders need products and solutions



Training in the field plays a key role in improving smallholders' yields

which are relevant to their situation and which offer attractive returns at low financial risk.

- > The second driver group is composed of “enablers.” These include training, loans and weather insurance.
- > A third crucial factor for improved management is delivery: ensuring that new products do not stay in laboratories, but actually reach smallholders. Hand-outs are not the answer here: researchers need to link up with commercial partners who establish organized and sustainable markets.
- > Fourth, markets also play a vital role on the output side. For smallholder farming to be sustainable, and to offer the rural young an attractive alternative to urban migration, farmers must be able to earn good incomes from their produce.

## “Lack of seed access is the single most important reason for Africa’s low crop yields”

When small farmers benefit from these four drivers, they can be efficient producers and careful stewards of natural resources. Sadly, this is often not the case. Good infrastructure, wise policies, public and private investment and public-private cooperation are all needed to overcome the market and institutional failures that often prevent smallholders’ success. An example of market failure is the limited access of many smallholders to certified, healthy, modern seeds. In Sub-Saharan Africa alone, critically important crops such as sorghum, potatoes, beans and cassava grow on more than 29 million hectares and support



Future global food security depends heavily on smallholders' access to modern technology

### Case study: Seeds2B

Together with partners, the Syngenta Foundation runs a program known as Seeds2B. It is designed to strengthen seed systems through technology transfer and capacity building for local seed production. Seeds2B currently runs in Sub-Saharan Africa and parts of Asia. The operating models, called Connect and Build, increase the choice of seed. They help smallholders raise their income and improve food security.

Seeds2B “Connect” facilitates the introduction of quality seeds to local businesses. It links a wide range of public and private breeders with seed producers and distributors. Services include trialing, selection and registration. This approach is particularly suitable for technology transfer where demand is initially unproven, and for niche markets or vegetables. The focus is on low-volume, high-value products. “Build” helps establish local production of licensed varieties. This approach is particularly relevant for bulky and perishable seeds, where local demand is significant but transport expensive. It builds the market through investment coupled with technical and regulatory improvements, and helps link breeders with local producers. Potatoes are an example of a crop whose yields can benefit hugely from the “Build” model.

over 100 million smallholders. Yet only a tenth of the seed used there is of certified quality. Business models are often lacking, and markets are uncertain. Lack of seed access is the single most important reason for the region’s yield gap. Market entry for small and medium-sized companies therefore needs to be made much easier.

### Creating a virtuous circle

Clearly, new technology initially costs more than old versions. Buying seed is more expensive upfront than saving it from the previous harvest. However, the returns on investment – both in terms of food production and farmer income – can be high. The requirement, therefore, is for smart ways which can lower the entrepreneurship threshold – in other words, to make it easier for smallholders to invest in their harvests. Government subsidies may help kick-start a change, but are not a sustainable option. Making credit and/or insurance affordable and accessible is a better way to encourage investment, year after year. Well-designed insurance products not only help shift the burden of risk from smallholders’ shoulders. By acting as security, they can also open the door to loans. With the initial barriers to investment reduced, smallholders can wait much more confidently for the increased yield and income brought by better seed. Be-

fore, they were caught in a poverty trap caused by very understandable reluctance to invest their limited cash months before a harvest can be sold. Now a virtuous circle can begin instead.

### Conclusion

The world’s population will continue to grow over the coming decades. With increasing wealth in many countries, calorie demand will rise even faster. Reducing harvest losses and food waste will help close the production gap to a degree. However, the main contributor to future food security will be the sustainable intensification of agriculture, with resulting increases in crop yields. Smallholders have a crucial role to play in farming worldwide. To grow more and better food, they need improved access to technology and training, to credit and insurance, and to markets in which they can earn good incomes.

*Abridged and adapted from an article by Marco Ferroni and Yuan Zhou submitted to the November 2015 Emerging Markets Forum in Tokyo, and included in a recently published book.*

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# China's Nutrition Activities in Africa

## Lessons for developing countries

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### Key messages

- > After years of economic growth, food security has become an area of great concern for China.
- > As an essential part of its Go Global strategy, China plans to further expand its overseas economic engagement.
- > China's current policy in Africa is driven by its desire to secure access to adequate levels of natural resources and nutrition.
- > China has developed a "kind of a modern barter system" whereby developing countries pay for infrastructure through the long-term supply of natural resources.
- > If Sino-African co-operation is to benefit Africa, local leaders must think in the long term, while Chinese officials must learn from mistakes made in managing the agriculture of their own country.

### The strategic drivers of Sino-African co-operation

The recent growth of Sino-African development co-operation has not been at front of mind for many western politicians and economic leaders. One reason for the sparse attention the topic has received could be the lack of available information and reliable analyses. However, Chinese trade with Africa now outstrips the USA's trade with the continent.<sup>1</sup>

China's current policy is driven by its desire to secure access to adequate levels of natural resources and nutrition. Driven by increasing pollution and population growth – both of which put pressure on Chinese food production – China's foreign policy therefore has a strong focus on Africa's natural and agricultural resources.

**“China's policy is driven by its desire to secure access to adequate levels of natural resources and nutrition”**

Since 1980, China's population has grown from 987 million to more than 1.3 billion.<sup>2</sup> Potential options for achieving the desired levels of resource security could include the long-term leasing of agricultural land in some sub-Saharan countries, expansion of the Chinese agricultural industry into Africa, and a deepening of the long-standing technical co-operation between China and Africa with a view to increasing the productivity of Africa's agriculture.<sup>3</sup> It is widely recognized that China's engagement in Africa has consequences not only for the African countries and their populations but also for the international utilization of natural resources.

### China's agriculture

Driven by its goal to rapidly expand its food production, China's agricultural policy originally had little regard for the negative environmental consequences of its increased productivity. However, burgeoning ecological problems and decreasing arable acreage<sup>4</sup> have obliged China's leaders to give greater attention to reducing environmental damage and finding new sources to feed its growing population. In the past five years, China has introduced various measures to increase the sustainability of its agricultural activities.<sup>2</sup>

China's agriculture sector has been very successful at producing food in recent decades. It has produced food for 22% of the global population on just 7% of the world's arable land. However, this impressive increase has had its price. Since the mid-2000s, agriculture has surpassed industry as the largest polluter of the Chinese water system. The calculated costs of the relevant environmental impact are some \$32–67 billion (US), and are equivalent to 3–7% of China's agricultural GDP.<sup>2</sup>

The environmental costs are only one result of this increased agricultural output. Another is the negative impact on human health.<sup>5</sup> For more than 30 years, most of the environmental bur-

den in China has related to the intensive usage of fertilizers in the production of cereals, vegetables and fruit. The overuse of chemical fertilizers and manure is the dominant cause of eutrophication, soil acidification and high greenhouse gas emissions in the country. Another negative impact on China's ecosystem is the heightened levels of intensive livestock production, which increase air and water pollution.

### China's Go Global strategy

As an essential part of its Go Global strategy, China plans to further expand its overseas economic engagement. In 2014, during his visit to the Ethiopian capital Addis Ababa, Li Keqiang, the current Premier of the State Council of the People's Republic of China, sent a clear signal that China will further invest in the development of Africa. Li emphasized Africa's role as an equal partner of China and announced plans to double China's trade volume with Africa from \$200 billion to \$400 billion by 2020. Since Li has been in office, China has signed more than 70 bilateral barter-system-based co-operation contracts (infrastructure against resources) with African countries.<sup>6</sup>

.....

**“China has signed more than 70 bilateral barter-system-based co-operation contracts with African countries”**

.....

### China's economic activities in Africa

To reach its goal of sustainably meeting the needs of its economy and population, China has developed a “kind of a modern barter system” whereby developing countries pay for infrastructure through the long-term supply of natural resources. Often these contracts are linked to the use of Chinese companies and workers. China therefore provides not only infrastructure and goods to Africa but also a large number of its own citizens. More than one million Chinese have migrated to sub-Saharan Africa, e.g., as farmers, retailers and entrepreneurs.<sup>1</sup>

China's activities in pursuit of its strategic goals in Africa are becoming increasingly complex. Apart from direct sales, Chinese companies also benefit from the African Growth and Opportunity Act (AGOA), which permits the customs-free re-export of goods to the EU and the USA. Furthermore, there is increasing demand on the part of Africa's growing number of consumers for technologically more advanced products. Chinese communication technology offers these consumers better access to the internet and to online shops. In contrast to the resource industry, this sector employs more local people and therefore generates purchasing power in Africa. Another important aspect of China's policy in

Africa is that it covers not only state-driven companies. In 2011, 45% of Chinese direct investments in Africa were made by private-sector companies.<sup>7</sup> These Chinese investments in Africa are very dynamic and have a broad impact on Africa's development. By 2010, nearly 2,180 Chinese companies had expanded their operations to Africa, more than 8,000 projects were in progress, and the trade between China and Africa was 16 times as high as in 2000.<sup>8</sup>

### China's agricultural engagement in Africa

After years of economic growth, food security has become an area of great concern for China. China's leaders are therefore increasingly focusing on Africa's rural sector. This strategic investment in Africa's underutilized arable land is viewed by some NGOs as “land grabbing” because it could limit smallholder farmers' access to land and threaten the national food security of African countries.<sup>9</sup> Agriculture in Africa has great potential<sup>10</sup> because, according to FAO, only 14% of Africa's total arable land is cultivated, and African agriculture “suffers from low productivity, chronic underinvestment and difficulties in accessing potential foreign export markets.”<sup>3</sup> These factors offer huge opportunities for Chinese agriculture, aquaculture and food companies to lift their low margins,<sup>10</sup> meet China's growing demand in China for safe food, and avoid the environmental problems that exist in China.

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**“Agriculture in Africa has great potential because only 14% of Africa's total arable land is cultivated”**

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In trying to achieve food security for China, Beijing does not rely on existing African infrastructure, skills and know-how, instead transferring the necessary equipment, agricultural (bio-) technology and expertise from China to Africa. More than 100 Chinese senior agricultural technicians were sent to 33 African countries between 2007 and 2009 to work with local groups on improving the performance of the agricultural sector. China's activities in Africa's rural sector are often viewed critically by African community organizations, which have already expressed their concerns about China's lack of consideration for the social and environmental impact of these activities and the size of the land acquisitions being made.<sup>11</sup>

### Outlook

Since the end of the Cold War, competition for economic and political influence in Africa has grown dramatically, and the African market is opening up. The approach to aid-giving for Africa var-

ies greatly between China and the USA. Whereas China deploys 70% of its investment on infrastructure, 70% of US aid funds focus on health.<sup>12</sup>

China has successfully entered the African agricultural sector. Its market-driven approach to solving its food security problem seems to be taking increasing hold in the African countries within which it operates.<sup>3</sup> Hence, if local leaders act in the public interest, the increasing competition between western countries and China for cultivating long-term relations with Africa is “in itself not negative to the interests of the African people.”<sup>8</sup> However, if local leaders lack long-term orientation, and if Chinese officials fail to learn from the mistakes they have made in managing the agriculture of their own country, this growing Sino-African development co-operation could have “disastrous environmental consequences” for Africa.<sup>3</sup>

China therefore offers many important lessons for developing countries on other continents besides Africa.<sup>11</sup>

## “China offers many important lessons for developing countries on other continents besides Africa”

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# The Protein Challenge 2040

## Sustainable protein production and consumption for the future

### Simon Billing

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#### Key messages

- > The way in which we currently produce and consume it is having a negative impact on the environment and human health.
- > This has led us to The Protein Challenge 2040, which addresses the question: How are we going to feed nine billion people enough protein by 2040 in a way that is healthy, affordable and good for the environment?
- > There are great inequalities of access to protein, with some of us eating more than sufficient protein and others facing a serious lack. Both sets of circumstances are associated with major health risks.
- > There is increasing recognition that protein security could be an issue in the future.
- > We need to take a full systems approach and promote the transition to consumption of more plant protein by humans.
- > Forum for the Future is seeking more partners to help drive forward and scale up solutions. If you are an organization with the resources and expertise to help transform the future of protein, we would like you to join us.

Protein has been thrown back into the spotlight. It is essential for a healthy diet, yet the way in which we currently produce and consume it is having a negative impact on the environment and human health, which will only increase if no concerted action is taken. There are serious questions around whether we will be able to provide sufficient protein sustainably for a further two billion people by 2040.

This has led us to The Protein Challenge 2040, the culmination of a year of enquiry by a really unusual coalition of food companies, retailers, feed companies and NGOs into the central question: How are we going to feed nine billion people enough protein by 2040 in a way that is healthy, affordable and good for the environment?

#### Understanding the protein system

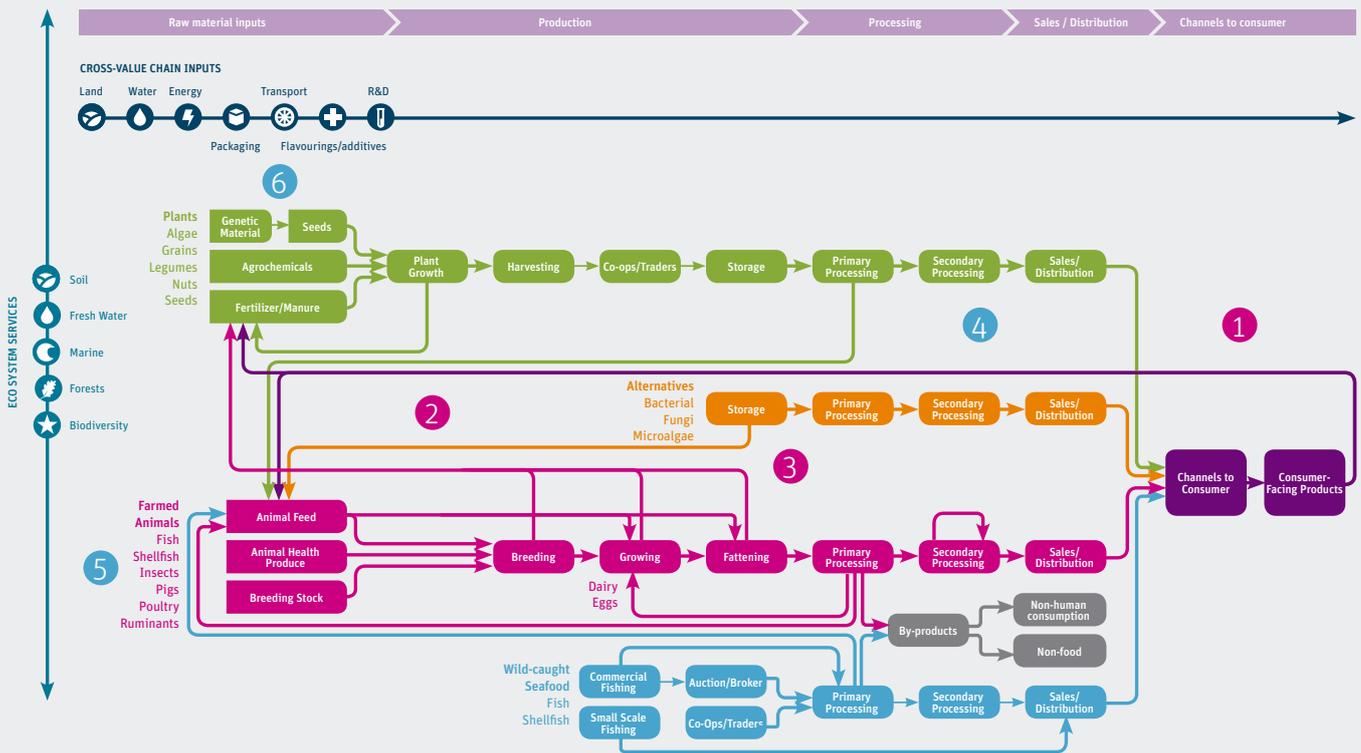
The protein system comprises the animal, plant and alternative protein industries and all their value chains, all of which are very deeply linked. To address the protein question properly, we knew that we needed to understand the system, in all its complexity, as a whole. Drawing on research and expertise from across the system (including by Dr Klaus Kraemer, Director of *Sight and Life*), we worked hard to map the entire protein system – something that has never been done before. We identified different protein supply chains that provide for human nutrition from animal, plant and alternative sources. We mapped the interrelationships between the supply chains and the impacts across the system including social issues, environmental consequences and health problems.

**“Not all sources of protein are the same in terms of how much nutrition they provide and how much impact their production has on the environment”**

**FIGURE 1:** The global protein system

These 6 areas of innovation address key hotspots within the protein system, in order to accelerate change at a system level

- 1 Increasing the proportion of plant-based protein consumption with consumers
- 2 Scaling up sustainable feed innovation to meet demand for animal protein
- 3 Closing the protein nutrition loop
- 4 Developing indigenous plants as protein sources for local communities
- 5 Scaling up sustainable aquaculture for food and animal feed
- 6 Restoring soil health



We discovered that there are great inequalities of access to protein, with some of us eating more than sufficient protein and others facing a serious lack, and both sets of circumstances being associated with major health risks. Not all sources of protein are the same in terms of how much nutrition they provide and how much impact their production has on the environment. Some are resource-intensive and have many environmental impacts such as greenhouse gas emissions, heavy water consumption and habitat destruction.

Over 50% of good-quality plant protein grown is fed to animals, and a good proportion of wild-caught fish is fed to farm animals and fish. The protein system is over-dependent on soy for animal feed, and the cultivation of soy in turn drives deforestation. So it's not simply enough to find more sustainable ways of growing a crop; it's also about finding alternatives and tackling demand.

**Protein security**

We also found that there is increasing recognition that protein security could be an issue in the future. We found that there is a

lack of agreement on the solutions and that the current discussions are quite polarized, with little consideration of the balance between health and sustainability. On a more positive note, we discovered organizations working toward more sustainable protein in different ways. Some are exploring sustainable nutrition, while others are investigating which future protein sources to support. Realizing the complexity of the issues and the number of different protein sources – not just animal and plant – these organizations saw the benefits of joining forces for the first time, and The Protein Challenge 2040 was formed.

The Protein Challenge 2040 includes leading NGOs World Wildlife Fund (WWF) and Global Alliance for Improved Nutrition (GAIN), retailers Target and Waitrose, leading dairy nutrition firm Volac, taste and flavor experts Firmenich, and food manufacturers The Hershey Company and Quorn. It is the first partnership that brings together representatives from animal, plant and alternative protein industries to understand the protein system's challenges, identify a common way forward, and find new solutions collectively.

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## “The Protein Challenge 2040 is the first partnership that brings together representatives from animal, plant and alternative protein industries”

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### Balancing healthy consumption with sustainable production

Using future scenarios to test the system in different possible worlds and working with over 200 experts and innovators in London, New York, Rotterdam and San Francisco, we have identified six areas for innovation and action. While each area in itself will need significant investment, we believe that multiple areas need to be addressed to truly have an impact on the scale needed in order to balance affordable and healthy consumption with eco-friendly production.

The first of these “innovation areas” involves encouraging the consumption of more plant-based protein in daily diets. In the West, we consume far too much animal protein, and demand for animal protein is also growing exponentially among emerging affluent classes in developing economies. Rebalancing consumption of animal, plant and alternative proteins among consumers will help address many key impacts across the protein system, such as the impact on human health, greenhouse gases, water use and pollution, land use change and habitat loss.

We are working to overcome barriers to increasing the intake of plant protein. This might happen by influencing government policy, supporting new product innovations, or creating common messaging around plant proteins. We are now working with food service companies, retailers and food manufacturers to design potential solutions, from re-training chefs to establishing a new discourse around the consumption of plant protein.

The second area of innovation is about scaling up sustainable animal-feed innovations. Over the last 60 years, farmed cattle, chickens, pigs and fish have increasingly been fed on grains, soy and fishmeal. Many of these feedstocks are high-quality sources of protein that could be used to feed humans, particularly in places where protein deficiency is common. Additionally, the use of fish as animal feed puts pressure on our ocean ecosystems. Developing new sources of animal feed to meet the growing demand for animal protein is critical for taking the pressure off land use, and to reduce the overall land footprint of agriculture and impact on ocean ecosystems.

There is already a huge amount of innovation in alternative feeds, from insects to methane based products, and we are working with innovators such as Calysta, which is a methane-bacteria feed producer. We want to help scale up these innovations,



A fish farm. The use of fish as animal feed puts pressure on our ocean ecosystems.

turning them into an unstoppable systemic change in favor of sustainable feedstocks that reduce the pressure on land use for agriculture. We will develop a place where feed innovators can come together to scale up their solutions.

Third, we want to end the loss of good protein sources while also finding new protein sources from waste sources from animals and humans. Globally, 30% of all produced food is wasted, much of which could be converted into useful protein sources. For example, waste protein sludge from starch companies could be used as animal feed. Or proteins could be recovered from sugar beet leaves, which are typically left in the field. Closing the loop on protein waste would mean we could drastically reduce the environmental footprint of protein production.

Some innovation is already happening in this space, but mainly in the form of commercial agreements between two or more businesses. We need greater collaboration in order to scale up the most effective solutions – and eventually make this type of nutrient cycling a mainstream activity across the food industry. This innovation area will bring together groundbreaking research to explore how and where protein loss occurs, as well as to drive advocacy work and practical initiatives that focus on piloting and scaling up solutions.

We are exploring three further areas for innovation, which will need greater engagement with businesses, governmental organizations and NGOs across the world, and particularly in the developing world. We want to encourage the development of new indigenous plant protein sources in countries where undernutrition is a problem, so as to support local food security. Many of these crops are often better suited to local climatic conditions, and may even be more resilient in the face of global climate change.

# Can Crickets Save the World?

## How edible insects hold the key to solving the protein problem

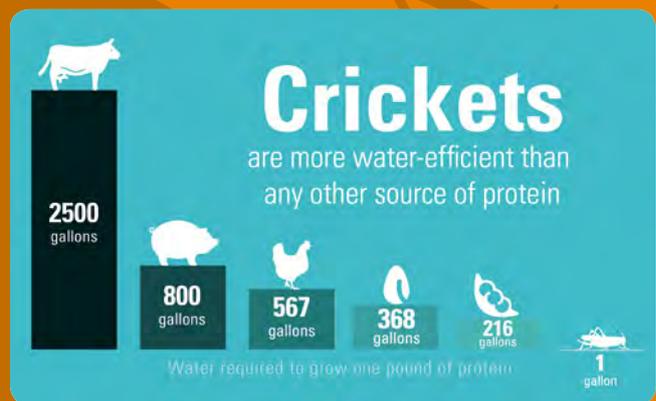
**Leslie Ziegler**  
Bitty Foods, San Francisco, CA, USA

Eighty per cent of the world already eats insects. They are the least water- and resource-intensive protein source on the planet. They contain a multitude of vitamins and minerals, and are high in fiber and protein. The United Nations calls edible insects a “key to global food security.” And since by 2050 there will be nine billion people on the planet, finding scalable ways to improve our food systems are critical. So why hasn’t the western world put them on the menu until now?

For the uninitiated, the idea of popping an insect into your mouth sounds rather unappealing, though they are consumed that way in many cultures. But they can also be roasted and milled into a fine powder and easily incorporated into the foods we eat every day. Chips, cookies and bars containing this highly sustainable, all-natural ingredient are already on the market. And if no one mentioned it, you would never know it’s there, as crickets – which are the most popular insect du jour in the United States to date (the “gateway bug”, if you will) – have a nutty flavor that mirrors that of almonds.

**“Crickets are nutritionally complete, containing fiber, omega-3 fatty acids, iron, and a slew of other important vitamins and minerals”**

Crickets are nutritionally complete, containing fiber, omega-3 fatty acids, iron, and a slew of other important vitamins and minerals. Every pound (0.456 kg) of crickets grown take up just 2 square feet (0.6096 m<sup>2</sup>) of pasture versus beef’s 200 square feet (60.96 m<sup>2</sup>). They emit zero greenhouse gases. They require only one gallon (4.55 L) of water for every one pound grown as compared to beef, which takes 2,500 gallons (11,365 L). Beef is only 20–28% protein and crickets are 65%, which means they’re also far more



For conversion to metric scale see text

efficient pound for pound and kilo for kilo (cf. *Edible Insects: Future prospects for food and feed security*. FAO 2013. [www.fao.org/docrep/018/i3253e/i3253e.pdf](http://www.fao.org/docrep/018/i3253e/i3253e.pdf)).

The company I cofounded, Bitty Foods, is doing exactly what I just described. Our patent-pending, all-purpose baking flour can be used cup for cup in any recipe, making baked goods a rich source of omega-3 fatty acids and many nutrients not found in its non-fortified counterpart. We also make wholesome, delicious chips and cookies, supercharging even snacks with protein. Though our current markets are primarily the United States and Europe, our flour’s transformative potential will also reach developing countries, providing a source of high protein to populations that need it the most.

We must move toward alternative protein sources and delivery mechanisms that reduce our dependency on meat, instead moving it into the staple foods we eat every day. Not only will we be able to feed the world, we will also reduce the environmental impacts of animal protein consumption, which is just as critical to the generations to come. As individuals and organizations, the most powerful way we can help create change is to shift market demand from the goods that consume the most resources to those that consume less. And if today’s growing insect market is any indication, it’s going to be a delicious future.

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Indigenous crops such as finger millet, yams and tubers are better suited to local climates and can play an important role in regional food security.

Our fifth goal is to tackle sustainability issues in the aquaculture industry, in particular the issue of sustainable feed. Today, aquaculture supplies over 50% of all fish consumed by humans globally. It is projected to be the prime source of seafood by 2030, due to demand from the growing global middle class and the depletion of wild-capture fisheries. It will be very important in Asia and for feeding growing populations, and addressing the sustainability issues around aquaculture will help it become a much more viable and effective protein source in the long term.

Finally, we will lead on creating a global plan to restore soil health – which underpins our plant protein production and without which no food could be produced!

### Transforming our food production processes

Something we have learned during this journey is that there is not going to be a one-size-fits-all solution. Protein needs inevitably vary by population, and the means of meeting these needs should be individually developed for local circumstances. Prices for animal proteins are undoubtedly going to rise in the future, so finding sustainable and affordable locally produced alternatives – particularly those from plant and novel protein sources – will be critical. One of the UN's seventeen Sustainable Development Goals is 'to end hunger, achieve food security, improve nutrition and promote sustainable agriculture.' Yet forecasters suggest that the number of available food calories worldwide will need to increase by 50% by 2030 simply to ensure that everybody is adequately fed. To achieve the goal requires not just a complete transformation of our current food production processes, but a global clampdown on waste and a shift in attitudes towards healthier products.

“Prices for animal proteins are undoubtedly going to rise in the future, so finding sustainable and affordable alternatives will be critical”

The Protein Challenge is urgent. As we struggle to feed nine billion people, demand for protein is growing, and much of that demand will be for animal protein, which is resource-intensive. We need to meet the needs of the future population for protein. So we definitely need to take a full systems approach and promote the transition to consumption of more plant protein, while also addressing the diets of animals themselves.

A challenge on this scale is not something any one organization can tackle alone. There needs to be much stronger collaboration between government, business and the not-for-profit sector. Forum for the Future is actively building new partnerships and seeking more partners to help drive forward and scale up solutions. If you are an organization with the resources and expertise to help transform the future of protein, we would like you to join us.

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Demand for sustainable sources of protein is growing worldwide, and the Protein Challenge 2040 is urgent.

# The Role of Animal Nutrition in Sustainable and Healthy Food Systems

## Gilbert M Weber

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The requirement of humans for protein represents on average 10–35% of the daily caloric intake. According to the Dietary Reference Intakes (DRIs) issued by the Institute of Medicine of the US Food and Nutrition Board,<sup>1</sup> adults need to eat about 60 grams of protein per day. The typical diet of the Western world contains more protein than is strictly necessary, while in developing countries and emerging economies, the supply of high-quality protein is still insufficient.

Protein is mainly found in meats from poultry, pork and beef, in fish, eggs and dairy products (cheese and milk), but also in vegetable sources such as legumes (soya, beans), grains, nuts and seeds, and also in certain vegetables. Protein that comes from animal sources is in general nutritionally more complete, because it contains the essential amino acids in a more adequate pattern than is the case with plant proteins.

## Current production of animal-derived protein

### Poultry meat and eggs

Several avian species have been domesticated for the production of food, the most important being broiler chickens and laying hens, which are currently kept all over the globe for the production of high-quality meat and eggs. Poultry meat is relatively cheap, is considered to be a healthy food, and is well accepted, as there are no restrictions on its consumption by major religions or local traditions. Poultry meat production is therefore constantly on the increase, and will soon become the most popular animal-derived food worldwide.<sup>5,6</sup>

“Poultry meat will soon become the most popular animal-derived food worldwide”

Today's laying hens can produce more than 280 eggs per production cycle. Eggs are appreciated as being among the most nutritious foods. Furthermore, eggs represent a perfect vehicle for the transfer of high-quality nutrients, such as vitamins, to human subjects. Eggs can be fortified via the dietary route with  $\alpha$ -tocopherol and  $\beta$ -carotene, two antioxidants which are associated with health benefits for humans.<sup>2,3</sup> Alternatively, multiple-enriched eggs can be obtained by feeding laying hens with linseed, long-chain essential fatty acids, minerals, vitamins and lutein, resulting in eggs of greater nutritional value that contain several times the usual levels of omega-3 fatty acids, more of the vitamins A, E and D<sub>3</sub>, the B-vitamins B<sub>2</sub>, B<sub>12</sub>, folic acid, pantothenic acid, more lutein and zeaxanthin, and more phosphorus, iodine and selenium.<sup>4</sup>

### Pork production

Today's swine industry is still less concentrated and less integrated than the poultry industry, and the production of growing



Broiler chicks – chickens are the most popular of the domesticated avian species.



Laying hens – capable of producing more than 280 eggs per production cycle.

and fattening pigs is less efficient than that of broilers. Pig meat is not accepted by certain religious communities such as Muslims, and accordingly this industry is not present in several large countries of the Middle East and Asia. Nevertheless, pork is the most widely consumed meat in the world.

#### *Ruminants: Beef cattle and dairy cows*

Although meat produced via beef cattle is the least efficient of all animal protein types, it is ecologically important, as it utilizes a vegetable biomass which otherwise would be wasted to yield high-quality protein for human consumption. Ruminants can digest ligno-cellulosic material in their rumen; this process results in protein (bacterial biomass) and volatile fatty acids (energy) for the host animal.

In most countries, the dairy industry uses cattle breeds which were genetically selected for high milk production over many generations. Dairy cows in highly developed production systems deliver on average only 2.5 lactation cycles, which is seen as a dissipation of resources, considering the long investment required to bring a calf/heifer to sexual maturity. Frequent health issues in dairy cattle, which result in the culling of cows, are fertility problems, lameness due to serious claw disorders, and chronic mastitis.

#### *Aquaculture*

Since levels of wild fishing are stagnating, aquaculture has developed exponentially in order to satisfy the growing demand for this type of food. Farming of aquatic species represents the most diverse food-producing industry, ranging from invertebrates such as mollusks and crustaceans and a large variety of

fish to reptiles such as crocodiles. The animals belong either to freshwater or marine species, and rearing takes place in tanks, ponds, rivers, lakes and the ocean.

A special requirement of carnivorous fish species such as salmonids is that they need fishmeal for fast growth, which is produced in enormous quantities via the processing of wild-caught fish. As such farming conditions might not be sustainable in the future, research efforts are directed towards diet compositions which allow using more vegetable protein, e.g. soya. Moreover, there are indications that aquaculture could use insect protein, whose amino acid composition is largely similar to that of fishmeal.

“Aquaculture has developed exponentially to make up for stagnating levels in wild fishing”

#### *Global demand and future requirements*

The world average meat consumption is 41.9 kg per person per year (data from 2009<sup>5</sup>). However there is a considerable difference between the developed and developing world. Although meat consumption is tending to stagnate in highly developed societies, a strong increase is expected in emerging economies due to urbanization and growing affluence of the people in these countries.

According to FAO,<sup>6</sup> total global meat production reached 296.1 million tons (mT) in 2013, of which pork had the largest share with 109.4 mT, followed by poultry with 99.1 mT and beef with



Pigs – pork is the most widely consumed meat worldwide.



Dairy cows – selected for high milk production over many generations

67.8 mT. The highest per annum growth rate between 2000 and 2010 was observed in poultry (4.3%), followed by pork (2.2%). It can therefore be anticipated that in a few years' time, poultry meat production will overtake that of pork. Total egg production reached 69.1 mT in 2010 with a growth rate of 2.5% over the last 10 years. Milk production is comparatively low at 0.72 mT on a global scale. There is still more fish coming from capture (88.6 mT) than from aquaculture (59.9 mT), but fish availability from fishing is on the decline in most global regions.

According to OECD<sup>7</sup> (2014), global meat production will increase by 19% between 2014 and 2023, with the highest share of this increase in poultry (34.0%) and in swine (23.5%). If this strong growth were to persist or even accelerate, meat production might need to be doubled by the year 2050, when the world population is predicted to reach 9 billion.

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**“According to OECD, global meat production will increase by 19% between 2014 and 2023”**

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#### **Opportunities to increase meat production**

Doubling animal-derived protein production in a sustainable way represents an enormous challenge for this industry. It means finding the land for placing the farms for the addition-

al animals, but also increasing the production of raw materials for feed, particularly the main ingredients such as corn, cereals and soybean. For the transport of both feed and animals, adequate carriage capacity and infrastructure will be needed, and new processing plants will have to be constructed. Furthermore, the additional waste (manure, slurry, gases, slaughter offal) will need to be handled in a way that optimally protects the environment (soil, water, air).

#### *Breeding*

Increased efficiency in meat production must accompany the overall rise in livestock production. In poultry, growth and feed conversion rates – being the ratio of amount of feed in kg per kg live weight (typically 1.5 to 1.8) – have already been massively improved, and this development must be pursued. For swine, there seems to be considerable potential for better performance, but progress is slower on this front. Efforts to increase productivity are ongoing in beef cattle and in dairy cows as well. Although already rather efficient, aquaculture could still increase overall performance levels by improving the flesh yield in fish.

#### *Nutrition*

For maximum production efficiency nutrition, both in terms of macronutrients and of micronutrients such as vitamins, meat production needs to be optimized. High-yielding breeds are delicate hybrids, and their nutrition must be carefully balanced in

order to exploit their full genetic potential. Since supplemental vitamins, which are not instantly utilized by the metabolism, are deposited in meat, eggs or transferred into the milk, they eventually improve the nutritional value of these end-products for the consumer.

#### *Feed utilization*

To improve the sustainability of animal-derived protein production, the limited resources of feedstocks must be exploited to the maximum. For this reason, feed enzymes are commonly used in monogastric animals (poultry, swine) to improve the digestibility of nutrients. Carbohydrases with different specific activities can degrade fibrous material in cereals and thereby make energy available to the host which otherwise would be wasted. Proteases improve the digestibility of protein, which is the most expensive feed ingredient and of which the supply might become limited in the future. Finally, phytases release inorganic phosphorous (P) from plant-bound phytate, which could not be utilized by monogastric animals in former times. By using such products, less non-digested potentially pollutant P is excreted by the animal.

#### *Alternative feed ingredients*

Another necessity for keeping a higher production rate sustainable is to find alternative feed ingredients, since the production of common crops might not be increased to the necessary extent, and as the main feedstuffs (corn, cereals, soybean) compete directly with human consumption. There are tropical raw materials available which could serve this purpose.<sup>8</sup>

Besides vegetable sources of protein, insects have recently been considered as potential feed ingredients for livestock and aquaculture production. The larvae of insects contain up to 60% of high-quality protein and the content of indigestible chitin is lower than in the adult stage. Insects can be grown on bio-waste from the food processing industry or from households, and certain species could even utilize ligno-cellulosic biomass. Insects have a more efficient feed conversion capacity than any other farmed animal, and the requirements for management and husbandry are rather low.

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**“Insects have recently been considered as potential feed ingredients for livestock and aquaculture production”**  
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#### *Longevity of high-yielding livestock animals*

Under production conditions, farm animals are prone to fatal diseases of various origins. Furthermore, high productivity is

rapidly exhausting the metabolic resources of long-lived animal categories (laying/breeder hens, breeding sows, dairy cows) and reduces their life expectancy. A prolongation of their lifespan would contribute substantially to an improvement of the production efficacy, with more eggs or day-old chicks, more piglets, and more milk.

#### *The elimination of antibiotics*

A special challenge of meat production is the elimination of antibiotics from animal farming. For a long time, antibiotic growth promotors (AGPs) were added to the feed of livestock for the prevention of infectious diseases. Since certain of these products are structurally related to antibiotics used in human medicine, the considerable risk of inducing cross-resistance in life-threatening pathogens has been recognized. Consequently the prophylactic use of AGPs has been banned in Europe, but is still allowed in the rest of the world. As alternatives to AGPs so-called “Eubiotics” – which have the ability to beneficially modulate the gut microflora – are being developed. Pre- and probiotics, organic acids and essential oils have the potential to foster adequate gut health. Yet the therapeutic use of antibiotics for treating animal diseases is currently not under scrutiny, although the approval for certain products from human medicine has been revoked.

#### *Environmental considerations*

Facing the massive increase in demand for animal-derived food and consequently the enormous expansion of animal husbandry, the environmental emissions from this industry must be given special attention.<sup>9</sup> The first concern should be the sustainable



Salmon – a carnivorous fish species that needs fishmeal for fast growth when farmed

disposal of manure. Although animal excreta and slurry are convenient fertilizers, grasslands and croplands should not be oversupplied with nutrients which cannot be bound by the soil matrix and therefore would leak out into rivers and lakes, causing eutrophication of the water resources. Furthermore, trace elements such as zinc, copper and cobalt, which are essential for animal performance, can accumulate in the soil and thereby create damage to the growing crops. Making animal-derived protein production more efficient should result in less excreta per unit of edible product. But considering the expected expansion of production, novel concepts for processing the manure and potentially extracting valuable fractions from this material for re-use are urgently required.

Gas emissions of carbon dioxide, ammonia and methane, which contribute to the greenhouse effect and thus aggravate the global warming problem, should not be allowed to increase.<sup>10</sup> For this environmental issue, a few feed additives are available on the market, but none of them currently seems sufficiently efficacious to allow anticipated levels of production growth in poultry and swine with neutral or shrinking emissions. Methane from enteric fermentation in ruminants represents the single largest source of anthropogenic origin. For this segment, a feed additive is under development which has the potential to reduce methane emissions by at least 30%.<sup>11</sup> Nevertheless, more research and development in this field is urgently needed.

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# Food Waste in the Developing World

## The potential impact of engineering less waste

### Jenifer Baxter

Head of Energy and Environment, Institution of Mechanical Engineers, Westminster, London, UK

### Key messages

- > We produce approximately 4 billion tonnes of food globally each year.
- > We waste 30–50% of all food produced.
- > Levels of wasted food lead to overproduction in both the developed and the developing world.
- > Engineering solutions can reduce food waste and protect the food-growing environment.
- > Engineering solutions can use food waste for heat, power and fertilizer.
- > Less food waste and good engineering practices can lead to better access to food for those in developing countries.

### Definitions

#### Food loss

The decrease in edible food mass at the production, post-harvest, processing and distribution stages in the food supply chain. These losses are mainly caused by inefficiencies in the food supply chains, like poor infrastructure and logistics, lack of technology, insufficient skills, knowledge and management capacity of supply chain actors, no access to markets. In addition, natural disasters play a role.

#### Food waste

Food which is fit for consumption being discarded, usually at retail and consumer level. This is a major problem in industrialized nations, where throwing away is often cheaper than using or re-using, and consumers can afford to waste food. Accordingly, food waste is usually avoidable.

#### Food wastage

Any food lost by wear or waste. Thus, the wastage is here used to cover both food loss and waste.

**Source:** Food Wastage Footprint and Environmental Accounting of Food Loss and Waste. Concept Note. Natural Resources Management and Environment Department, Food and Agriculture Organization of the United Nations. March 2012.

### Diminishing resources, rising energy costs

Across the globe we currently produce around four billion metric tonnes of food per annum. The UN has projected that by 2100 the population could peak at 9–12 billion, creating an extra 3–5 billion mouths to feed. Today we waste some 30–50% of all food produced: this happens at farms, in storage and transportation, in factories and retail outlets, as well as in the home. In spite of this huge wastage, people starve and depend on social safety nets and food banks in both the developing and the developed world.

**“Today we waste some 30–50% of all food produced”**

The United Nations describes three types of countries: developing economies, economies in transition, and developed economies. The classifications are designed to reflect the characteristics expected with each type of economy, and some countries in the transition category will appear in more than one cat-

egory.<sup>1</sup> This article will consider developing and transitioning nations together and developed nations separately.

The Institution of Mechanical Engineers in its 2013 Global Food report identified three areas where impacts will continue to cause problems for food production and climate change in the future. They are:

- > The area of land available for agriculture will diminish due to factors including environmental degradation, stresses related to climate change, and restrictions aimed at preservation of ecosystems, as well as competition with other demands on land use, such as biomass-derived energy initiatives, urbanization, transport, industrial and leisure needs.
- > Increased competition for available water from urban developments and industry will reduce the quantities available for crop and livestock production. This will happen in a world of uncertain rainfall patterns, drought and flooding, due to the effects of global warming. The impact of global warming on water resources, the potential regional losses of fresh water, the rise of sea levels and the subsequent consequences for agriculture present a future global challenge whose extent is currently unclear.
- > Energy costs, particularly for fossil fuels, are likely to rise substantially, with increasing demand for, and diminishing availability of, easily exploitable secure supplies. This applies to fuels used directly to power agricultural machines, processing equipment, transportation and storage facilities, as well as to the significant amount of natural gas that is used in the production of fertilizers and pesticides.

Tackling these three challenges will be key to successfully reducing not only food waste but also the unnecessary waste of energy, water, human resources and emissions, as well as the associated damage to soils and ecosystems. This will lead to more efficient food production, better access to food globally, and a reduction in the impact of food wastage.

### Developing and transitioning nations

Food loss is created in the developing world primarily through poor or low-tech approaches to the farming, storage and transportation of crops. This may occur through inefficient farming techniques whereby food is damaged or remains unharvested and is left to rot.

This type of harvesting may be followed by inappropriate storage, where there is not sufficient cooling to keep crops fresh or else early biodegradation is increased through dense storage techniques that create excess heat. Further losses can occur in the transportation of food: this may be due to lack of refrigeration or to damage caused to badly secured food products in transport. This can be seen in rice losses in South East Asian countries: in



Despite huge advances in agricultural technologies, some 30–50% of all food produced is lost

China, a country experiencing rapid development, the rice loss figure is about 45% of the crop, while in less-developed Vietnam, rice losses are as high as 80%.<sup>2</sup>

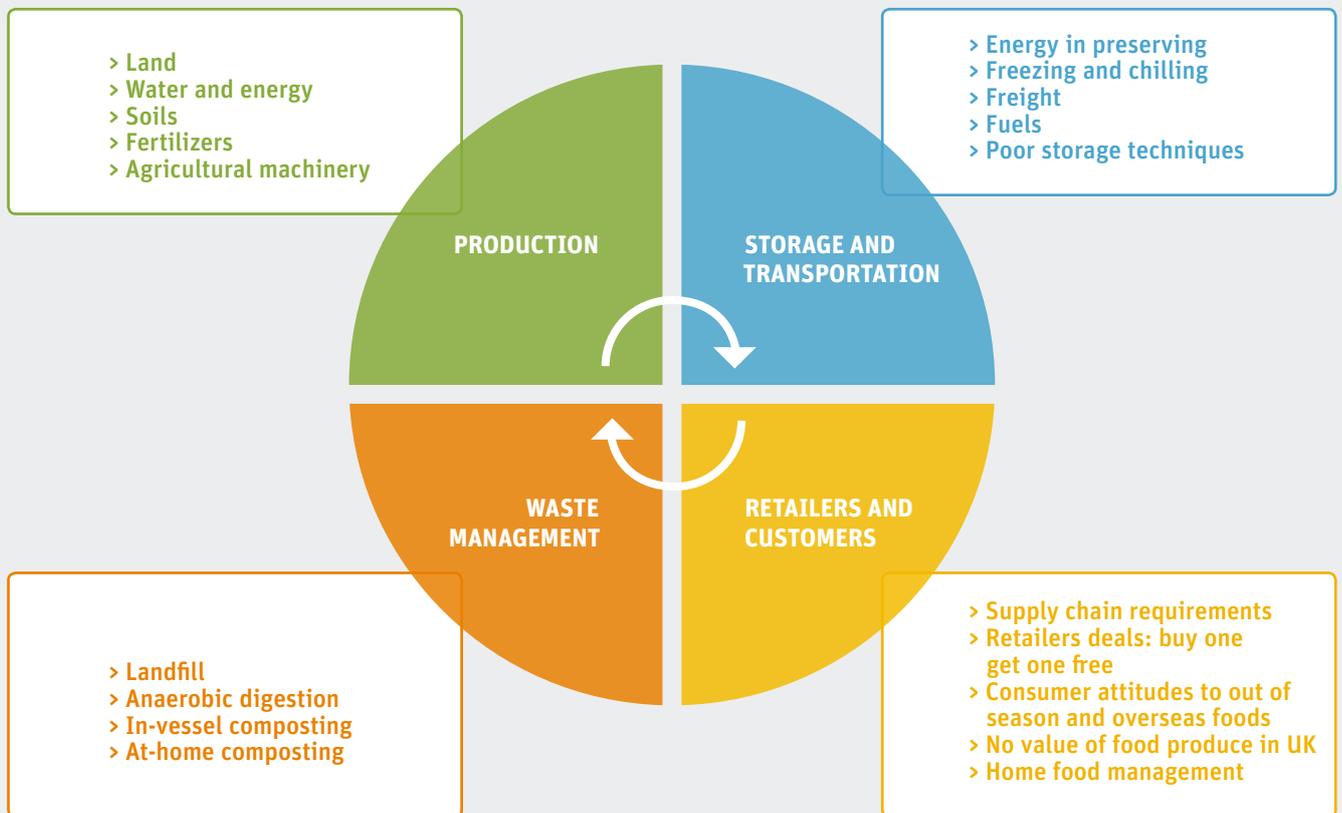
As nations move into a transitional phase of development, the technologies used for efficient farming reduce the waste at production, but an increase is seen further along the food chain at transportation, storage, retail and consumption.

In addition to this food waste being created by easier access and consumption of food in transitioning nations, further packaging waste is produced. This is often unmanaged, as commercial economies experience growth faster than the transitioning nations can build infrastructure to manage wastes. That said, innovations in smart packaging have the long-term potential to reduce food loss by keeping produce fresh and safe to consume for longer.

The production of food is a service that comes from our planet's natural ecosystems and requires these systems to remain fertile and pollutant-free. In many developing nations, access to fertile land is dwindling. It is expected that the demand for agricultural production will increase by up to 70% by 2050, with particular increases of up to 45% in meat consumption.

### Engineering a solution in developing and transitioning nations

Across the globe, engineering has consistently provided solutions to help increase food production. These range from effective techniques for spreading fertilizers and pesticides to advancements in crop management techniques. Today we look to engineering to provide a low-carbon, clean solution that will help developing and transitioning nations to feed their

**FIGURE 1:** The cycle of production, storage & transportation, retail & consumption, and waste management

populations without devastating the land. This is becoming increasingly important as populations grow and land space for farming shrinks.

Agriculture produces greenhouse gas emissions; these emissions then create a warmer climate that reduces access to water and fertile land areas. The need to engineer out the emissions from agricultural practices and wastes is evident if the vicious cycle described above is to be broken.

As the 21<sup>st</sup> century unfolds, the role of systems thinking in engineering is beginning to draw in all aspects of life. From food production to the generation of consumer waste, engineering systems can be used to both reduce waste and provide heat and power to communities. These can then be used to facilitate the better storage and transportation of crops.

When considering systems in developing and transitioning nations, there are some technologies that are equally suitable to managing wastes and creating heat and power. The idea of combined heat and power, whereby a small gas or biomass generator provides both electricity and heating, is not new in technological terms, but it is rarely thought of as useful in countries where there is too much heat. Technologies employing anaerobic digestion – a process that digests food and sewage waste and

produces a biogas – can be used to generate both electricity and gas for adapted farm vehicles. Waste heat from this process can be used to produce cold from absorption chillers. Cooling can then be transported through pipes to manage storage spaces for food crops.<sup>3</sup>

An absorption chiller is a technology that uses heat and a concentrated salt solution to produce chilled water. Absorption refrigeration uses very little electricity compared to an electric-motor-driven refrigerator. Variable heat sources can be used to drive the absorption refrigerator.<sup>4</sup>

In many developing and transitioning countries where the climate is warm and sunny, solar power for retail and domestic cooling is another technology that could significantly reduce food waste. There are two ways this can be achieved. Solar energy can be harvested through the heating of water on roof tops, and this water can then be used to drive an absorption chiller for air conditioning. The second approach involves using solar panels that produce electricity and can be deployed directly to drive refrigeration.

These types of technology can be particularly useful in regions where continuous mains electricity is intermittent. Taking the off-grid approach to managing cold not only reduces

the food waste and maintains the nutritional value of the food, but also reduces emissions of carbon dioxide and other greenhouse gases.

For this to be successful across the globe, support from developed countries will be required in technology and skills transfer, along with aid to support infrastructure development. These technologies may not be successful if there is not adequate support for governments, locally and nationally, to implement waste collection and management schemes.

## “Engineering systems can be used to both reduce waste and provide heat and power to communities”

### The role of engineering out food waste in nutrition

As an engineer, it is relatively easy to see how we could solve many of the problems globally associated with wasted food. Effective cooling and consumer management of food allows that food to last longer and retain its nutritional value. However, these changes involve new technologies, and they are not being implemented in developed countries due to the financial investment and potential policy changes needed to create a clean, low-waste food chain.

The low political and financial value placed on food loss in developed countries has led to a situation in which low-income families are seeking support from charity food banks and a waste management infrastructure designed to deal with huge amounts of waste that is actually fit for human consumption. In

turn, this lack of political will has stifled innovation and created a society in which food must be perfectly formed to merit being consumed, rather than being seen first and foremost as nutritious fuel for humans.

In the developing nations, there is an opportunity – if it can be financially supported by the developed and transitioning nations – to create a sustainable and clean food production environment through the implementation of policies and technologies described in this article. Without forward planning for developing and transitioning nations, there will be a lot more food waste globally, as populations swell and associated resources are wasted, simultaneously contributing emissions to global warming.

We can feed the projected 2075 population today, but it will be necessary to change our attitudes, diets, behavior and technologies to ensure that everyone in the world benefits.

## “We can feed the projected 2075 population today, but it will be necessary to change our attitudes, diets, behavior and technologies”

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An agricultural worker in a paddy-field. The world's ecosystems must remain fertile and pollutant-free if the nutritional needs of the rapidly growing global population are to be met.

# Dr Urban Jonsson (1944–2016)

## Bjorn Ljungqvist

United Nations System Standing Committee on Nutrition (UNSCN)

Dr Urban Jonsson passed away on March 8, 2016, just a few days after his 72<sup>nd</sup> birthday.

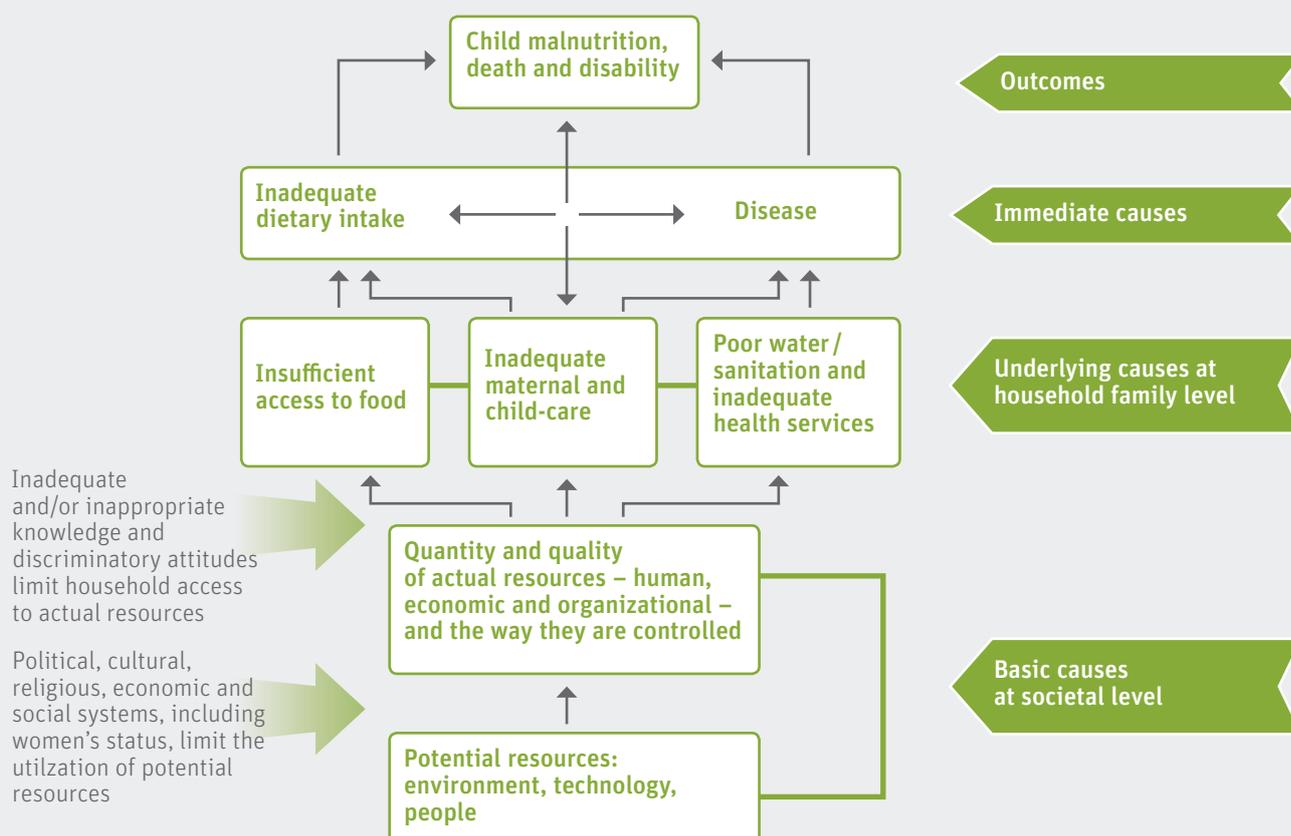
Urban Jonsson, a national of Sweden and resident of Tanzania, held a PhD in Food Science with focus on Nutrition. He pursued advanced training in nutrition at Cornell University and

lifelong studies in philosophy, mathematics and a series of other disciplines in order to build his impressive competence within the broad areas of development and human rights, often with the problems of nutrition and hunger as the point of reference.

## A long and successful career in UNICEF

Following academic and research work at Chalmers University in Sweden, the Tanzania Food and Nutrition Center and the United Nations University in Tokyo, he started his long and successful career in UNICEF as the country representative to Tanzania in

FIGURE 1: UNICEF conceptual framework on the causes of child malnutrition (1990) – a key element in Dr Jonsson’s legacy.





Dr Urban Jonsson

1981. He went on to become the chief of nutrition for UNICEF globally, and then regional director, first in South Asia, based in Kathmandu, and then in Eastern and Southern Africa, based in Nairobi. He completed his career in UNICEF as senior advisor on human rights, and then went on to work on a series of significant assignments and publications in this area.

Dr Jonsson will be remembered for leading the groundbreaking work to develop the “UNICEF conceptual framework for nutrition causal analysis,” which has become universally adopted and used as a tool to understand and find solutions to nutrition problems. He will also be remembered for introducing the principles of “duty-bearers and claim-holders” in human-rights-based development programming.

#### **A phenomenal capacity for systematic research**

For those who were privileged to know and work with Urban, there is a wide range of issues related to development, nutrition, HIV and AIDS, human rights, and social justice where his phenomenal capacity for systematic research and analytical clarity helped to open new insights and, indeed, amazing opportunities for enhancing human dignity and respect. He was tireless in his commitment to children, and to all of humanity.

Urban leaves behind his wife, Dr Olivia Yambi, his two daughters Asa and Anna, his grand-daughter, and family in Sweden. He will be greatly missed by his many friends and colleagues, and by countless other persons in all parts of the world – from ordinary mothers and fathers to leaders in the highest positions – whose lives he touched. The world will surely be diminished, and less lively, without him.

Urban Jonsson, with strength and determination, stood up against oppression, indifference, and pure nonsense, and created meaningful ways to realize children’s right to health, nutrition, education, and a life free from all forms of violence.

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*This obituary first appeared on the website of the United Nations System Standing Committee on Nutrition (UNSCN), the food and nutrition policy harmonization forum of the United Nations ([www.unscn.org/](http://www.unscn.org/)). UNSCN thanks Urban Jonsson for his important support to UNSCN, especially his dedicated chairmanship of the UNSCN working group on nutrition, ethics and human rights.*  
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# A Day in the Life of Patrizia Fracassi

**Patrizia Fracassi** is Senior Nutrition Analyst and Strategy Advisor for the Scaling Up Nutrition (SUN) Movement Secretariat. She discusses her remit within the Secretariat and the wider role of the SUN Movement as it celebrates the first five years of its existence and prepares itself for the next five.

**Sight and Life (S&L):** *Patrizia, the SUN Movement has developed immensely since it was first created in 2010, but perhaps not all our readers might be familiar with it. Could you start by explaining what the acronym “SUN” stands for, and what the Movement is about?*

**Patrizia Fracassi (PF):** SUN stands for “Scaling up Nutrition.” It’s not an initiative or a program or an agency, but a combination of all of the above and more! The SUN Movement is essentially country-owned and country-led. Currently it has 56 country members, Sudan being the most recent to join. Governments sign up to become members of the SUN Movement. It’s not a grassroots movement as such, but we believe that solutions must come from within each country in order to achieve the best possible results, and we strive to encourage this mindset. Bottom-up, country-led dialogue is what the Movement was founded on.

The SUN Movement aims to bring stakeholders together – from different government sectors, national and global civil society organizations, businesses, and the UN system, as well as researchers and scientists – to contribute to improved nutrition outcomes. It aims to provide all these stakeholders with a collaborative space for sharing, aligning and coordinating actions and approaches. The emphasis of the SUN Movement is on the multi-sectoral and multi-stakeholder approach, with clear recognition of the unique role and expertise of each sector and stakeholder.

**S&L:** *What is your role within the SUN Movement?*

**PF:** I’m the Senior Nutrition Analyst and Strategy Advisor in the

SUN Movement Secretariat and as such my role covers content management and coordination. Essentially, I maintain an overview of the core aspects of the Movement. My main tasks involve advancing the country-led agenda on effective multi-sectoral approaches for planning, costing, managing and monitoring implementation, tracking financing and mobilizing resources.

Most recently I’ve been working on the 2016–2020 mutual accountability and monitoring & evaluation frameworks for SUN. This involves making sure that everyone is reading from the same page, albeit in many, many different languages. You’d be surprised how many different perceptions exist sometimes, even in the one language!

**S&L:** *What’s your background, Patrizia, and what brought you to SUN?*

**PF:** Before joining the SUN Secretariat, I worked in Ethiopia with UNICEF on strengthening nutrition information systems and for the World Bank on linkages between the Productive Safety Net Program and the National Nutrition Program. I also worked for UNICEF Uganda as a nutrition specialist, and previously for the Italian humanitarian organization CESVI and Oxfam Italia in Vietnam as Country Representative, specializing in community-based nutrition, primary health care and livelihoods.

I started my professional career in Mumbai with the Indo-Italian Chamber of Commerce, working on female entrepreneurship. As a student, I spent nine months in Ethiopia studying participatory community methods, and I ended up doing my dissertation on the importance of formal and informal education.

I have an MA in Human Sciences and an MSc in Development Management, which I did at the Open University UK while working. I am currently a Doctoral candidate in Health Research. It’s challenging to work and study at the same time, but it helps put things in perspective. I believe one should always be open to question things, including one’s own assumptions. It keeps you sharp and focused.



Patrizia Fracassi on the road in Uganda

I came to SUN by chance. I was looking for a job in Europe and this sounded interesting. The interview with David Nabarro – who was Special Representative of the UN Secretary-General for Food Security & Nutrition and SUN Movement Coordinator at the time – was very eye-opening. I felt I came out of it having learned a lot.

**S&L:** *What is the remit of the SUN Movement Secretariat?*

**PF:** Our main remit is to empower countries to take the lead in their fight against malnutrition. We provide them with a platform where they can share their experiences, articulate their needs and also be challenged on what they do and how they do it. A lot of the work we've been doing requires continual adaptation. We don't have all the answers and solutions, but we can all learn from different shared experiences. We always try to work with what we have, and aim for continuous improvement. In reality, there's never a perfect way forward, so part of our role is to make sure that we do at least "move forward" – then we can see where we are!

**S&L:** *Where does the SUN Movement Secretariat fit within the wider framework of the United Nations?*

**PF:** The SUN Movement Coordinator is an Advisor of the Secretary-General. We work with the UN Agencies and with the other UN initiatives, but we also work with donors, NGOs and the private sector. We're neither a normative agency nor an implementing one. We could be considered a catalyst, because we exist to move the process along.

**S&L:** *Could you describe your office and your normal working day?*

**PF:** My "normal" working day is never that normal, actually! I work with colleagues within and outside the SUN Movement

Secretariat – mostly outside. My job involves a lot of communication, analyzing available data and information, working on common understandings and approaches, and always trying to find a way to move things forward. This requires a good balance between theory and practice, looking at the feasibility of ideas but also at their acceptability. I'm a bit of a troubleshooter too, making sure all the right cogs are oiled in the engine room.

**S&L:** *What projects are you currently working on?*

**PF:** I'm finalizing the 2016–2020 SUN Roadmap at the moment, focusing on the core of what the SUN Movement aims to achieve, which is to translate plans into successful impacts. My activity builds on the work countries are doing around planning, budgeting, financing and delivery. The project aims to find a simple way for decision-makers to look at these elements together as a coherent framework so that the results reflect the work of the various different sectors and stakeholders. This is no small task! There's a lot still to be understood, and many implications and assumptions of which we are unsure. But transparency and openness can help to identify any warning signs and help us to learn, adapt and, as I've said before, "move forward." "Always move forward" is my motto: if you don't, you stagnate.

**S&L:** *What do you enjoy most about your job, Patrizia?*

**PF:** I enjoy collaborating with people, especially experts from different disciplines. I have the privilege to work with people who are passionate about what they're doing. I've found collaboration with these people – who range from international experts through country focal points to local activists – incredibly liberating and creative. I also like to work with people who have a client-focused ethos, especially when working on requests from member countries. Their drive is exhilarating!

**S&L:** *What would you change about your job if you could?*

**PF:** I'd like to spend more time in the countries once more. That's where I started, with four years in Vietnam, two in Uganda, and four in Ethiopia. Back to implementation, in other words: I miss that aspect of my previous work. I'd like to have the opportunity to spend some time in the communities and look at the details on the ground, examining what works, and what doesn't, and all the implications. There's a lot to be said for working with local communities. You get to see the real effect of what you are doing.

**S&L:** *Does your work with the SUN Movement Secretariat involve extensive travel?*



Patrizia Fracassi with Benin Minister of Development Marcel de Souza at a workshop on Costing and Financial Tracking in Benin, October 2014



Patrizia Fracassi leading a focus group discussion on infant and young child feeding (IYCF) in Uganda

**PF:** Yes, I travel all the time. Mostly to participate in workshops around the world.

**S&L:** *What has been your best moment since joining SUN?*

**PF:** I've really enjoyed the journey I've been on since joining SUN. Great memories are of the first SUN Movement Global Gathering in 2011, which was very emotional, and of the Nutrition for Growth event in London in 2013. From a professional perspective, my most rewarding moments have been the regional workshops that have been organized with UNICEF and other partners since November 2013. We've always tried to take these workshops as an opportunity to unjam sticking-points. Last year it was great to see that 30 countries participated and that they were investigating nutrition in their own national budgets.

**S&L:** *What, in your opinion, are the biggest challenges currently facing the SUN Movement?*

**PF:** The biggest challenge is also, in many ways, the biggest opportunity. The "Movement" needs to ensure that it continues to be country-owned, with all operative parts of the constituent societies wholly committed to improving nutrition across the board. I think that the role of civil society alliances is pivotal in making nutrition an issue of justice. In other words, it's the "multi-stakeholder" aspect that's both the biggest challenge and the biggest opportunity. This requires working with multi-disciplinary teams while looking at scientific, practical and political aspects as well as the legal implications.

**S&L:** *What are your interests outside work?*

**PF:** I love travel, the sea, socializing, playing tennis, dancing, music and cinema. And my husband, of course, without whose support I wouldn't be able to do any of the above! He is my rock.

**S&L:** *Has working for the SUN Movement influenced your relationship with food?*

**PF:** It's made me more aware of the different food systems existing in the world today – the origin of the foods we eat, that is to say. But I come from Italy, and the concepts of "slow food" and of food as identity are part of our way of life. In fact, I think that the cultural aspects of eating and of food should play a bigger part in any discussion about nutrition!

**S&L:** *Is there a book on nutrition that you would recommend to our readers?*

**PF:** *The Road to Good Nutrition*, edited by Manfred Eggersdorfer, Klaus Kraemer, Marie Ruel et al, and on which you yourself worked, is a pretty good one, I'd say. I would recommend *From Field to Fork: Food Ethics for Everyone* by Paul Thompson. And also, not directly related to nutrition, *Famine Crimes: Politics & the Disaster Relief Industry in Africa* by Alex de Waal.

**S&L:** *Do you have a hero or heroine, Patrizia?*

**PF:** I've always been fascinated by the jazz singers Nina Simone and Billie Holiday. Their passion and struggle were completely expressed by their music. The female activists that were killed last year and the years before for speaking out are also my heroines. In 2015 alone, Joan Kagezi, Nadia Vera, Norma Angélica Bruno Román, Catherine Han Montoya, Losana McGowan, Intisar al-Hasairi, and Angiza Shinwari were murdered for defending human rights. And of course, Nelson Mandela is a hero of mine. I can never get enough Mandela!

**S&L:** *If you could have been anything in this life, what might you have become?*

**PF:** I wanted to become a documentary-maker. The first time I went to Ethiopia for my research, I turned down the opportunity to attend a documentary school in Marseilles. There's still time, though. Who knows – maybe I'll pitch the idea of one that covers the origins of the SUN Movement. It's a story worth telling, don't you think? And I've certainly got plenty of material!

**S&L:** *Thank you, Patrizia, and the best of luck with that concept and with all your current work for the SUN Movement.*

**PF:** Thank you, Jonathan.

**Patrizia Fracassi** was interviewed by Jonathan Steffen, February 2016

# The Lazio Declaration for Implementation Science in Nutrition



Leading scientists and nutrition professionals meet in Gandolfo, Italy, in February 2015 to establish the Society for Implementation Science in Nutrition

.....  
“Poor implementation and low quality of service delivery remain major bottlenecks to achieving scale and impacts”  
.....

Chronic malnutrition affects 165 million children and causes 3.1 million child deaths annually, or 45% of all child deaths.<sup>1</sup> Malnutrition is the single largest cause of death because it potentiates fatal infectious diseases. And if children survive, mal-

nourished children have higher odds of poor health and development outcomes.<sup>1</sup> We know how to prevent almost all these deaths and improve nutrition, health and child development with current interventions, but poor implementation and low quality of service delivery remain major bottlenecks to achieving scale and impacts.<sup>2</sup> In response to these challenges and the threats to food security caused by climate change, conflicts and economic crises, there is renewed interest and investment in nutrition, exemplified by the Scaling Up Nutrition (SUN) Movement, the Nutrition for Growth Summit, the Sustainable Development Goals, the Second International Conference in Nutrition, and the Power of Nutrition Fund. As commitments build, and countries engage more deeply with questions about how to

deliver nutrition programs at scale, the two critical challenges are: achieving high coverage, and delivering high impact from interventions already shown to have health and human capital benefits.<sup>3</sup>

.....

**“Fulfilling our commitment to health and human development requires an ambitious implementation science agenda”**

.....

In 1991, Alan Berg blamed the general failure in reducing malnutrition on the lack of focus on *how* nutrition interventions and programs are delivered.<sup>4</sup> More than 20 years later, we still lack sufficient knowledge about how to translate knowledge into effective programming, including how to overcome system barriers. Fulfilling our commitment to health and human development requires an ambitious implementation science agenda for informing the scaling-up of nutrition actions; generating evidence on the cost-effectiveness and equity of delivery strategies; and improving our understanding of the management processes and frontline capacities that increase the quality of nutrition service delivery.<sup>3</sup> This requires developing innovative research modalities, including more effective ways to link research to implementation. Importantly, we need significant increases in funding for implementation research because currently nutrition comprises less than 0.5% of total overseas development assistance, and estimates suggest that less than 3% of that funding is allocated to implementation research.<sup>5</sup>

.....

**“This Society values scientific and practitioner knowledge, bestows professionalism through affiliation and continuing education, and actively creates partnerships”**

.....

In February 2015, at Castel Gandolfo, Italy, the Society for Implementation Science in Nutrition was established ([www.implementnutrition.org](http://www.implementnutrition.org)). This Society values scientific and practitioner knowledge, bestows professionalism through affiliation and continuing education, and actively creates partnerships, acknowledging that nutrition is implemented through integrated multi-sectoral (and hence complex) programs, policies and strategies. There is a need for: **1)** scientists in academic centers

to fully engage in implementation research in the challenging context of real-world policies and programs; **2)** action agencies, program planners and funders to invest, support and partner in such research; and **3)** high-quality and influential peer-reviewed journals to publish this work.<sup>2</sup> Only through a collective effort involving financing, evidence generation, training, dissemination and policy engagement can we ensure that nutrition actions are appropriately designed and implemented at scale to reduce malnutrition in all its forms.

**Jean-Pierre Habicht**, member of the writing committee, **on behalf of the Founding Members** of the Society for Implementation Science in Nutrition.

**The Society for Implementation Science in Nutrition**

To learn more about the Society or about becoming a member, please visit [www.implementnutrition.org](http://www.implementnutrition.org).

**The criteria for membership are as follows:**

.....

Full members of the Society are individuals from civil society, academic, government, UN agencies, and/or business sectors with a record of accomplishment in nutrition implementation science, who have published in peer review journals, are active in implementation research, are actively implementing nutrition programs, or working at the interface of policy and program planning and/or operations.

**Full membership is open to individuals who are:**

.....

- 1.** Investigators with a doctoral degree or equivalent experience with proven track record of research pertinent to the areas of implementation research.
- and/or**
- 2.** Professionals with demonstrated experience, interest and/or proven track record in the implementation of nutrition programs and interventions, or the operationalization of nutrition policy.

**Contributors**

Jean-Pierre Habicht oversaw the writing of the letter. The Founding Members conceptualized, drafted, gave final approval and agreed to be accountable for the work. The writing committee (identified by an asterisk\* below) wrote the first drafts of the letter and incorporated improvements made by the other Founding Members. Eva Monterrosa\* managed the writing committee and is the corresponding author.

**The Founding Members**

Mandana Arabi, Jean Baker, Gilles Bergeron, Martin Bloem, Howarth Bouis, Namukolo Covic,\* Luz Maria De-Regil, Patrizia Fracassi, Stefan Germann, Stuart Gillespie, Susan Horton, Jessica Johnston, Joyce Kinabo, Rolf Klemm, Klaus Kraemer, Karin Lapping,\* Anna Lartey, Purnima Menon,\* Eva Monterrosa, Robert Mwadime, Lynnette Neufeld, David Pelletier,\* Gretel Pelto,\* Juan Pablo Peña Rosas, David Peters, Ellen Piwoz,\* Juan A Rivera, Marie Ruel,\* Werner Schultink, Meera Shekar, Rebecca Stoltzfus, Emorn Udomkesmalee, Cesar Victora, Patrick Webb, Stanley Zlotkin.

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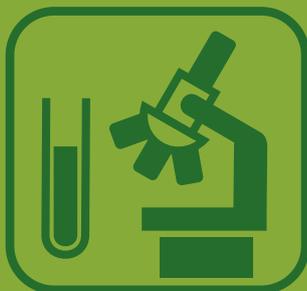
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“We declare that we have no conflicts of interest.”  
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# For a world free of malnutrition.

**advance**  
research

We initiate and support nutrition research, contributing to evidence and supporting key discussions.



*Sight and Life* is a  
humanitarian nutrition  
think tank of DSM



# The 2<sup>nd</sup> International Conference on Global Food Security

## Keiron Audain

Department of Food Science and Nutrition,  
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Take-away messages from the Junior Researcher Task Force

The second international conference on Global Food Security was held at Cornell University in Ithaca, New York, on October 11–14, 2015. It was co-hosted by Cornell University, Columbia University, and Elsevier Publishing, along with the Daniel and Nina Carasso Foundation as an Exclusive Platinum Partner. Well over 600 participants from more than 60 countries were in attendance, representing a diverse range of research domains within the context of global food security.

Following up from the 2013 conference in the Netherlands, the aim of this meeting instalment was to further broaden the participation of multi-disciplinary researchers, journalists and policy-makers involved in all aspects of food security. Organizers placed special emphasis on ensuring that the information presented at the conference was shared far beyond the attendees. This was the idea behind the Junior Researcher Task Force (JRTF) – a group of 22 competitively selected researchers assigned the task of disseminating conference information on social media. Special training in communication methods was provided to the JRTF members the day prior to the conference. In addition, eleven 90-minute “workshop cafés” were organized, in which participants had the opportunity to engage in critical discussion of some of the trending topics related to food security, such as: “Is there a role for genetic engineering in ensuring a food-secure world by 2050?”

**“Organizers placed special emphasis on ensuring that the information presented at the conference was shared far beyond the attendees”**

## Highlights from the plenary sessions

A few of the important highlights from the plenary sessions included an insight into the state of food security in a commodity-driven world. Global economic growth has led to several countries moving from low-income to middle-income status. The growth in commodities such as aquaculture and soybeans has created opportunities to increase income per capita and combat micronutrient deficiencies (hidden hunger) within emerging economies, and thus improve cognitive development among the



Conference attendees at the Bailey Hall during the plenary sessions

respective populations. However, such growth occurs against the backdrop of environmental degradation, and is accompanied by the risk of homogenization of the food supply.

The sustainability of food security and nutrition was also discussed, stressing the importance of rethinking the global food system with a focus on sustainable intensification, gender equality, fair trade and the reduction of food wastage. Methods to reduce the impact of climate change on current food systems were highlighted. Agriculture, which contributed 49 gigatons of greenhouse gases in the year 2010 alone, cannot be excused from emission targets. The impact of climate change is indeed a real one: losses in yield and damage by crop pests are already occurring, and are predicted to increase considerably by 2050. Hence the need for the promotion of climate-smart agriculture, which focuses on reducing emissions without compromising productivity.

Small-scale African farmers are highly reliant on markets, yet grossly disadvantaged by their dependence on these. Market access needs to improve in order to benefit the poorest smallholders, which can be achieved by the provision of reliable and low-cost market information, as well as low-risk contracts. It was pointed out that small markets in many developing countries are reassuming control of the pricing of their commodities, and that Africa needs to follow suit.

The question of whether smallholder farmers can benefit from agriculture and food security policies highlighted the need for trustworthy and transparent institutions to assist farmers with trading. With more people to feed and fewer resources with which to feed them, food security is becoming an increasingly

complex problem. Agriculture can indeed play a more involved role in improving nutrition, and therefore needs to become more nutrition-sensitive. This means much more than simply investing in biofortification.

The argument was put forward that genetically modified (GM) crops should be allowed and promoted in Africa, given the need for micronutrient-enriched foods as well as pathogen- and weed-resistant crops. However, it was advised that GM technology should be implemented only when no other alternative is available.

Behavioral economics should be considered in the context of developing food policies to promote better nutrition. It is important to identify, and communicate with, consumers who put little thought into their food choices and habits.

It was highlighted that global arable land expanded at a rate of 0.5% per year between 1986 and 2010, and that this increase has been accompanied by extensive deforestation. Yet this has done little to combat global hunger. Instead, there has been an increase in the consumption of foods high in sugar, sodium and animal protein, which in turn contributes to hidden hunger. As consumers become more aware of the sustainability of the foods they purchase, there are growing efforts to preserve available land by increasing agricultural adjustments to maintain land quality.

#### **Sustainable food systems: From consumption to production**

The Daniel and Nina Carasso Foundation hosted a special symposium on Sustainable Food Systems entitled "From Consumption to Production." Essentially, a sustainable food system resembles



Plenary Speaker Eleni Gabre-Madhin from Eleni LLC in Ethiopia

a situation whereby total food and nutrition security is achieved, coupled with a low environmental impact. However, the agricultural intensification model is not considered sustainable, as exemplified by declining aqua systems and inefficient irrigation. Such a system also erodes genetic diversity and keeps farmers in poverty due to the need to purchase high-cost inputs. At present, 80–90% of livable land is under agricultural production. There has, however, been an explosion of innovation to preserve ecosystems, such as the Evergreen Agriculture Project in West Africa. In essence, the entire agricultural landscape needs to be re-examined, and sustainable development must be led locally. Indeed, a sustainable food system will have long-term social and economic benefits that will be reflected in nutrition and health outcomes. Thus it is beneficial to examine the food system from a consumer's perspective in order to help identify and develop innovative solutions. One such solution is “food systems literacy,” whereby the consumer is educated as to how the food system affects individual food choices and dietary behaviors.

The remainder of the conference consisted of oral presentations that covered a broad array of topics from multi-sectoral researchers. Research presented by Smith and colleagues from Harvard University and Tufts University highlighted the effects of pollinator loss on global health. It was stated that a total removal of pollinators could reduce the global supply of fruits by 22.9%, vegetables by 16.3%, and nuts and seeds by 22.1%. All of these foods are major sources of micronutrients and play a role in lowering the risk of communicable and non-communicable diseases.

Empirical results from work done by Chiputwa and colleagues from the World Agroforestry Centre (ICRAF) in Kenya and the University of Göttingen in Germany showed that equipping smallholder farmers with certification to supply organic products improved both income status and gender equity, which in turn improved micronutrient and calorie consumption.

Data from the International Lipid-Based Nutrient Supplement research program showed that lipid-based nutrient supplements improved linear growth, decreased stunting and wasting prevalence, and improved aspects of cognitive and behavioral development in children aged 6–18 months from rural Burkina Faso who were being monitored and treated for malaria and diarrhea. Research conducted at the International Potato Center (CIP) in Uganda revealed that upon the promotion of biofortified orange-flesh sweet potato, the crop was adopted by 45,000 households with children under the age of five years, particularly in areas where farmer and community groups were involved.

### “More communication across disciplines is required”

The take-away messages from the conference included the need for an increase in communication across disciplines to combat the complicated problems related to food security. In addition, multi-sectoral partnerships must play a more prominent role in helping to alleviate the current data constraints across various aspects of the food system.

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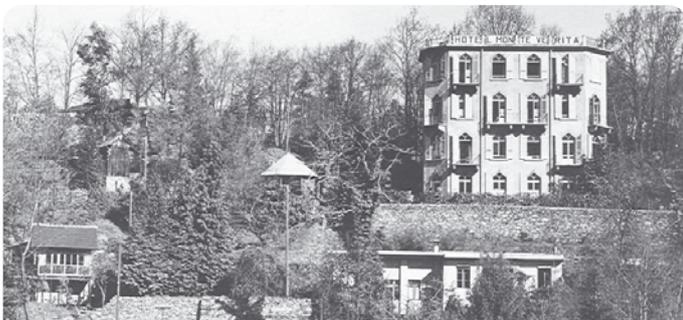
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# Tackling Food System Challenges

Thought leaders explore the role of interdisciplinary research and cross-sector collaboration in addressing food system challenges

**Michelle Grant and Aimee Shreck**  
ETH Zurich World Food System Center,  
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Monte Verità in former times

Tackling the challenge of providing a safe, sufficient, and healthy diet to everyone on the planet in a way that is socially, economically, and environmentally sustainable requires collaboration across disciplines, sectors and scales – an approach that is not easy either in theory or in practice.

Last year, an international group of thought leaders came together to share their experiences and exchange ideas on this topic with a diverse community; they discussed their methods, presented the food system topics emerging as most critical in their fields of study or practice, and discussed possible solutions. The group of 100 participants from 25 countries and 57 different organizations was convened in late June 2015 at Monte Verità by the World Food System Center at ETH Zurich (Swiss Federal Institute of Technology).

Monte Verità, the “mountain of truth,” is a special venue in southern Switzerland that has inspired new ways of thinking since the 1900s. The hilltop was first settled by a group of idealists from northern Europe who wanted to explore new ways of

living based on the principles of freedom, simplicity, cooperation and a respect for the natural environment. Though much has changed since then, the location and its unique atmosphere still provide the ideal backdrop for inspiring and creative discussions about ways of shaping a sustainable future.

**“Monte Verità provides the ideal backdrop for inspiring and creative discussions about ways of shaping a sustainable future”**

This gathering aimed to be a little different than an ordinary academic conference. Firstly, the participants came not only from academia but from a mixture of other sectors too. Representatives from nearly 35 universities and research institutions worked together with colleagues from international organizations such as the UN Food and Agriculture Organization, Bioversity, *Sight and Life*, the Global Alliance for Improved Nutrition, the International Food Policy Research Institute, government entities such as the Swiss Federal Office for Agriculture, and transnational companies including Nestlé, Bühler, and Syngenta. Secondly, the emphasis was intentionally on cross-disciplinary collaboration in order to learn from one another about viable solutions and identify emerging topics that need increased attention from partnerships that bridge traditional boundaries. The event was kept deliberately small in order to encourage participants to get to know one another and exchange ideas meaningfully in a relaxed and open setting.

## Food for thought

We structured the conference in a way we hoped would highlight a broad range of emerging topics, where interdisciplinary col-

laboration and new cross-sector solutions are urgently needed. Sessions balanced succinct presentations with significant time for discussion among panelist and audience participants. The dialogue often reflected the diversity of the group, and offered valuable contributions that also illuminated an underlying challenge of working across “disciplines, sectors, and scales” – namely, that communicating in this varied terrain can be tricky! We learned, for instance that while many are working in the area of “resilience,” this term can connote different things if you come from an agricultural or from a nutrition perspective. Or that the significance of the term “wicked” in the context of food system problems was not immediately clear to everyone in the room. Herein lie some of the ways this work itself is challenging, but herein also lies the value of gathering and finding a space to have these discussions.

Embracing this challenge, a number of topics that will benefit from more robust collaboration did emerge, including:

- > Embedding “resilience thinking” into our ways of working and designing interventions. A new buzzword, “resilience,” has great potential for designing and building food systems that deliver food and nutrition security in the face of increasing environmental, social, economic and political shocks.
- > Addressing the “triple burden” of malnutrition, which refers to the increasing concomitant occurrence of undernutrition, micronutrient deficiencies and overweight and obesity within the same population. We can no longer consider these as separate issues of North versus South,



Conceptualizing, assessing and building resilience in food systems

#### Conference participant

“By attending this conference, I was able to briefly take a step back from my detailed work, take a deep breath, and remind myself of the bigger picture as well as where I fit in now and how I can help in the future. On a professional level, it was helpful to hear new perspectives on issues which I don't often discuss at work, and to see how relatively unrelated topics are in fact extremely inter-related ... These concepts and themes have already given me a lifetime of ideas ... It also helped that the energy of the conference was electric. You could feel the passion emanating from the speakers and audience members.”

or of rural versus urban areas. We are now seeing all these challenges playing out within the same countries, communities and even households. Indeed, much evidence now points to the fact that those who are born undernourished tend to have a higher risk of being overweight or obese as adults and of dying of non-communicable diseases.

- > Reframing the challenges of food systems as “wicked problems” – meaning that these are not only complex problems but ones for which there are no simple solutions, as each solution will in fact lead to new problems. Tackling wicked problems requires an understanding of causal factors and the engagement of stakeholders to understand their differing interests, needs and relationships. Power over decision-making becomes an important factor, thus developing interventions in food systems requires managing tradeoffs and negotiations.
- > Making “the invisible” faces behind food systems visible – namely, people involved in agricultural labor, food processing, transportation, retailing and food service. Our current system does not offer sustainable livelihoods to many of these actors, and they are often the same people at risk of food or nutrition insecurity.
- > Giving more attention to the potential of diversity (biodiversity, genetic diversity, dietary diversity) to support human nutrition, environmental health and resilience by building nutrition-sensitive agriculture, landscapes, value chains and markets.
- > The need to widen the availability of affordable, nutritious foods for the poor, particularly women and children. Opportunities exist to develop new and innovative food products that can be produced and distributed locally, to support value chains based on their nutritional contribution, and to look at the potential of traditional food products, crops and preparation methods that may have been lost over time.
- > Value chain analysis that focuses on identifying opportuni-



Negotiating how to manage trade offs when dealing with wicked problems

ties that create value for all actors, including measures to add value to products closer to the farm gate. This can help to create sustainable livelihoods but can also help reduce losses and spoilage.

#### The way forward

Undaunted by these challenges, conference participants were overwhelmingly enthusiastic for more. Feedback emphasized that the conference was exceptional in its diversity: in terms of topics discussed, disciplines represented, approaches to problem-solving, and experiences shared. The broad range of themes in plenary sessions encouraged everyone to move out of their comfort zones and make connections to bigger issues. The attendees appreciated the chance to actively participate in a multi-day workshop on assessing and building resilience in food systems, a cutting edge concept in food systems analysis, which provided people with new tools and methods to integrate into their work.

In general, the conference echoed the need for further collaboration across disciplines, sectors and scales and better integration of participatory approaches to engage stakeholders. The conference was a first step in what is envisaged as an international forum to build and expand a food systems community, create new and uncommon collaborations and drive innovation to build sustainable and resilient food systems for all.

.....  
 “The conference was a first step  
 in what is envisaged as an  
 international forum to build and  
 expand a food systems community”  
 .....

#### Further information

More about the conference and presentations is available at [www.worldfoodsystem.ethz.ch](http://www.worldfoodsystem.ethz.ch).

The World Food System Center will continue this initiative under the banner of the “World Food System Forum.” Every two years an international event will take place at a different location around the world together with key partners. The next event is slated for mid-2017. Further information will be available at [www.worldfoodsystem.ethz.ch](http://www.worldfoodsystem.ethz.ch).

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 .....

# Technical Meeting on EED,\* the Microbiome and Undernutrition

## \*Environmental Enteric Dysfunction

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Nutritional and Health-Related Environmental Studies Section, Division of Human Health, Department of Nuclear Sciences and Applications, International Atomic Energy Agency (IAEA), Vienna, Austria

### Key messages

- > Stunting affects 161 million children under 5 years of age in low- and middle-income countries.<sup>1</sup>
- > Evidence-based nutrition interventions, at 90% coverage, amount to only one-third reduction in stunting.
- > Environmental insults acting through damaged gut function (a phenomenon referred to as environmental enteric dysfunction [EED]), are hypothesized to be responsible for a large part of intrauterine growth restriction and postnatal stunting, but the mechanisms remain largely unknown.
- > Combating EED and stunting needs an integrated approach to improve the following: maternal health and pre-conception nutrition, infant and young child feeding (IYCF) practices, access to health care, and access to safe water and sanitation.
- > A tool to assess EED is urgently needed to facilitate evaluation of interventions.

> Application of cutting-edge innovations such as the *omics* technologies and stable isotope techniques offer unprecedented opportunities to diagnose and characterize EED.

> Since EED depicts multiple causal pathways, striking the right mix of evidence-based interventions is a key prerequisite for success. Synergies across disciplines and sectors are needed.

Some 50 experts participated in a technical meeting on environmental enteric dysfunction organized and hosted by the International Atomic Energy Agency (IAEA) in Vienna, Austria on October 28–30, 2015. The meeting aimed to discuss current research, developments and experiences in diagnosing and evaluating EED, and the potential role of stable isotope techniques in EED diagnosis.

### What is known about EED

Stunting develops as a result of sustained inadequate nutrition and recurrent infection.<sup>2</sup> Environmental insults affect linear growth through mechanisms that are yet to be fully understood.<sup>3</sup> Environmental enteropathy is a combination of infection-undernutrition induced failure of the mucosal barrier of the gut and has recently been referred to as environmental enteric dysfunction to reflect the numerous gut function deficits associated with it. EED affects approximately 50–95% of children under the age of 5 years in resource-poor settings. There is compelling evidence to support the association of EED with: **1)** gut permeability/leakiness; **2)** nutrient malabsorption; **3)** microbial translocation; **4)** alterations in gut microbiota diversity; **5)** gut and systemic inflammation; **6)** linear growth faltering; **7)** reduced effect of vaccines and; **8)** severe acute malnutrition (SAM).<sup>4</sup>



Participants of the technical meeting come from diverse professional fields

### 1. Gut microbiome and EED

The gut microbiota is largely acquired at birth and develops quickly in the first year of life toward an adult-like pattern. It influences host development, immunity, metabolism and gut

motility<sup>5</sup> and is in turn influenced by factors including mode of delivery, breastfeeding practices, dietary diversity, genotype, pathobiology, physiology, age, the environment, immune system and host lifestyle.<sup>6</sup>

Unfavorable nutritional conditions can influence the microbial community composition, most often resulting in sub-optimal microbiota maturity, which is in turn correlated with host weight loss. Although there are no studies to date of the gut microbiome in the specific context of EED, there is evidence that some gut intestinal pathogens have specific mechanisms of action (such as mucin degradation) that make a link with EED biologically plausible.<sup>7</sup>

### 2. How does EED limit growth?

Insulin growth factor (IGF-I) regulates growth and other functions in the body during pregnancy. Inflammation of the small intestine in EED is associated with high C-reactive protein and may be accompanied by release of cytokines such as interleukin 6 (IL-6) that reduce appetite and food intake and impair production and action of chondrocyte growth factors. Stress-induced activation of the hypothalamic-pituitary-adrenal axis stimulates a rise in cortisol and insulin-like growth-factor-binding protein-1 (IGFBP-1), which inhibit IGF-1 action and induce chondrocyte apoptosis. A reduction in hepatic growth hormone (GH) receptor expression and inhibition of GH signaling by fibroblast growth

## Technical Meeting on Environmental Enteric Dysfunction, the Microbiome and Undernutrition

1. Knowledge and gaps on causes and consequences
2. Implementation and evaluation of programmes addressing EED
3. Management of EED and undernutrition, and tests for diagnosis
4. Knowledge gaps in EED where the IAEA can add value

➤ About 50 participants from academia, NGOs, BMGF, WB  
Oct 28-30, 2015



Cornelia Loechl, Head of the Nutritional and Health-Related Environmental Studies Section, welcomes participants, gives an overview of IAEA's activities in nutrition, and outlines meeting objectives.



Panelists from different sectors deliberate how interventions can best be packaged to address EED and stunting.

factor 21 and possibly zinc deficiency, further limit IGF-1 production and thereby contribute to growth failure.<sup>8,9</sup>

### 3. Energy and nutrient requirements in EED

Nutrient deprivation is associated with a decrease in epithelial barrier function and elevated detection of indicators for bacterial translocation. Vitamin A, zinc and some amino acids such as glutamine, threonine, leucine and cysteine are potentially involved in improving gut barrier function and absorptive capacity. Zinc, probiotics, flavonoids and n-3 polyunsaturated fatty acids (PUFA) have been associated with reduced inflammation.<sup>4</sup> In contrast, inorganic iron potentially shifts the microbiome towards a more pathogenic profile and increases gut inflammation. Inflammation and reduced absorption, both of which are evident in EED, may result in increased energy and nutrient requirements in children with EED. In children with EED, energy and zinc requirements are increased by up to 15% and 50%, respectively.

### 4. Use of stable isotopes in evaluating gut dysfunction

Stable isotopes have been used to assess gut dysfunction (small intestine bacteria overgrowth [SIBO], celiac disease and chemotherapy-induced small-intestinal damage in rats) with different substrates (starch and other carbohydrates, mixed triglycerides, fatty acids, proteins, etc.). An example of a diagnos-

tic <sup>13</sup>C breath test is the <sup>13</sup>C-urea breath test used to diagnose and monitor *Helicobacter pylori* infection in the stomach. The high specificity and sensitivity associated with the test makes it the ideal non-invasive diagnostic technique.<sup>10</sup> The <sup>13</sup>C-sucrose breath test is a promising future technique to assess gut function and has been used in Australia to measure the absorptive capacity of the small intestine.<sup>11</sup> The glucose hydrogen breath test is currently the most accurate non-invasive test to diagnose SIBO. Combined <sup>13</sup>C and H<sub>2</sub> breath tests could also be used to assess fermentation and SIBO with higher specificity by correcting for gastric emptying rate.

### 5. Biomarkers of EED

While malabsorption, gut barrier dysfunction and gut inflammation are overlapping components of EED, it is difficult to identify specific markers of each that could be used solely for EED diagnosis. An ideal EED biomarker should be highly associated with stunting, age- and population-specific, and classified according to the underlying causes of EED, namely: **1)** intestinal permeability and nutrient absorption (e.g., <sup>13</sup>C sucrose breath test, lactulose-mannitol intestinal permeability test), **2)** bacterial translocation (e.g., lipopolysaccharides), **3)** intestinal inflammation (e.g., myeloperoxidase), **4)** systemic inflammation (e.g., C-reactive protein), **5)** functional enterocyte mass (e.g., citrulline), **6)** intestinal repair (e.g., promoter glucagon-like

peptide-2 [GLP-2]), **7**) mucosal immune underachievement (e.g., kynurenine/tryptophan ratio)<sup>12</sup> and **8**) alterations in microbiota diversity.

### 6. Ongoing interventions to address EED

Interventions to address EED include: **a**) water, sanitation and hygiene (WASH), **b**) reduction of exposure to feces and contact with domestic animals; **c**) provision of probiotics and prebiotics; **d**) improvement of dietary diversity and breastfeeding practices; **e**) supplementation with nutrients such as zinc, PUFA and amino acids and; **f**) treatment with anti-inflammatory agents and antibiotics in the context of SAM and infection. Some of these aspects are already being tested individually or combined in large randomized controlled studies in a number of countries. Determining the right mix of evidence-based interventions to maximize effectiveness against EED remains a major gap.

### 7. The way forward

Several gaps in knowledge requiring attention include the classification and better understanding of the underlying causes of EED. Developing practical, simple, and affordable tools to diagnose and characterize EED to allow better targeting of interventions in vulnerable populations is overdue. Stable isotopes can be used to assess absorptive capacity/permeability of the gut, bacterial translocation and body composition as a proxy indicator of dietary quality and morbidity. Since EED depicts multiple causal pathways, striking the right mix of evidence-based interventions is a key prerequisite for success. Synergies across disciplines and sectors are needed.

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**“There is a need to develop tools to diagnose and characterize EED in order to allow better targeting of interventions in vulnerable populations”**

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# Nutrition for Sustainable Development

## The 17<sup>th</sup> Latin American Congress on Nutrition

### Noel W Solomons

CeSSIAM, Guatemala City, Guatemala

The XVII Latin American Congress on Nutrition was held in Punta Cana in the Dominican Republic under the auspices of the Latin American Society of Nutrition (SLAN). The theme of the meeting was “Nutrition for Sustainable Development.” The inaugural Keynote Plenary Lecture was in concert with that theme, featuring Francesco Blanca, Head of the Nutrition Division of the World Health Organization in Geneva. He positioned the newly released UN Sustainable Development Goals in the context of health in general and nutrition in particular.

The program included 25 individual presenters, as well as 80 symposia; completing the platform program was a controversies debate and a series of oral communication sessions with 320 free papers. A total of 598 free-paper presentations were scheduled as posters. Within this, four of the individual formats were explicitly devoted to issues of micronutrients, whereas 11 of the symposia were micronutrient-related.

### Plenaries and conferences

Dr Kathryn Dewey of the University of California at Davis was the winner of the McCollum International Award of the American Society of Nutrition for 2014–2015. Her presentation “Meeting nutrient needs during the first 1,000 days: A global challenge but a wise investment” constituted the awards lecture. Dr Dewey emphasized that exclusive breastfeeding remains the pillar of infant feeding during the first 6 months of life. She also updated the Congress on the emerging findings from the International Lipid-Based Nutrient Supplement (ILiNS) Project in Burkina Faso, Ghana and Malawi, in which anemia was largely controlled but additional linear growth was not seen. It should not be overlooked that none of the sites for the ILiNS Project were in Latin America or the Caribbean.

Omar Dary of the US Agency for International Development gave a conference in which he reviewed the history of the use of salt assays and urinalysis for iodine to assess the risk of io-

dine deficiency disorder. He recounted the misunderstandings that have been propagated over the interpretation of these two indicators and pointed to situations in which some sections of a population may be receiving excessive iodine as frequent consumers of ramen-noodle instant soups that double iodized salt intake; this was totally opaque to the index of households consuming adequately fortified salt.

Helena Pachón, of the Emory University in Atlanta, Georgia, spoke about making agriculture sensitive to the nutritional needs of populations. She reflected on her experience as the only nutritionist in the world of agronomists at the International Center for Tropical Agriculture in Cali, Colombia. To this she added a request for both patience and ingenuity in seeking improved food production from the agricultural sector. There is pressure on the land for non-edible or non-nutritious cash-cropping such as cotton, coffee and sugarcane as well as for the production of grains for animal feed. The first barrier to overcome is opening allocation of land for items that are consumed by humans. These must be high in yield and profitable for the producer. Taking the next step – i.e., to biofortified or protein-enriched varieties in the human-designated crops – requires these same conditions of production and profitability in order to engage the commitment of farmers.

“Conditions of profitability are essential for winning the commitment of farmers”

The Micronutrient Forum (MNF) Global Conferences have emerged to replace the international meetings sponsored by the various micronutrient “consultative groups” over the decades. The first revitalized MNF conference was held in Addis Ababa, Ethiopia, in 2014. News of particular interest to a Latin American constituency was delivered by Lynnette Neufeld of GAIN as the chairperson of the Steering Committee for the II MNF Global Conference, as it will be held in Cancún, Mexico, in October of



From left to right: Hector Cori, Edna Rodas, Ricardo Uauy, Rodrigo Valenzuela, Fernanda Elías and Ignacio Arauz

2016. The theme of the next conference will be: “Positioning Women’s Nutrition in the Center of Sustainable Development.”

### Congress symposia

Fortification strategies of a diverse nature were the topics of five of the 11 symposia. This included an overview of the overall risks, benefits and trade-offs of fortification programs as analyzed from the perspective of professionals from Spain. The Flour Fortification Initiative sponsored a symposium evaluating the fortification of cereal grain products with micronutrients across the Americas. Recommendations for addition to wheat and maize flours are in place. The impact of flour fortification on anemia prevalence in Costa Rica and on anemia and various vitamin deficiencies in Colombia were documented. A mathematical association between levels of red blood cell folate and risk of neural tube defects (NTD), derived by US data collected at the Center for Disease Control and Prevention, suggests that NTD prevention can be achieved if women attain, and maintain, a specific red cell level.

A fascinating joint forum was put together by the Pan American Health Organization and Micronutrient Initiative to explore the contradictions in contrasting public health policies of reducing the consumption of sodium to benefit vascular health and using table salt as a vehicle for iodine and other micronutrients. The evidence for the WHO recommendation for lower sodium

intake is solid and the efficacy of salt in controlling IDD is undeniable. The obvious way forward is rebalancing the fortification levels as salt intake declines. Drinking-water is often a naturally occurring source of essential minerals, but decades of experience in Brazil have demonstrated that water can be a vehicle for iron fortification to combat anemia in preschool- and school-children. Finally, biofortification is a strategy that has been advanced in the Americas by HarvestPlus and other partners. Presenters were able to provide concrete evidence of efficacy for human micronutrient status with crops fortified with iron, zinc and provitamin A. Much of the plant biology to inform the technology of enriching plants with carotene sources of vitamin A is now being understood.

### “Vitamin D deficiency extends throughout the Latin American and Caribbean region”

An entire symposium, in fact, was devoted to carotenoid biology in plants and in consumers, sponsored by the Ibero-American Network for the study of carotenoids as food ingredients; presenters came from Spain, Brazil and Panama. The symposium covered the dietary sources of provitamin A in Spain and the

Americas, as well as the factors surrounding the bioconversion of food carotenoids into retinoids. Vitamin D occupied the attention of another entire symposium. It was shown that deficiency in the vitamin extends throughout the Latin American and Caribbean region, despite the tropical location of most of the countries.

The state of the art regarding the so-called emerging micronutrients and trace elements was covered in two symposia. DSM sponsored a session in which vitamin E is seen as an emerging micronutrient in the Latin American region. The essential polyunsaturated fatty acid docosahexaenoic acid (DHA) has a number of functions that become more relevant in the dietary and environmental circumstances of low-income societies. The relevance and importance of interactions in the diet and in supplements was addressed with consideration of iron-zinc-copper and iron-zinc-calcium supplements. Diabetes is an emerging theme in the context of trace elements. Insofar as the zinc-binding proteins are related to insulin secretion, saturating intakes of oral zinc may have promise in diabetic and glycaemic control. Type 2 diabetes, moreover, is associated with obesity. Excessive iron exposure seems to be a factor in aggravating the inflammation associated with obesity, and in combination, diabetic control is more difficult and sequelae more prominent. The latter topic was revisited in a separate symposium on micronutrients, inflammation and obesity. Obesity is associated with lower status of zinc and of the B-complex vitamins. There is a bi-directional association of micronutrients and non-communicable, chronic diseases.

The PROCOMIDA was a 5-year, community-based, family-food diversification project conducted in the north-central area of Guatemala and based around the distribution of edible oil, beans, rice and fortified corn-soya blend along with a supplement for home-fortification of young children's rations. The US Agency for International Development sought to gather information on the relative cost-efficiency of various combinations of intervention packages, by providing only one or a few of the commodities with or without various multiple micronutrient supplements. Thus they created a nested, cluster-randomized study within the larger intervention, delivering numerous permutations of the basic delivery package, and called on the International Food Policy Research Institute (IFPRI) to monitor the process and impact within the study. The presentation at SLAN only described the process aspects of the comparative interventions, but it seemed obvious that the communities expressed a differential acceptability for the micronutrient supplements, with the sachet powder more widely accepted than the lipid-based nutrient spread.

An even greater proportion of the 918 free-paper presentations in oral or poster formats was related to issues of micronutrient nutrition and biology. At the conclusion of the meeting, the presidency of the SLAN passed from María de las Nieves García-Casal of Venezuela to Juan Rivera of Mexico for the next three-year period, to culminate in Cancún, Mexico in 2018.

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# Technology and the Future of Food

## Exploring the potential of IT to address food system challenges

**Michelle Grant and Aimee Shreck**

World Food System Center, ETH Zurich, Switzerland

Last year, at least US\$4.6 billion dollars in venture capital flowed into start-ups in the agriculture and food sectors worldwide.<sup>1</sup> Many of these companies try to harness information technology to address a market need, with food delivery being one application that has gained much attention. The current hype around digital disruption in the agro-food sector leads many to ask the question: how can information technology help us tackle serious and persistent food system challenges? Against this backdrop, we recently embarked on a study tour of the San Francisco Bay Area in California to seek answers to this question and to experience these developments first hand.

The study tour was designed as an educational program for a group of 20 university students from Switzerland and California. The group lived and worked together for five days, travelling over 760 km and visiting 21 different organizations. This “Field Report” provides an overview of some of the impressions we gathered during this study tour.

### “ETH Meets California”

The ETH Zurich World Food System Center organized a week-long course, *Tackling Food System Challenges with IT Innovation* as part of an initiative called “ETH Meets California.”

The course took students on a tour of California’s Silicon and Central Valleys to investigate the potential for disruptive technologies to contribute to food and nutrition security in a highly complex world food system. As a university, ETH Zurich

plays an important role in building the capacity of the next generation of food system leaders. This includes preparing students to engage responsibly and appreciate the opportunities and challenges of digitalization in the agro-food sector.

### For further information, please visit

[www.worldfoodsystem.ethz.ch/education/study-tours](http://www.worldfoodsystem.ethz.ch/education/study-tours).

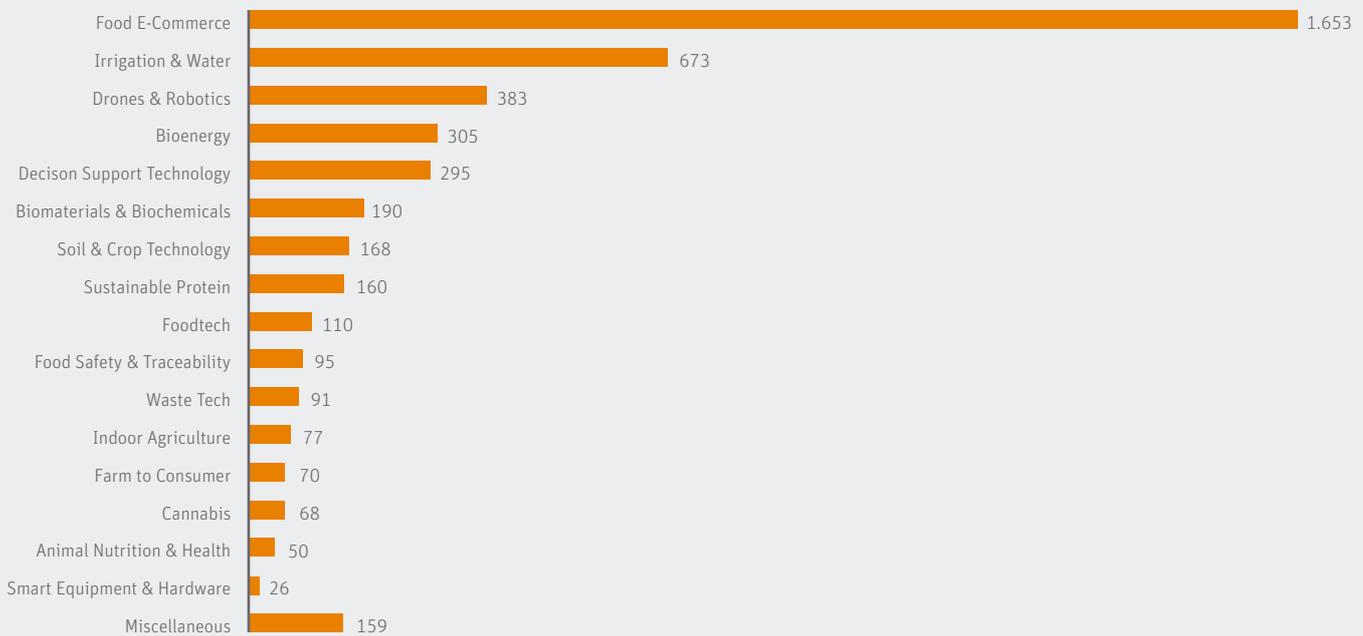
Reports from participating students may be found at [www.foodsystemstories.org](http://www.foodsystemstories.org).

### Hacking food banks for healthier food

During the trip, we were exposed to a wide range of challenges and solution approaches. One of those that highlighted the potential of IT as a change enabler was a food bank that aims to help the one in five food-insecure people in the Yolo county region access a healthy meal when they need it. The visionary leader of this food bank is trying to apply a business mindset to the way he runs the charity, including a closer collaboration with the nearby university to transfer the latest knowledge and tap into skilled volunteers and collaborators.

“Students designed an app to link agricultural producers with the food bank to redirect produce that would otherwise go to waste”

This partnership recently included a hackathon where a group of students from the University of California, Davis, de-

**FIGURE 1:** Ag and food tech investments by subsectors

**Source:** Burwood-Taylor L, Leclerc R, Tilney M. AgTech Investing Report: Year in Review 2015. Published by AgFunder, February 16, 2016. Page 15.

signed an app that would link nearby agricultural producers with the food bank in order to redirect produce that would otherwise become losses on field. The director of the food bank was

quite optimistic that IT could further help them in their mission to become a nutrition-focused food bank, though exactly how that could happen had not yet been defined. He felt that the only way to tap into this potential was to create more opportunities for those familiar with the technological possibilities to sit together with people out in the field who tackle the problems on a daily basis.

A panel of experts speaking at UC Berkeley in a public lecture on “The Challenge of Making Good Food Affordable” likewise felt the potential of IT innovation has not yet been exploited for this purpose. Toward the end of the event, one of our students raised the issue of IT and its potential to address the complex challenges they had outlined. All the panelists appeared a little surprised by the question, suggesting that this discussion is yet to trickle down from fast-paced start-ups to government and community-based organizations in a meaningful way. Yet as they reflected on it, there was a realization that there could be an opportunity to increase efficacy, targeting, and impact through improved harnessing of available technology.

### Apps for food delivery

The area that has seen perhaps the most concrete application of IT and the largest investments is the food e-commerce sector, which centers on (non-restaurant) food delivery services (**Figure 1**). The activity to date has focused on improving the health and well-being of urban professionals with disposable incomes



Visit to Yolo County Food bank to learn about how they are trying to become a nutrition-oriented food bank and helping tackle food insecurity in the region. A business-, data- and solution-driven approach is helping them overcome some of the challenges they face.



Visting IndiBio in San Francisco, the world's first synthetic biology accelerator, where biology is seen as "a technology to help solve our culture's most challenging problems."

in over 20 countries.<sup>1</sup> As this market gets crowded out by an overcapacity of these solutions, we are hopeful that the search for untapped markets will encourage new players to look at contributing to the challenge of getting healthy and affordable food into food deserts. These are the communities who are most in need of healthy, affordable and convenient meal options, and the technology and know-how already exists.

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**“The search for untapped markets will hopefully encourage new players to get healthy and affordable food into food deserts”**

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The limited range of applications to address this type of challenge highlights one of the major issues facing this sector – that what nutritionists, agriculturalists, and food system professionals want to see happening is typically not where venture capitalists wish to invest, or where start-ups are putting their energy. Fortunately there are examples of motivated individuals creating new business models with social impact in mind. With time, we hope these social entrepreneurs and impact investors will help further tap the potential this technology may hold.

### Synthetic food

The other field we saw receiving much attention is synthetics and food replacements – for example, meatless meat, egg-free eggs, liquid nutrition, and algae-based seafood. All of these applications, in one way or another, aim to bypass some of the serious environmental and social impacts of our current food production methods without requiring consumers to bear any of the discomfort or change their consumption patterns.

Despite the millions of dollars in capital flowing into these ideas, at the end of the day they are essentially trying to produce the same product that is already available at a much lower price. Given the extremely small margins in the food and agriculture sectors, these low prices are only possible due to a large number of externalized costs in our current food production systems. It was difficult for us to see how these start-ups will scale up economically and offer more than a “novelty” for the small number of conscious consumers with the disposable income to appreciate them. The responsibility and resources to “disrupt” the existing unsustainable systems are, however, still needed, and it is unclear if these approaches are helping us to address the root problems.

### Technology, labor, and livelihoods

Another major externality in the food system that was front and center during this study tour was labor. At many different stops we were told about a “labor problem in California,” and that it was becoming increasingly difficult to secure workers to plant, harvest, process, prepare, or distribute food. This was seemingly one of the major factors – along with the additional potential to improve precision and efficiency – driving the interest in automation and mechanization and the associated applications of robots and drones.

For us, this was a good example of how solutions are linked to how problems are framed. During our short tour, we saw only a few examples where people were asking deeper questions around the ethics of our current food system, which relies on millions of poorly paid laborers to carry out difficult work, often under trying conditions. Meanwhile, many of the workers whose labor supports the food system are simultaneously food-insecure, and they themselves experience some form of malnutrition. It is thus impossible to be concerned about malnutrition and not be concerned about labor conditions and livelihoods.

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**“It is impossible to be concerned about malnutrition and not be concerned about labor conditions and livelihoods”**

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As the tour came to a close, we wondered if these complex questions were being reduced to a problem that could be solved through a shift to automation and increased mechanization. These developments certainly offer great potential, however it is important that challenges around labor in the food system are not dehumanized at the same time. We couldn't help but think what could happen if we took the same enthusiasm, creativity, and funding that is currently being applied to robotics and drones and also applied it to answering the underlying question of how can we build a food system that ensures value creation and sustainable livelihoods for all?

### Potentials and selective optimism

Our experience suggests to us that there is great potential for IT to help address food system challenges in the areas of precision agriculture, food waste reduction, food safety, resource efficiency, personalized nutrition and convenience. These data-intensive fields can greatly benefit from the improved processing and analytics capacity IT offers today and can support solutions for these aspects of our food system.

Due to the limited time we had during our study tour, we only managed to scratch the surface of this huge space. Although we didn't see it first-hand, we heard about many other examples, such as how robotics and downscaled precision agriculture concepts are helping small-scale farmers maintain diverse cropping systems in a cost-effective way. Or how, for example, low-cost

“smart tractor” systems are allowing farmers to engage in a sharing economy to access state-of-the-art farm machinery in Nigeria. The breadth and potential of these technologies and their applications certainly left us hungry to learn more.

Perhaps not unexpectedly, we also saw that IT alone is no silver bullet to address the myriad complex issues we are facing today. It is most definitely an enabler of change in some sectors, but its potential will lie in our capacity to resist the seduction and current hype of the technology itself and to keep clear what the key needs, drivers and levers are for creating appropriate and effective solutions. We believe this will require greater exchange across disciplines and sectors, taking the entrepreneurial mindset and technological potentials and talking with people who deeply understand the issues in order to come up with meaningful applications.

If we can create an ethos around this sector that is based on an understanding of our most pressing societal challenges and a commitment to harness technology for the greater good, then this is certainly a powerful tool in our global toolkit. This is particularly important as we look to expand these approaches beyond wealthy urban areas and their neighboring agricultural lands and into more remote parts of the world, with the most vulnerable populations.

## “Would an increased reliance on technology to address our critical food system challenges leave us more or less resilient to shocks?”

At the end of our tour, we were bemused as we watched a group of IT professionals huddle around a laptop trying to get a presentation to work. For all the talk about harnessing information technology, it still leaves even the brightest among us at times at a complete loss to even get a PowerPoint presentation to play. And so we wonder, would an increased reliance on technology to address our critical food system challenges leave us more or less resilient in a future prone to shocks?

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Visiting a large-scale strawberry farm to learn about the challenges and opportunities of mechanization, productivity and labor conditions

# Tackling Malnutrition through Food Systems Approaches in Colombia

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Three sisters from Isla Fuerte Cordoba, in the north

Current patterns of development in Latin America and the parallel processes of urbanization and globalization around the world have accelerated the pace of the nutrition transition (changes in diet and physical activity and their effect on body composition).<sup>1,2</sup> As a result, the prevalence of diet-related chronic diseases such as obesity, diabetes, and cardiovascular disease has dramatically increased.<sup>3</sup> Countries like Colombia have experienced a rapid rate of change in behavioral health patterns, demographic distribution, and profile of disease.<sup>4</sup> Health care,

policy and food systems have not had sufficient time to respond to these rapid changes. In addition, unequal distribution of resources within the region has increased population health disparities, placing a higher burden of disease on the most disadvantaged and vulnerable groups.

Colombia is still battling the prevalence of infectious diseases, while also experiencing an increasing rate of morbidity and mortality due to non-communicable diseases (NCDs). In the midst of this dual burden of disease and in the transition from underweight to overweight, children and women are more vulnerable and are being disproportionately affected. According to UNICEF, one in 10 children in Colombia suffers from chronic malnutrition, which is an average figure for Latin America and significantly lower than in Africa and Asia.

“One in 10 children in Colombia suffers from chronic malnutrition”

## Colombia's success in fighting malnutrition

In recent years, the population of Colombia has shown a significant improvement in its nutritional indicators. According to the latest Global Nutrition Report 2015, Colombia is the only country that is on track to achieve four of the nutritional indicators given by the World Health Assembly: **1)** reduction of stunting in children under 5 years of age, **2)** reduction of wasting or low weight for height (pathological thinness), **3)** reduction in the number of children under 5 years who are overweight, and **4)** reduction of anemia in women of reproductive age.<sup>5</sup>

Colombia has various policies and interventions to reduce malnutrition that have holistic approaches and are focused on prevention, which are established in the National Policy of Food and Nutrition Security of 2008.<sup>6</sup> Although overweight and obesity are growing concerns for the population, most of the policies and programs are centered on tackling undernutrition



Girl from the outskirts of Bogota living in poverty. Most of the children only receive a meal given at the school.

with interventions such as food fortification, micronutrient supplementation, conditional cash transfer with nutritional education, promotion of breastfeeding as well as individual and group counseling, and food assistance programs such as the school feeding programs.<sup>6</sup> Unfortunately the food assistance programs of the country, and in particular the school feeding programs, have been highly criticized and are currently under investigation due to serious corruption allegations and budgetary concerns, preposterously in the states of the country with the highest need for nutritional assistance such as Guajira, Cesar, Atlántico, and Choco.<sup>7</sup> Conversely, the only existing effort to prevent overweight and obesity in Colombia is the Law 1355 of 2009, which has yet to be implemented. The law outlines regulations, policies, and practices for the prevention and control of obesity and takes an inter-sectorial approach.

Despite improvement in overall nutritional indicators, major problems remain, such as unequal access to water, sanitation and education, which highly influence nutritional outcomes. Among the most affected populations are the rural and indigenous populations, who are more likely to have some form of malnutrition, either underweight, overweight or double burden (chronic malnutrition in children under 5 years, and mothers more likely to be overweight or obese).<sup>8</sup> An integrated food systems approach is lacking in the majority of the official programs and policy level interventions, which usually take an individual-focused approach.

## “Rural and indigenous populations are more likely to have some form of malnutrition”

The country's economic growth, reduction of poverty levels and satisfactory response to existing nutrition policies have contributed to Colombia's improved performance in nutritional indicators. Still, the challenge for the design and implementation of new protection strategies and interventions will be to direct them to face new challenges such as the increase in overweight and obesity in the adult population, the dual burden of malnutrition in states such as Guajira, and the precarious situation of segregated areas and populations of the country such as Choco, Atlántico, Cesar, and Guajira where corruption related to nutrition assistance programs is rampant. Strategies should be aimed at strengthening community-based programs and directing them mainly at the early days of childhood in order to counter malnutrition problems in adulthood. They should also ensure that the impact produced is measured by monitoring systems and periodic nutritional assessments.

### Deaths from malnutrition

Colombia's economy depends heavily on exports of coal and oil. The prices commanded by these commodities have the potential to improve the economic and social status of the rural population while reducing problems related to malnutrition. However, this growth should in fairness ensure that revenues benefit all the population, beginning with minority populations such as Afro-Colombians and indigenous people, who in many cases lack coverage of their basic needs such as safe drinking water or sewage disposal. For instance, the states of Meta and Vichada, which are among the largest agricultural and fishing regions of the country, have already documented the deaths of seven indigenous children in 2016 due to malnutrition and food insecurity.<sup>9</sup> It is not uncommon for Colombian newspapers to report news about children dying from malnutrition, particularly in the northern states of Colombia (Guajira and Cesar) and among indigenous communities. In fact, more than 2,000 children have died from malnutrition in Colombia during the past decade, many of them in states that have a rich and successful agriculture system and enjoy large revenues from oil and coal production.<sup>10</sup>

Focusing on diet quality is imperative to reduce problems of under- and overnutrition in the country. Micronutrient malnutrition and overweight/obesity are linked to poor-quality diets, and both promote the development of NCDs. Programs and policies that promote sustainable food systems and strategies

to enhance diet quality with a life-cycle approach should be implemented.<sup>11</sup> The implementation of selective and tailored nutrition programs can be part of the solution, but can also be part of the problem. It is important for policy-makers to recognize the importance of screening strategies, based on the selection of adequate anthropometric indicators, when implementing nutrition programs. Using universal strategies that are not linked to healthy and sustainable food systems is likely to increase disparities in malnutrition and to promote obesity.<sup>12</sup>

**FIGURE 1:** Boy from the Island of San Andrés in the Caribbean coast of Colombia, enjoying a fried plantain local dish. San Andres is the Colombian state with the highest childhood and adult obesity rate in the country. Poor dietary habits and extremely high levels of physical inactivity and sedentary lifestyle are the major drivers behind this situation. According to the last national nutrition survey of Colombia (2010), the Caribbean region of San Andres has some of the lowest consumption of fruits and vegetables and the highest consumption of highly processed food products including sugar-sweetened beverages and fast food. In addition, the average daily time spent watching TV among children between the ages of five and 12 is one of the highest in the country, at 2.8 hours, with 27.4% of the population spending more than four hours a day watching TV.<sup>13</sup>



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**“Focusing on diet quality is imperative to reduce problems of under- and overnutrition”**  
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#### Using a food systems approach

Concentrating on the social determinants and using a food systems approach through policy and economic regulations is imperative in order to begin tackling the root causes of malnutrition. Promoting fair trade and agriculture policies that support and ensure diet quality is a must for Colombia. Sustainable agriculture can alleviate poverty in rural areas and can also improve food security by increasing food availability.<sup>14</sup> Agricultural policies and programs that subsidize and promote the harvesting and production of healthier local fresh foods with high levels of micronutrients should be encouraged.<sup>15</sup> Likewise, increasing the involvement and role of women in agricultural productivity,<sup>16</sup> diversification of diets encouraging consumption of fruits, vegetables and legume-based protein,<sup>17</sup> and bringing the agriculture and health sectors together, should be encouraged.<sup>18</sup> In recent years, Colombia has implemented a series of activities and programs in rural areas to increase productivity and diversification within the agricultural sector, including the initiative *Colombia Siembra* (Sowing Colombia).<sup>19</sup> This program, which is implemented by the Ministry of Agriculture and supported by the World Bank, aims to increase the amount of agricultural land in Colombia by a million hectares in 2018.<sup>20</sup>

The negative and unintentional effects of market liberalization policies, the levels of political corruption, the increased presence of highly processed products from transnational food corporations in local markets as well as other local or native food industry products or preparations, and the negative effect of food advertising should be considered in the design of comprehensive food system interventions aimed at controlling malnutrition in the country.<sup>14,21–23</sup> Recognizing that the economic growth of a country does not necessarily translate into better nutritional outcomes is crucial to help Colombia stay on track in tackling all forms of malnutrition.

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**“We must recognize that economic growth does not necessarily translate into better nutritional outcomes”**  
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Child on the north coast of Colombia eating a highly processed snack

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# Key Findings from the European Commission Global Food Security 2030 Foresight Study

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### Key messages

- > The Joint Research Centre's Foresight study on Global Food Security argues that multiple components of the food system can no longer be dealt with as static, isolated elements, but rather must be addressed together as an interconnected and dynamic system. This requires a change in mindset.
- > Food security will increasingly be considered as securing food supply in response to a "new and emerging demand."
- > Securing "regular" access to adequate food for the majority of the 8–9 billion people who will live on earth in the period 2030–2050, while addressing the food insecurity of a fraction of that total, is how a future European food security policy should be approached.
- > The Joint Research Centre's Foresight study calls for an evolution of present-day policies on food and nutrition security and beyond into a Common Food Systems Policy in which both the systemic and global dimensions of food security are fully incorporated.

## The humanitarian aspects of food security

Despite its multifaceted nature, the debate surrounding food security over the last few decades has largely focused on production and on the challenges facing the agricultural system. Food security, however, encompasses a far broader range of challenges, being directly associated, for example, with humanitarian concerns such as hunger and poverty.

Although agriculture and fisheries are fundamental and essential components of the food system, it is misguided to address the future of food security without looking at the system's many other determinants. The time has come to overcome this conventional approach and to look systemically at food security and its complex nature.

The Joint Research Centre's Foresight study on Global Food Security brought together a group of scientific experts and stakeholders to develop a vision for food security in 2030. This Vision was then challenged in a test of resilience to uncertainty and underestimated trends. The entire process was designed to establish a structured and inclusive discussion that could be useful for guiding future EU policies.

The report calls for an evolution of present-day policies on food security and beyond into a Common Food Systems Policy in which both the systemic and the global dimensions of food security are fully incorporated.

**"The time has come to look systemically at food security"**

**FIGURE 1:** Global Food Security Vision 2030

A world where food security is guaranteed for all on a sustainable basis via:



The significant transformation of agriculture production systems (through investments, research and training)



The maintenance of an adequate enabling environment in all rural areas (rural development)



A food system where production and consumption are balanced between local, regional and global levels (market and trade)



A largely demand-driven food system where responsible consumer behaviour shapes sustainable objectives

**Credit:** Joint Research Centre, European Commission

### Vision 2030

Vision 2030 foresees a significant reduction in the relative number of undernourished people, and that food security will be guaranteed on a sustainable basis via:

- > The significant transformation of agriculture production systems (through investments, research and training)
- > Maintenance of an adequate enabling environment in rural areas (rural development)
- > A food system where production and consumption are balanced between local, regional and global levels (markets and trade), and
- > A largely demand-driven food system where responsible consumer behavior shapes sustainable objectives.

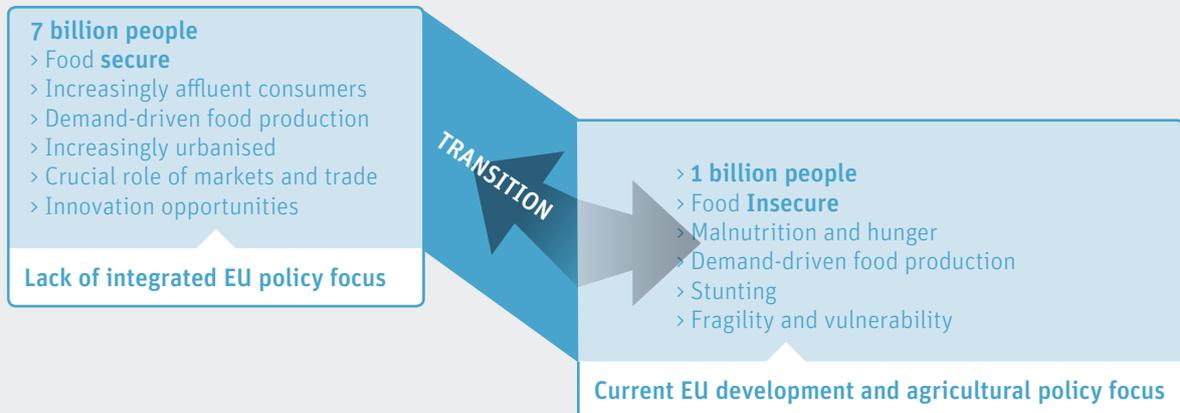
The EU could have an important role to play in working towards this vision by designing, supporting and implementing policy initiatives today that could contribute towards achieving the four features of Vision 2030.

### EU policy alignment

Currently, EU policies are aligned with meeting the first two objectives: agricultural transformation and the creation of an enabling environment. These interventions put smallholder farmers in the most food-insecure regions at the center of the strategies and rely on the transformation of their own activities into a competitive and sustainable agri-business which is expected to enable the achievement of three objectives:

1) Ensuring food security; 2) escaping the poverty trap; and 3) fostering the sustainable use of natural resources. Within this approach, global food markets provide an arena for new fruitful opportunities for smallholder farming, as long as infrastructure, risk-management mechanisms and information systems are put in place. A special focus on malnutrition is also a major component of these interventions, as is global coordination between public and private stakeholders.

For the other two – a balanced and demand-driven food system – the policy framework on food security will need to adopt a more comprehensive and integrated food-systems approach if it is to tackle the challenges ahead and the opportunities that arise. In this regard, EU food security policies seem neither to fully consider, nor to address, the challenges and opportunities that are likely to arise from the changing demographic and socioeconomic trends that could significantly transform the future food system. Instead, current food security policies focus mainly on targeting those pockets of food insecurity, where hunger and malnourishment persist now and may or may not do so in the future. While such policies are certainly worthwhile and commendable, they seem to miss the bigger picture – namely that food security will increasingly be considered as a means of securing food supply in answer to new and emerging trends in demand. This requires that the role of trade and markets in securing this supply, and the extent of these changing trends in demand, should increasingly be considered and integrated into EU food security policy.

**FIGURE 2:** Approach to achieving a balanced and demand-driven food system

“Food security will increasingly be considered as a means of securing food supply for new types of demand”

#### Uncertainty in trade and markets

Domestic and international trade plays a fundamental role in global food security. It also allows countries with a comparative advantage in the production of agricultural commodities to specialize in these activities and to sell and export food and agricultural commodities and to purchase other products with the resulting revenues. The same applies within the agricultural sector itself, since most countries export agri-food commodities and import other products. Trade in food and agricultural products has evolved strongly in recent decades: traded volumes and values of agricultural products have increased; trade flows in terms of origins and destinations have changed; and international trade agreements have enabled freer trade between nations.

In Vision 2030, the development of a balanced food system assumes steady economic growth; further liberalization of markets and trade; and increased transparency and governance of the food system. In reality, however, such a transformation is mired in uncertainty. What would happen if there were a reversal in the trend towards autarky rather than the globalization of agriculture and food? What possible trade-offs exist when envisioning the future of trade and its implications for food security? In policy terms, what role can the EU play in shaping and effectively participating in this future system, and how will

it address the trade-offs that are certain to occur? Such issues have yet to be thoroughly addressed at the level of EU policy on food security – indeed, much of the discourse seems to be based on the assumption that the trade system will invariably continue to become more liberalized and integrated. However, any considerations of Europe’s role in the quest for global food security in the future will certainly need to take greater account of the uncertainty surrounding the evolution of trade and markets.

“Any considerations of Europe’s role in the quest for global food security must take greater account of the uncertainty surrounding the evolution of trade and markets”

#### Changing demand and urbanization

As regards the development of a demand-driven food system in Vision 2030, we also see uncertainty arising from the changing socioeconomic and demographic drivers. A rapidly growing middle class, mostly in Asia and Africa, is likely to put significant pressure on the food system, with an increasing demand for meat and dairy products. The expansion of the middle class is closely linked to the continuing urbanization of the world’s population, 60% of whom will be living in cities by 2030. Urbanization, along with growing incomes, brings substantial changes in demand for food products, and redefines how the food system will cope with growing demand.

Urbanization can be a source either of additional constraints or of new opportunities for enhancing food security both in urban and rural areas, yet it has hardly been seen as a key driver for food security and, in fact, is a largely underestimated phenomenon in terms of its potential impact. The underlying rationale for this focus is that more than 65% of the poor live in rural areas, that agriculture has been underfunded for decades in developing countries, that agriculture offers the best return for investment, and that there is a structural “urban bias” in favor of cities. Although the current focus makes perfect sense – which is why there is a general consensus on it – it fails to acknowledge three things: first, that there is already a high level of urban food insecurity; second, that the ratio between rural and urban poor seems likely to be reversed soon, which is a situation that should not be overlooked; and third, that there are usually “two cities within a city,” and many urban dwellers do not benefit from any such urban bias in terms of food security.

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**“A wide-ranging program of research and policy dialogue is urgently needed to uncover the dimensions and complexities of urbanization”**

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From the EU policy perspective, urbanization and, indeed, changing demand dynamics, have not been thoroughly consid-

ered as potential game-changers for the future of global food security. Indeed, there are many knowledge gaps, and a wide-ranging program of research and policy dialogue is urgently needed to uncover the dimensions and complexities of the phenomenon.

#### Achieving Vision 2030

Lack of EU policy intervention or, indeed, failure to consider uncertainty in trade and markets, and/or changing demand and demographic trends, could lead to significant challenges in the future, or even a missed opportunity for Europe. Indeed, as regards the major transformation foreseen in Vision 2030 – namely the development of a more balanced and demand-driven food system – it is apparent that current trends and major uncertainties could jeopardize the achievement of the latter two features in Vision 2030. This is likely to be the case if a more comprehensive and integrated approach to food security does not materialize into policy actions that consider the opportunities found in changing trends.

A comprehensive food-systems approach is necessary, which focuses on tackling pockets of food insecurity while, at the same time, being prepared for the challenges and opportunities related to feeding a more affluent, demand-driven, and increasingly urbanized majority of the population. While uncertainties will persist and transformations will occur regardless of EU policy intervention, policy interventions made today at all levels of governance, including EU level, could help secure our society and environment in such a way that ensures sustainable provision of safe and nutritious food to our citizens in the future.

**FIGURE 3:** Food security is influenced by a variety of dynamics



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Transformation of agriculture production systems, the maintenance of an adequate enabling environment, a food system in which production and consumption are balanced, and a demand-driven food system together create the preconditions for sustainable food security.

**Credit:** Joint Research Centre, European Commission

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**“Policy interventions made today could help secure our society and environment so as to ensure provision of safe and nutritious food to our citizens in the future”**

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**Systems-thinking**

The multiple components of the food system can no longer be dealt with as static, isolated components, but rather must be addressed together as an interconnected and dynamic system. This requires a change in mindset. While the dialogue on food security should continue to focus on the issue of hunger – i.e., those scattered pockets of food insecurity which persist even in our plausible yet optimistic Vision 2030 – the real challenge of feeding a world of 8.5 billion people in 2030 consists in addressing the idea of a changing food system, characterized by consumption and demand-side challenges, such as a growing and increasingly affluent population and rising urbanization. Europe may want to carefully consider tackling food security challenges by continuing policies that address hunger and diet-related diseases while integrating new policies that simultaneously address food systems focusing on the needs that will arise from future global markets.

Future policies need to fully consider and address the challenges and opportunities that are likely to arise from such changing demographic and socioeconomic trends that will significantly transform future food systems. Current food security policies that focus on targeting those pockets of food insecurity will need to be revised.

Securing “regular” access to adequate food for the majority of the 8–9 billion people who will live on earth in the period 2030–2050, while addressing the food insecurity of a fraction of that total, is how a future European food security policy should be approached. To do so, the EU needs to streamline its policies into addressing the various aspects of global food chains. At the same time, Europe will continue to pay particular attention to the eradication of hunger and malnutrition through special anti-poverty, rural development and food aid actions. In line with this, and as an ultimate goal, the report calls for an evolution of present-day policies on food and nutrition security and beyond into a Common Food Systems Policy in which both the systemic and global dimensions of food security are fully incorporated.

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**“The report calls for an evolution of present-day policies on food and nutrition security and beyond into a Common Food Systems Policy”**

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# African Countries Commit to Improve Vitamin A Supplementation Programs

## Regional GAVA workshop in Dakar



Participants from the GAVA VAS workshop in Dakar, Senegal, April 2016



The Global Alliance for Vitamin A

Helen Keller International (HKI), Micronutrient Initiative (MI), and The United Nations Children's Fund (UNICEF) – hosted a three-day regional workshop in Dakar, Senegal from April 4–6, 2016. The workshop was attended by approximately 120 participants from 23 countries in sub-Saharan Africa representing both nutrition and immunization sectors, policy-makers and managers from Ministry of Health, country-, regional-, and global-level technical partners from the GAVA, and Global Affairs Canada.

The Global Alliance for Vitamin A (GAVA), through its technical partners – Centers for Disease Control and Prevention (CDC),

The goal of the workshop was to re-examine vitamin A supplementation (VAS) programs in sub-Saharan Africa in light of epidemiologic and programmatic changes, and to develop broad, country-specific roadmaps for VAS for the next five years. Specifically, the workshop aimed to:

- 1) Review and re-establish the relevance of VAS as a child survival intervention in the region;
- 2) Examine delivery models, especially in light of the phasing-out of polio campaigns;
- 3) Share experiences and best practices on VAS delivery, emphasizing Child Health Days and other community outreach strategies;

- 4) Identify ways to better integrate VAS into existing healthcare delivery systems, including, but not limited to, EPI; and
- 5) Develop strategies to increase support and institutionalization of VAS as an important component of a package of services so as to improve child survival rates in Africa.

## “Vitamin A supplementation remains vital in sub-Saharan Africa”

Throughout the workshop, participants developed, vetted and came to consensus on key points to include in a declarative statement entitled “Vitamin A Supplementation Remains Vital in Sub-Saharan Africa,” which is outlined below. Participants agreed to use the Declaration to advocate and inform priority actions for the integration of VAS within their respective country’s health system and to work toward its institutionalization. Some

key elements of this commitment to advocacy shared between participants included the need to:

- > Develop country-specific advocacy strategies, using the Declaration as a foundation;
- > Advocate for a dedicated budget line for nutrition, and for activities within which VAS can be integrated, in domestic health budgets;
- > Target high-profile political leaders, such as members of parliament, to sensitize them to the benefits, cost-effectiveness and importance of VAS for child survival and to enlist them as key advocates for this intervention; and
- > Use every relevant opportunity to promote the importance of investing in VAS for child survival, such as budgeting or strategic nutrition and health workshops, meetings of nutrition coordinating bodies, polio legacy planning meetings, or any other relevant structures, meetings and/or high-visibility events.

### Vitamin A Supplementation Remains Vital in Sub-Saharan Africa Declaration made in Dakar, April 6, 2016

Delegates from 23 countries as well as technical partners concerned with the public health impact of vitamin A deficiency gathered in Dakar, Senegal from April 4–6, 2016 to discuss current levels of vitamin A deficiency, plus under-5 mortality and status of vitamin A supplementation (VAS) programs, inclusive of strategies, institutionalization, and current threats and opportunities. The following Consensus Statement was endorsed by participants.

#### Consensus Statement

Vitamin A deficiency remains a pervasive problem in much of Sub-Saharan Africa, with levels having changed little over the past two decades. The most recent estimates suggest that 48% of children in this region suffer from deficiency, placing them at a greater risk of dying.<sup>1</sup> Despite progress, unacceptably high rates of child mortality persist.<sup>2</sup> Furthermore, reductions are not equitable with national averages, masking areas of high mortality.

We recognize that great progress has been made over the last 15 years in scaling up the provision of high-dose VAS. Estimates show that the proportion of children aged 6–59 months who received two age-appropriate doses of VAS in 2014 was 69%,<sup>3</sup> in line with previous estimates. Because many countries have continuously achieved higher coverage (> 80%), these efforts have contributed to recent population level reductions in under-5

mortality, since VAS reduces child deaths by 12–24% when provided every four to six months to children 6–59 months of age, where vitamin A deficiency is a public health problem.<sup>4</sup>

Efforts to reach all children 6–59 months of age twice a year with VAS have made a substantial contribution to mortality reduction in countries with consistently high coverage,<sup>5,6</sup> but there is much more to do. Further reductions are possible in countries where VAD is a public health problem among children by: **1)** implementing specific strategies to reach those currently not reached, ensuring all children are reached with VAS two times per year; **2)** increasing efforts to reach children immediately at six months of age;<sup>7</sup> and **3)** strengthening integration with immunization programs.

Globally, there have been shifts in the patterns and epidemiology of under-5 child deaths, with neonatal mortality representing a greater proportion of under-5 deaths than it did two decades ago. However, the number of deaths in children over six months of age remains far too high, reaching almost one million in sub-Saharan Africa in 2015.<sup>2,7</sup> In the absence of VAS programs, these deaths would be even greater.

Causes of under-5 deaths have also changed, with fewer deaths resulting from measles, but with infections continuing to play a substantial role in child deaths.<sup>2</sup> Such deaths are those in which children would be expected to benefit from an immune system

replete with vitamin A, or a high-dose supplement where this is not the case. Thus we agree that, until there is a sustained rise in population serum retinol with a reduction of vitamin A deficiency to below 5%, the continued provision of VAS in deficient populations, such as in sub-Saharan Africa, is a priority for child survival.<sup>8</sup> This is in line with the GAVA decision-making framework for scaling back VAS.<sup>9</sup>

While continuing VAS programs, we agree that there is a critical need to address the direct and underlying causes of vitamin A deficiency: the inadequacy of vitamin A, or its precursor, in the diet, as well as poor hygiene and repeated infections. Improvement is a long-term goal, but efforts to improve breastfeeding practices, access to fortified foods, availability of high-quality complementary foods and improved hygiene and infection control must be initiated and more explicitly integrated into child survival strategies. This will benefit all population groups that are vitamin A deficient. Assessment of progress toward this goal will rely on recent population data regarding vitamin A deficiency, which is currently limited.

We acknowledge that programmatic data to identify those currently not reached also needs to be strengthened. Strengthening the collection of coverage data, along with its use for corrective action and links to national health information systems, is critical to ensure that all children who need VAS can be identified and reached in a timely manner. Furthermore, intermediate outcomes should also be monitored, and program performance improved, by identifying and addressing bottlenecks. We therefore recognize that greater investments are needed to strengthen data collection and use.<sup>10</sup>

Finally, we recognize that the changing global and regional landscape, inclusive of changes in financing and delivery platforms, will significantly impact VAS programs, and that now more than ever there is a need for better coordinated efforts between governments and partners.

Delivery strategies have evolved substantially over the last 15 years, with Child Health Days and Weeks serving as a platform in an increasing number of countries, and immunization campaigns and polio eradication efforts continuing to provide a platform for reaching many more children. Both approaches have helped to drive up VAS coverage in numerous countries.

We are aware that substantial international financing has supported these delivery platforms for many years and that it is time for this lifesaving intervention and platform to be institutionalized in national health systems, including national budgets, management and coordination, with continued external support where national resources are limited. As we look toward the future, we are in agreement that VAS programs are highly cost-effective<sup>11</sup> and also that there are ways in which this cost-

effectiveness can be improved. Thus, there is an urgent need to find innovative ways to embed VAS in delivery strategies linked to public healthcare systems to consistently reach children under five with VAS and other lifesaving interventions, particularly in countries where a transition in strategy and financing will take place. Key criteria for selecting such a delivery strategy should include: providing the opportunity to reach all children 6–59 months of age, particularly the most vulnerable; maximizing all contacts within the health system, including routine contacts; meeting the needs of caregivers, incentivizing their attendance; and having a mechanism to ensure accountability. We believe that engagement in the polio legacy planning process and expanding novel immunization approaches, such as “Reaching Every Community” and other platforms (e.g., community-based screening for acute malnutrition), are critical to reach all children under five with VAS.

We acknowledge that institutionalization is a process which will require substantial time and effort on the part of many stakeholders. It must be prioritized, while maintaining an urgent focus on continually reaching all children 6–59 months of age with life-saving VAS, every six months.

Achieving this vision will require continued advocacy to decision-makers to make them aware of the evidence for VAS programs and the need for continued prioritization and support.

#### As such, we hereby declare the following:

> We, the participants of this symposium, pledge our support to improve the delivery of twice-yearly VAS to reach all children 6–59 months, which will require a focus on the most vulnerable and attention to ensure equity, and we urge decision-makers in national governments and donor agencies to maintain their support.

> We will work to ensure that VAS is integrated within health systems – including the 6-month contact point – and will facilitate the co-delivery of VAS with other high-impact interventions. We strongly and urgently advocate for building on and/or expanding novel approaches such as Reaching Every Community and community-based platforms and, in relevant countries, engaging in the polio legacy planning process to capitalize on earlier investments.

> We specifically note that routinization within health systems often includes outreach to target the most vulnerable, but that the planning and monitoring of such outreach activities should be fully embedded within the health system.

- > We pledge to leverage national investment to support VAS programs because of their high impact and documented cost-effectiveness.
- > We support the strengthening of interventions to address the unacceptably high prevalence of VAD in sub-Saharan Africa.
- > We will increase efforts to generate high-quality population-based data on vitamin A status, intervention coverage and

quality, and dietary intake in order to use it to guide program and policy decisions.

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Countries that attended the GAVA workshop in Dakar included: Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Cote d'Ivoire, Chad, Democratic Republic of the Congo, Ethiopia, Ghana, Guinea, Kenya, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Senegal, Sierra Leone, South Sudan, Togo, and the United Republic of Tanzania (Ed).

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## “We, the participants of this symposium, pledge our support to improve the delivery of twice-yearly VAS to reach all children 6–59 months”

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# Some Common Myths Associated with Food Debunked

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### Key messages

- > Seafood from aquaculture (fish farming) is neither more dangerous than wild-caught species nor less ecologically sustainable.
- > Pasteurization does not make milk and dairy products less nutritious, nor does it make them dangerous to consume, causing lactose intolerance and allergic reactions.
- > Consumption of wheat and wheat products is not dangerous and does not lead to a multitude of illnesses in many consumers.
- > Processed foods in general are not less nutritious than non-processed foods, and the vast majority of food-borne illnesses are not caused by/found in processed foods.

### Evolving food myths and evolving science

Food myths are common and sometimes entertaining. It was probably your mother who told you not to believe everything you read. Food myths are often as ridiculous as “urban myths” – sometimes partially true, and sometimes even dangerous! The

following are four common myths that have been popular in recent years and which we here attempt to debunk with solid scientific evidence taken from current literature.

Having said this with tongue in cheek, we all know of food-related truisms that have changed because the science has taken a closer look in search of the unadulterated truth. For example, we once believed that animal fats (butter, lard, tallow, etc.) were less healthy than vegetable fats (oils manufactured from canola, soy, corn, sunflower, etc.). We now know that for heart health, the total amount of fat in the diet is far more important than the type of fat – but for at least one exception: fish oil.

The following examples are provided in the light of the most recent scientific knowledge available, but that isn't to say that things won't change with time!

### Four common food myths

1. *Seafood from aquaculture (fish farming) is more dangerous than wild-caught species and less ecologically sustainable; farmed fish in particular contain dangerously high levels of aquaculture drugs, heavy metals, polychlorinated biphenyls (PCBs), and dioxins – all of which are hazardous to health. Farmed salmon is also to be avoided because it is colored with an artificial dye, making it different from the wild species.*

With a growing world population, the demand for protein is rapidly increasing. In developing coastal countries, this often translates into demand for seafood, and this demand cannot be met with traditional wild catch fishery. The sustainable world landings of wild fish have reached their maximum levels,<sup>1</sup> and therefore the growth in aquaculture has increased exponentially to meet the requirement for high-quality seafood protein at a reasonable price. In 2012, approximately 50% of the world seafood requirement was met by aquaculture; this proportion is expected to grow to 62% by the year 2030.<sup>1</sup> Nevertheless, aquaculture has been criticized for a variety of reasons, many of which are grounded in myth.

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## “The major health hazards related to seafood consumption in general lie with the ingestion of raw fish or shellfish”

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The major health hazards related to seafood consumption in general lie with the ingestion of raw fish or shellfish; the predominant hazards are biological in nature (bacteria, viruses and parasites),<sup>2</sup> although marine biotoxins most commonly associated with molluscan shellfish are considered to be chemical hazards and are generated in the food chain by marine algae. The problem of raw fish consumption can be overcome by cooking insofar as bacterial and viral contamination are concerned, although aseptic handling of landed fish and subsequent refrigeration can be valuable tools for lowering the microbial load. The advantages of aquaculture fish in this regard include the following:

- > The proximity of the processing facility to the fish farm, enabling the fish to be harvested and processed within one day and permitting the continuous maintenance of the “cold chain” from farm to fork. This is difficult to accomplish aboard a fishing vessel which is often at sea for days or weeks. Moreover, commercial harvesting of wild stocks is often damaging to the catch (trawling with nets, long lining, gill netting) or to the environment (dragging the ocean floor for shellfish).
- > Parasites are found sporadically in wild-caught seafood, but are rare in aquaculture species, since these fish are grown in a water column, confined by the walls of the net cages and unable to access parasites from mammalian hosts found in fecal material only on the ocean floor.<sup>2,3</sup> Consumption of raw fish in sushi, ceviche or marinated finfish is considered hazardous unless aquaculture fish is used in the preparation or if wild fish are frozen prior to consumption. Salting or marination in vinegar or lemon juice have been shown to be an ineffective or unreliable means of destroying fish parasites.<sup>2</sup>
- > Marine biotoxins are rarely found in cultured finfish, although cultured mussels have on occasion been contaminated with marine biotoxins such as paralytic shellfish toxins, amnesic shellfish toxin, etc.<sup>4</sup> The risks associated with the potentially deadly foodborne intoxications in both wild and cultured shellfish are principally mitigated through surveillance programs (gathering samples and testing for the presence of toxins by regulatory personnel). The geographic distribution of toxic algal blooms may be wide-

spread, thereby making it difficult to collect representative samples of contaminated shellfish or seawater. Sampling aquaculture shellfish farms on a regular basis is common, particularly in regions with a history of contamination, thus permitting regulatory agencies to quarantine harvests should the need arise.

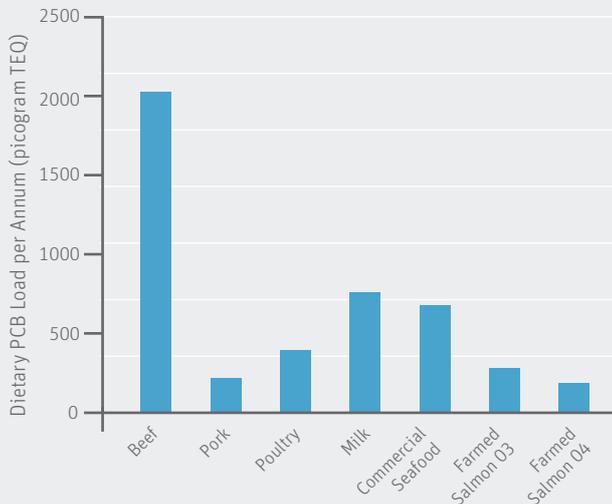
The question of the ecological sustainability of fish farming is perhaps best addressed by examining the feed conversion ratios for common farmed agricultural and aquaculture species. The current feed conversion ratios are much higher in farmed salmon than in wild salmon, swine, poultry or beef. Globally, aquaculture uses about half a metric ton of wild whole fish as feed to produce one metric ton of farmed seafood, meaning that aquaculture is a more efficient means of converting plant protein into animal protein.<sup>5</sup> As research progresses, plant-based proteins and fats are gradually being substituted for the fish meal and oils traditionally found in aquaculture feeds, making farmed fish more affordable and even more efficient to produce.

In recent years, it has been suggested that farmed salmon contains high levels of polychlorinated biphenyls (PCBs), dioxins, and heavy metals such as mercury,<sup>6</sup> and furthermore, it has been suggested that farmed salmon flesh is tainted with artificial dyes to give a more desirable pink hue.

PCBs and dioxins are man-made environmental pollutants now banned in many jurisdictions, as they are potential carcinogens; mercury found naturally in the environment is known to cause neurological damage.

Although it is true that some fish contain high levels of heavy metals such as mercury, cadmium and lead, there are no farmed fish on the US FDA list of “species to avoid.”<sup>7</sup> Since heavy metals are subject to the phenomenon of “biological magnification,” only the largest specimens of carnivorous species are listed as foods to avoid or consume infrequently. These include for example, large tuna, swordfish, marlin and shark,<sup>8</sup> but do not include most canned tuna; much of the canned tuna products are prepared from smaller species such as yellowfin and skipjack. Smaller species such as salmon (canned or other), groundfish species such as cod, haddock, or flatfish species such as sole tend to have very low heavy metal contents.

Farmed Atlantic salmon is particularly high in fat (as compared to wild salmon), rich in omega-3 fatty acids that have been proven to maintain healthy heart function, and is recommended for pregnant women, since omega-3s play an important role in fetal brain and eye development.<sup>9</sup> The health benefits of dietary omega-3 fatty acids are proportional to the amount of fish fat consumed (see below). Therefore, consumption of farmed salmon is more “heart-healthy” than consumption of wild salmon; and herring and mackerel are more “heart-healthy” than demersal (groundfish) species that contain only negligible levels of fat.<sup>9</sup>

**FIGURE 1:** Annual *per capita* load of dietary PCBs

Data taken from Environmental Working Group Report, 2003<sup>5</sup>

In all but a few cases, the research found that the health benefits of consuming seafood far outweighed the relatively small risks associated with mercury consumption.<sup>9,10,11</sup> **Figure 1** illustrates the dietary load of PCBs derived from various types of food with data re-plotted from a 2003 US Environmental Working Group study<sup>6</sup> claiming that levels of PCBs ingested via the consumption of aquaculture salmon could be up to 40 times as high as other foods, making farmed salmon dangerous to consumer health. However, when the levels are adjusted for the relative levels of consumption of the individual foods, the picture becomes clearer (**Figure 1**). In fact, based on the 2003 consumption data,<sup>6</sup> the PCB load derived from beef, poultry and milk was far greater than that derived from aquaculture salmon.

“The research found that the health benefits of consuming seafood far outweighed the relatively small risks associated with mercury consumption”

In addition to the health benefits associated with farmed salmon as a rich source of omega-3 fatty acids, recent research evidence also suggests that there may be anti-diabetic benefits associated with Atlantic salmon proteins.<sup>12</sup> This is significant insofar as type 2 diabetes is the fastest-growing chronic disease

in North America. Other recent work has shown that farmed Atlantic salmon peptides are also antihypertensive<sup>13</sup> as well as having antioxidative properties.<sup>14</sup>

The issue of artificial pigments in aquaculture salmon has also become a concern in recent years. Wild salmon, trout and char (*salmonids*) derive their natural pink color from the food they eat (crustaceans, which in turn derive their pigment from aquatic vegetation). The principal natural pigment astaxanthin<sup>15</sup> is the same pigment used in aquaculture feeds to achieve the same natural color found in wild salmon (**Figure 2**). The only difference is that commercial astaxanthin is manufactured rather than being extracted from shrimp shells or marine algae. The so-called bogus colorant (astaxanthin) is chemically identical to the pigment found in nature. Thus, the use of “artificial” pigment in salmon feed is no more dangerous or unethical than taking vitamin C tablets purchased at the local pharmacy, rather than eating oranges.

Finally, there has been a recent concern over the indiscriminant use of antibiotics and parasiticides in farmed fish husbandry. The concern over antibiotics is the same made for the use of antibiotics in agricultural livestock, such as the use of  $\beta$ -lactam antibiotics including penicillin as a growth promoter in poultry and swine. Antimicrobials are also sometimes used in aquaculture, but not for growth promotion.<sup>16</sup> The food safety issue is the possible development of antibiotic resistance in human bacterial pathogens due to trace levels of these drugs perhaps contaminating the food supply.<sup>16</sup> A second concern is that many individuals are allergic to antibiotics and can experience adverse reactions to contaminated foods.<sup>17</sup>

**FIGURE 2:** Measurement of redness in farmed Atlantic salmon using a reflectance colorimeter to monitor astaxanthin content in the flesh. Astaxanthin is added to aquaculture feeds and is the same pigment found in wild salmon species.



**TABLE 1:** Classes of chemical compounds used in Atlantic salmon aquaculture (Burridge et al, 2007).<sup>17</sup>

Country	Salmon production (tonnes)	Therapeutic type	kg used*	kg used   tonne
Norway	821,997	Antibiotics	649	0.0008
		Anti-louse	132	0.00016
Chile	300,791	Antibiotics	385,600	1.17
		Anti-louse	600.1	0.0018
UK	132,528	Antibiotics	1553	0.0117
		Anti-louse	194.8	0.0015
Canada	121,370	Antibiotics	21,330	0.175
		Anti-louse	19.8	0.00016

\*Data represent kg used per kg finished product.

Table 1 shows the relatively small amounts of antibiotics and parasiticides currently being used in the aquaculture industry in relation to the volume of finished seafood produced.<sup>17</sup> The therapeutic amounts used in aquaculture are far less than the levels used in agriculture, the latter sometimes used non-therapeutically. It has been estimated that approximately 80% of all antibiotic use in the US is directed to therapeutic and non-therapeutic (growth promotion) uses in farm animals. There are currently no known advantages in the inclusion of antibiotics at sub-therapeutic levels in fish feed.

The sporadic presence of “sea lice” on farmed salmon continues to be a problem.<sup>17</sup> Sea lice are members of the copepod family and are ectoparasites, attacking the external surfaces of farmed salmon. Because sea lice become immune if the same type of chemical is repeatedly used at the same sites, avoidance of overcrowding, fallowing, removal of dead and sick fish, and prevention of net fouling are examples of good husbandry and effective in reducing parasite levels without the use of chemicals. Although most of the parasiticides present an ecological risk, they are not considered to be of immediate concern to human health. Antibiotics have largely been replaced by vaccines to treat microbial diseases in farmed fish, and are considered to be more efficacious in the treatment of disease.

2. *Some believe that pasteurization changes the chemistry of the milk and dairy products in some way, making them dangerous to consume, causing lactose intolerance and allergic reactions, destroying their nutritional value and therefore making them less wholesome and healthy than raw milk and products.*

The process of food pasteurization dates back to Louis Pasteur (1822–1895), the founder of modern microbiology, who was responsible for the “germ theory of disease” and discovered

that the spoilage of beverages such as wine, beer and milk was caused by tiny microorganisms. The process he discovered bears his name, i.e., pasteurization.

However, the first planned heat treatment of foods for the purpose of preservation is credited to Nicholas Appert (1749–1841), a French confectioner who began working on an idea to preserve containerized food by heating in 1795. By 1810, Appert had perfected a process for a number of foods using heat, and won a prize of 12,000 francs for his invention from the Emperor Napoleon.

Today a number of foods and beverages are heat-processed to ensure the destruction of foodborne microorganisms. Pasteurization of milk is based on heating for specific time-temperature combinations to destroy *Coxiella burnetii*, the most heat-resistant bacterium associated with raw milk and the causative organism of Q fever. Pasteurization also destroys a wide variety of pathogenic organisms including enterotoxigenic *Staphylococcus aureus*, *Campylobacter jejuni*, *Salmonella species*, *E. coli*, *Listeria monocytogenes*, *Mycobacterium tuberculosis*, *Mycobacterium bovis*, *Brucella species* and *Yersinia enterocolitica*.

.....  
**“Pasteurization does *not* alter the nutritional value of raw milk, nor does it change the proteins in any way to make them more allergenic”**  
 .....

The shelf life of pasteurized milk is far greater than that of raw milk, although not nearly as long as commercially sterilized (canned) food. The latter process is designed to destroy the much more heat-resistant spore-forming bacteria that are only able to grow in the absence of air and in low-acid foods such

as canned meats, fish and most vegetables. Pasteurization kills harmful organisms responsible for such foodborne diseases as listeriosis, typhoid fever, tuberculosis, diphtheria, and brucellosis.<sup>20,21</sup> Pasteurization does *not* alter the nutritional value of raw milk, nor does it change the proteins in any way to make them more allergenic.<sup>20</sup> The phenomenon of lactose intolerance is related to the milk sugar lactose that is present at the same levels in both raw and pasteurized milk. Thus pasteurized milk is neither more nor less likely to cause lactose intolerance than raw, unheated milk.

North American consumers are 160 times more likely to contract listeriosis from cheeses made with unpasteurized milk as compared to its pasteurized counterpart, as shown in a recent quantitative risk assessment study published jointly by Health Canada and the US Food & Drug Administration.<sup>20</sup> In Canada, although cheese production is permitted with unpasteurized milk, such cheeses must be aged for a period of ≥ 60 days. The sale of unpasteurized raw milk for human consumption is illegal in many jurisdictions, including all Canadian provinces. Health Canada and the US Food & Drug Administration discourage consumption of soft cheeses produced from unpasteurized milk, particularly in pregnant women, the very old, the very young, and individuals with compromised immune systems. As an added note, unpasteurized raw “organic” milk is as dangerous to consume as non-organic dairy products.

**3. Consumption of wheat and wheat products is dangerous and can lead to a multitude of illnesses in many consumers because wheat contains a toxic substance called gluten.**

Gluten is a protein that occurs naturally and is actually composed of two individual proteins, glutenin and gliadin, which form a complex during the bread-making process. It is gluten that gives bread its three-dimensional structure, providing elasticity to the loaf of leavened bread. During the leavening process, the baker’s yeast produces carbon dioxide that becomes trapped in the dough upon rising, and it is gluten that forms the structure around the “air pockets.” Gluten is found in a number of grains besides wheat, including triticale, barley, rye and oats.<sup>22</sup> Publications about gluten intolerance and gluten sensitivity are often contradictory, but the fact that gluten can cause two independent foodborne maladies is now well accepted.<sup>23</sup>

- > Celiac disease: affects an estimated 0.5 to 2% of population.<sup>24</sup>
- > Wheat allergy: affects an estimated 0.2 to 0.5% of population.<sup>25</sup>

In addition to gluten, other wheat components have been associated with non-celiac wheat sensitivity, fructose malabsorption

and irritable bowel syndrome. Unfortunately, many of the gluten-related illnesses are either undiagnosed or mis-diagnosed.<sup>26</sup>

It should be noted, however, that only a very small proportion of the human population is subject to these wheat-related disorders and that gluten is not always the causative agent; the exact role of other wheat components in the latter three disorders is also unclear.<sup>23</sup> For example, in a double blind study of non-celiac wheat sensitivity, Carroccio et al<sup>26</sup> showed in a placebo-wheat challenge study, approximately 70% of the 900 patients identifying as wheat-sensitive were actually not affected by dietary wheat. Thus, for the vast majority of the population, wheat-related illness is not an issue. It has been suggested that the apparent increase in wheat-related illnesses is due to selective wheat breeding to increase yields. Davis<sup>27</sup> suggested that ancient or heritage varieties have fewer allergens, but the scientific literature does not support this claim. Patients suffering from gluten-related illnesses are advised to avoid all wheat varieties, both heritage and modern.<sup>24</sup> Some researchers have suggested that the apparent increase in wheat-related sensitivities is due to better tools for diagnosis.<sup>24</sup> Still others have suggested that modern wheat-processing technologies tend to expose more immune-reactive epitopes on constituent proteins, making them more likely to stimulate adverse reactions within the digestive tract.<sup>23</sup>

.....  
 “Only a very small proportion of the human population is subject to these wheat-related disorders, and gluten is not always the causative agent”  
 .....

**4. Processed foods in general are less nutritious than non-processed foods, often containing ingredients that are either unnecessary or harmful. The vast majority of foodborne illnesses are caused by/found in processed foods.**

We are currently living in the age of the “empowered global consumer”. Never before has the consumer been faced with as many choices. Modern, large-scale food production and processing has enabled the consumer to select foods from around the world at reasonable prices. However, the fact that foods are now transported from across the globe has implications for food safety. As a “rule of thumb,” the further the distance from the food source, the greater the risk and challenge in keeping the food safe for human consumption.<sup>28</sup>

Food processing has a long history and has been used for thousands of years. The ancient Greeks had three major foods including bread, olive oil and wine. All three involved compli-

cated processing steps to convert the perishable raw materials (wheat, olives and grapes) into shelf-stable finished products that were safe, nutritious and flavorful.<sup>29</sup> The principal aims of food processing are shown in **Table 2**, along with some examples of the benefits of processing and the technologies that have been developed to provide tangible benefits to the consumer. Processed foods are not necessarily less nutritious than foods prepared in the home. For example, frozen vegetables can be more nutrient-rich than fresh ones because they are picked, blanched and frozen immediately upon picking, when they are at the height of their nutritional value. Many processed foods, such as processed milk products, are fortified with vitamins D and A as required by law in North America, although they are not present in raw, unprocessed milk – the latter being illegal for sale in Canada and several other jurisdictions. The question of the nutritional value of commercially processed foods is complicated because, like foods prepared in the home, processed foods range from being highly nutritious to those with high calorie densities (e.g., pastries and candy) and relatively low nutritional value.

To a certain extent, the adage that “necessity is the mother of invention” is true, and many of the important discoveries in food processing were developed as a result of some impending need. For example, the development of thermal processing as a form of preservation (canned food) came about in the 18<sup>th</sup> century, when the French Emperor Napoleon needed a means of sustaining his troops on their military campaigns in Europe. The idea that heat could preserve food by destroying bacteria was not known until much later; Appert had no idea why his invention worked.

The development of HACCP (hazard analysis and critical control points) strategies to improve the safety of processed foods world-wide, stemmed from the US Apollo space program and its requirement for the safety of the foods consumed in space travel. Food safety remains an integral component of space travel today, and it was Pillsbury Corporation that landed the contract with NASA to ensure the safety of the foods processed for the Gemini and Apollo programs.<sup>30</sup> The HACCP strategy now widely used worldwide in commercial food production is a proactive process in which foodborne hazards to health are divided into three broad categories: biological hazards (pathogenic microorganisms, parasites and viruses); chemical hazards (pollutants, pesticide residues, heavy metals, drug residues, naturally occurring biotoxins); and physical hazards (metal fragments, glass, small bones). All HACCP-based food protection strategies also require the construction of a plan in which all hazards are identified and preventive measures recorded in a plan for each food product and process for production. In many cases, these strategies involve pre-determined limits for heating/cooling temperatures, holding times, pH values, water activities and redox potentials.

In addition, HACCP-certified plants in North America and the EU must comply with sanitary standards for food processing facilities and equipment design.

The food safety issue was developed by a NASA initiative so as to be certain that there was a “zero” probability of foodborne illness on any of the manned space missions. Prior to that time, food processing quality control involved extensive end-product testing, most of which is destructive by nature, and the only way to ensure “zero” tolerance on safety was to test every package of food for hazards before lift-off. A group of researchers consisting of a team from the US Army Laboratories in Natick MA, NASA and Pillsbury Corporation decided to use a proactive approach, strictly controlling the “unit operations” involved in each of the food manufacturing processes, rather than testing final products for safety – the hypothesis being that if all processes are in control, the final products should be safe to eat. This strategy is now an integral part of the food safety strategy world-wide, and is endorsed by the Codex Alimentarius.<sup>31</sup> The Codex Alimentarius or “food code” was established by the United Nations (FAO and the World Health Organization) in 1963 to develop harmonized international food standards which protect consumer health and promote fair practices in food trade. This is not to say that all commercially processed food is safe. However, the HACCP concept is now a global phenomenon used by all countries importing or exporting foods. If systematically applied, the HACCP foods have a remarkable success record for food safety, considering the size of the global food processing industry. In many cases, commercially processed foods offer several advantages over home-processed foods. Convenience and safety are two important features of commercial products.

.....  
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 .....

**Table 2** illustrates some other examples of significant advances in food processing technologies that have contributed to at least one of the five objectives listed by Floros et al.<sup>29</sup>

The myth that foods prepared in the home are generally safer than commercially processed foods is unjustified. According to the US Centers for Disease Control, home-canned vegetables are the most common cause of botulism outbreaks, with 48 out-

**TABLE 2:** Objectives, nature, specific examples and technologies used in typical food processing operations.

Objectives <sup>29</sup>	Nature of objective	Examples	Technologies
Preservation	Shelf-life extension, reduce waste (spoilage)	Canned food, frozen food, acidified or fermented foods, dried shelf-stable foods, powdered milk or soups	Continuous sterilizers for canned foods, <sup>32</sup> vacuum-microwave drying, <sup>33</sup> sous-vide technology, <sup>34</sup> active packaging <sup>35</sup>
Improved quality	Flavor, odor, appearance, nutritional value, etc.	Flash freezing, vitamin fortification, freeze-drying	Quick frozen foods, <sup>36</sup> micro/nano-encapsulation <sup>37</sup>
Safety	Eliminate/control pathogens or other biological, chemical or physical hazards	Pasteurized milk, cured meats, hurdle technologies, freezing to eliminate parasites, metal detectors	Ultra-high temperature (UHT) technology, <sup>38</sup> high pressure processing (HPP), <sup>39</sup> modified atmosphere packaging <sup>40</sup>
Availability	Permit consumers to access foods that are not always available	Not from concentrate orange juice, controlled atmosphere (CA) apples, live shipping of seafood (shrimp, lobster, fish)	CA storage permits year round access to fresh apples, <sup>41</sup> aseptic year-round bulk storage of tomatoes <sup>42</sup>
Sustainability	Processes that permit continued supply of foods with minimum wastage of raw materials or energy inputs	Re-usable or re-cyclable packaging such as glass, plastic, aluminum beverage containers	Active and intelligent packaging <sup>43</sup>
Convenience	User-friendly products that require minimal or no preparation time/effort	Microwaveable products: soups in plastic cans, popcorn; frozen pizza, UHT milk/juice (drink in a box)	Microwave cooking, <sup>44</sup> blanching, thawing etc.
Improved health & wellness	Processes that provide “functional foods” that have health-related benefits other than traditional values	Fortification of everyday foods with vitamins, minerals, enriched fish oils; probiotics, “healthy” bacteria in yogurt	Micro-encapsulation, <sup>45</sup> delivery of nutrients or nutraceuticals.

breaks reported over a 12-year period. Botulism outbreaks are far less common with commercially processed foods, despite the relatively large volume of commercially processed products. These outbreaks often occur because home canners did not follow canning instructions, did not use pressure canners, ignored signs of food spoilage, and were unaware of the risk of botulism from improperly preserving vegetables.<sup>46</sup>

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**Did you know?** You can now visit the *Sight and Life* website [www.sightandlife.org](http://www.sightandlife.org) on a regular basis to get the latest news about what is happening in the field of nutrition. Check out our new blog at [www.sightandlife.org/blog.html](http://www.sightandlife.org/blog.html)! You can also follow us on **Facebook** and **Twitter @sightandlife**.

## Designing Nutrition-Sensitive Agriculture Investments: Checklist and guidance for program formulation



Current food systems are increasingly being challenged to provide adequate, safe, diversified and nutrient-dense food amidst the increasing constraints of resource scarcity, climate change, inequitable distribution and unsustainable production and consumption patterns. The FAO's Nutrition Division (ESN) and Investment Center (TCI) has launched a guidance checklist towards achieving one of the targets in the Framework of Action of the 2<sup>nd</sup> International Conference on Nutrition (ICN2) that emphasizes the importance of “reviewing national policies and investments and integrating nutrition objectives into food and agricultural policy, program design and implementation.”

There is a growing commitment to ensuring that investments in food systems are “nutrition-sensitive,” but for many it is not clear what this entails in terms of program design and implementation. The checklist and guidance document can be used as a tool for improving nutrition through agricultural and food systems.

The aim of the guide is to assist in identifying creative, unique and sustainable solutions that help families improve their nutrition by making the most out of available resources. The checklist provides 10 key recommendations developed in consultation with a wide range of sectors. These recommendations have been designed around the first phase of a programming cycle – namely, situation assessment, program design, and program review. Each recommendation is followed by a list of questions to help the practitioner find locally relevant solutions, and provides tips and additional resources. This is going to be a valuable tool for anyone working at the community level in agriculture, but it also makes excellent reading for those of us that are interested in implementation science.

The publication can be downloaded at [www.fao.org/3/a-i5107e.pdf](http://www.fao.org/3/a-i5107e.pdf)

## Ten recommendations for improving nutrition through agriculture and food systems

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1. Incorporate explicit nutrition objectives and indicators into the design, and track and mitigate potential harms, while seeking synergies with economic, social and environmental objectives.
2. Assess the context at the local level, in order to design appropriate activities to address the types and causes of malnutrition, including chronic or acute undernutrition, vitamin and mineral deficiencies, and obesity and chronic disease.
3. Target the vulnerable, and improve equity through participation, access to resources, and decent employment.
4. Collaborate and coordinate with other sectors (health, environment, social, protection, labor, water and sanitation, education, and energy) and programs through joint strategies with common goals, to address concurrently the multiple underlying causes of malnutrition.
5. Maintain or improve the natural resource base (water, soil, air, climate, biodiversity), critical to ensuring the livelihoods and resilience of vulnerable farmers and to sustainable food and nutrition security for all.
6. Empower women by ensuring access to productive resources, income opportunities, extension services and information, credit, labor- and time-saving technologies (including energy and water services), and listen to women's voices in decisions concerning the household and farming.
7. Facilitate production diversification, and increase production of nutrient-dense crops and small-scale livestock (for example, horticultural products, legumes, livestock and fish at a small scale, underutilized crops, and biofortified crops).
8. Improve processing, storage and preservation to retain nutritional value, shelf-life, and food safety, to reduce seasonality of food security and post-harvest losses, and to make healthy foods convenient to prepare.
9. Expand markets and market access to vulnerable groups, particularly for marketing nutritious foods or products vulnerable groups have comparative advantage in producing.
10. Incorporate nutrition promotion and education on food and sustainable food systems that builds on existing local knowledge, attitudes and practices.

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# 02 Sustainable Food Systems Programme Launched

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The Sustainable Food Systems (SFS) Programme of the UN 10-Year Framework (10YFP) for Programmes on Sustainable Consumption and Production (SCP) Patterns was launched during the Milan Expo at the end of last year.

The program was developed through coordination between the FAO, UN Environment Programme (UNEP), and an agri-food expert group, and will be implemented over the next seven years. Given the central role of food in society, the SFS Programme is a multi-stakeholder initiative that aims to accelerate the shift towards more sustainable food systems – consumption and production – in both developing and developed countries. Sustainable food systems are key to ensuring sustainable development. They have to ensure food security and nutrition and satisfy a growing demand, for quantity, quality and diversity. At the same time, current food production and consumption already exert a considerable impact on the environment and play a significant socioeconomic role.

The SFS Programme will seek to promote sustainability along the food chain, through four work areas:

1. Raising awareness of the need to adopt SCP patterns in food systems
2. Building enabling environments for sustainable food systems
3. Increasing the access to, and fostering the application of, actionable knowledge, information and tools to mainstream SCP in food systems
4. Strengthening collaboration among food system stakeholders to increase the sector's SCP performance.

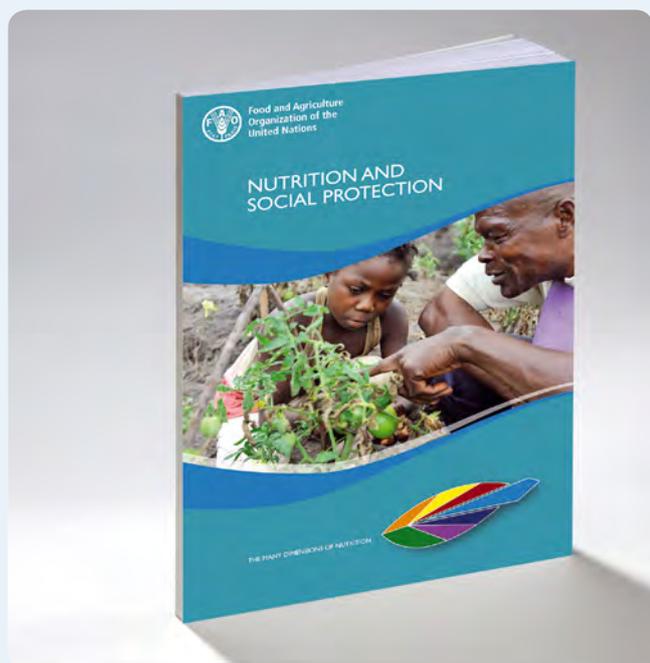
Forty organizations have become Programme Partners so far, and the program is open to further organizations and individual experts interested in joining a collaborative platform.

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**For further information, please contact the Coordination Desk of the Sustainable Food Systems Programme at [sfsprogramme@blw.admin.ch](mailto:sfsprogramme@blw.admin.ch)**

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## Harnessing Social Protection to Deliver Improved Nutrition



Just as agriculture needs to address nutrition issues, so too should social protection policies and programs. Every social protection instrument provides specific entry points for increasing its impact on nutritional outcomes, and thus holds immense potential for improving the nutrition situation of especially vulnerable populations.

“Over the decades, social protection has cushioned and, in many instances, prevented vulnerable people from falling into states of abject poverty and malnutrition, while at the same time improving nutrition, productivity and food self-sufficiency,” is the opening sentence from a new FAO technical paper. This paper identifies how the main social protection instruments can address the causes of malnutrition and proposes guiding principles to make these nutrition-sensitive.

**“Social protection can help address the multiple dimensions of malnutrition”**

The paper discusses the main linkages and synergies between social protection and nutrition within an agricultural context and identifies possible ways of using these synergies to ensure greater positive impact of social protection measures on nutritional outcomes. It highlights how through improving dietary quality, increasing income and improving access to health services, social protection can positively impact nutrition. In addition to the direct links related to the diversity, safety and quality of the food consumed, social protection can also influence other determinants of malnutrition such as care practices, sanitation and education. The paper is action-oriented and targets program designers and implementers.

Social protection and nutrition share many core characteristics, for example:

- Social protection can address immediate, underlying and basic causes of malnutrition.
- Social protection and nutrition are linked by their capacity for building resilience and linking emergency and development approaches.
- Both nutrition and social protection require a multi-sectorial and multi-stakeholder approach.
- Both nutrition and social protection have to acknowledge and leverage the vital role of women.
- Both nutrition and social protection use the life-cycle approach, acknowledging that economic and nutritional vulnerabilities differ throughout the various phases of life and that malnutrition, as well as poverty and social exclusion, have a “hereditary” character, being passed from one generation to the next.

To read about the key principles for using social protection to improve nutrition, the approaches that can be harnessed and interesting case examples, please download the full paper at [www.fao.org/3/a-i4819e.pdf](http://www.fao.org/3/a-i4819e.pdf)

## Mycotoxin Control – A Key Issue for Low- and Middle-Income Countries



Although aflatoxins have been a massive food safety issue since their discovery in 1961 and billions of dollars have been spent to address their presence in grain staples, exposure to aflatoxins in developing countries has barely diminished, and the world's poorest remain highly vulnerable to this food safety threat.

A new and important report on “Mycotoxin control in low- and middle-income countries” is now available from a Working Group convened by The International Agency for Research on Cancer (IARC). The report makes for sobering reading, and provides a systematic, independent review of the scientific evidence for the adverse health effects of aflatoxin and fumonisin exposure through consumption of contaminated maize and groundnuts.

The report examines four key areas – the extent of exposure; the effects on prenatal, infant and child health; relevant mechanistic information; and effective intervention strategies. The good news is that the recommendations for addressing the mycotoxin problem are not only financially feasible, but can be also implemented at a number of different levels, from the government and non-governmental organizations to the farmers themselves.

Fifteen interventions are evaluated and placed in one of four categories ranging from those that have sufficient evidence for implementation, through those that require further field evaluation or formative research, to those which are not supported by scientific evidence or else have been shown to be ineffective. There are several existing and promising interventions, but it remains to be seen whether the necessary national and regional policies will be put in place and whether their implementation will be encouraged and followed up so as to ameliorate the impact of this disastrous situation.

The report can be downloaded at

[www.iarc.fr/en/publications/pdfs-online/wrk/wrk9/IARC\\_publicationWGR9\\_full.pdf](http://www.iarc.fr/en/publications/pdfs-online/wrk/wrk9/IARC_publicationWGR9_full.pdf)

### Did You Know?

- Some 500 million of the poorest people in Sub-Saharan Africa, Latin America, and Asia are exposed to mycotoxins at levels that substantially increase mortality and morbidity.
- Infants and children, in particular, are severely affected by mycotoxins, which they ingest unknowingly from contaminated food.
- Aflatoxin exposure is linked to liver cancer, and acute exposure can lead to death.
- Long-term exposure to aflatoxins may also contribute to poor growth or stunting in children, and negatively influences immune system and gut functionality.

# 05 Integrating Agriculture and Nutrition Education for Improved Young Child Nutrition



“Evidence confirms that increases in agricultural production and/or increased income do not automatically translate into improved diets and nutrition”

The FAO has over the last five years been collaborating with Justus von Liebig University in Germany on a research and advocacy project entitled: “Improving the dietary intakes and nutritional status of infants and young children through improved food security and complementary feeding counseling.” This project aims to contribute to the body of evidence on the relationship between agricultural diversification, food security and nutrition education, and their nutritional outcomes.

Improving nutrition is a major goal of agricultural programs and policies, and substantial evidence confirms that increases in agricultural production alone and/or increased income do not automatically translate into improved diets and nutrition. Essential prerequisites for this to happen are concurrent and well-designed nutrition education and behavior change approaches, women’s empowerment, and inter-sectoral collaboration.

The project has now reached its end, and two documents have been published. The first summarizes the proceedings of the project technical meeting held in July 2015, and the second is a very useful compendium of program lessons that covers six key areas – namely, program planning and design; capacity development; implementation; supervision; monitoring, evaluation and impact assessment; and sustainability and scaling-up. Although essentially aimed at program planners and managers working in the field of agricultural production in low-income countries, it makes interesting reading for anyone involved in program implementation. It provides practical guidance and examples of good practices and issues to consider, based on empirical research and programmatic experiences reflecting the cumulative experiences of diverse experts from the field.

Both documents can be downloaded at [www.fao.org/nutrition/education/infant-and-young-child-feeding/en/](http://www.fao.org/nutrition/education/infant-and-young-child-feeding/en/)

## Recommended Reading

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### Changing Food Systems for Better Nutrition

As this edition of *Sight and Life* focuses on food systems, we would like to draw your attention to an issue of SCN News from 2013 (No 40 2013 ISSN 1564 – 3743) that has a number of interesting articles addressing how to change food systems for better nutrition.

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### It can be downloaded at

[www.unscn.org/files/Publications/SCN\\_News/SCNNEWS40\\_final\\_standard\\_res.pdf#page=10](http://www.unscn.org/files/Publications/SCN_News/SCNNEWS40_final_standard_res.pdf#page=10).

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### Children and AIDS

On World AIDS Day in December 2015, UNICEF released its annual Statistical Update on the situation of Children,

Adolescents and AIDS, which we believe is important reading. It can be downloaded at <http://www.childrenandaids.org/home>. In the words of UNICEF Executive Director Anthony Lake, “The number of lives saved thanks to the HIV and AIDS response in this century is remarkable. But for the sake of the children and adolescents still affected, and for all future generations, we cannot mistake advancement for attainment. We must do more, and do it faster than ever. That's the only way to achieve an AIDS-free generation.”

## Appointments: Gerda Verburg and David Nabarro



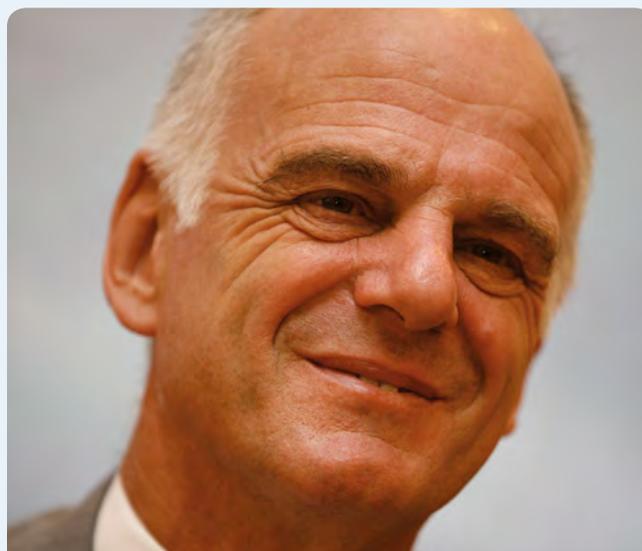
Gerda Verburg

### Welcome to Gerda Verburg as the new SUN Coordinator

Following in the footsteps first of David Nabarro and then of Ad-interim Coordinator Tom Arnold, is Gerda Verburg of the Netherlands – the newly appointed Coordinator of the Scaling Up Nutrition (SUN) Movement.

Ms Verburg, who among other roles served as Chair of the UN Committee on World Food Security (CFS) until 2015, takes up the task of working with the 56 country governments that lead the SUN Movement together with UN agencies, civil society, business and donors, in a common mission to defeat malnutrition in all its forms. We believe her enthusiasm and pragmatic approach will ensure that the SUN Movement continues to remain focused on delivery of evidence-informed scaled-up interventions to address malnutrition in all its forms.

To read more about Gerda and the latest SUN news, please go to <http://scalingupnutrition.org/> and follow her on Twitter @GerdaVerburg. Also follow the various SUN groups @SUN\_Movement (SUN Secretariat) @SUNSCN (SUN Civil Society Network) @SUNBizNet (SUN Business Network).



David Nabarro

### Special Adviser on the 2030 Agenda for Sustainable Development

After his successful tenure establishing the SUN Movement as a powerful driving force for nutrition, David Nabarro became Special Envoy of UN Secretary-General Ban Ki-moon on Ebola in 2014. Dr Nabarro's role was to provide strategic and policy direction for the international response.

Ban Ki-moon has now called on Dr Nabarro to take on the role of Special Adviser on the 2030 Agenda for Sustainable Development. He will work with Member States and other relevant stakeholders to galvanize action on implementation of the Agenda, while also overseeing the Secretary-General's special initiatives, for example, "Every Woman, Every Child." Dr Nabarro also remains Special Representative of the Secretary-General for Food Security and Nutrition, so he continues to be involved with nutrition, which we are delighted about.

## Helping Children to Reach their Potential through Micronutrient Powder in School Feeding Scheme



Helping school children in South Africa to have brighter prospects and a better chance of supporting their communities as they grow and develop

As part of *Sight and Life's* humanitarian projects, we work with the giving-back projects undertaken by Savanna Game Lodge in South Africa. We support their work at the Tiyimiseleni Centre. This is a home-based care center in the village of Marbarhule, where every day 250 orphans and vulnerable children (age 3–17 years) are given a meal and a beverage that provides them with all the essential vitamins and minerals.

Recently, we have expanded this project to provide a multiple micronutrient powder to supplement the school meal of the local Mketse primary school that feeds some 650 children each day. We had an inspiring launch visit, first meeting with the school Managing Board, who were really excited at the idea of improving the health status of their pupils, who come from

a very poor community. We then met with all the parents/caregivers and were able to share with them how the project was aimed at assisting their children. Finally, but most importantly, we spent time training the dedicated ladies from the community who each day get up at 4 a.m. to come to the school and prepare a mid-morning meal for the children, many of whom arrive hungry and for whom this meal will be the only balanced meal they receive during the course of that day.

We felt humbled by the words of one of the parents during our meeting, “We are very happy that *Sight and Life* is helping our young children to become those who can go to university in the future and make a difference for the whole community.

**Thank you, *Sight and Life!*”**

## First Foods – Accelerating Global Progress to Improve Complementary Feeding



Recent years have seen nutrition in the global spotlight. This attention has catalyzed political commitment and increased the need to identify concerted actions to end childhood under-nutrition. In November 2015 a global meeting, First Foods, was held in Mumbai, India, with the object of accelerating progress on complementary feeding in young children. To date, a variety of program strategies to improve complementary feeding practices have been implemented all over the world with varying rates of success. The chief successes have been achieved by nutrition education and behavior change communication using locally available foods and improving food systems, and the provision of specialized food products, food fortification and supplementary food programs. Progress in implementing large-scale, sustainable, complementary feeding programs has been slow, but some recent country examples show that it is possible to achieve significant improvements in complementary feeding.

The First Foods meeting provided an opportunity to review, discuss and rethink existing programs and to look at research gaps. The report is easy to read and practical, providing country case studies and key take-away messages from each of the sessions. It is essential reading for anyone working in the field of young child nutrition.

“Recent country examples show that it is possible to achieve significant improvements in complementary feeding”

Seven key recommendations to accelerate progress on complementary feeding for young children are included in the meeting report, available at [www.firstfoodsforlife.org/summary/First\\_Foods\\_Global\\_Report.pdf](http://www.firstfoodsforlife.org/summary/First_Foods_Global_Report.pdf):

1. Programs should communicate clearly that adequate complementary feeding contributes to a broad spectrum of short- and long-term outcomes.
2. Programs need to combine two or more strategies for improving complementary feeding in order to effectively increase the adoption of optimal feeding behaviors across diverse population groups.
3. To be effective, sound situation analysis and formative research tailored to the local context must serve as the basis for the design, planning and implementation of complementary feeding programs. Tools to do this are easily accessible and adaptable.
4. To be successful, complementary feeding programs need to involve multiple sectors relevant to food systems, such as health and gender, whose roles and responsibilities need to be mutually agreed upon and clearly articulated based on situation analysis.
5. Evidence-based behavior change communication is an essential component of strategies to improve complementary feeding practices in all settings.
6. Monitoring and evaluation tools and processes must be aligned with program design, information needs, and the available time and resources.
7. Advocacy for complementary feeding programs needs to address the significant resources required to build capacity and scale up and institutionalize effective programs and strategies for the longer term.

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## Access to Nutrition Index 2016: Ranking 22 of the largest companies on their contributions to tackling obesity and undernutrition

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The Access to Nutrition Index (ATNI) is published by the Access to Nutrition Foundation, an independent non-profit organization dedicated to objectively assessing and improving the contribution the private sector makes to addressing global nutrition challenges. The Foundation publishes a set of indices that assess and rate major food and beverage manufacturers' nutrition policies, practices and disclosure, for use as a benchmarking tool by investors, health advocates and companies themselves.

The 2016 Global Index is the second in the series to be released. It evaluated each of the companies on its corporate strategy, management and governance related to nutrition; formulation and delivery of appropriate affordable and accessible products; and positive influence on consumer choice and behavior, through nutrition information, food marketing and labeling. In addition, the 2016 ATNI also assessed the policies and practices of the world's largest breast-milk substitute manufacturers to gauge whether their marketing aligns with the International Code of Marketing of Breast-Milk Substitutes and subsequent World Health Assembly resolutions.

The findings show that while some companies have taken positive steps since the last index in 2013, the industry as a whole is moving far too slowly. Out of a possible scoring of 10, the highest score was 6.4, with Unilever leading the list. Within the breast-milk substitute category of manufacturers, the research found that none of the six companies assessed was fully compliant with the Code, although there was significant variation in their performance.

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**To access the 2016 index, please visit**  
[www.accesstonutrition.org/index/2016](http://www.accesstonutrition.org/index/2016)

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**“The food and beverage industry is moving far too slowly on their nutrition-related commitments, practices and levels of disclosure”**

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# Ending Rural Hunger: Need and actions for food and nutrition security

**“Success in ending rural hunger requires at least doubling the current rate of progress. This makes a new approach critical”**

The Sustainable Development Goals (SDGs) have formally set the target of ending world hunger within the next 15 years. According to the Ending Rural Hunger Report, however: “Success will not come easily. It requires at least doubling the current rate of progress... This makes a new approach critical.” Especially critical if we are to ensure that in reaching SDG 2, we leave no one behind.

The report thus focuses on the three-quarters of the 795 million undernourished people in the world who live in rural areas within developing countries, where the issue is about more than growing enough food. It is about demand for, as well as supply of, food; quality as well as quantity; an adequate diet today, and the assurance of one tomorrow. Emphasis must be placed on the needs of small-scale farms, including the special challenges faced by women farmers if the goal of zero hunger is to be achieved. To date there has been too little long-term strategic planning and accountability.

The report, which is accompanied by a toolkit, aims to help track and compare the efforts of developing and developed country governments to end rural hunger. It contains the key results and actionable recommendations of a comprehensive effort to quantify the rural food and nutrition security needs, policies, and resources in 116 developing countries, alongside an assessment of 29 developed countries’ domestic agricultural and biofuel policies, plus their food and nutrition security aid policies.

On a positive note, the report highlights six trends that hold the promise that the end of rural hunger lies within reach:

1. Distortions in global agricultural markets have fallen substantially.
2. Global resources for food and nutrition security are increasing.
3. Public and private actors are increasingly collaborating to solve global food and nutrition security problems.
4. The global SDG negotiations have sharpened focus on infrastructure priorities that are critical to small-scale farmers’ physical and informational connectivity with markets.
5. Agricultural research is making inroads on many key farming constraints.
6. A number of high-level initiatives have been announced at major meetings of the UN, G-20, G-7, and African Union which, if sustained and properly scaled, could signify the start of long-term international leadership.

**What is new and different is that the report is accompanied by an interactive website:**

*www.endingruralhunger.org. This website presents the full results of the analysis together with the underlying data, allows you to view country profiles and map specific country data, and includes ready-made research and advocacy tools.*

## Did You Know?

- > 3/4 of the 795 million undernourished people in the world live in rural areas within developing countries.
- > There are about 500 million small farms around the world that provide livelihoods for up to 2.5 billion rural people.

## Continuing Education and Engagement



- > The eNutrition Academy (eNA) is a global nutrition training platform that was founded by the African Nutrition Society, the American Society for Nutrition, the Federation of African Nutrition Societies, the International Union of Nutritional Sciences, and the Nutrition Society of the United Kingdom and Ireland. **Visit** [www.enutritionacademy.org/](http://www.enutritionacademy.org/) **to register and trial the available nutrition modules.**
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- > Education for Effective Nutrition in Action (ENACT) is an 11-week undergraduate course in planning, promoting and implementing effective nutrition education and communication. The module has been developed by the FAO together with partner universities in seven African coun-

tries. **The course can be downloaded FREE** from [www.fao.org/nutrition/education/professional-training/enact/en/](http://www.fao.org/nutrition/education/professional-training/enact/en/).

- > Alive & Thrive is an initiative to save lives, prevent illness, and ensure healthy growth and development through improved breastfeeding and complementary feeding practices. Alive & Thrive has a series of case studies – including short how-to videos, sample communication strategies and adaptable research tools – that illustrate the principles and processes for designing strategic behavior change programs. **Just go to** [www.aliveandthrive.org](http://www.aliveandthrive.org) and click on the “Resources” tab.

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- > The SUN Movement has launched an interactive online SUN Forum. The Forum is hosted by en-net, and offers a space to support knowledge management across the SUN Movement. People in the Movement are being invited to share their views, ask questions and make their experience, expertise and opinions available to others via this new virtual learning space. **To engage, please go to** [www.en-net.org/sunmovement](http://www.en-net.org/sunmovement).

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- > We cannot fail. We will not fail, as success is in our collective hands.

# World Health Assembly Adopts Resolution to Further Protect and Promote Breastfeeding



The World Health Assembly in action

Ensuring optimal infant and young child feeding has been recognized as a critical issue that should be incorporated in country nutrition plans and policies with a view to promoting long-term development and achieving the Sustainable Development Goals (SDGs). The 69<sup>th</sup> World Health Assembly (WHA), held in Geneva, Switzerland at the end of May, adopted a resolution (WHA 69.9) that provides policy guidance for member states on two issues:

1. Follow-up formula and so-called growing-up/toddler milks are breast-milk substitutes. As such, they should not be promoted, because they fall under the International Code of Marketing of Breast-Milk Substitutes and subsequent relevant Health Assembly resolutions. A breast-milk substitute should be understood to include any milks (or products that could be used to replace milk, such as fortified soy milk), in either liquid or powdered form, that are specifically marketed for feeding infants and young children up to the age of three years (including follow-up formula and growing-up milks).
2. There is now clear guidance concerning promotion that applies to all commercially produced foods marketed as being suitable for infants and young children between the ages

of 6 and 36 months. The seven recommendations recognize the role of appropriately formulated complementary foods, but aim to ensure that breastfeeding is promoted, protected and supported; that obesity and non-communicable diseases are prevented; that healthy diets are promoted; and that caregivers receive clear and accurate information on feeding that is free from commercial influence.

### Summary of the seven recommendations to end the inappropriate promotion of foods for infants and young children

#### Recommendation 1

Optimal infant and young child feeding should be promoted based on the Guiding principles for complementary feeding of the breastfed child and the Guiding principles for feeding non-breastfed children 6–24 months of age.

#### Recommendation 2

Products that function as breast-milk substitutes should not be promoted.



Representatives of civil society presenting their statements at the 69<sup>th</sup> World Health Assembly

**Recommendation 3**

Foods for infants and young children that are not products that function as breast-milk substitutes should be promoted only if they meet all the relevant national, regional and global standards for composition, safety, quality and nutrient levels and are in line with national dietary guidelines.

**Recommendation 4**

The messages used to promote foods for infants and young children should support optimal feeding, and inappropriate messages should not be included.

**Recommendation 5**

There should be no cross-promotion to promote breast-milk substitutes indirectly via the promotion of foods for infants and young children.

**Recommendation 6**

Companies that market foods for infants and young children should not create conflicts of interest in health facilities or within health systems. Health workers, health systems, health professional associations and non-governmental organizations should likewise avoid such conflicts of interest.

**Recommendation 7**

The WHO set of recommendations on the marketing of foods and non-alcoholic beverages to children should be fully implemented.

**The full guidance can be found at:**

*[http://apps.who.int/gb/ebwha/pdf\\_files/WHA69/A69\\_7Add1-en.pdf](http://apps.who.int/gb/ebwha/pdf_files/WHA69/A69_7Add1-en.pdf)*

**The resolution WHA 69.6 itself can be found at:**

*[http://apps.who.int/gb/ebwha/pdf\\_files/WHA69/ACONF7Rev1-en.pdf](http://apps.who.int/gb/ebwha/pdf_files/WHA69/ACONF7Rev1-en.pdf)*

A world  
free of  
malnutrition.

**Editor's note:** This section contains reviews of books, publications, and websites that, whether brand new or classic, we hope will be of interest to our readers. Notices of relevant new publications that do not actually constitute reviews will from henceforth be published on [www.sightandlife.org](http://www.sightandlife.org).

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Book Review

## Nutrition for Developing Countries

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**Edited by** Felicity Savage King, Ann Burgess, Victoria J Quinn and Akoto K Osei  
Third Edition, Oxford University Press, 2015

**Bibliographic Information**

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ISBN 978-0-19-968522-6

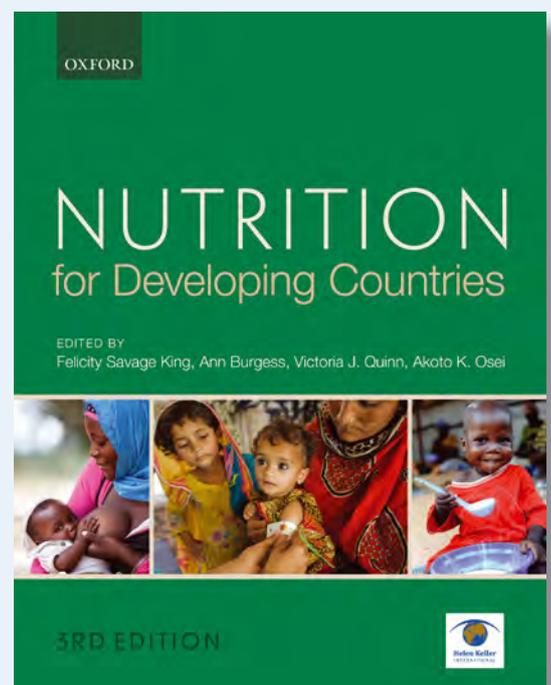
**Keywords:** nutrients, nutrient needs, foods, meals, nutrition problems, malnourishment, communities, nutrition education

The first edition of *Nutrition for Developing Countries* was published by Oxford University Press in 1972. As its co-author Maurice King writes in his preface to this third edition, it was written in response to a request to write a “nutrition manual,” and its success led to King being dubbed a “knowledge engineer” for his achievement in presenting such a complex topic with such admirable clarity.

In her Foreword to this third edition, Anna Lartey, Director of Nutrition at the UN Food and Agriculture Organization (FAO), writes: “This book is a ‘one-stop shop’ nutrition textbook for anybody working in a developing country who needs to update their knowledge on key nutrition topics.” Encountering the first edition for the first time in the 1980s when she was working as a nutrition lecturer at the University of Ghana, Dr Lartey recalls that she was “amazed by the breadth of topics covered and the simplicity of the language. For me,” she con-

tinues, “it is a ‘must-have’ book for anybody teaching or doing community nutrition work in Africa or elsewhere.” Dr Lartey notes that the new edition of *Nutrition for Developing Countries* “still retains its easy-to-read and well-illustrated style,” noting that the content “has been expanded to take into consideration current challenges and opportunities for nutrition, which health and nutrition professionals working in developing countries must face.”

This fully revised and updated third edition has been prepared by an international editorial team with extensive field experience in Africa and Asia. Using clear, simple language and many illustrations – some of them drawn from the previous two editions, many of them newly created for this one – it brings together the essentials of nutrition in a way which is accurate, up-to-date, and suitable for a wide range of readers.



.....

“Nutrition in Developing Countries brings together the essentials of nutrition in a way which is accurate, up-to-date, and suitable for a wide range of readers”

.....

The book explains nutrients, nutrient needs, meal planning, and how to ensure good nutrition over the life cycle – during pregnancy, infancy and childhood, adolescence, and adulthood, including old age. Emphasis is given to the most vulnerable periods of the life cycle, especially the first 1,000 days from conception to the second birthday. It addresses the causes, diagnosis, prevention and treatment of undernutrition and micronutrient deficiencies, as well as the growing

epidemic of overnutrition and obesity, which is a leading cause of non-communicable diseases.

The new edition adds to the existing subject matter sections on the nutrition-related management of non-communicable diseases; how to feed children exposed to HIV and people with HIV/AIDS; the essential nutrition actions that improve health and survival; the key target groups (e.g., women and children under two) during critical times during the life-cycle; and optimal nutrition practices for girls and women. Appendices include recommended nutrient intakes, food composition tables, anthropometric standards and useful websites. The book is – very appropriately – dedicated “to health and nutrition workers around the world who are working to improve nutrition, especially that of women and young children.”

.....

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# Imprint

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It does this by supporting innovation that aims to eradicate malnutrition.