

sight and life

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STUNTING AS AN
INDICATOR**
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INNOVATION**

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THE FOOD INNOVATION
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Welcome

Innovation for a planet free from malnutrition

Innovation is one of the most studied and debated themes in social sciences, management, and business. Diverse views abound concerning what it is and what makes it successful.¹ “Change that creates a new dimension of performance” is the management theorist Peter Drucker’s pithy definition;² others describe innovation as “the generation, acceptance, and implementation of new ideas, processes, products, or services,”³ “the creation of new knowledge and ideas to facilitate new business outcomes,”⁴ and “the effective application of processes and products new to the organization and designed to benefit it and its stakeholders”⁵ – to cite but a few.

Creating value for people

However we define it, innovation is about change created by *people* to create value for *people*, and therefore should have people, rather than technology or processes, at its heart. Innovation can modify or generate new products, processes, services, or systems. In speaking about innovation, we may be referring to the process involved, or to the outcome of that process, or indeed to both. Recent emphasis on innovation as a disciplined and repeatable process has somewhat obscured the fundamental role that creativity plays in it. Whatever the process and its outcome, it is the human creative spark that fuels innovation. As Mauro Porcini puts it, “what really drives innovation is not the process, it’s the mind, the soul, the heart of whoever drives that process.”⁶ That creative spark emerges from multiple sources: the *curiosity* to gain insight into what makes people tick and operate the way they do; the *openness* to look at a problem from fresh, completely different angles; the *attitude of becoming one* with those whose lives one aspires to change for the better; the sharp *attunement* to the major trends shaping humanity and to scientific and technological breakthroughs; the *exploration* of adjacent or analogous fields of knowledge; the *synthesis* of new ideas from previous ones; the *observation* of outliers and positive deviances; the *passionate pursuit* of the question “why not?”; and so forth.

Food product innovation

In this issue, we focus on product innovation – specifically, *food* product innovation, which implies some degree of food transformation or processing, be it artisanal, lab-based, or industrial. We live in exciting times. The food and beverage industry is going through a period of intense innovation, which can be appropriately characterized as a *revolution*, influenced by the broader Fourth Industrial Revolution.⁷ This food industry revolution is propelled by a number of factors. There is growing realization of the unsustainability of the world’s current approach to food. Poor diets lead to the double burden of concurrent undernutrition and overnutrition, which substantially contributes to the unsustainable burden of non-communicable diseases on health systems. Many agricultural practices imperil our ability to adequately nourish nearly 10 billion people by 2050 and indeed threaten the survival of the planet itself. Advances in food and nutrition sciences and increased access to nutritional knowledge are transforming consumer preferences. Both aging populations and millennials are demanding healthier, transparently sourced and produced, and also sustainable foods. Having learned the lesson that they are not adequately positioned to develop and market disruptive food innovations, large food companies are investing in myriad venture capital funds and startups to innovate with healthier and more credible products. These products are novel along the various dimensions of food – experience, function, convenience, health, accessibility, and sustainability – and the multiple associated product attributes.

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 “The food and beverage industry
 is going through a period
 of intense innovation, which
 can be appropriately characterized
 as a revolution”

We are delighted to publish in this issue of *Sight and Life* magazine contributions from a broad range of authors, spanning the public, private, social, and academic sectors. Our thanks go to them all. Contributors from the private sector, in particular, carried out a task not usually included in their job descriptions, and for that we are especially thankful. Their perspectives highlight not just the vital role the food and beverage industry has to play in overcoming malnutrition, but also the sincere commitment so many industry professionals share with professionals from the other sectors to meaningfully contribute to a healthier world.

The process of innovation

A number of articles featured in this issue address the process of innovation. Lynda Deakin from IDEO discusses the application of some of the intriguing design approaches her firm has successfully employed in other domains to food system innovation. Jörg Spieldenner from Innosuisse and Klazine van der Horst from Bern University introduce us to the evolutionary approach of food product reformulation. A thought-provoking approach and tools that draw on dietary trajectories to facilitate optimal choices for both food innovators and consumers are presented by Heribert Watzke from Watzke Heribert Consulting. Various facets of the concept of innovation and the relevance of Human-Centered Design to food innovation and public health problem-solving are explored by Alain Labrique from Johns Hopkins University, Cesar Vega from Mars, Inc., and their coauthors. David Ball and his colleagues at SecondMuse familiarize us with the concept of network-centered innovation and argue that “collaborative equilibrium” in an innovation ecosystem leads to more and better innovation than a purely competitive model. Simone Frey from the Nutrition Hub gives us an illuminating tour of the thriving food innovation ecosystem. Henk Bosch from DSM broadens our perspective on food innovation by addressing its ever more important dimension of sustainability. Continuing their engaging Sizanani Mzanzi series, my colleagues Kesso van Zutphen and Madhavika Bajoria take us through the journey of new product development and pricing targeting low-income consumers. Together with Darshana Joshi and Preen Moodley from Africa Improved Foods, we describe a nutrition-focused social enterprise that is building a new public-private partnership model in East Africa and innovating on several fronts to reduce malnutrition in the region.

Influencing nutrition outcomes

We also cover several innovations that have had enormous impact on nutrition outcomes or hold the potential to do so in the years to come. Senoe Torgerson and Dipika Matthias from the Bill & Melinda Gates Foundation argue the need for evolution in one of the most successful nutrition-relevant innovations in

history – food fortification. An interesting frugal innovation research effort to produce high-protein-quality spreads for pregnant and lactating women in India is presented by Andrew Tony-Odigie from Bern University of Applied Sciences and coauthors. Simon Billing and Heidi Spurrell from the Protein Challenge 2040 Initiative at Forum for the Future walk us through the effervescent landscape of new protein sources and the promise they hold. Mark Manary and Meghan Callaghan-Gillespie from Project Peanut Butter expand on the past, present, and future of another highly successful, life-saving innovation: ready-to-use therapeutic foods. Mark is also featured in our A Day in the Life interview as a bright example of an entrepreneurial scientist who has spent most of his career innovating for impact in low-resource settings. Danone’s research-driven effort to improve nutrition during the first 1,000 days is described by Eline van der Beek from Danone Nutricia Research. Together with colleagues from Yoba for Life and PATH, we explore the potential for innovation drawing on emerging microbiome science to improve nutrition and gut and overall health, particularly using probiotic fermented foods. Panam Parikh and Rolf Bos from FrieslandCampina highlight the potential of prebiotics to, combined with iron supplements and micronutrient powders, more effectively and safely combat iron deficiency in vulnerable populations.

We can also relish in this issue another delicious serving of Jonathan Steffen’s Nutrition in Literature series, this time thoughtfully exploring references in Homer’s *Odyssey* to the Mediterranean Diet.

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“Transforming ideas and science into nutrition and health impact for people is a noble and high-value endeavor”

Food for Thought

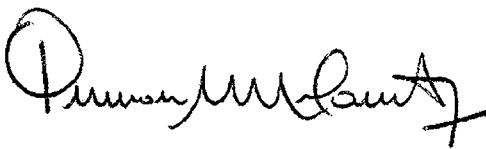
Last but not least, I’d like to draw your attention to two highly current Food for Thought pieces. The first one, by Klaus Kraemer, revisits the topic of the use of stunting as the main success indicator of nutrition interventions from the study or program level through the Sustainable Development Goal level. His article gives voice to a growing community of researchers, practitioners, and funders that acknowledge the need to expand the array of responsive outcomes and indicators associated with nutrition interventions and evolve to a more holistic framework of child development that includes but goes beyond linear growth. The second piece, by Saskia de Pee from the World Food Programme, offers important clarifications on the

WHO *Guideline for assessing and managing children at the primary health-care facilities to prevent overweight and obesity in the context of the double burden of malnutrition* issued in October 2017. The points Saskia makes represent the consensual position of WHO, WFP, and UNICEF on the implementation of that guideline.

By itself an exciting topic, innovation is a source of even greater enthusiasm when done with the most vulnerable and our planet in mind. From the most frugal to the most sophisticated innovation, whether aimed at urban or rural populations, transforming ideas and science into nutrition and health impact for people – humanity as a whole and the underprivileged in particular, as illustrated by the articles in this issue – is a noble and high-value endeavor that accelerates our journey towards a world worthy of our descendants.

We hope this issue of *Sight and Life* magazine will sharpen your curiosity, spark your own insights and ideas, and intensify our collective sense of urgency, possibility, and optimism towards a sustainable planet that is free from malnutrition.

Warm regards,



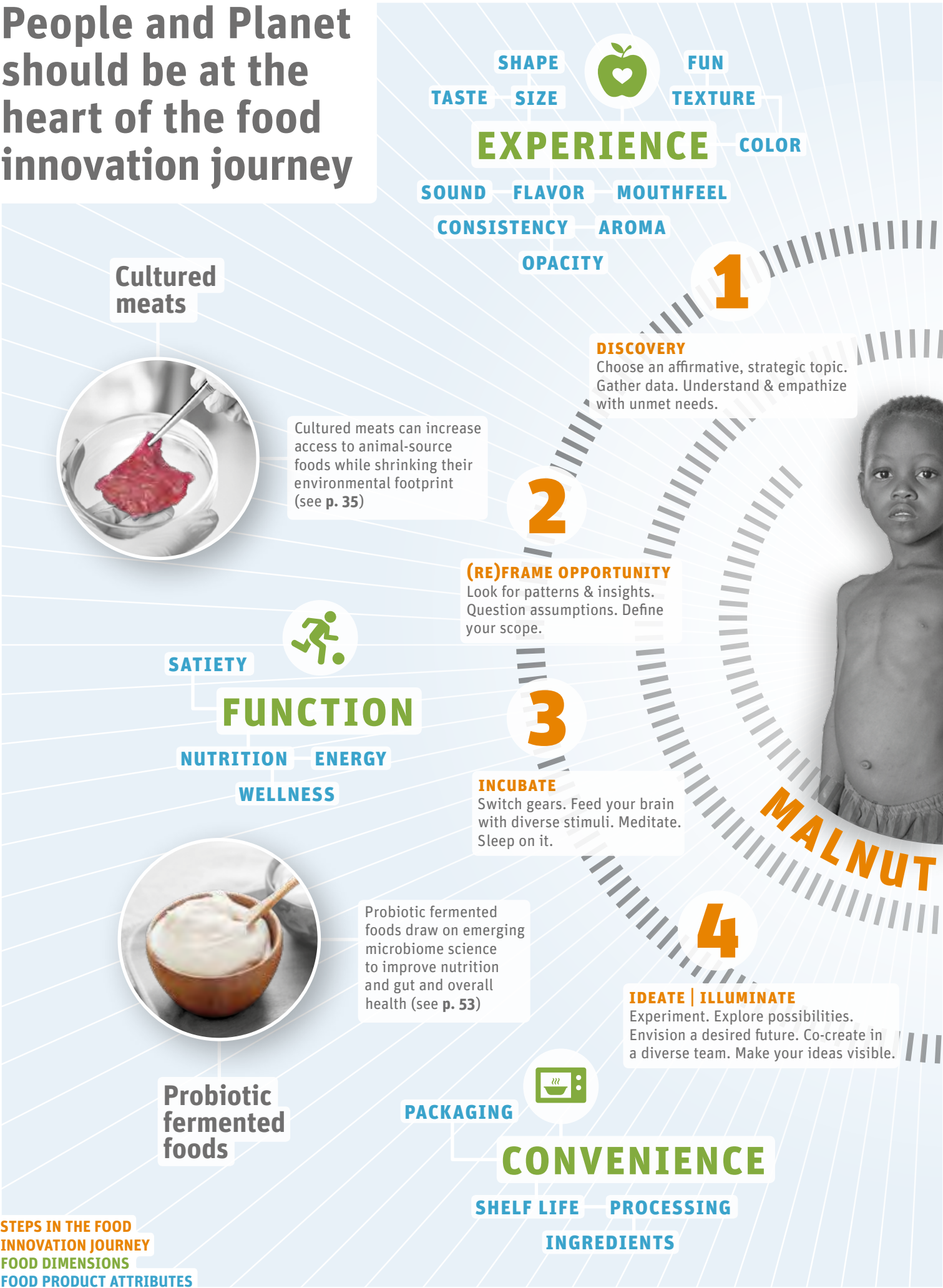
Peiman Milani

Global Lead, Public-Private Partnerships
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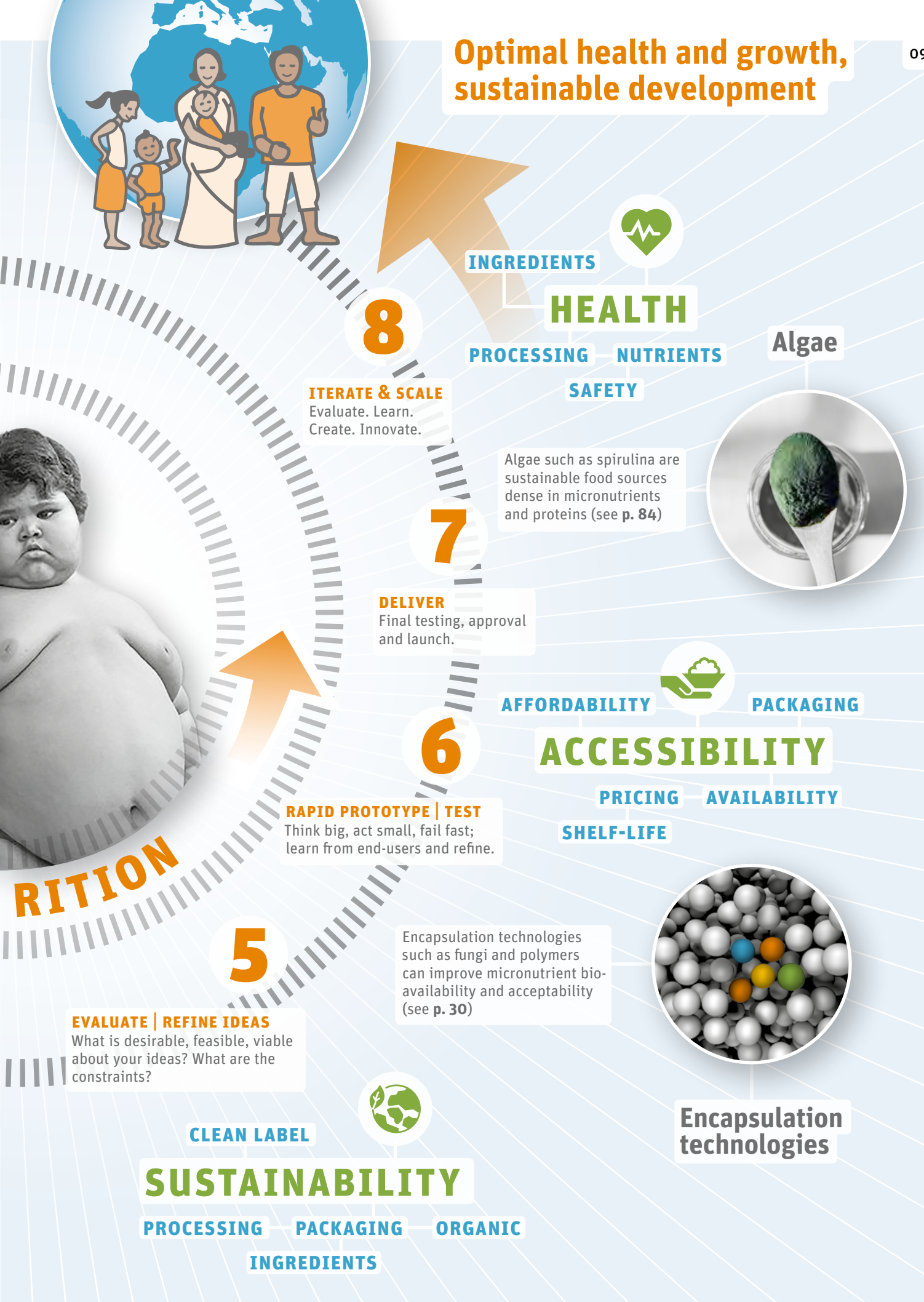
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People and Planet should be at the heart of the food innovation journey



Optimal health and growth, sustainable development



Nutrition ARISE – New Frontiers for Public Health Nutrition

Klaus Kraemer

Managing Director, *Sight and Life*

Five years have passed since I wrote “The Stunting Enigma” in the 2/2013 edition of *Sight and Life* magazine. At the time, I expressed my deep concern for our lack of understanding of the causes of stunting. The causal chain seemed just far too complex. Five years later, and new research has shaken the foundations of what little understanding we felt we did possess. New findings have obscured rather than shed light on any of the hypotheses we have been working with.

However, there is some good news. The recently modeled spatial and temporal changes in sub-Saharan Africa for the period of 2000–2015 showed that the prevalence of stunting is gradually decreasing.¹ Nevertheless, there are disparities in these trends and the reasons for this are still not understood. Randomized controlled efficacy and effectiveness trials have generally reported only small improvements in linear growth and reductions in stunting during the first few years of life.

There are many possible factors for such modest results – the most important being that the multiple complex biological contributors to stunting may not be fully addressed in a single or limited set of interventions. This has led to a growing recognition that linear growth stunting may be a “community syndrome” in which multiple stresses, both nutritional and otherwise, operate from preconception through early childhood.

“The biological contributors to stunting may not be fully addressed in a single or limited set of interventions”

A move toward improvement

To improve linear growth in populations of children, we therefore need to widen the lens of research to include these additional factors. Each one has potential long-term implications and can be profoundly impacted by timely nutrition interventions. These factors may also respond to behavioral, early childhood development (ECD), and water, sanitation, and hygiene (WASH) interventions and may occur even in the absence of accelerated linear growth. There is also a need to recognize that nutrition interventions can affect a broad array of child health outcomes, including cognitive and motor development, anthropometric, metabolic, micronutrient, and immunological status, maturation, and domains of behavior. Therefore, to evolve toward the necessary full spectrum of public health efficacy and effectiveness research, we must also consider these diverse outcomes.

Much work is required to broaden the toolkit of indicators across the domains of early childhood health and development. This is where Nutrition ARISE comes into play.

“Nutrition ARISE aspires to expand the set of measurable responses to interventions intended to improve the life of children in populations affected by undernutrition”

What is Nutrition ARISE?

Nutrition ARISE – Adding Responsive Indicators to Stunting to Expand Early Life Nutrition and Development Achievement – is a gathering of nutrition researchers and practitioners with the goal of giving formal voice to (1) the importance of promoting adequate linear growth and (2) the need to recognize the potential of other facets of health and development. The aim is to

10 y/o Girl
125cm (-2SD)

10 y/o Girl
138cm (norm)



embrace the full public health response to early life nutrition, WASH, and childhood development interventions. With this goal in mind, Nutrition ARISE aspires to expand the set of measurable responses to interventions intended to improve the life of children in populations affected by undernutrition.

Outcomes of the first Nutrition ARISE expert consultation in Boston, USA

On June 12, 2018, 35 expert researchers, practitioners and funders of nutrition interventions gathered in Boston, USA for the first Nutrition ARISE expert consultation. This gathering of expert voices exceeded our expectations. We hoped our first meeting would merely initiate a dialogue and maybe seek a consensus on the complexity of this area of research. I was impressed not only by the quality of the presentations, but also by the outstanding discussions that ensued. Without a doubt, we had the right people to address such an important and challenging issue. We benefited from a diverse and dynamic set of speakers and participants including, but not limited to, the fields of nutrition, pediatrics, anthropology, economics, epidemiology, psychology, statistics, ethnography, and demography – to name but a few!

Five key needs emerged from the consultation:

1. More research to clarify causal relationships for scientific purposes.
2. Development of alternative and practical indicators. These should include five types, for policy and programmatic purposes:
 - a. Nutritional status (current situation)
 - b. Intermediate outcomes of interventions contributing to improved nutrition
 - c. Outcomes that respond to nutritional improvement
 - d. Outcomes that respond to nutrition interventions, even if there is no improvement in stunting or other indicators of nutritional status
 - e. Indicators of intervention or program delivery and uptake
3. Collaboration with researchers in other disciplines on these five types of indicators.
4. A set of carefully crafted messages and outreach strategies that aim to maintain the interest and momentum for nutrition. These should clarify and offer alternative frameworks, arguments, and indicators for various purposes.

5. Collaborative advocacy with the ECD and WASH communities, aimed at improving human capital through biological and developmental pathways. We want healthy, smart, productive, and happy people and populations.

As marvelously summarized by Dr. David Pelletier, the over-reliance on stunting as a “simple/best/most practical/best available indicator of undernutrition for all purposes” has led to numerous difficulties. These are:

- > Disappointing results of efficacy and effectiveness trials
- > A threat to the current momentum on nutrition and ability to improve nutrition
- > Undervaluing of other outcomes of nutrition interventions of public health importance
- > A narrow approach to child development that fails to appreciate other relevant dimensions of human capital, nurturing, and fulfillment (cognitive, motor, socioemotional, etc.).

The day was rich with discussion. It yielded the desired consensus that the time has come to broaden our approach to nutrition interventions. We should expand in terms of context, exposures, outcomes, and their respective markers and indicators. Nutrition ARISE marks the beginning of this endeavor.

Next steps

Nutrition ARISE will compile contributions from all consultation presenters and generate the proceedings of the consultation for publication and dissemination. We want this new perspective to be discussed and peer-reviewed. Periodic calls will be scheduled for follow-up discussions and to promote further coordination. Finally, a wider meeting will be convened in early 2019 to advance the Nutrition ARISE agenda and engage the ECD, WASH, and global development communities. Additionally, you will soon be able to access content from the proceedings, available on our website, with related resources available for download.

The focus areas of Nutrition ARISE are:

1. Update evidence on the efficacy of early life nutrition-specific and -sensitive interventions in accelerating linear and ponderal growth, and in reducing the prevalence of stunting and wasting.
2. Affirm health, development, growth, behavioral, and functional outcomes and their indicators that can currently,

or could with further evaluation, take their place alongside linear growth as plausible responses to early-life nutrition interventions in infancy, and stages of childhood and later adulthood.

-
3. Propose a research agenda to integrate a wider array of exposure to intervention (including extent of change of nutrient intake, behavior, etc.) and outcome indicators of growth, development, and biological and other factors to monitor, alongside linear growth and change in prevalence of stunting, that can respond to nutrition-specific and -sensitive interventions and improve data for evaluating SDG target achievement.

Perhaps one of the most encouraging outcomes of the consultation remains the nutrition community's commitment to step up and take responsibility for rectifying an issue it has identified, and to some extent created. The confusing of science, politics, and policy can be discouraging and lead to passivity on our part. But we have a moral obligation to separate these and not shy away from our duties, staying true to the science. We need to further the pursuit of evidence-based policymaking,

interventions, and programs. Now is the time to build on the initial momentum created by our first gathering and to join together in this initiative as a group whose goal is to help those in need and whose full potential has been stolen by circumstances beyond their control.

I am deeply encouraged by the commitment and humility of all. As the famous British chemist Sir William Ramsay once said, *"Progress is made by trial and failure; the failures are generally a hundred times more numerous than the successes; yet they are usually left unchronicled."* Let us not dwell on our mistakes; instead, let's allow them to teach us better ways to tackle the challenges ahead.

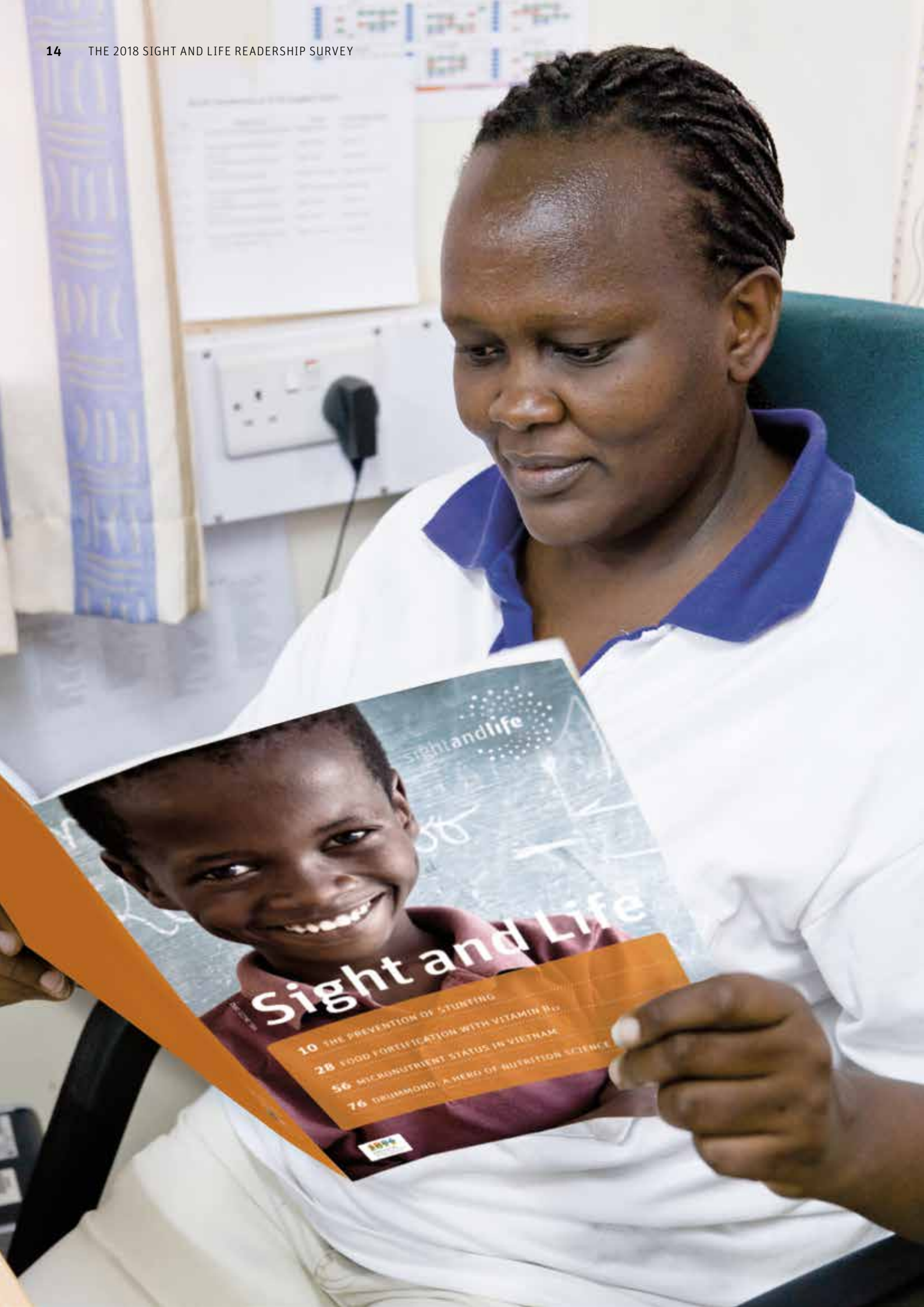
Sincerely,



Klaus Kraemer

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We'd love to hear from you

*Sight
and Life*
Readership
Survey
2018

We are always trying to improve *Sight and Life* magazine, and we very much value your views on it.

As a thank-you for your feedback, your name will be entered in a prize draw for a hard copy of *The Biology of the First 1,000 Days!*

Please take a moment to complete our readership survey.

Visit rebrand.ly/SALsurvey before it closes on Friday, September 28.

What Electric Cars Can Tell Us About Redesigning the Food System

Lynda Deakin

IDEO, San Francisco, CA, USA



We are faced with food shortages while at the same time fighting an obesity epidemic

The world of food contains all kinds of internal tensions: on the one hand, we're faced with hunger and food shortages, while on the other, we're fighting an obesity epidemic. In an effort to be more conscious of our own health and the health of our planet, we're being told to eat a plant-based diet, while at the same time lab-grown meat is gaining traction. How do we wrap our heads around all of this?

We think design can help. But a few things have to shift if we're going to drive the global food system toward greater sustainability. At the consumer level, it's about supporting people to make healthier decisions about how they eat. At the level of

large companies or complex systems, it's about helping organizations reinvent themselves, ask bigger questions, and make more thoughtful changes from within.

In either case, change isn't easy. To help our clients in the food space get inspired and energized, we often recommend looking for insights in unexpected places: we call it "analogous inspiration." It's easy to get caught up in what you already know and mired in the same cyclical ways of thinking; to innovate, you have to break out.

Here are a few ways to innovate in the food landscape (and beyond).

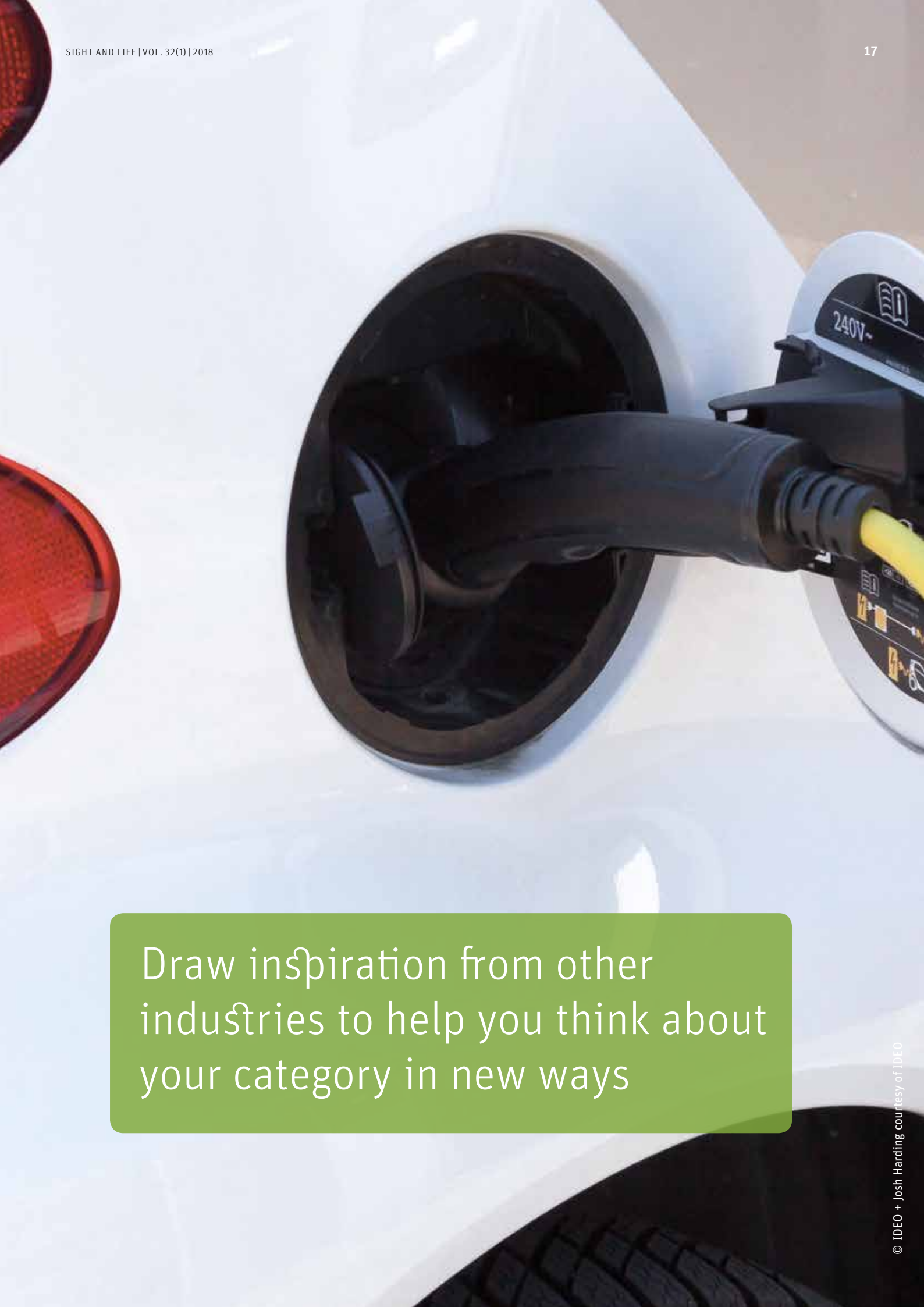
"A few things have to shift if we're going to drive the global food system toward greater sustainability"

1. Design for emerging behaviors

During a recent project to help a global beverage company think beyond its current business, we set up interviews with people outside the food industry, including one with a company that makes charging stations for electric vehicles. When the car charging company was just starting out, leaders assumed they would follow the model of gas stations by building stand-alone charging stations spread throughout a city. That's how people had fueled cars for decades, right?

But it turns out consumers don't want to stand around for 30 or 40 minutes while their cars charge; instead, they want to fold charging into another errand, such as a trip to the grocery store. Because their lives are increasingly complex, they want to streamline wherever they can.

This insight prompted the charging company to completely rethink its approach. Though the beverage business has nothing to do with cars, seeing the charging company's abrupt change in tactics to address a human need inspired our client to think far beyond existing consumer behaviors and to advocate for big changes in their business model.



Draw inspiration from other industries to help you think about your category in new ways



The United States generates
63 million tons of food waste
annually

The takeaway: Instead of taking the established route, innovators should be on the lookout for new and emerging behaviors that indicate an alternative path to designing for the future.

2. Get up close and personal

A lot of living happens outside of conference rooms and surveys. In order to capture what's really on people's minds, we often spend days or weeks shadowing people and looking for unconscious behaviors that can influence how we design for them.

Recently, we were working with a food company looking to expand its line of products. We met real customers and shadowed them for days: at home, on their commutes, while shopping, and when preparing food. By traveling on the subway with them, watching them buy groceries, and sitting with them in their homes as they cooked and ate, we noticed the workarounds they used and the subconscious actions they were taking to counteract what wasn't working for them.

These insights, while seemingly small, helped inform how we designed our client's packaging. It was the little observations we made by diving in head-first with consumers that enabled us to create an experience that felt significantly more human-centered.

The takeaway: Invest wholeheartedly in real human interactions and don't overlook the small stuff. Sometimes, subconscious behaviors and common workarounds indicate the need for a redesign.

“Look outside to other industries and sectors to see how they've solved problems”

3. Look beyond your industry

When you walk into a hotel room, you're often greeted by signs encouraging you to save water by reusing your towels or foregoing a change of sheets. While no longer new to most of us, these reminders were fairly revolutionary when they first appeared and have helped save millions of gallons of water since.

When we set out to help the Rockefeller Foundation find ways to reduce food waste, we looked for examples of waste reduction in other industries, including hospitality. Hotel signage cueing visitors to reuse towels is more than just a pesky reminder to save water; it's a way for people to incrementally change their behavior while feeling like they're a part of something bigger for the betterment of the planet. In this case, understanding what motivates people resulted in a drastic drop in water waste.

The United States generates 63 million tons of food waste annually. Of that, roughly 40% is estimated to come from consumer-serving businesses like hotels and restaurants.



© : IDEO + Josh Harding courtesy of IDEO

Stepping into the consumer's shoes is an invaluable tool to design solutions that best serve consumer needs

With the Rockefeller Foundation, we tapped into data on food waste and were able to use it to predict human behaviors and test subtle changes in a number of industries. Hyatt Hotels prototyped some of this thinking in their buffets – by switching from whole cakes to individual sweets, for example – resulting in a 10% cost savings for the company and an enormous reduction in food waste.

The takeaway: Instead of looking within your own walls for inspiration, look outside to other industries and sectors to see how they've solved similar problems.

Share your ideas!

We've found these three design approaches useful. Have other ideas? We'd love to hear them! Tag @IDEO and use the hashtag #designforfood.

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Commentary

Joint UN Note Clarifies WHO Guideline's Recommendation on the Use of Supplementary Foods for the Treatment of Moderate Acute Malnutrition

Saskia de Pee

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Friedman School of Nutrition Science and Policy,
Tufts University, Boston, MA; Human Nutrition,
Wageningen University, Wageningen, the Netherlands

The WHO Guideline for Assessing and Managing Children at Primary Health-Care Facilities to Prevent Overweight and Obesity in the Context of the Double burden of Malnutrition: Updates for the Integrated Management of Childhood Illness, which was published in October 2017, includes a recommendation regarding the provision of supplementary foods for the treatment of moderate acute malnutrition (MAM), which has caused confusion.

Recognizing that there was a need for clarity, WHO, WFP, and UNICEF met in March 2018 to discuss the guidance for the use of supplementary foods for the treatment of MAM and developed a joint Note for Implementation of the above-mentioned Guideline (see below). The Note reiterates that treatment of MAM requires a continuum of care that should be defined by context and may require counseling, dietary support in the form of provision of supplementary foods, medical interventions, and/or complementary programming in health, food security, and WASH.

“Treatment of MAM requires a continuum of care that should be defined by context”

The provision of supplementary foods in MAM treatment programs should be considered when families are unlikely to be able to provide adequately nutrient-dense foods to support their child(ren)'s recovery from MAM. Children suffering from MAM have higher nutrient requirements than normal, healthy peers;¹

and often a vulnerable nutritional home environment is a factor in the development of MAM, making recovery without some form of nutritional support difficult to achieve. Circumstances where this may be the case include both food insecurity that affects the quantity of food available to the household (e.g., lower number of meals and/or smaller meals than preferred) and situations of low dietary diversity due to the non-availability (lean season) or unaffordability of nutrient-dense foods, including animal-source foods, beans, nuts, fruits, and vegetables.

Furthermore, with regard to the recommendation in the Guideline to not routinely provide supplementary foods to children suffering from MAM,² it is important to note that:

- a) This wording was meant to be interpreted as “not all children presenting to primary health care facilities with MAM anywhere in the world should always receive supplementary food,” i.e., it should not be the default response that is implemented everywhere, but there are circumstances where the provision of supplementary foods is indicated; and
- b) No evidence was found that supplementary foods used in the treatment of MAM increase the risk of overweight, obesity, and non-communicable diseases.

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Notes

- 01. Golden MH. Proposed nutrient densities for moderately malnourished children. *Food Nutr Bull.* 2009;30:S267-S342.
- 02. The term “supplementary foods” here refers to foods that have been formulated to support recovery from moderate acute malnutrition. See the WHO Technical Note for further information on target nutrient content (see Note 3).

Note for Guideline Implementation

WHO, WFP, and UNICEF

1. The Guideline for Assessing and Managing Children at the Primary Health-Care Facilities to Prevent Overweight and Obesity in the Context of the Double Burden of Malnutrition is an update for primary healthcare facilities.¹
2. Every child with moderate acute malnutrition (MAM) deserves treatment. Treatment includes medical interventions – when necessary – and counseling, dietary support, and other complementary interventions as indicated. The reason for not systematically recommending supplementary foods as a default component of treatment for MAM is that not every child with MAM in every context requires this specific intervention.
3. Infants and children aged 6–59 months with moderate acute malnutrition need to consume a diet consisting of nutrient-dense foods to meet their extra needs for nutritional and functional recovery. Ideally, this should come in the form of locally available nutritious foods. Feasibility of which should take into account the availability, affordability, and accessibility of nutrient-dense foods. Nutrient-dense foods are those high in nutrients relative to their caloric content, i.e., they have a relatively high content of vitamins, minerals, essential amino acids, and healthy fats. Examples of nutrient-dense foods include animal-source foods, beans, nuts, and many fruits and vegetables.
4. In some contexts, there is a role for supplementary foods² as part of the management of MAM to improve the nutrient density of the child's diet. This is supported by an evidence base that shows that supplementary foods that are formulated in compliance with the WHO Technical Note contribute to the recovery of children with MAM.³
5. The use and composition of supplementary foods for the management of moderate acute malnutrition should continue to follow existing guidance (WHO Technical Note, CMAM Tool, Decision Tree for MAM in emergencies, national guidelines where they exist).
6. There is concern about the association between rapid weight gain in childhood, including in the first three years of life, and the rising prevalence of overweight, obesity, and non-communicable diseases (NCD), even in settings where undernutrition is prevalent within communities and within the same households. No evidence, however, was identified indicating that supplementary foods used in the treatment of MAM increase the risk of overweight, obesity, and NCDs.

Notes

01. Note that this guideline is not intended for guidance on the prevention and comprehensive treatment of acute malnutrition.
02. The term “supplementary foods” here refers to foods that have been formulated to support recovery from moderate acute malnutrition. See the WHO Technical Note for further information on target nutrient content (see Note 3).
03. WHO. Technical note: supplementary foods for the management of moderate acute malnutrition in infants and children 6–59 months of age. Geneva: World Health Organization; 2012. Internet: http://apps.who.int/iris/bitstream/handle/10665/75836/9789241504423_eng.pdf?sequence=1 (accessed 23 April 2018).

Development of High-protein Spreads for Pregnant and Lactating Women in India

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Key messages

- Maternal undernutrition, including insufficient protein intake, compounds the risk and prevalence of low birth weight.
- Lipid-based spreads seem to be an appropriate approach for nutritional supplementation.
- Ready-to-use high-protein-quality spreads using whey and soy proteins were produced using simple processing steps and equipment that required no special expertise.
- This setup could be implemented in virtually any rural setting.
- These spreads could be effective for undernourished pregnant and lactating women.

Background and motivation


In Rajasthan, India, dietary intake among pregnant and lactating women (PLW) is nearly 30% lower than the level currently recommended by the Indian Medical Research Council for calories and protein in the third trimester of pregnancy or during exclu-

sive breastfeeding.¹ Maternal nutrition is critical for fetal growth and development and for optimizing nutrient levels in breast milk. It was also recently found that stunted children had significantly lower serum concentrations of all essential amino acids than non-stunted children.² This emphasizes the importance of good protein quality and might be the reason why micronutrient and lipid supplement interventions have mostly had a modest impact on maternal nutritional status and child growth.

A high-protein intervention through effective supplementation among PLW is thus desirable. In an expert consultation held at the Bill & Melinda Gates Foundation in 2016, lipid-based spreads ranked the highest among eight other food categories based on the needs and context of PLW, production and distribution constraints, and nutrition specifications.³ In the present study, economically viable processing and product concepts to produce protein-rich spreads for PLW in India were developed and evaluated. Strong focus was placed on comply-



Staff at a local partnering plant (JV Foodworks Pvt Ltd., Gurgaon, India) holding sachets of the ready-to-use spreads

A photograph of a woman in a red and blue headscarf holding a sleeping baby wrapped in a colorful blanket. The woman is looking directly at the camera with a neutral expression. The baby is sleeping peacefully with its eyes closed. The background is a blurred outdoor setting with trees and a dirt path. A green text box is overlaid on the image.

Maternal nutrition is critical for fetal growth and development and for optimizing nutrient levels in breast milk.



Serving suggestions for the spreads. The sweet spreads such as Coconut Chocolate (*left*) and Ginger Jaggery (*middle*) can be eaten with bread (roti), while the savory spread Tamarind Cumin (*right*) can be eaten with boiled rice. Savory spreads can be consumed like chutneys, a popular type of spicy sauce that accompanies staple foods such as rice and bread.

ing with local raw material constraints and cost targets, as well as adopting simple, low-cost processing techniques.

“A high-protein intervention through effective supplementation among pregnant and lactating women is desirable”

Materials and methods

Market analysis

For market and competitor analyses, the Mintel database was screened in the spreads and dips categories for products re-

leased into the Indian market within the period of September 2016–September 2017.⁴

Raw materials and production of Spreads

Prototypes of the spreads were produced in the laboratory of an Indian company, JV Foodworks Private Limited, in Gurgaon, close to the border of Rajasthan state. All materials were locally sourced in Gurgaon. Spreads were produced combining a protein-rich powder phase, including soy protein isolate (SPI), whey protein isolate (WPI), cocoa powder, sugar, salt, jaggery, citric acid, antioxidants (ascorbic acid and TBHQ), and spices, with a lipid phase consisting of soya bean oil, rapeseed oil, peanut butter, tamarind paste, shortening, soya lecithin, and flavors.

Based on specifications,³ 11 different prototypes were developed at laboratory scale, using a Wonderchef Nutri-Blend Mix-

FIGURE 1: Process flowchart for the production of high-protein spreads as applied in this study

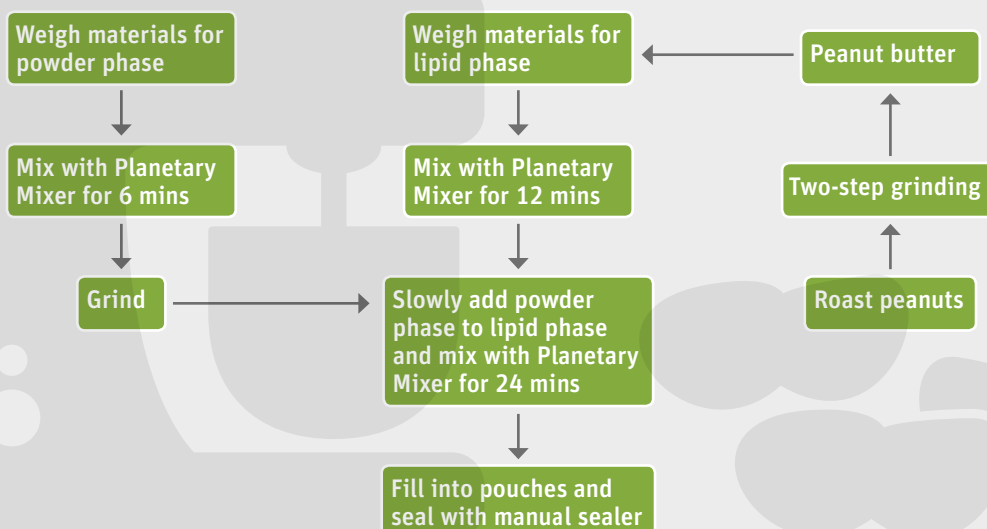
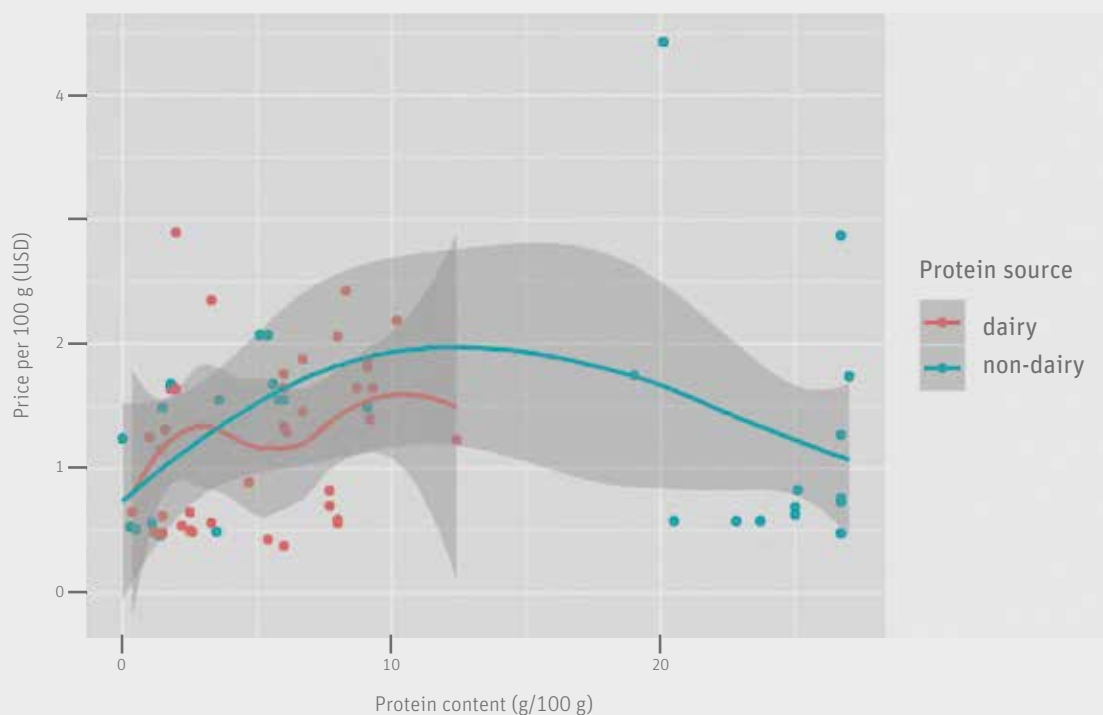


FIGURE 2: Scatterplot of price per 100 g of spread versus protein content for spreads released into the Indian market, Sept. 2016–Sept. 2017 (Mintel database)



er Grinder aiming at cost-effective high-protein products with a minimum protein concentration of 14 g protein/42 g serving size. In a subsequent step, the three most promising variants were produced at larger scale in a manufacturing site (JV Foodworks). The process involved grinding the powder phase to reduce the particle size before mixing it with the lipid phase (Figure 1). The produced spreads were manually filled into a 2 g triple-layered packaging film of polyester, aluminum, and polythene, and immediately sealed with a manual sealing machine. The illustrations for this paper show JV Foodworks staff holding the finished product at the production site, as well as some applications of the spreads, such as spreading on bread or roti or eating with rice.

Analyses

Sensory analyses were performed by four untrained panelists for taste, smell, appearance, spreadability, viscosity, and stickiness using a 9-point hedonic scale, where 9 is extremely liked and 1 is extremely disliked. Chemical analyses to assess the nutritional profile were conducted for selected samples at an external lab in Gurgaon.

Linear programming

We used Microsoft Excel to calculate the contribution of each ingredient, material, and other factors of production (such

as labor, wastage, utilities, and delivery) to the final cost of the product. This was also useful in estimating the minimum amount of WPI required to attain the target Digestible Indispensable Amino Acid Score (DIAAS) of 0.90,³ since WPI had the greatest impact on product cost. DIAAS is a popular metric used for assessing protein quality; for example, roasted peanuts, soy, whey, and milk protein have a DIAAS of 0.43, 0.91, 1.09, and 1.18 respectively.⁵ When comparing costs of the prototypes from the present study with other supplements previously produced, an inflation calculator⁶ was used to estimate the current cost.

Results and discussion

Existing protein-rich dips and spreads and used raw materials

During the market screening, we found 73 protein-rich dip and spread products that had been released between September 2016 and September 2017.⁴ Of these, 42 contained dairy sources of protein, while 31 contained non-dairy sources. The dairy sources of protein included milk, cheese, and whey powder, while the non-dairy sources included peanuts, soy sauce powder, fish sauce, chickpeas, and almonds. There was no significant correlation between protein content and price ($r = 0.03$, $p = 0.82$). Protein content in savory spreads did not ex-

ceed 9 g/100 g of net weight. Spreads with dairy protein did not exceed 12 g protein/100 g (Figure 2). It is assumed that protein concentrations are kept low in order to keep products affordable, given the relatively high cost of the dairy ingredients used. The blue curve in Figure 2 represents the price of the spread with protein from non-dairy sources, which tends to increase until about 12 g and then, interestingly, starts to decline. Spreads made with peanuts had the lowest prices and contribute to the declining blue curve. This informed the inclusion of peanut butter in the intended spreads as a cost-efficient protein source.

Spread development

For supplementary purposes, the serving size of the spread should be as small as possible while still delivering the required nutrients. In the current study, a total serving size of 42 g of spread was sufficient for all developed variants to comply with the target protein concentration of 14–16 g per serving.³ Following a first evaluation by five untrained panelists, three major prototypes (Coconut Chocolate [CC], Ginger Jaggery [GJ] and Tamarind Cumin [TC]) were selected and improved. Table 1 shows the developed variants of spread along with their total energy, content in fat, carbohydrates, added sugar and trans fats. The produced spreads had an energy density of 5.3 to 5.6 kcal/g, which is in line with previous works.^{7,8} Furthermore, added sugars and trans fat levels were in line with existing recommendations.³

Recipe formulation, quality, and pricing

WPI costs about 2.4 times more than SPI, and 7.8 times more than peanut butter. In a bid to reduce the cost of the spread, peanut butter was also added, but in such a way that the target protein quality score (DIAAS 0.90) was still attained. The produced

spreads contain at least 11.2% WPI (which contains about 90% protein). WPI has a DIAAS above 100%, and the excess amino acids from such protein sources could have complementary effects on amino acids from other protein sources in the product, further complementing the total protein quality.⁹ Added sugar was used to sweeten the prototypes except for the GJ variant, in which jaggery (*gur* in Hindi) was used due to its popularity in India as a healthier alternative to sugar.¹⁰ It was aimed at producing mainly low-fat spreads. For a spread to be referred to as reduced-fat, it should have a fat content >41% but <62%, while a low-fat or light spread should have fat content ≤ 41%.¹¹ Following this definition, the CC and GJ prototypes are low-fat spreads, while the TC prototype is a reduced-fat spread with a fat content of approximately 44% (Table 1). The spreads also have a n-3:n-6 ratio of approximately 1:6. A range of 1:5–1:9 has been reported to be ideal.⁸

Product quality challenges

During prototype development, it became evident that three major challenges were arising in the produced spreads: **1)** separation of oil from the spread; **2)** stickiness and mouthfeel of the spread; and **3)** shelf-life stability of the produced spread.

Oil separation from the spread was observed after about 1–2 days. It has been listed as one of the challenges faced by the spreads industry because apart from reducing consumer acceptability,¹² it could act as a reaction medium that facilitates lipid autoxidation, which could lead to the production of off-flavors.¹³ Proteins dissolve well in water but poorly in oil. Therefore, with increasing protein concentrations, protein solubility in the oil phase could become more challenging. About 2 g shortening/100 g was incorporated into the recipe and the oil separation problem was curbed. Increasing the heterogeneity of the fatty acids increases the tendency

TABLE 1: Macronutrient contents of the spread prototypes per 42 g daily serving

Dietary Factor	Target ³	Coconut Chocolate	Ginger Jaggery	Tamarind Cumin
Total energy (kcal/42 g)	250–500 per daily serving	222 kcal	236 kcal	237 kcal
Total fat	Low-fat spreads should have ≤41% fat, while reduced-fat spreads should have ≤ 61% (EC 1994)	33% Low-fat spread	39% Low-fat spread	44% Reduced-fat spread
Fat content (% of total energy)	10%–60% of total energy	56%	62%	70%
Protein (g/42 g)	16 (range of 14–18)	16.1	14.9	13.8
Total carbohydrates (g/42 g)	No specifications	7.4	7.3	3.0
Added sugar (% of total energy)	No specifications but ≤10% of total energy recommended	10.6%	10%	3%
Trans fat (g/100 g)	≤1	0.14	0.1	0.09

TABLE 2: Comparison of the spread prototypes developed in this study with other existing lipid-based ready-to-use supplements

	RUFC India ¹⁷	Plumpy'Doz™ ¹⁷	Coconut Chocolate	Ginger Jaggery	Tamarind Cumin
Daily serving size (g)	50	46	42	42	42
Energy (kcal/100 g)	520.0	537	528.8	562.6	564.5
Protein (g/100 g)	10.0	12.8	39.7	36.2	35.0
Fat (g/100 g)	31.0	34.8	33.3	38.7	44.0
Cost (USD/100 g)	0.26	0.43	0.51	0.49	0.49
Year	2009	2009	2017	2017	2017
Cost (USD/100 g) in 2017	0.30⁶	0.49⁶	0.53	0.51	0.51
Cost (USD/16 g protein) in 2017	0.48	0.61	0.21	0.23	0.24

toward the formation of desirable and much smaller crystals that can incorporate larger amounts of liquid oil and prevent separation.¹⁴

Stickiness is the attribute of a food product that sticks to the roof of the mouth and is difficult to remove with the tongue. This was not observed when spreads were eaten with bread or rice, but was observed when eaten directly. Stickiness is easily solved when there is a good oil-in-water or water-in-oil emulsification system. However, the prototypes contained no added water. If the water droplets in an emulsion system are too small, the phase inversion that happens in the mouth by shear and saliva will either not occur or else will occur too slowly, leading to stickiness.¹⁵ Proteins can easily absorb saliva in the mouth, and the high-protein content further worsens the problem. Using locally available ingredients, a number of approaches were explored to reduce stickiness, such as the addition of lecithin or the use of hydrocolloids such as starch. In the present study, 0.04% ascorbic acid and about 0.14%–0.65% citric acid were added to the recipe. Although the stickiness was not completely eradicated, it was significantly improved as judged by the panelists (mean acceptance score of 7.5 on a 9-point hedonic scale).

The major stability challenge in our product type is autoxidation, which was addressed by the addition of antioxidants. However, packaging and storage conditions should be checked during storage in order to prolong shelf life. An ideal packaging should be able to reduce exposure to moisture, oxygen, and light. Unlike plastic packaging, metal packaging such as aluminum provides a better barrier to water vapor, gases, and light.¹⁶ The packaging material used in this study cost just 0.5 Indian rupees (US\$0.008) per sachet. This choice of packaging also provided the advantage of being sealable with simple manual sealing machines that do not require any special skill to operate and can thus be deployed in rural settings. However, a means of recycling the sachets should be developed for environmental sustainability.

“The costs of the prototypes in this study are more than two times lower than that of RUFC India and Plumpy'Doz™”

Costs

The total costs for the CC, GJ, and TC prototypes were calculated at 0.53, 0.51, and 0.51 US\$/100 g respectively, and include waste, utilities, labor, and delivery costs. These costs were compared with ready-to-use foods previously produced (RUFC India and Plumpy'Doz™)¹⁷ (Table 2). When compensated for their protein contents, the costs of the prototypes in this study are more than two times lower than that of RUFC India and Plumpy'Doz™, making them a relevant and cost-effective high-protein spread. When compared with the data on Indian spreads assessed during preliminary studies, the prototypes show the potential to become one of the most affordable spreads on the Indian market.

Conclusion

Ready-to-use high-protein-quality spreads using whey and soy proteins could be effective for undernourished pregnant and lactating women. They can be prepared using a simple and cost-effective method requiring no special expertise and can thus be implemented in virtually any rural setting.

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An Innovation Evolution

Why one of the world's most cost-effective tools in the fight against malnutrition still needs innovation

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Key messages

- As the first major fortification initiative in developing countries, Universal Salt Iodization paved the way for the technology, systems, and structural innovations that have enabled us to reach nutritionally vulnerable populations with micronutrients globally.
- An innovation evolution is needed to maximize the future impact of food fortification. This calls for ingredient innovations that expand beyond micronutrients, systems innovations that leverage the data revolution and artificial intelligence, and structural innovations that widen the remit of responsible parties to consumer-facing food manufacturers, retailers, and the start-up ecosystem for food innovation.
- Innovations to improve nutrition should be driven by a deep understanding of the unmet nutritional needs, aspirations, behaviors, and preferences of consumers who remain underserved by markets and face limited access to affordable, nutritious foods.
- We bear a collective responsibility for transforming our food systems to provide more nutritious and affordable foods to consumers in low- and middle-income countries, and we need to move forward with optimism and urgency.

The impact of Universal Salt Iodization

One of the greatest public health success stories is also one of the least known. It started with a beautifully simple innovation: putting iodine into table salt. Salt is regularly consumed around the world by rich and poor alike, and so by fortifying salt with iodine, most people's daily iodine needs could be met at a negligible cost with no change in behavior. In the 1990s, 113 countries were classified as iodine-deficient; that number is now 20. The impact of Universal Salt Iodization (USI) on human capital development is staggering when one considers that iodine deficiency is the most common cause of preventable mental retardation worldwide and that it can reduce IQ scores by an average of 13.5 points. The global scale-up of USI inspired the establishment of new institutions in the early 2000s to extend the success of USI into the fortification of edible oils and cereals such as wheat, maize, and rice to address other micronutrient deficiencies in low- and middle-income countries. With that amplification, the global infrastructure for reaching nutritionally vulnerable groups in developing countries with fortified foods was born.

In the past 15 years, mandatory fortification of various staples and condiments has been scaled across sub-Saharan Africa and many countries in Asia. However, in the context of a dynamic and rapidly evolving food system, fortification cannot realize its full potential for impact as a static public health intervention based upon delivering what is known and accepted today. Even an intervention as successful as salt iodization has had to respond to a changing context, including increased consumption of salt through processed foods, growing rates of diet-related chronic disease in lower- and middle-income countries, and technological advances that enable the addition of multiple micronutrients to salt. These present both challenges and opportunities for innovation.

Breakthroughs in fortification

Historically, there has been a tendency to emphasize innovations in products and technology. However, the types of



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In the past 15 years, mandatory fortification has been scaled across sub-Saharan Africa and many countries in Asia

breakthroughs needed to improve global nutrition will not stem from product or technological innovations alone but will also require innovation in the underlying systems and structures. Viewed through this lens, three types of innovation can be defined:

- > **Technology innovations** enable formulation of the appropriate food vehicles with the appropriate levels of micronutrients to reach consumers with fortified products that can withstand real-world transport, storage, and food preparation conditions.
- > **Systems innovations** are necessary to galvanize and incentivize industry to manufacture, package, and distribute fortified foods within the constraints of their businesses.
- > **Structural innovations** have enabled complex yet accountable public-private partnership structures between ministries of health, regulators, food processors, and international and non-governmental organizations to pursue public health objectives through both commercial food markets and public-sector channels.

Technology innovations

Technology innovations in food fortification have addressed the combinability, stability, bioavailability, and sensory challenges posed by certain micronutrient compounds, with iron being a critical focus given its public health importance and the persistent challenges faced with its delivery. For instance, sodium iron EDTA (NaFeEDTA), which has been on the market for over 20 years, has over time been introduced into a number of fortification programs to enhance iron bioavailability in foods with strong absorption inhibitors, such as phytates in high-extraction wheat flour. Newer solutions also exist to address technical challenges associated with specific food vehicles, such as new, encapsulated iron forms that can be blended with salt, and chelating ferric pyrophosphate (FePP) with citric acid and trisodium citrate to improve bioavailability while minimizing sensory challenges in rice. Additionally, a range of encapsulation technologies, from fungi to polymers, are in development to protect iron and other micronutrients from sensory interaction with the food matrix, improve their combinability with other micronutrients, and in some cases, improve the bioavailability of iron. Technologies are also in development that address the safety risks associated with iron intake. These technologies take different approaches to more slowly releasing iron into the bloodstream, better mimicking the



pathway of iron from natural sources, and avoiding the inadvertent feeding of pathogens in high-infection populations.

“There is a need to widen the range of ingredient solutions to better capture evolving consumer needs”

Looking ahead, we believe there is a need to widen the range of ingredient solutions to better capture evolving consumer needs and reflect emerging evidence on the determinants of poor growth. For instance, we need to think more creatively about potential codelivery of solutions to improve gut health, as simply adding micronutrients into the diets of children with chronic infection or environmental enteric dysfunction will not solve micronutrient malnutrition in these subgroups. The range of emerging solutions from bioactive peptides to polyphenols with prebiotic properties to oligosaccharides that have demonstrated impact on non-communicable diseases in developed-world markets may also play a significant role in improving micronutrient utilization. In fact, early research on the effect of prebiotics on iron absorption, particularly in complementary foods, has shown promise.

Additionally, with the renewed interest in the role of proteins in growth and development, the pendulum seems to be swing-

ing back, this time recognizing that deficiencies in both macro- and micronutrients contribute to poor linear growth and weight gain and therefore that both need to be considered part of the solution. This coincides with a strong resurgence in protein research by the private sector, driven mainly by developed-world interests in satiety for weight control, glycemic management for diabetes, and the impact of specific amino acids on cell growth and digestibility for better differentiation. Newer plant-based and alternative protein sources, with lower costs and lighter environmental profiles, are becoming widely available and show promise to be adapted to a range of applications.

“Consideration should be given to expanding the use of nutrient-dense, natural ingredients grown in the developing world”

Consideration should be given to expanding the use of nutrient-dense, natural ingredients grown in the developing world, such as spirulina, to help reach fortification goals. These types of ingredients have the potential to deliver proteins and micronutrients simultaneously; they have components, such as provitamin A, that are less vulnerable to degradation from heat and humidity compared to the retinyl palmitate that is added to foods, and they pose fewer safety issues when it comes to increasing fortification levels. While an ingredient such as spirulina does confer a change in color, specific varieties are flavorless, and therefore hold strong potential for integration into ready-to-use therapeutic foods and lipid-based nutrient supplements, for which both proteins and micronutrients are needed. Moreover, demand is growing among consumers in middle- and lower-middle-income countries for “natural” ingredients and products, which are perceived to be healthier. Innovations to improve manufacturability at scale are critically needed to drive down costs and expand sources of raw materials for fortification programs.

Ultimately, innovations to improve nutrition should be driven by a deep understanding of the unmet nutritional needs, aspirations, behaviors, and preferences of consumers who remain underserved by markets and face limited access to affordable, nutritious foods. For an increasing proportion of lower-income consumers in Africa and Asia, processed foods represent a significant percentage of the daily calories consumed. There is a considerable opportunity to enhance the nutritional profile of widely consumed packaged foods through innovations that improve nutrient density, while simultaneously reducing saturated fat, salt, and sugar intake from these foods. These types of products can complement the more traditional approaches of forti-

fying staples and basic condiments, and can increase nutrient intakes across the food basket.

Systems innovations

A more consumer-driven approach to innovation should put greater focus on systems innovations. Consumers – and the food system in which they are immersed – are, by definition, dynamic. Therefore, a data-driven feedback loop needs to be established that regularly assesses consumption patterns and resulting nutrient intake, and then optimizes the impact achievable through fortification by calibrating combinations of nutrients and levels, the mix of products that are fortified, and the economic cost and benefit to society. New ways to source and analyze data, whether through big-data approaches or innovative means such as crowdsourcing product information through mobile platforms, provide potential alternatives to relying on stand-alone data collection efforts that are time- and resource-intensive.

“New ways to source and analyze data provide potential alternatives to relying on stand-alone data collection efforts”

In the past, systems innovations that integrated certification and procurement schemes enabled access to high-quality mi-

cronutrient premix supply at lower prices and favorable credit terms. The next generation of innovation in quality systems has tremendous potential to leverage the data revolution and artificial intelligence in order to enable data-driven decision-making. Smart dosifiers are already being implemented in small-scale commercial maize mills in Tanzania to largely automate fortification. This type of equipment transmits data to a cloud-based system to remotely monitor fortification levels. Paired with the technology innovation is a business model innovation that subsidizes the cost of the micronutrient premix through cost-savings generated by other value-added services. Such models could offer insights into new ways to approach monitoring in larger-scale systems for specific value chains. Another promising opportunity area is the application of blockchain technology to ensure traceability and accountability throughout the value chain so that the appropriate micronutrient levels are maintained within food products from factory to fork. Finally, building upon the growing global trend toward personalized health and nutrition, IT-enabled *in vitro* diagnostics could lead to better targeting to ensure the right nutrients are reaching the right people for the greatest impact.

“The next generation of systems innovations has tremendous potential to leverage the data revolution and artificial intelligence to enable data-driven decision-making”

Structural innovations

As food fortification programs shift from a focus on the beneficiary to the consumer, structural innovations will be required to enable a new level of coordination and accountability to transform food systems so that they provide greater access to affordable nutrition. This means including partners within the fortification ecosystem with the greatest ability to influence and reach consumers, namely consumer-facing food manufacturers and retailers as well as consumer advocacy groups, to increase their accountability. The evolution in many humanitarian and safety-net programs from food-based to cash- or voucher-based schemes that involve food retailers is a good example of innovation to date that has structural implications for how disparate actors can work together in new ways to meet the needs of underserved consumers and empower them with choice and greater convenience. Bringing these actors together could also be an opportunity to connect those working to address undernutrition,



We bear a collective responsibility for transforming our food systems to provide more nutritious and affordable foods to consumers in low- and middle-income countries

on the one hand, and obesity and chronic disease, on the other, through a common platform for better-quality food.

The existing food fortification infrastructure has evolved from single-vehicle initiatives to platforms that promote micro-nutrient fortification across a range of food vehicles. This infrastructure includes multisectoral alliances of public- and private-sector stakeholders to oversee implementation of national food fortification programs, industry associations, technical partners supporting policies and programs, and the scientific research community. In the future, this infrastructure could be leveraged and broadened to include, for example, entities involved in protein research, manufacturing, and sales. This also creates an opportunity for convergence with the new ecosystems that are now emerging for food innovation, including start-ups and social enterprises, food- and agriculture-focused venture capital funds, and a host of accelerators and incubators.

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**“There is an opportunity
for convergence with the new
ecosystems that are now
emerging for food innovation”**

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Conclusion

In conclusion, current thinking about food fortification must evolve to incorporate macrorends, emerging research, the convergence of certain health needs across rich and poor countries alike, and innovation from other sectors. A radical transformation of existing food systems is required to better serve lower-income consumers at risk of malnutrition, involving layers of innovation to reshape underlying systems and structures. No single entity in isolation can bring about this type of transformation. But collectively, we all bear responsibility for making food systems work more effectively for nutritionally vulnerable consumers.

In the end, is fortification a silver bullet? No. Can more be done through fortification to close the gap in nutrient intakes among vulnerable populations? Yes. And is this reason to invest in new ways of thinking about innovation in fortification? Absolutely. This calls for both optimism and urgency.

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New Protein Sources

Lab-grown meats, plant-based meats, single-cell proteins, and edible insects

**Simon Billing
and Heidi Spurrell**

The Protein Challenge 2040 Initiative
at Forum for the Future, London, United Kingdom

Key messages

- > Since 2017 there has been growing consumer and investor interest in alternative proteins, such as lab-grown or plant-based meat, single-cell proteins including mycoprotein and microalgae, and insects, which have the potential to play a major role in reducing the impact of our current food and agriculture system.
- > Alternative proteins generally have good nutritional profiles compared to meat and also promise significant advantages in helping to reduce pressure on dwindling natural resources and to cut down emissions. However, many of these sources face significant barriers to scale in the form of consumer and regulatory skepticism. Ongoing investment is also required to scale up product development, production, and marketing.
- > At the same time, traditional plant-based proteins such as beans and legumes should not be forgotten: they are cheaper, more accessible, and familiar to consumers, and they offer other nutritional benefits.
- > The prospect of converting the world's population wholesale to vegetarianism is unrealistic, but the increased availability and affordability of alternative proteins will help consumers diversify their diets in order to ensure a more secure food and environmental future for all.

The year 2017 saw an explosion of interest in alternative protein. Exciting new innovations such as lab-grown meat or plant-based “meats” captured public imagination and turned the spotlight on new opportunities to provide protein to the

world's growing population in a way that is healthy, affordable, and good for the environment.

Together with increasing awareness and understanding of the full impact of the food system, and of animal protein production in particular, we have seen growing interest in alternative proteins that have recently attracted significant investments from high-profile investors such as Bill Gates and Richard Branson, as well as big food companies like Tyson Foods in the United States. There is significant potential for alternative proteins to play a major role in reducing the environmental and social impacts of the current food and agriculture system, and this will be crucial in meeting the second Sustainable Development Goal (SDG) of ending all forms of malnutrition by 2030, as well as contributing strongly toward the achievement of many of the other SDGs.

“Alternative proteins have the potential to play a major role in reducing the environmental and social impacts of the current food and agriculture system”

What are these alternative proteins, and how can they contribute towards providing nutritious protein sources for a population of 9 billion? This article presents some examples of the innovators behind these novel protein solutions and explores how close they are to delivering truly scalable nutritional solutions.

Lab-grown meats

Cultured meat, also known as *in-vitro* or lab-grown meat, is created in a lab by using stem cell technology to create muscle tissue that is biologically identical to meat tissue from animals.

Once seen as a futuristic food concept, cultured meat has now been proven, and there is a network of start-ups across the world, such as Memphis Meat (US), Super Meat (Israel), and Mosa Meat (Netherlands) that are working on displacing the cow completely. And the cow is not the only animal that might



Lab-grown meat could hugely reduce pressure on the world's scarce resources

be displaced in this way. Finless Foods aims to develop and mass-manufacture seafood in the lab for human consumption. Other cultured animal products are being developed in Silicon Valley, such as Perfect Day's dairy-based milk without cows, created through a yeast fermentation process, and Clara Foods' animal-free egg white replacement.

A key argument for lab-grown meat is that by eliminating the need for livestock and feed cultivation on land, it could hugely reduce pressure on our scarce land and water resources, mitigate deforestation, eliminate inputs such as fertilizers and antibiotics, and reduce greenhouse-gas emissions. Development in a highly controlled environment creates opportunities to engineer "healthier" meats by adding nutrients and fats, such as omega-3 fatty acids, as required. This would cut down the need for livestock farming and its consequent animal welfare concerns: only one "harmless" biopsy of an animal is required to extract muscle to grow 20,000 tons of cultured beef.

Yet, while *in-vitro* meat production offers immense potential health and environmental benefits, it also presents significant social and cultural challenges. Consumer skepticism around product safety, health concerns, and ethical issues about eating meat from cloned tissue will be barriers to adoption. Also, while lab meat might provide a means of substitution for animal-based meat, it risks promoting overconsumption of meat, with negative impacts on human and planetary health.

Going forward, acceptance and uptake will be heavily influenced by how the media frame the discussion of this alternative protein source. Innovators will need to find ethical and safe ways to scale up manufacturing and reduce production and supply costs in order to bring prices down. Furthermore, ongoing investment will be required for continued research and development (R&D), as well as the creation of market conditions conducive to rapid scaling. Regulatory frameworks will also need to be robust and adaptable to mitigate potential ethical and health risks for consumers, while preserving companies' competitive advantage. These will be tough barriers to overcome – yet they can be overcome, with the right support.

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“Acceptance and uptake will be heavily influenced by how the media frame the discussion of lab-grown meats”

Plant-based meats

There has also been a spurt of innovation around “plant-based meat,” using a combination of food science, biotechnology, and tissue engineering to process vegetable protein ingredients such as proteins from soy, pea, wheat, and potato into products that mimic meat in taste, mouthfeel, and flavor profile.

Unlike lab-grown meat, products of this nature are already widely sold, with fairly widespread market acceptance by consumers. Some companies leading this space include US-based Beyond Meat and Impossible Foods, whose plant-based burger products are widely available in the US and are coming to markets elsewhere. Other innovators include Wageningen University in the Netherlands, which is creating a “vegetarian” steak with support from Unilever and seven other food giants.

Single-cell proteins

Single-cell proteins are basically proteins derived from single-cell microorganisms, such as algae, fungi, yeasts, and bacteria.¹ There are significant environmental benefits to using these sources, a crucial one being that they utilize low-cost feedstock and wastes as sources of carbon and energy for growth to produce biomass, protein concentrate, or amino acids. They also do not have to be cultivated on fertile soil, have a very low water footprint, and often have excellent nutritional profiles.

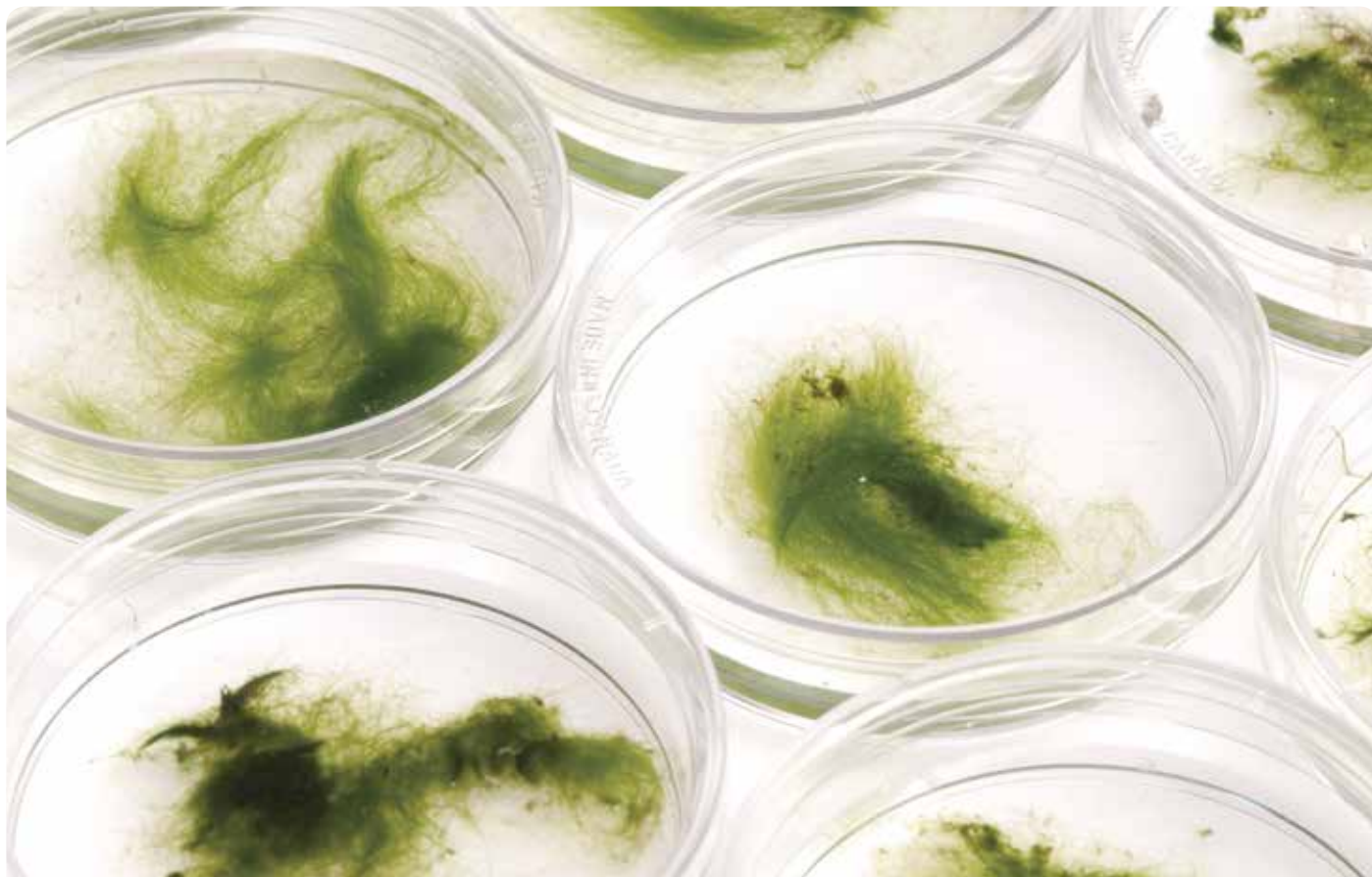
The best-known form of single-cell protein is the mycoprotein, derived from fungi through fermentation. It is rich in fiber and protein but very low in fat. Many consumers in the UK and elsewhere have consumed mycoprotein as the key ingredient in the highly successful Quorn-branded products, sold as a meat substitute. New start-up 3F Bio is aiming to produce 1 million tons of mycoprotein as a sustainable protein food ingredient by 2030.

Another emerging source of single-cell proteins is algae: simple plants that can range from the microscopic (microalgae), such as chlorella, to seaweeds (macroalgae) like kelp, which can be cultivated in seawater all over the world. In a closed fermentation production process, algae are used to convert a wide variety of plant sugars into oil, food ingredients, and other products.

Historically marketed as a niche health food in the form of chlorella or spirulina, algae have recently received more mainstream attention due to their immense potential viability as a source of food, fuel, and animal feed. They can reproduce very rapidly and have an amino acid profile that is superior to that of soy and other plant sources. They do not compete with traditional crops for land and resources and provide vital ecosystem services during their lifecycle, such as carbon dioxide absorption and the purification of waste waters.

Currently, algae are commonly marketed as a key additive to food products. For example, Corbion's AlgaVia uses algae powders with protein content of up to 63% as an ingredient for cereal, shakes, dressings, and more.

Challenges to scale include the fact that microalgae protein extraction and production is still expensive, in its infancy, and at small scale. More R&D is also required to address issues around digestibility, as well as better production, ex-



Single cell microorganisms such as microalgae often have excellent nutritional profiles

traction, and processing systems in order to improve efficiency and reduce costs.²

“Algae do not compete with traditional crops for land and resources”

Edible insects

Entomophagy, the eating of insects, is an age-old practice among humans. Insects are consumed widely by over 2 billion people in Asia, Africa, and Latin America. They are high in protein, at levels comparable to meat sources, and are generally rich in minerals and vitamins. Large-scale production can take place with minimal space and water consumption and can utilize organic waste streams. In 2013 the UN recognized the significant potential and scale of insects as a source of both food for humans and feed for animals in an FAO report.³

On the whole, innovation in using insects for animal feed, particularly for chickens and fish (which consume insects as part of their natural diet), seems to be growing more rapidly. For example, Protix cultivates insects using local organic byproducts from

the food and feed industry, keeping its impact low by recycling low-value waste products in a closed loop system. The resulting insect protein is used to produce feed for pets and fish, while insect-derived lipids are used in piglet diets. Initial results are promising, with pigs fed on insect lipids displaying better growth rates, lower mortality, and a reduced need for antibiotics.

Despite a relatively widespread aversion in the West to the consumption of insects, there has recently been a proliferation of insect farming and food manufacturing start-ups capitalizing on the use of insects as food ingredients to create novel products such as insect protein bars and crisps. These are currently niche markets, but should the cultural aversion be overcome, insect-based products could eventually move into the nutritional mainstream.

“Edible insects are high in protein, and are generally rich in minerals and vitamins”

Conclusion

Given the sociocultural and geographical aspects of food consumption, converting the world’s population wholesale to veg-

etarianism is unrealistic.⁴ A more pragmatic goal is to make alternative proteins more widely available, affordable, and accessible, which will enable consumers to diversify their diets and will also have direct positive implications for global food security and for reducing pressure on the world's limited natural resources such as arable land and water.

On the whole, global consumer diets need to shift significantly from those dominated by animal proteins, as prevalent in the West, to ones containing a much higher proportion of plant-based foods. In the discussion of alternatives, we should not forget the plant-based proteins that are already widely available and familiar to most and, in comparison, are more affordable than the alternatives described above. Legumes such as beans and lentils are just a few of the many plant-based food options that come highly rated for nutritional qualities of fiber-packed protein. Encouraging consumers to increase the proportion of protein they acquire from plant foods will also bring about nutritional benefits in increasing fiber uptake and reducing saturated fat consumption.

“Consumer diets need to shift from those dominated by animal proteins to ones containing a much higher proportion of plant-based foods”



Insect-based products could eventually move into the nutritional mainstream

The protein source options listed in this article are just some of the promising and exciting solutions out there that may offer affordable, healthy, and sustainable alternatives that can be taken to scale. Animal protein will remain a vital part of the future balanced plate of food, but with growing awareness of the environmental and health costs of meat, consumers may be more willing to give alternatives a chance. A mix of many factors – ranging from the right marketing mix, research, and product development, to continued investment, favorable market conditions, behavior change, and government legislation – will be of utmost importance not only in making alternative proteins relevant, aspirational, and desirable, but also in scaling up the most promising solutions to hit the critical mass required to truly meet our future health and nutritional needs within environmental limits.

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Ready-to-use Therapeutic Food (RUTF) and Ready-to-use Supplementary Food (RUSF)

New approaches in formulation and sourcing

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Key messages

- > Our vision is to eradicate childhood malnutrition and our mission is to advance the treatment of acute malnutrition, using effective, locally produced ready-to-use therapeutic foods (RUTFs).
- > While RUTF is an energy-dense, peanut butter paste with proven efficacy giving the high-quality nutrition necessary for a child to recover from acute malnutrition, we are continuously working to improve the formulation.
- > Our aspiration is to see children – more than just surviving or recovering – truly thriving with the enduring benefits from their RUTF treatment.

Introduction

Globally, 51.7 million children under five are wasted, defined as a weight-for-height below the third percentile.¹ Wasting is a symptom of acute malnutrition – a significant public health challenge that, although declining in prevalence and related mortality, still persists, leaving millions of children at increased risk of illness and death.² The greatest incidence of acute malnutrition occurs in children between 6 and 59 months

of age, a crucial period of dynamic and rapid physical and neurological development.^{3,4} As a result, it can cause long-term consequences that pose a threat to a child's ability to reach full cognitive potential.⁵

Ready-to-use therapeutic foods (RUTFs) were derived from the existing liquid F-100 diet recommended by the World Health Organization (WHO) for the treatment of children with severe acute malnutrition (SAM) prior to 2007; at the time, F-100 had already been used successfully to treat a million of these children.⁶ The formulation of the first RUTF in the early 2000s was obtained by replacing about half of the milk in the F-100 formula with peanut paste.⁷ This resulted in a food that looked like a paste and could be used without the addition of water, which eliminated the risk of bacterial contamination after opening the container/sachet. Standard RUTF has since proven to be highly effective in promoting rapid weight gain in children recovering from SAM.^{8–10}

“Providing greater access to this lifesaving treatment is a moral and global health imperative”

Challenges

In the late 1990s, when convenient and effective treatments were needed to treat children with SAM, the nutrition community rose to the challenge.⁶ The development of RUTF revolutionized the management of children with acute malnutrition, offering a superior alternative to inpatient treatment, but with a vision to increase the numbers of children under treatment and eradicate malnutrition. To accomplish this, it is essential to improve RUTF and increase its distribution.¹¹



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Pujehun, Sierra Leone: Aminata and her mother, who is relieved to have access to a lifesaving treatment for her daughter suffering from severe acute malnutrition

1. Economic logic, misconceptions, and millions of children without a lifesaving treatment

A study conducted in Northern Nigeria on the cost-effectiveness of community-based management of acute malnutrition (CMAM) reported a cost of US\$1,117 per death averted and a US\$30 cost per DALY (disability-adjusted life year) averted.¹² Given the GDP per capita of US\$610.60 to US\$2,078.80 in low- and lower-middle-income countries, this intervention is considered exceptionally cost-effective by WHO standards.¹³ Unfortunately, economic logic for the investment in the treatment of acute malnutrition is overshadowed by the misconception that acute malnutrition is characteristically a byproduct of emergency crisis situations such as famine or war. These beliefs have guided inconsistent implementation of acute malnutrition management, leaving 80% of children suffering from SAM without access to treatment.^{11,14} Given the irrefutable link between wasting and mortality, providing greater access to this lifesaving treatment is a moral and global health imperative.

2. More than just surviving, thriving with enduring benefits from RUTF treatment

The essential fatty acids or polyunsaturated fatty acids (PUFA), such as omega-6 and omega-3, require dietary consumption, as

they cannot be synthesized endogenously.¹⁵ Children suffering from SAM have depleted all of their fat stores and are placed on a very monotonous diet, primarily RUTF.^{15,16} The fats come from vegetable oils and peanuts. Peanut fat is almost entirely omega-6 PUFA, and the vegetable oils commonly used in RUTF are monounsaturated fats. Diets high in omega-6 support recovery and weight gain but are antagonistic to endogenous production of the key omega-3 fatty acids DHA and EPA, both required for neurocognitive restoration.¹⁷

Treatment with RUTF has allowed for home-based care of malnourished children, reducing costs and increasing effectiveness, and there is a critical demand to make RUTF more accessible. However, for those that survive SAM, lifelong effects such as neurodevelopment insults can persist, presenting an additional challenge. Recent evidence suggests that RUTF formulations could be optimized to help these children not just survive, but also thrive.¹⁵

3. Opportunities to optimize RUTF as a supplement for vulnerable populations

Moderate acute malnutrition (MAM) treatment protocols include a health and nutrition component, and many different foods have been used with success to treat MAM.¹⁸ The most common



A young child with moderate acute malnutrition independently indulging in an alternative low-cost RUTF during an acceptability trial

supplemental foods for MAM treatment are fortified blended flours (FBF).¹⁹ These flours require preparation in the home; they must be mixed with water and heated for 5–10 minutes to make a porridge-like cereal. Though more involved in terms of preparation and packaging, the new formulations have shown to have equivalent outcomes to soy ready-to-use-foods (RUF); however, ready-to-use supplementary food (RUSF) has showed the most effective recovery rates.^{20–22}

Malnutrition in low- and middle-income countries is largely the result of food insecurity, lack of food diversity and disease, resulting in inadequate nutrient intake and losses. Pregnancy exacerbates these risk factors by requiring additional nutrients that further deplete a woman's nutritional status. Maternal undernutrition is estimated to contribute to 20% of maternal deaths and increases risk for adverse pregnancy outcomes, childhood mortality, and stunting.²³ This implies that pregnancy is a critical time-window during which adequate nutrition leads to healthy fetal growth and development, producing lifelong benefits.²⁴ Several supplemental foods targeting malnourished pregnant women have been introduced; however, minimal evidence demonstrating the effectiveness of the supplementation has been generated.^{25,26} Additionally, the development of a product that is accepted and also meets all the nutrient requirements for the mother's recovery has remained challenging. Lack of an endorsed standard for treating pregnant women with malnutrition and the vagueness and limited implementations of existing recommendations for treating these women highlight the need for improved, evidence-based solutions.

“There is a need for improved, evidence-based solutions”

Solutions

1. Linear programming technology, local ingredients, innovation, and acceptability

Reducing the overall cost of treatment could help promote scale-up of treatment. One way this can be achieved is through reducing the cost of RUTF ingredients.^{27,28} The standard formulation for RUTF has been used for over a decade, and although several alternative formulations have been developed and tested by leading researchers, most of these products have not been successful in achieving comparable effectiveness to the current milk- and peanut-based formula.^{29–31} This emphasizes the need for a solution that could produce alternative RUTF formulations that do not compromise the high-quality nutrient specifications of the well-known and effective standard formulation.

In 2013, a multiphase alternative RUTF formulation project began with support from the Children's Investment Fund Foundation (CIFF). This work began with a comprehensive literature and nutrient database analysis and subsequent development of a food formulation linear programming (LP) tool.³² The LP tool is a conventional computer database program that lists all potential ingredients, nutritional composition, prices, and country-specific availability for the countries we have worked in.³² The tool has default nutrient constraints that help ensure the formulations align with the UNICEF RUTF nutrient specifications, but these can be adjusted to help meet specifications for other populations. The tool also allows for ingredient constraints, which supports organoleptic optimization.³²

The process of formulation development is more complex than setting constraints in an Excel-based program; however, this eliminates and streamlines some of the trial and error characteristic in the process. One of the most significant functions is that the program's objective uses Solver to meet the set objectives (ingredient and nutrient constraints) using the most cost-optimal ingredients. There is a small cost increase from the default formulation (with no ingredient constraints) when the formula is optimized for production feasibility and taste acceptability, but overall cost savings are still easily obtained with the LP tool.³³

A total of eight alternative RUTFs with cost savings have been produced and tested for acceptability among malnourished children. Alternative cost-optimal RUTFs with locally available ingredients have been developed for Ghana, Ethiopia, Pakistan, and India.³⁴ These formulas were all found to be at least as acceptable compared to standard RUTF. Local RUTF producers in Ghana, Ethiopia, and India also successfully produced alternative formulations in-country. The alternative RUTF in Ghana is being investi-

gated in a non-inferiority clinical trial. A low-cost alternative RUTF was also formulated for the international market, optimized for ingredient costs in the United States. The RUTFs have demonstrated acceptability among children in Sierra Leone and Malawi. This reduction in ingredient costs is one strategy for making RUTF more accessible and enabling treatment to reach those who need it.

2. Improved PUFA RUTF

We have developed a new RUTF recipe, improved PUFA RUTF, with a new variety of peanut (high-oleic peanuts) and a small amount of a less common vegetable oil, linseed oil. A pilot study with 140 severely malnourished children compared standard RUTF to improved PUFA RUTF.¹⁵ Blood concentrations of omega-3 PUFAs were low during therapeutic feeding in children receiving standard RUTF but increased in the children consuming improved PUFA RUTF.¹⁵ This is compelling evidence that RUTF could be improved by changing the dietary fatty acids in their composition. It may well be, for example, that if a child loses 10 IQ points when he/she has severe malnutrition and typically gains back 5 of these points, the improved PUFA RUTF might mean a gain of 4 more IQ points.

3. RUSF optimization for moderate acute malnutrition and malnourished pregnant women

The advent of home-based therapy with RUTF and its proven efficacy for treatment of SAM has led to the consideration of possibilities of optimizing RUTF for other vulnerable populations such as children with MAM and malnourished pregnant women.

A recent study comparing the effectiveness of peanut-based RUSF with soy protein and novel dairy RUSF with whey permeate and whey protein concentrate showed that the proportion of children that recovered from MAM was significantly higher in the group that received whey RUSF than in the soy RUSF group.³⁵ One assumption about this evidence is that dairy proteins, such as cow's milk, have high-quality protein with generous quantities of essential amino acids, which has been associated with improved growth.^{36–38} However, several factors may explain the apparent superiority of milk protein, and the effect of protein quality needs to be more comprehensively quantified.

To gain a better understanding of protein quality, we have developed two isonitrogenous peanut/dairy RUSFs, one of which has been optimized for protein quality, whereas the other, the control RUTF, has standard protein quality. The protein quality of these RUSFs was assessed using the digestible indispensable amino acid score (DIAAS), which uses true ileal digestibility of each amino acid in the protein components of the RUSF relative to the human reference amino acid requirement.^{37,39} The human reference amino acid requirement has been adjusted based on the physiological state of the consumer, children with MAM. These two RUSFs will be investigated in a clinical effectiveness trial for the treatment of MAM.

A need to prioritize effective interventions for malnourished pregnant women has propelled the development of a novel supplementary food. The LP tool was adapted to list potential ingredient data specific to Sierra Leone, and the nutrient parameters



Pregnant women in the Beleuman Welbodi, “Belly Women-Well Body,” a comprehensive study offering both nutrition and infection components

were determined through a panel of maternal nutrition experts. The supplement is optimized to provide ideal protein quality and PUFA composition with the use of dairy proteins and high oleic oil. Organoleptically, the product was optimized in-country through acceptability testing among the target population. The informal acceptability showed millet, a locally available cereal, to be the overwhelming favorite. The RUSF, referred to as Mama Dutasi, has been produced on a large scale at Project Peanut Butter, a local RUTF (Dutasi) production factory in Freetown. Mama Dutasi is currently being investigated as the nutrient component of a bundled nutrition and anti-infective interventions clinical trial to reduce intrauterine growth restriction and low birth in Sierra Leonean malnourished pregnant women.

Impact: Saving futures and saving lives

Acute malnutrition puts 52 million children at high risk of not reaching their physical and cognitive potential, and the regions shouldering the highest burdens of this life-threatening condition, southern Asia and Africa, represent some of the most underresourced and underdeveloped countries in the world.¹ The call to end hunger in Sustainable Development Goal 2 will require more than just advancing the treatment of acute malnutrition using effective, locally produced RUTF.²⁴ RUTF saves lives as a proven and high-quality nutrition treatment needed for a child to recover, but ensuring that all children can reach their full development potential requires us to go further.

“The global nutrition community must encourage the use of innovative approaches for improving RUTF formulations”

The global nutrition community must step up to lingering challenges by encouraging the use of innovative approaches for improving RUTF formulations so that they become more accessible, reach more vulnerable populations, and provide lifelong benefits. In doing this, we will save not just lives, but also futures.

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Nutritional Programming and Later Life

The role of macronutrient quality during the first 1,000 days

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Key messages

- > Between conception and the conclusion of the first two years of life, growth is faster than during any other period in life including puberty.
- > Nutritional requirements in early life are relatively high, but the relative (macro)nutrient contribution and the dietary supply both change.
- > Nutritional interventions during the first 1,000 days of life provide a window for “primordial disease prevention” – preventing disease in later life by reducing developmental risk factors.
- > The quality of growth and metabolic development can be positively impacted by dietary protein quantity and quality as well as dietary fat quality, securing a foundation for later health.

Primordial disease prevention

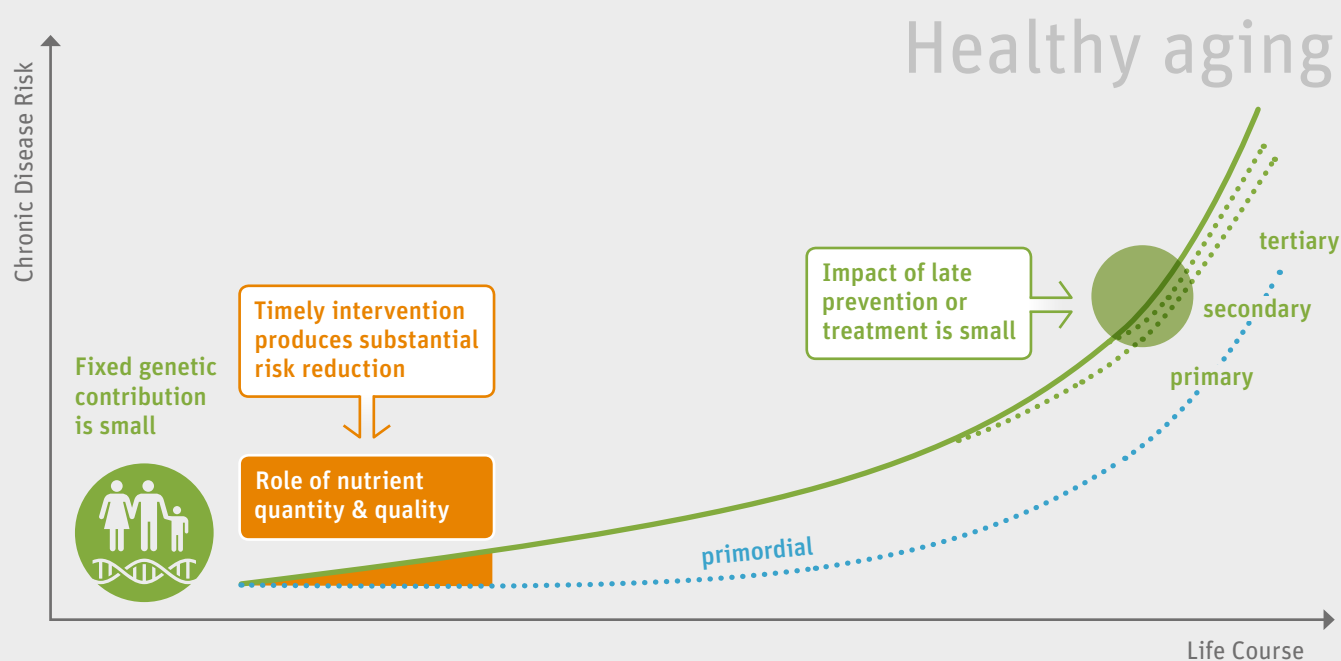
Worldwide, changing lifestyles and an increase in life expectancy have led to an increased number of people suffering from chronic noncommunicable diseases (NCDs).^{1,2} Clearly, unhealthy diets and sedentary lifestyles contribute to obesity risk throughout life, but growing evidence indicates that the vulnerability to NCDs is largely set during the first 1,000 days, the period from conception until 2 years of age. Interventions during this period may induce only subtle changes in the devel-

opmental path, but, from a life-course perspective, have great potential to reduce later chronic disease risk compared to late interventions.³ Interventions in early life thus provide a window for “primordial disease prevention” – an opportunity to prevent later life disease by reducing developmental risk factors. As an industry player active in the field of early life nutritional solutions and education, Danone’s scientific interest is to better understand the role and contribution of the diet to later health and disease risk, and to translate these insights into our products and educational work.

“Growing evidence indicates that the vulnerability to NCDs is largely set during the first 1,000 days”

Growth during the first 1,000 days

Growth during the first 1,000 days is faster than during any other period in life, including puberty.⁴ Between birth and 3 years of age, body size doubles and body weight increases fivefold. Consequently, relative nutritional requirements are high, but the actual nutrient needs as well as the dietary supply change considerably. While initially the health and nutrition status of the mother play a pivotal role, after the introduction of solids the increasing contribution of complementary foods and the development of healthy eating and drinking habits may become more important dietary factors. The nutritional environment provides the energy and building blocks for growth, as well as the signals that steer the interplay between metabolic organs and influence their set points and response repertoire.⁵ Failure to provide the right nutrients may result in permanent alterations in organ size and functionality that cannot be changed thereafter.⁶ Fat stores in the body, for instance, start to develop during the final trimester of pregnancy and grow exponentially during the first year of life, leading to a peak in adiposity around

FIGURE 1: Early life provides a unique opportunity for later disease prevention

Modified from Gluckman PD, Journal of Developmental Origins of Health and Disease 2010;1(01);6-18. Adapted with permission.

6 to 9 months after birth. Although adipose tissue stores continue to grow throughout childhood and adolescence, they show a stable cell number in adulthood.⁶ Obese adults, however, have more adipose tissue cells compared to lean individuals.⁷ Cell numbers are already doubled around 2 years of age in children on an obesogenic development path, indicating that development of adipose tissue stores in early life strongly determines later storage capacity.

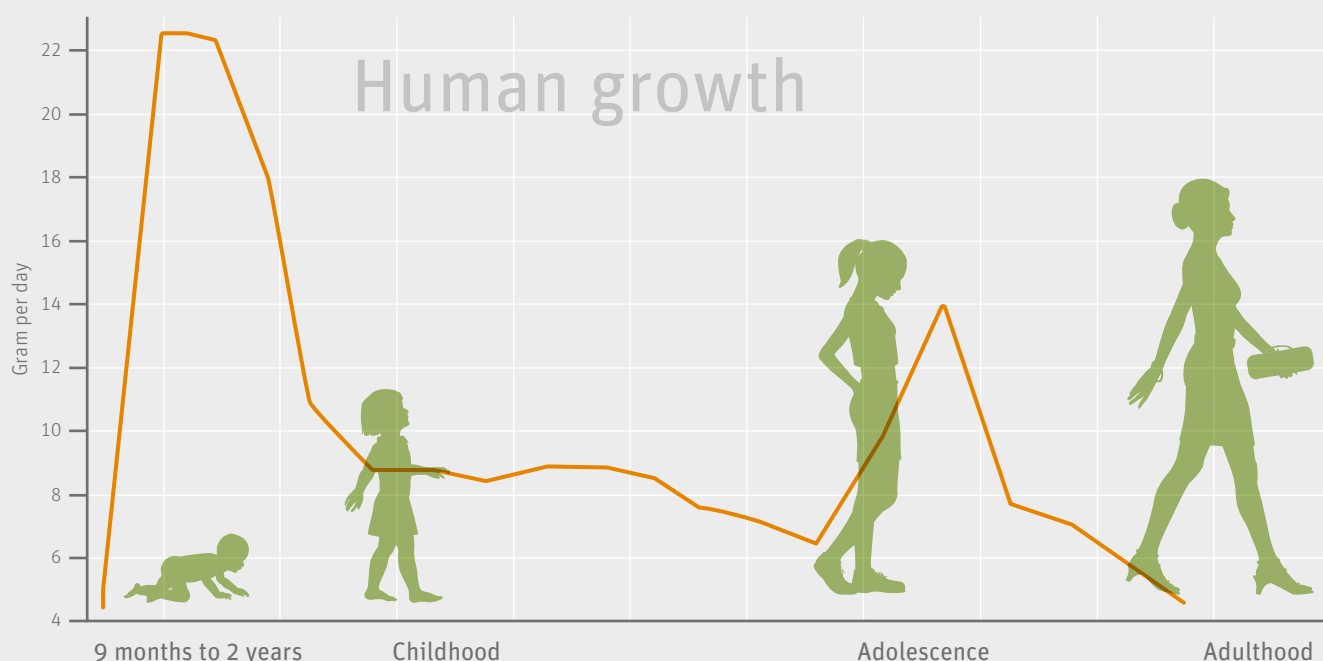
Changing nutrient requirements

The change in nutrient requirements from pre- to postnatal life up to the age of 3 to 4 years hints at the relevance of (micro)nutrient density and (macro)nutrient balance. We often talk about nutrition in terms of “evidence-based medicine”: we expect that the addition of a “good” nutrient will result in a desired effect. However, we eat foods, not nutrients, and most food sources provide multiple nutrients. These nutrients do not act in isolation and may interact with each other. Also, the addition of one nutrient will automatically change properties of the others. In addition to the amount and balance between nutrients, nutrient quality is also relevant. For instance, two sources of dietary fat may deliver the same quantity but, based on differences in fatty acid (FA) composition, a different quality. These differences may be meaningful, especially when organs are still growing and maturing, as is further explained below.

“During infancy, human milk is the gold standard for the feeding of any young infant”

During infancy, human milk is the gold standard for the feeding of any young infant. The current WHO recommendations advise 6 months of exclusive breastfeeding followed by continued breastfeeding up to the age of 2 years combined with appropriate complementary food introduction.⁸ As a manufacturer of infant and toddler foods, we actively support breastfeeding, for instance via our global parental policy that supports breastfeeding in the workplace.⁹ Especially for the first years of life, there is a need for a human milk alternative for those infants who are not, or are no longer, breastfed to ensure suitable nutrition. Consequently, the composition of human milk has been an important topic of research over the past decades.^{10,11} While recognizing the gap in composition and functionality between commercial infant milk formula and human milk, it is the responsibility of manufacturers to continuously strive to improve what they can offer as a suitable alternative when breastfeeding is not possible. Any alternative suitable for young infants should be safe and nutritionally adequate as proven in clinical studies with infants. Although some major steps in formula development have been made over the

FIGURE 2: The speed in growth from conception up to adulthood illustrates the uniqueness of the first 1,000 days and comes with particular age-specific nutritional requirements



See this article for specific examples.

past decades, there is still room for improvement, as illustrated by the examples of research on protein and lipid quality below.

Protein levels

Protein levels in infant formula today are still higher compared to human milk, mainly driven by differences in protein quality. It has been hypothesized that differences in protein intake may, at least in part, explain the observed protective effects of breastfeeding compared to formula feeding on later life obesity.¹² However, simply lowering the amount of protein without addressing protein quality may increase formula intake.¹³ A series of elegant studies using an amino acid oxidation method provided new insights into the essential amino acid (EAA) requirements for growth in young infants.^{14,15} These results enabled us to develop a new concept with improved protein quality by providing a modified EAA mixture to ensure adequate growth allowing for lower protein levels. Studies in young piglets addressed some of the basic safety and tolerance questions^{16,17} and supported the initiation of a clinical study to test the concept in infants to assess growth and body composition development in a public-private partnership with the support of an EU grant.^{18,19} Studies such as these will help gain insights and support further development of product concepts in which we optimize protein quality (and quantity) in line with child growth needs.

The relevance of lipids in milk

As mentioned earlier, the addition or lowering of one nutrient will automatically change the contribution of all others. Indeed, the “high protein hypothesis” as a driver for differences in growth between formula- and human milk-fed infants may also be explained by the fact that high protein intake is associated with low fat intake, of which the latter is suggested to have greater impact.²⁰ During the first 6 months of life, when milk is the sole source of nutrition, 40%–50% of the energy intake is provided by fat. Dietary fats not only provide the energy for growth and ensure adequate absorption of the fat-soluble vitamins, but also supply the essential FAs omega-6 linoleic acid (LA) and omega-3 α -linolenic acid (ALA), precursors for the long chain polyunsaturated fatty acids ARA and DHA. Qualitative differences in the supply of fatty acids like DHA and ARA may be of interest, as these can directly affect the development of the brain but also of adipose tissue, metabolic function, and the immune system.^{5,21,22}

Lipid quality

Over the past decades, agricultural changes driven by governmental policies have led to profound changes in the intakes of LA, and consequently in the balance between omega-6 and omega-3, leading to shifts in LA and DHA content in human

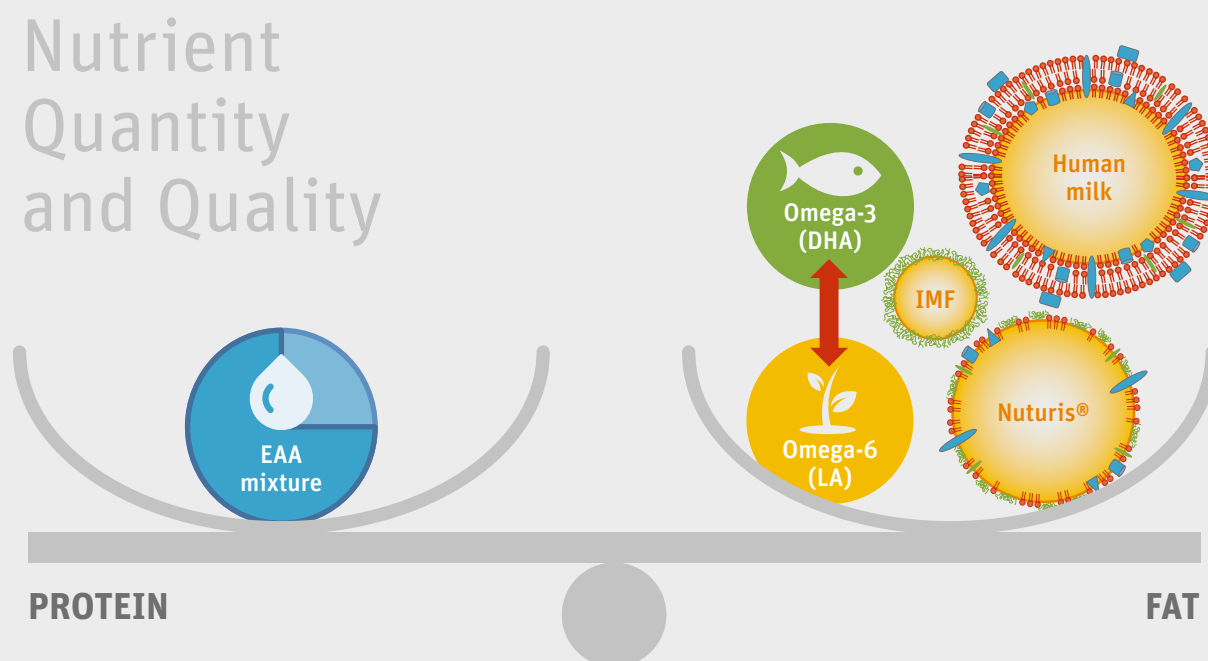
milk.^{23,24} Proof-of-principle experiments in a mouse model for neonatal nutritional programming showed that relatively modest changes in the postnatal diet restoring the balance and contribution of omega-3 and omega-6 FAs can reduce fat mass accretion during a later challenge with a Western-style diet.^{25,26} Not only differences in FA composition, but also the physical structure of nutrients may contribute to their use and metabolic fate in the body. Inspired by human milk, a formula concept containing large, phospholipid-coated lipid droplets (Nuturis®) was developed mimicking a matrix feature normally only present in raw, unprocessed milk.²⁷ Using a similar testing paradigm as described above, we showed that the altered dietary lipid structure also effectively reduced the development of excess adiposity when mice were challenged with a Western-style diet.^{28,29} This Nuturis® concept is currently being tested in a clinical setting.^{30,31}

“Obesity among pregnant women is becoming one of the most important women’s health issues”

Potential benefits of nutritional concepts

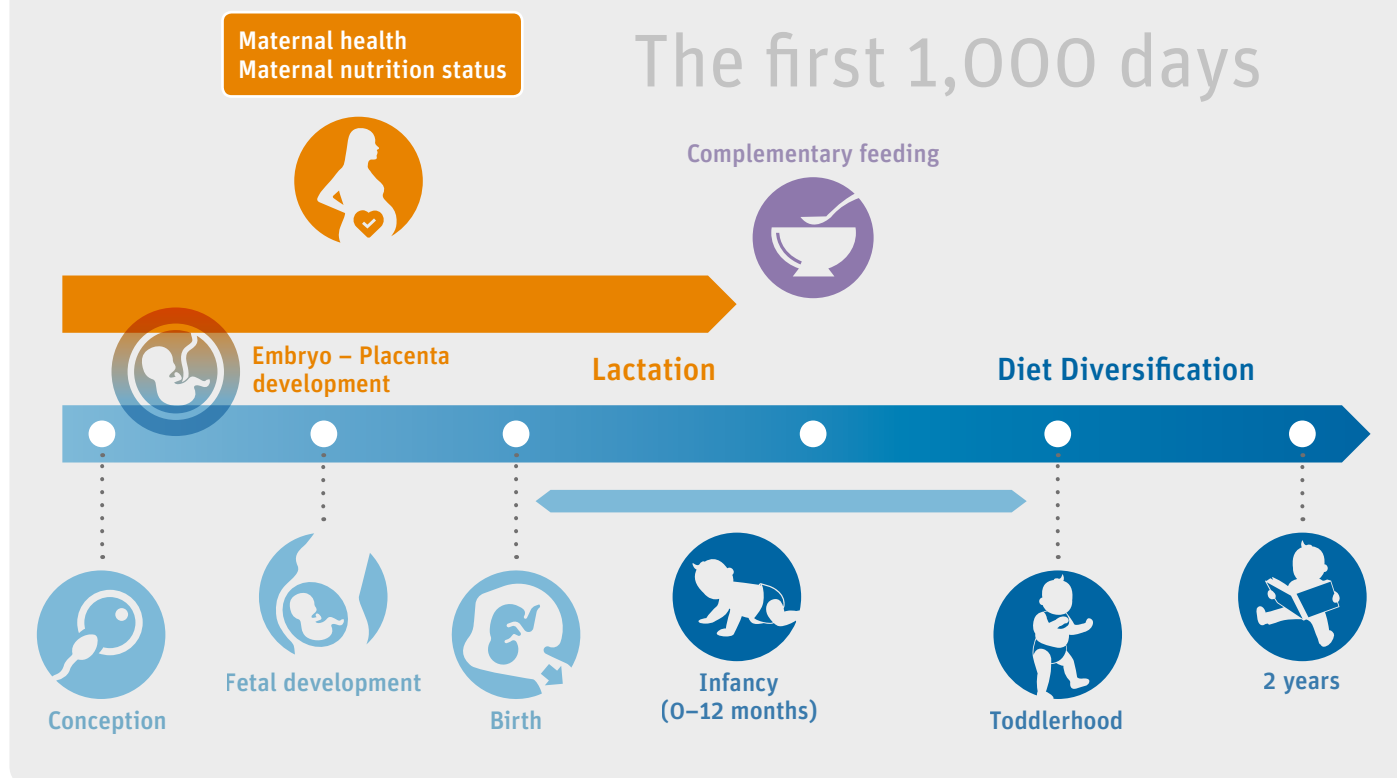
Examples like those on protein and lipid quality discussed above highlight some of the research that is currently delivering initial results on growth adequacy in clinical settings. Further research is ongoing, also illustrating the fact that it may take many years of research and product development before such innovations may be available on the market. For healthy term-born infants, such improvements in nutrient quality may only have a modest effect that is difficult to measure. Many children, however, already experience challenging conditions in the womb that may impact their fetal and postnatal growth, and for these children – for instance, offspring of obese women – the benefits of such nutritional concepts might be more meaningful. Obesity among pregnant women is becoming one of the most important women’s health issues.^{2,32} Maternal obesity is associated with higher birth weight and more body fat, partly related to the heightened risk of gestational diabetes mellitus (GDM), and representing a risk factor for unbalanced or faster growth and obesity later in life.^{32,33} GDM is currently one of the most common medical complications in pregnancy affecting one in every seven births globally.³⁴ Both mothers and their offspring are at increased risk of short- and longer-term complications, such as development of type 2 diabetes.^{35,36} Al-

FIGURE 3: An optimal balance between the amount of protein and fat as well as specific aspects of protein and lipid quality in the diet in early life are important



Examples of research on nutrient quality are, for instance, the mixture of essential amino acids provided by the protein blend, the balance between omega-6 and omega-3 fatty acids in the diet, and the physical structure of dietary lipids (see text for further details).

FIGURE 4: The first 1,000 days provide a unique window of opportunity to nutritionally support the quality of growth in the infant and the metabolic health of both mother and infant, with the potential to reduce the risk of NCDs later in life



though the currently available evidence favors actions directed at controlling prepregnancy weight and preventing obesity and GDM, adequate dietary guidance before and during pregnancy, especially in the case of GDM diagnosis, but also after birth for the offspring, is crucial.^{32,37}

The importance of adequate dietary data

To develop meaningful innovations, it is crucial to improve understanding of the health and nutritional reality of the relevant target populations. To this end, we use a standardized approach, consisting of literature reviews in a range of health care-related databases as well as gray literature obtained from international and national organizations and websites of ministries of health and NGOs.³⁸ The information gathered is subsequently compared to available nutritional recommendations providing reference values.³⁸ These reviews are repeated at regular intervals to update available insights and guide further research and product development. In the case of crucial knowledge gaps – for instance, in understanding the nutrient intakes of pregnant and lactating women in Indonesia – studies are performed to gather further information.^{39,40} Nutritional survey data indeed confirm that the diets of many pregnant and lactating women are often nutritionally unbalanced and do not meet local nutritional guidelines and recommendations.^{41,42}

Conclusion

In summary, the window of opportunity to nutritionally support the quality of child growth and metabolic health extends from preconception into pregnancy and continues throughout the postnatal period. The scientific evidence to date supports the notion that optimal nutrition in early life contributes to health and has the potential to decrease the risk of NCDs. Thus, a focus on improving dietary habits and approaches to support more balanced and adequate nutritional intakes tailored to the changing needs of the mother and her developing child during the first 1,000 days is likely to have significant public health benefits. As Hippocrates already stated around 400 BC, “The greatest medicine of all is to teach people how not to need it.”

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Probiotic Fermented Foods

A scalable approach to promote gut health and improve nutrition

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➤ Locally produced probiotic fermented foods can be suitable for a range of appropriate, cost-effective, scalable, and sustainable approaches implemented at the household, community, and market levels.

Key messages

- The emerging human microbiome paradigm is shedding new light on the centrality of beneficial microbial communities to both enteric and overall human health, with important implications for human nutrition.
- As a result of inadequate diets and high infectious disease burden, children in resource-poor communities can become entrapped in the malnutrition-infection cycle in which undernutrition increases susceptibility to infection and subsequent infections exacerbate undernutrition.
- Interventions to promote a healthy gut microbiome can decrease host susceptibility to enteropathies, including diarrheal disease, and promote nutritional well-being.
- A sustainable approach in resource-poor settings is to build upon the age-old practice of fermenting foods as the vehicle for consistent intake of beneficial microorganisms.

Introduction

Enteric and diarrheal diseases are a major cause of child mortality. Annually, over half a million children under five die in low- and middle-income countries (LMICs) because of complications related to diarrhea.¹ With or without overt diarrhea, enteric infections account for 25% of child stunting globally and are a major contributor to impaired cognitive development.² Undernutrition of children and mothers, both chronic and acute, is the leading underlying cause of child morbidity and mortality. Global estimates indicate that undernutrition directly contributes to 45% of all child deaths, some 3.1 million annually.² In addition, at least 151 million children are affected by stunting, 51 million children are affected by wasting,³ and 2 billion people suffer from deficiencies of essential micronutrients such as vitamin A, iron and zinc.² Enteric dysfunctions and undernutrition exhibit synergy, which amplifies the aforementioned deficits in child growth and development, limits a child's future potential, and provokes enormous losses of human capital.^{2,4}

“DNA sequencing has revolutionized our understanding of the role of microbes in human health and disease prevention”

Over the last two decades, technological and scientific advances stemming from the rapid development of high-throughput DNA sequencing techniques and studies on the composition and activity of the human microbiota have revolutionized our understanding of the role of microbes in human health and disease prevention. These advances enable innovative interventions, such as the introduction of health-promoting bacteria,



Schoolchildren enjoying Yoba probiotic yogurt in Uganda

that can both lessen the burden of enteric and diarrheal disease and improve the nutritional status of young children around the world.^{5,6,7} Such innovative technologies and approaches can build on the age-old traditional healthy practice of food fermentation to enhance gut health and prevent malnutrition in resource-poor communities. They additionally have the potential to sustainably scale up from the household to the global market level. More specifically, we propose that fermented foods containing probiotics can provide solutions to improve gut health with the potential for scaling up at low cost and affordably for resource-poor communities.

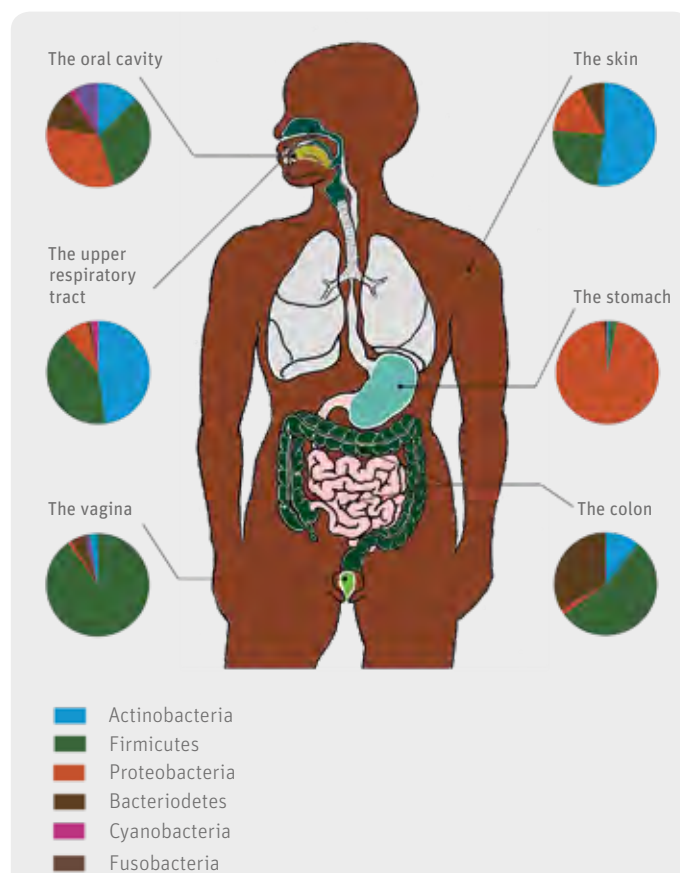
The human microbiome as a new paradigm in health and nutrition

Children's nutritional status is directly associated with the integrity of their gut, also known as the enteric system. When the enteric environment is disturbed, a child is at increased risk of nutritional dysfunction due to nutrient malabsorption and enteric infections such as diarrheal disease.^{3,8,9} The emerging human microbiome paradigm is shedding new light on the centrality of beneficial microbial communities to both enteric and overall human health. This complex enteric ecosystem hosts over 100 trillion microorganisms – the gastrointestinal microbiota – consisting of hundreds of different species of bacteria, archaea, fungi, protists, and viruses. The vast majority of these microorganisms live in a mutualistic or commensal relationship with their host. A healthy human gut provides a supportive habitat for microbiota, with a steady supply of nutrition for optimal growth and development. In turn, microbiota support digestive processes

of the host, prevent colonization of the gut by pathogens, and promote proper development of intestinal epithelium and immune responses. Together, the gastrointestinal system and its microbiome serve as the first line of immune defense for the body, acting as a gatekeeper to allow the absorption of essential nutrients while preventing pathogenic infiltration.¹¹

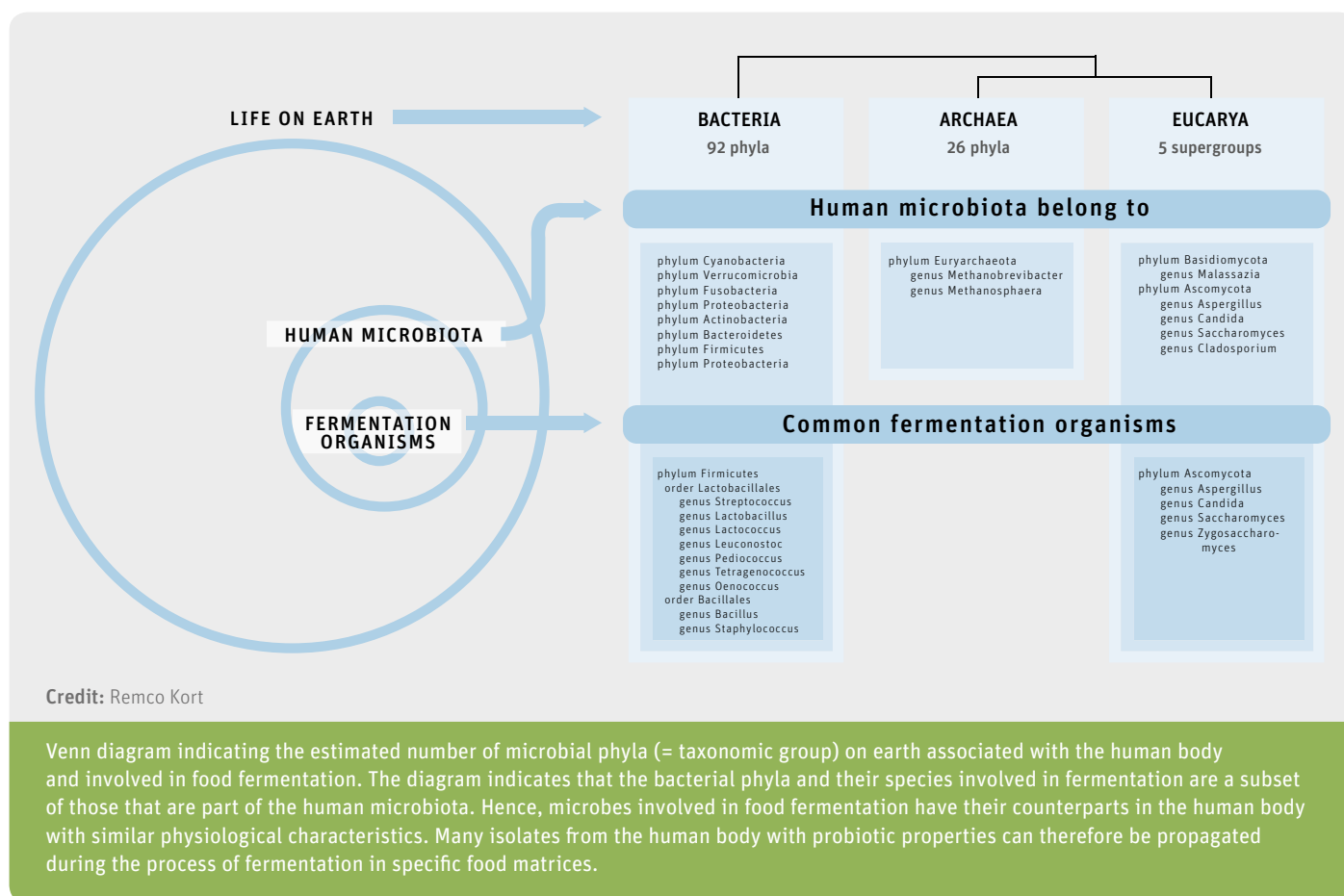
“Growing evidence points to the critical role of the gut microbiome in determining nutritional outcomes”

A growing body of evidence points to the critical role of the gut microbiome in determining nutritional outcomes and supporting overall child health and development.^{12,13} A healthy and homeostatic gastrointestinal system capable of maximizing the nutritional value of ingested foods fundamentally depends on



Credit: Image adapted with permission from the book *De microbemens* (The Microbe Man), authored by Remco Kort (2017, Atheneaeum – Polak & van Genneep).

Composition of bacterial phyla present in the human microbiota



a healthy microbiome. In turn, dietary choices directly impact the composition and function of the gut microbiome.¹⁴ Young children in resource-poor settings have inadequate diets that negatively affect their gut microbiome profile. They are also exposed to unsanitary conditions that increase the likelihood of persistent and repeated bouts of enteric infection. As a result of poor diet and high infectious disease burden, these children can become entrapped in a vicious cycle where undernutrition increases susceptibility to infection and then infection exacerbates nutrient deficiencies.^{3,15,16,17} Interventions promoting a healthy gut microbiome can decrease host susceptibility to enteropathies, including diarrheal disease, and promote nutritional well-being.¹⁸

The benefits of a healthy gut microbiome far exceed the absence of intestinal disease and pathogenic domination. A healthy gut microbiome secretes compounds and produces metabolites that are beneficial to the intestinal environment and the host. By feasting on foods consumed by the host, the bacteria produce essential vitamins, such as vitamins B and K.¹⁹ Overall immune function is also boosted by the microbiome, due to interaction of microbiota with immune cells present at the intestinal epithelium.⁹ In addition, the microbiota play a key role in the production of immune-regulating short-chain fatty acids, which also act as a fuel for epithelial cells. Emerg-

ing evidence also suggests that gut dysbiosis likely impacts the long-term health of children into their adult years. Overweight, obesity, and certain associated chronic diseases have been linked to the compositional profile of the gut microbiome, with a marked difference in the overall microbiota makeup found in comparison to healthy-weight individuals.^{12,20}

Toward a healthy gut microbiome

Although there is high variability between individuals and geographies in terms of gut microbiome composition, with similar functions often performed by different microbes, patterns of what could constitute a healthy microbiome are being recognized and hold promise in the design of gut health interventions.

Assembly of the gut microbiome starts at birth and matures into a stable configuration, primarily during the first three years of life.²¹ Parturition is believed to supply the initial microbial load to neonates, with the vaginal and fecal microbiome of the mother and the skin of those handling the newborn acting as the primary sources.²² Human milk helps colonize the infant's gut through microbes that are compositionally linked to the mother's microbiome, as well as oligosaccharides and other milk glycoconjugates that act as nutritious substrates for microbial symbionts, particularly of the *Bifidobacterium* genus.²³ Recent

evidence shows that a healthy child's gut undergoes a maturation process that is most intense during the first two years of life and is characterized by specific microbial community configurations that distinguish an age-appropriate microbiome. Malnourished children, by contrast, exhibit gut microbiota configurations that remained behind in the development and resemble those of children many months younger.¹²

The mature homeostatic microbiome is characterized by high taxon diversity with a predominance of commensal microbiota. Taxon diversity enables the development of complex functional networks of both microbe-microbe and host-microbe natures. These functional networks operate as cooperative consortia that perform vital metabolic tasks for the host: the more numerous and interconnected such networks are, the greater the microbiome's stability and resilience.²¹ Within the gut ecosystem, there is intense biochemical communication among microbes (both intra-species and inter-species) and host cells, an example of which is the quorum sensing mechanism.²⁴ The predominance of commensal and beneficial microbiota keeps pathogen populations in check through direct competition for nutrients and gut mucosal substrate, direct inhibition via production of bacteriocins, and immune system modulation. At the same time, the immune system shapes and shepherds the gut microbiome through a wide variety of molecular and cellular mechanisms.¹³ External factors also play a key role in shaping the gut microbiome, with diet, medication, and age being the most prominent.¹³ Recent research demonstrates that even short-term dietary changes can modify mi-

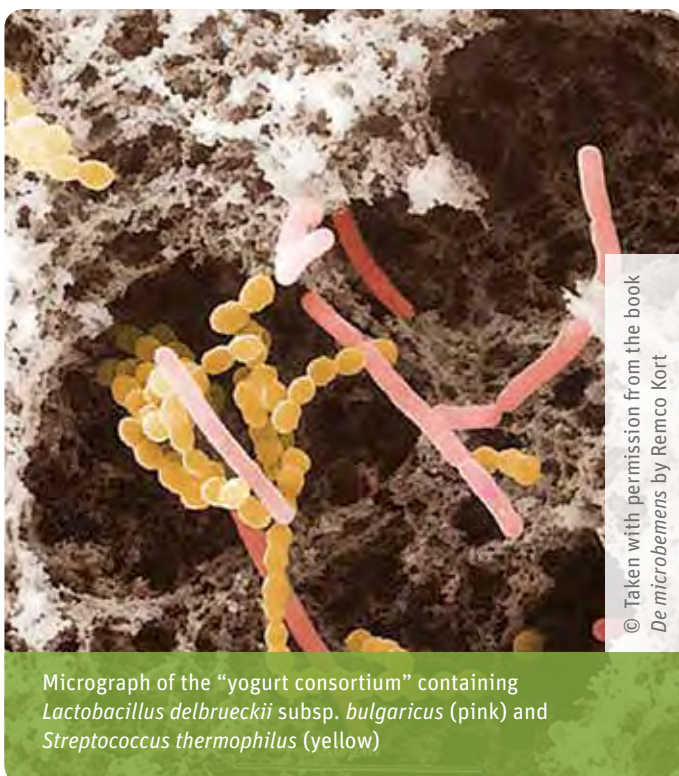
Box 1: Fermented foods

The origins of food fermentation as a food preservation method remain unclear, but it most likely began in the Neolithic Period over 10,000 years ago when populations shifted from food gatherers to food producers. Fermented foods provide a natural source of beneficial bacteria and yeasts and were traditionally produced by most human societies within the home as a means of preservation. Modern-day examples that are widely consumed include yogurt, kefir, cheese, sauerkraut, kimchi, fermented porridges, and injera. The ability to ferment foods enabled safe consumption of dairy and vegetable products regardless of season and improved shelf life without refrigeration. Fermented foods thus offer a foundation for promoting gut health that is safe, affordable, and accepted across societies in different forms. The use of affordable starter cultures can further enhance the quality and safe production of fermented foods and the resulting meals can be used as a platform for the delivery of beneficial microbes and strains optimized for specific age groups and nutritional needs.^{28,29,30}

crobial community structure and overwhelm inter-individual differences in microbial gene expression.²⁵

“Even short-term dietary changes can modify microbial community structure”

The enormous potential of dietary interventions to promote a healthy gut microbiome has led to the development of a large market for so-called “probiotic” products in Europe, North America, and Asia. These products usually fall into two categories: supplements and foods. Supplements are typically commercialized in tablet or powder form; examples of foods with probiotic claims include a variety of premium beverages and yogurts. Both probiotic supplements and foods may offer an appropriate approach to promote gut health in resource-rich areas, but present serious drawbacks for sustainable utilization in resource-poor settings. Their premium positioning and pricing, as well as intellectual property restrictions, put them out of reach for the populations that stand to benefit the most from improved gut health.²⁶ Generic probiotics may increase affordability, but barriers to access remain. Consistent intake of supplements would require costly supply chain setups to meet a yet-to-materialize demand through local markets or health systems. In the case of com-



Micrograph of the “yogurt consortium” containing *Lactobacillus delbrueckii* subsp. *bulgaricus* (pink) and *Streptococcus thermophilus* (yellow)

TABLE 1: Potential benefits of regular consumption of locally produced fermented foods for nutrition and health as well as social and economic factors

Nutrition and health	
Immune response	Fermented food products can significantly improve both specific (e.g., targeted response against specific pathogens) and nonspecific immune responses (e.g., protection against foreign material perceived to be harmful). ^{31,32,33,34,35}
Diarrheal prevention and treatment	Beneficial microbiota used in clinical settings have been shown to reduce diarrheal duration by 14% and stool frequency on the second day of treatment by 13%. ³⁶ Several strains have been shown to significantly prevent and/or treat diarrheal episodes, including <i>Lactobacillus rhamnosus</i> GG, ³⁷ <i>Saccharomyces boulardii</i> , ³⁸ <i>Lactobacillus reuteri</i> , ³⁹ and <i>Bifidobacterium lactis</i> .
Carbohydrate digestibility	Microorganisms present in fermented foods thrive on that food's carbohydrates prior to ingestion by the host. This partial breakdown of carbohydrates by the microorganisms benefits the human body by enhancing digestibility. ⁴⁰ Furthermore, fermenting lactose-containing foods – such as milk in yogurt production – has been noted to significantly reduce lactose content and improve digestion in lactose-intolerant individuals. ⁴¹
Nutrient density	A fermentation process involving amylase-rich flour (ARF) and a small amount of lactic acid bacteria starter culture increases the flour's fluidity, enabling addition of more ARF for increased nutrient density. ⁴⁴
Production of essential nutrients	Beneficial bacteria at the gut level produce essential vitamin B ₁₂ and vitamin K, which can be absorbed at the colon rather than the small intestine, as occurs with orally consumed vitamins. ¹⁸
Counteracting antinutritional factors	The ideal fermentation process provides optimum pH conditions for the degradation of phytate by phytase, thereby increasing the amount of bioavailable iron, zinc, and calcium, magnesium, and proteins. ⁴²
Aflatoxin degradation	Lactic acid bacteria fermentation can be used as an approach to significantly reduce aflatoxin levels within food. ^{43,44}
Heavy metal detoxification	The application of lactic acid bacteria and yeast as probiotics can be used to eliminate, inactivate, or reduce the bioavailability of toxic metals and toxins in food and feed. ⁴⁵
Social and economic	
Income generation and women's empowerment	Household and community production of fermented foods offer revenue-generating opportunities, particularly for women. ²⁶
Preservation	Fermentation promotes natural conservation of perishable foods, reducing food waste and creating preserved foods for later consumption and sale. ³⁰

mercial foods, cold-chain transport and storage requirements often limit availability to urban and peri-urban areas. Last-mile challenges all but preclude rural and remote populations being served by either product category.

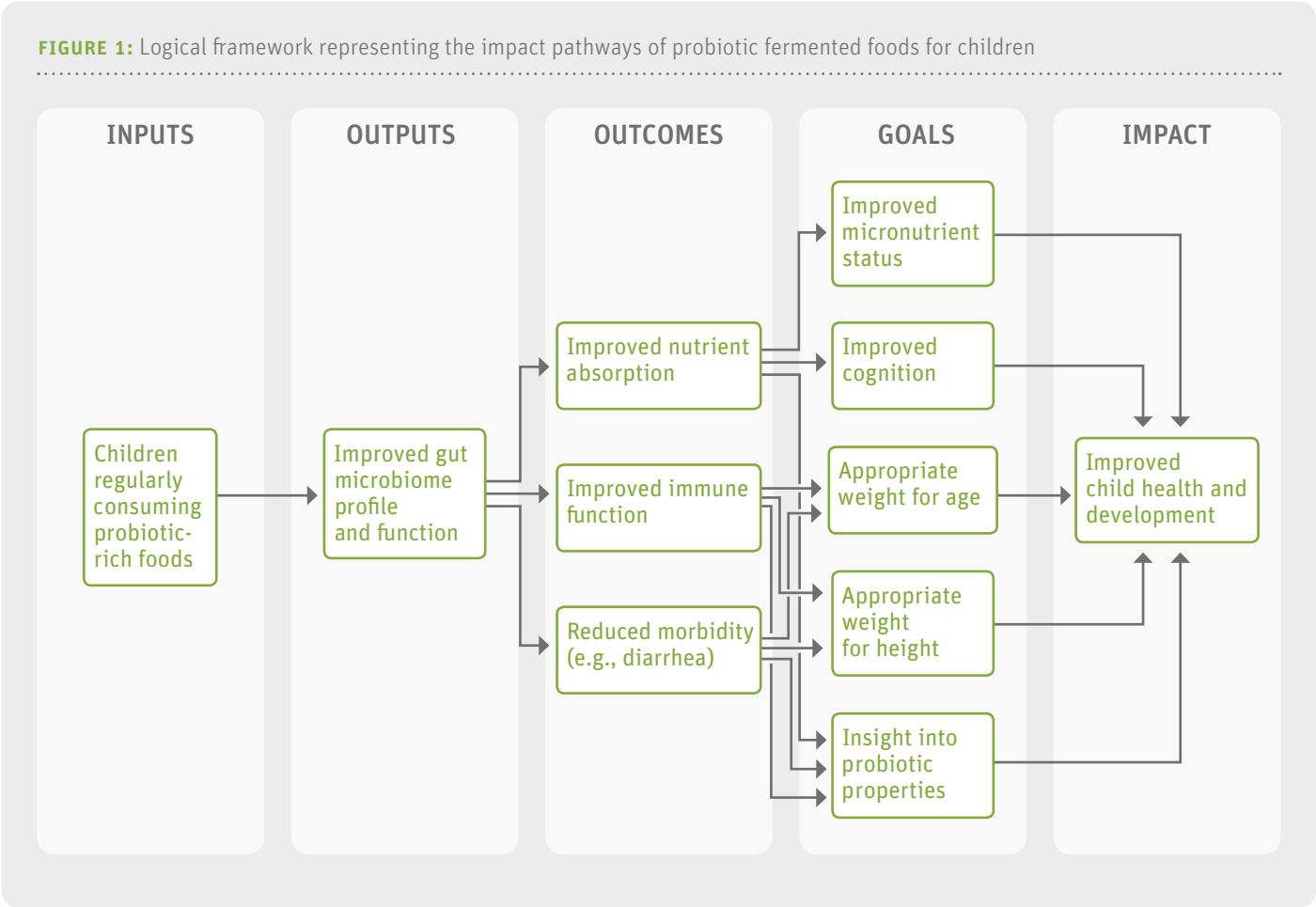
Probiotic fermented foods

In contrast, a much more sustainable approach in resource-poor settings is to build upon the age-old practice of fermenting foods (Box 1) as the vehicle for consistent intake of beneficial microorganisms. It is worth noting that naturally fermented foods intrinsically contain microorganisms with health benefits. However, these benefits have not been extensively studied or proven in scientific research due to the complexity, variability, and undefined nature of these foods. In addition, functional fermented foods or probiotic fermented foods are defined

as foods with specific health benefits resulting from probiotic strains – often from human origin – present in the fermentation process. Both types of food are suitable for a range of appropriate, cost-effective, scalable, and sustainable approaches that can be implemented at the household, community, and market levels. Table 1 lists the benefits that locally produced fermented foods could generate for nutrition, health, and socioeconomic purposes.

A particularly vulnerable age group that is likely to benefit from this intentional use of probiotic fermented foods is young children in resource-poor settings. Even in areas where such foods are already part of children's diets, for example in the form of yogurt or fermented porridges, targeted starter cultures may be used to enhance the probiotic profile of the fermented food and increase its beneficial impact on the child's

FIGURE 1: Logical framework representing the impact pathways of probiotic fermented foods for children



health. **Figure 1** depicts the pathways by which probiotic-rich fermented foods and a healthy gut microbiome can influence health outcomes and positively influence child health and development. It is presumed that regular access to and consumption of fermented food products, when combined with other interventions, lead to improved health and development through increased nutrient absorption, improved immune function, and decreased morbidity due to enteric infections.



Local entrepreneur producing probiotic yogurt in Tanzania

Examples of locally produced probiotic fermented foods include a state-supported program in Argentina, Yogurito, and a grassroots initiative for the local production and distribution of an affordable probiotic yogurt in East Africa, Yoba for Life.⁴⁶ In Argentina, a fermented milk containing probiotic *Lactobacillus rhamnosus* CRL1505 has been incorporated into the official nutritional programs of northern Argentinian provinces and provided to more than 300,000 children on school days. In East Africa, the Yoba for Life Foundation developed an innovative starter culture containing the probiotic bacterium *Lactobacillus rhamnosus* yoba 2012, the generic variant of the world’s best-documented probiotic strain *L. rhamnosus* GG.⁴⁷ One gram of the Yoba starter culture enables the production of 100 liters of probiotic yogurt. This concept has been adopted by local entrepreneurs and currently more than 200 production units in Uganda, Tanzania, and Kenya are transforming nutritious milk into Yoba’s even healthier probiotic fermented yogurt reaching over 250,000 consumers.²⁶

These examples illustrate the potential of probiotic fermented foods to cost-effectively and sustainably promote gut and overall health in resource-poor settings.^{47,48} However, in order to fully realize this potential, several issues need to be addressed through research, piloting of interventions, policy development, and legislation (**Table 2**).

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“The growing knowledge of the host-microbiome relationship has the potential to create substantial positive impact on the health and lives of millions”

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Looking ahead

As the human microbiome scientific revolution continues to unfold, it brings forth an exciting opportunity to put the cutting edge of science at the service of the most vulnerable populations. The growing knowledge of the host-microbiome relationship has the potential to create substantial positive impact on the health and lives of millions of underprivileged children and families throughout the world.

Most of the research in this field has thus far focused on isolating specific bacterial and yeast strains and subspecies, testing them for clinical benefits, and developing probiotic products based on them. A more promising, translational approach for low-resource settings is to identify commonly consumed fermented foods, characterize their microbiological profile, and assess the impact of the intrinsic strains on gut health, as well

as the potential of boosting them with microbial communities or strains with known efficacy and health benefits. The probiotic fermented foods will in this way serve as a vehicle for beneficial microbes, as well as a source of naturally enriched and sustainably produced healthy and appealing food.⁴⁹ This concept enables a wide range of opportunities for production and marketing at the household, community, and market levels.⁵⁰

Looking further into the future, we can envision what the next generations of probiotic fermented food will look like. We expect to see the emergence of fermented foods made by using starter cultures containing locally sourced probiotics, obtained from donors who showed a specific health characteristic when exposed to challenging environments and poor diets.³³ In parallel, we envisage the development of fermented foods containing genetically engineered strains enhancing the nutritional properties of the food, e.g., by specific conversion of certain proteins or carbohydrates in the food ingredients, or by delivering vitamins, bioactives or functional (digestive) enzymes to the gastrointestinal tract of the consumer.

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TABLE 2: Issues to be addressed for the sustainable introduction and acceptance of local and regional probiotic fermented food concepts

Consumer and market insight	<ul style="list-style-type: none"> › Understanding of local preferences for fermented foods and relevant market dynamics in a variety of geographic regions and among different segments of the population.
Technical	<ul style="list-style-type: none"> › Greater documentation of the microbial composition and nutritional value of various fermented foods, particularly those produced at the household level and served to children. › Development of starter cultures, processing equipment, and technologies for household, community, or industrial production of fermented foods, with an emphasis on affordability and productivity at the household level and enablement of small and mid-sized fermented food cooperatives and businesses in low-income countries. › Investigation of the shelf life, storage requirements, and nutritional integrity of dried and processed starter cultures. › Development of quality management methods for fermentation processes and fermented food storage and consumption to ensure food and consumer safety.
Health impact	<ul style="list-style-type: none"> › Investigation of the efficacy and effectiveness of probiotically enhanced fermented foods in addressing challenges such as diarrheal disease and enteric infections, intestinal inflammation from environmental enteric dysfunction (EED), immune function and response, weight gain, linear growth, and micronutrient deficiencies – particularly during the introduction of complementary foods and the first few years of a child's life. › Investigation of the benefits of probiotics to boost ready-to-use therapeutic foods (RUTFs) and ready-to-use supplementary foods (RUSFs) to accelerate patient recovery and gut microbiome restoration. › Research on healthy microbiome profiles that takes into account ethnic, dietary, geographic, and lifestyle differences.
Regulatory and political	<p>New legal, regulatory, and institutional frameworks at the national and international levels, enabling the full incorporation of fermented foods into complementary and school feeding policies.</p>

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Improving Iron Bioavailability with Prebiotic Galacto-oligosaccharides

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Key messages

- Nearly half of all children under five years, mostly living in Africa and Asia, suffer from anemia.
- One of the predominant factors contributing to this bleak outlook is iron deficiency.
- It is difficult to meet the iron needs of older infants and young children through local diet alone.
- Recent trials question the safety of MNPs containing a dose of 12.5 mg iron per sachet, particularly in areas with high malaria endemicity.
- New studies show that prebiotics can improve iron absorption and reduce the negative side effects of iron supplements in infants with iron deficiency.

Iron deficiency anemia is a global concern

Nearly half of all children under five years, mostly living in Africa and Asia, suffer from anemia (**Figure 1**).^{1,2} These children will likely fail to reach their full cognitive, motor, and social-emotional potential, will probably fail at school, fail to achieve their income potential, and remain trapped in the poverty cycle.³ One of the predominant factors contributing to this bleak outlook is iron deficiency.¹ In fact, according to the World Health Organization (WHO), iron deficiency is among the 10 most serious risks in countries with high infant mortality rates.³

Children aged 6–23 months, with their increased iron requirement due to rapid growth, are recognized as being at a

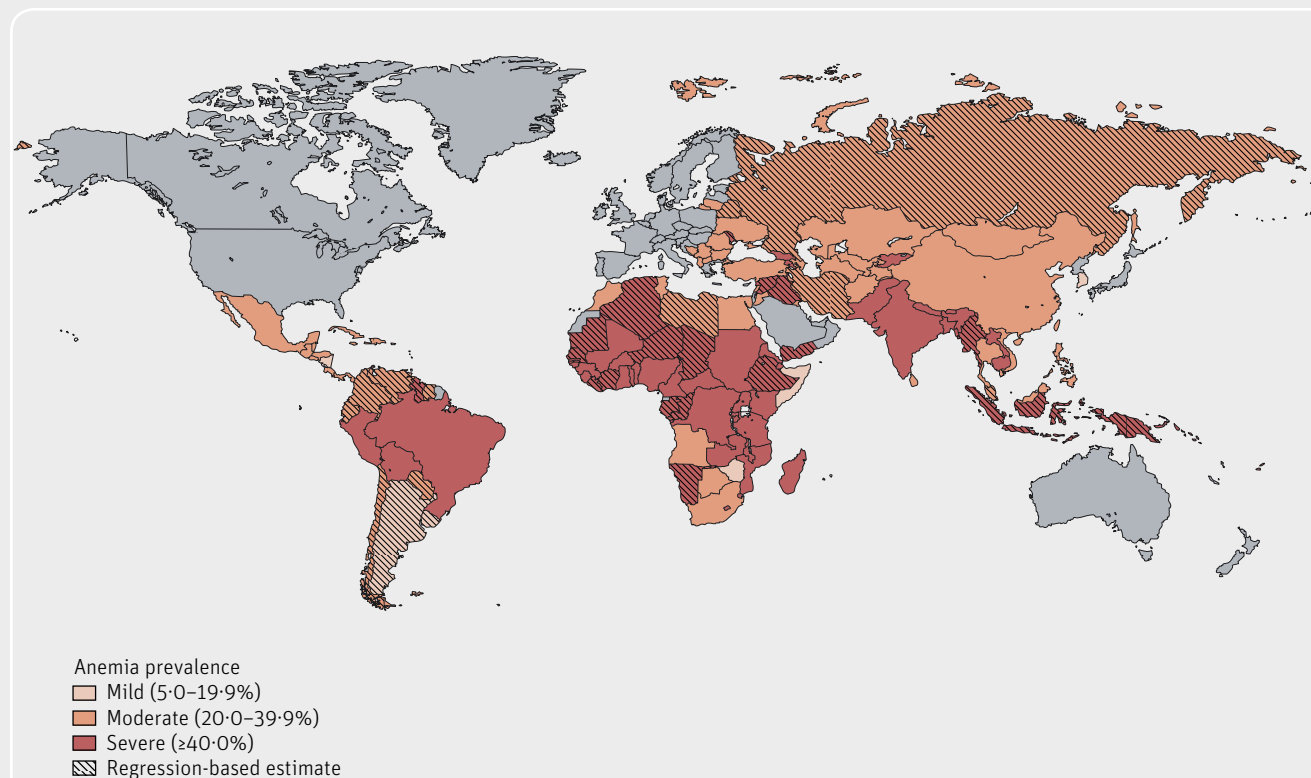
higher risk for iron deficiency anemia.^{3,4} While the iron stores received at birth are sufficient to support normal functions and growth for the first six months, it is difficult to meet the needs of older infants and young children through local diet alone,⁵ particularly in resource-poor countries. Inclusion of fortified complementary foods or supplements can help this age group meet the additional iron requirements of approximately 4 mg per day or more.⁵ It is imperative to have effective strategies in place for ensuring adequate iron nutrition and reducing anemia during these formative years.

“It is difficult to meet the iron needs of older infants and young children through local diet alone”

Strategies to ensure iron adequacy

Strategies to ensure adequate iron nutrition and/or to treat anemia include a combination of measures tuned to the specific situation and circumstances. First, breastfeeding should be promoted and supported. Other measures include promotion of dietary diversity, fortification of staples and complementary foods, and iron supplementation for groups at high risk or with especially high needs.⁶ Multiple micronutrient powders (MNPs) have been adopted as an approach for providing micronutrients to populations where needs are highest and other interventions are difficult to implement, such as in Africa and Asia.^{6,7}

For infants and young children aged 6–23 months, WHO recommends point-of-use fortification of complementary foods with iron-containing MNPs to improve iron status and reduce anemia.^{6,7,8} Current MNPs contain a dose of 12.5 mg iron per sachet, equivalent to the dose provided by oral iron supplements for the treatment of iron deficiency anemia in infancy.⁷ This high dose is to account for the potential inhibitory substances

FIGURE 1: Anemia as a public health problem by country: preschool-age children

in complementary foods and high plasma hepcidin concentrations due to infections.^{9,10} Recent trials, however, question the safety of these MNPs, particularly in areas with high malaria endemicity.^{11,12,13,14} Most of the iron from these MNPs passes unabsorbed into the infant colon, where it can promote the growth of enteropathogens and increase the risk of diarrhea, particularly in poor hygienic conditions.^{8,10,14,16} In a trial with Kenyan infants, MNPs increased the *Enterobacteriaceae:Bifidobacteriaceae* ratio, numbers of enteropathogenic *Escherichia coli*, gut inflammation, and diarrhea.¹⁶

Alternatives to lower the iron dose in MNPs while maximizing iron absorption and ensuring suitability for 6–24-month-old children are thus warranted.

“Alternatives to lower the iron dose in MNPs while maximizing iron absorption and ensuring suitability for 6–24-month-old children are warranted”

Prebiotics – a novel approach to increase the iron bioavailability from MNPs

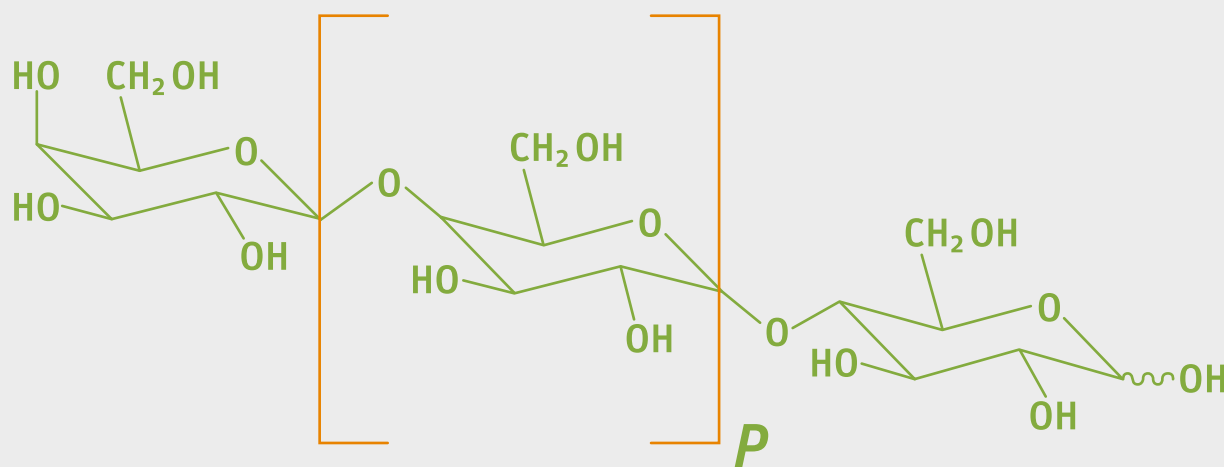
Prebiotics are substrates that are selectively utilized by host microorganisms, conferring a health benefit.¹⁷ Galacto-oligosaccharides (GOS) are an example of a prebiotic, and consist of soluble carbohydrates structured as chains of galactose with a glucose end-piece with varying chain length (Figure 2). They are enzymatically produced from lactose and may have increased selectivity toward *Bifidobacterium* spp. compared with the effect of some other prebiotics.¹⁸

Also known as “colonic food,” GOS resist digestion by gastric acid and pancreatic enzymes *in vivo* and are preferentially fermented by the beneficial intestinal bacteria. Fermentation results in the production of short-chain fatty acids (SCFAs) that decrease luminal pH, which may in turn reduce growth of enteropathogens. This favorable effect was recently demonstrated by Paganini et al. in a study with Kenyan infants.⁸

Several human studies have reported the positive influence of GOS on bacterial communities in the gut and in improving calcium absorption.^{19,20,21} However, evidence on the direct contribution of GOS-induced changes in microbiota to absorption of iron has only recently been demonstrated by Prof. Michael

FIGURE 2: Chain lengths in galacto-oligosaccharides (GOS)

di	Galactose	Glucose	n=	1			
tri	Galactose	Galactose	Glucose	2			
tetra	Galactose	Galactose	Galactose	Glucose	3		
penta	Galactose	Galactose	Galactose	Galactose	Glucose	4	
hexa	Galactose	Galactose	Galactose	Galactose	Galactose	Glucose	5
etc.							

FIGURE 3: Structure of galacto-oligosaccharides (GOS)

Zimmerman's group at ETH.^{8,10} Paganini et al.¹⁰ reported substantially higher iron absorption from an MNP with 5 mg iron and 7.5 g GOS in 6–14-month-old Kenyan children than previously described for MNPs containing 12.5 mg iron (18.8% vs. 4–9%). The authors estimate that the amount of iron absorbed from the new MNP would cover the total iron need of 0.69 mg/d in 6–12-month-old infants.¹⁰ In another randomized 4-month trial with Kenyan infants, a reduction in anemia was noted with the new MNP formulation containing a low dose of highly bio-available iron. Moreover, the provision of 7.5 g GOS in this new MNP mitigated the adverse effects of iron on the gut microbiome, resulting in greater abundances of *Bifidobacterium* and *Lactobacillus*, lower abundances of virulence and toxin genes of pathogens, less enterocyte damage, and a lower incidence of treated respiratory tract infections.⁸ According to Prof. Michael

Zimmerman, “These are the first human studies that clearly show that prebiotics can improve iron absorption and reduce the negative side effects of iron supplements in infants with iron deficiency.”

Mechanisms that may explain the increase in iron absorption with GOS include:^{8,10,22}

- Lowering of luminal pH, thereby improving iron solubility;
- Creation of an environment in the colon that promotes the reduction of Fe(III) to Fe(II);
- SCFAs stimulating the proliferation of epithelial cells, thereby increasing absorptive surface area of the colon;
- Increased expression of genes involved in iron absorption; and
- Anti-inflammatory effects in the colon, reducing circulating hepcidin.

It is also relevant to note that the studies by Paganini et al. were in mostly iron-deficient anemic infants,^{8,10} whereas previous studies were in non-anemic adults.^{10,22} In animals, anemia sharply increases colonic iron absorption, and this absorptive pathway may also become important in anemic humans.²² Also, infants have a gut ecosystem that differs from that of adults, including higher abundances of Bifidobacteria and lower colonic pH. It is plausible that potential prebiotic-induced changes in colonic iron absorption may be stronger in infants.^{8,10}

“New evidence suggests that prebiotic GOS offer opportunities to more effectively combat iron deficiency in vulnerable populations”

In conclusion

New evidence suggests that the prebiotic GOS can improve iron bioavailability as well as reduce the potential adverse effects of iron fortification on the infant gut. This offers opportunities to effectively and safely combat iron deficiency in vulnerable populations.

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Reformulating Food Products for Improved Nutrition

Or: How to improve processed foods quietly

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Key messages

- Reformulation of food products has enormous potential to improve nutrition without changing consumer behavior.
- Voluntary reformulation by the food industry is not enough. Smart regulations are needed to drive innovation and implementation of solutions for better foods.
- Reformulation needs innovative solutions at the interface of sustainability, food science, and nutrition.

Introduction

The triple burden of malnutrition is a growing challenge worldwide that hampers the health of populations. Virtually all countries in transition have to deal not only with undernutrition but simultaneously with alarming rates of overweight, obesity, and related non-communicable diseases. In Western societies, the prevalence of obesity is soaring, with every third adult person in the United States being obese, generating healthcare expenditures of US\$210 billion per year.¹ A healthy diet and physical activity are paramount to achieving a healthy weight. Most people, however, do not eat a healthy diet and are not physically active at the levels needed to maintain a healthy weight. One of the reasons is the changing food environment, which provides increasingly large supplies of rather inexpensive, highly palatable, energy-dense foods that are easily accessible, convenient to consume, and heavily marketed. This type of environment promotes excess caloric intake and eventually obesity.² Processed

and prepackaged foods provide extensive amounts of sodium and added sugar to the diet in the US, Australia and Europe,³ but are at the same time an important contributor to the adequate intake of micronutrients.⁴

Attempts to change consumer behavior

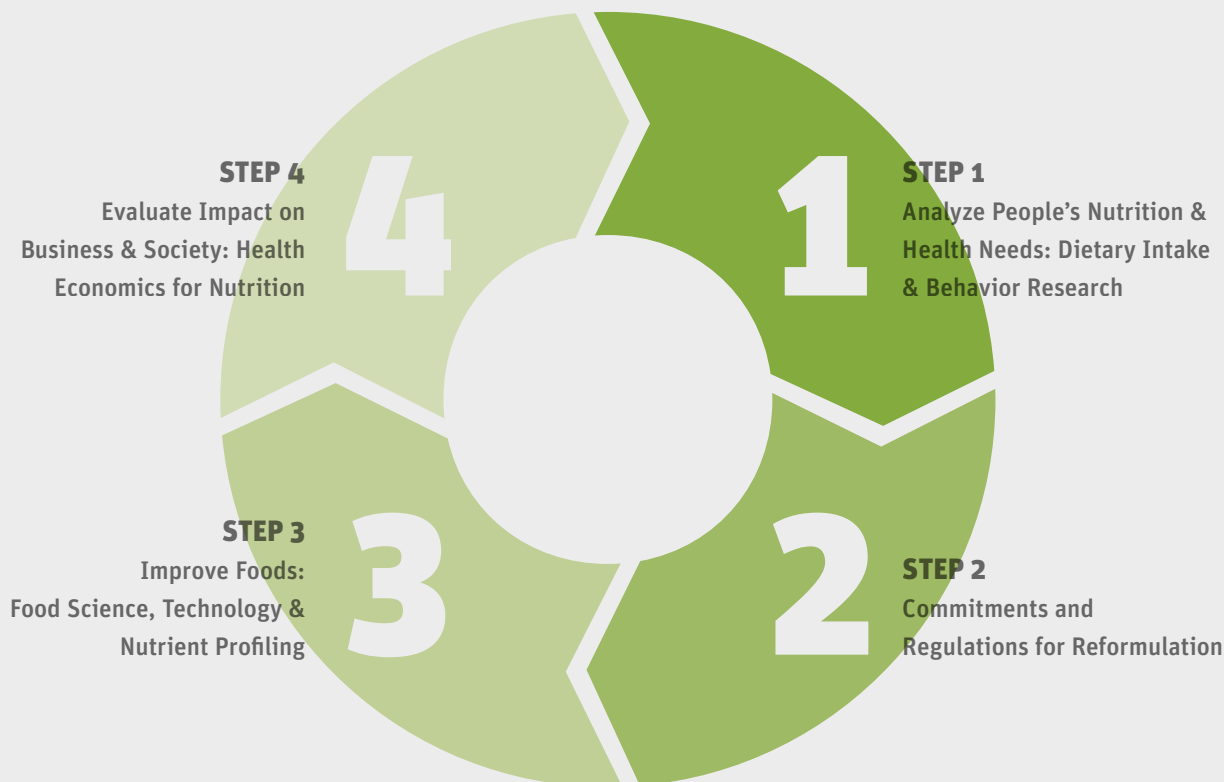
In countries of economic transition, the higher incomes of a growing middle class increase affordability of staple foods and lead to diets rich in “empty” calories. Attempts to shift consumer preferences toward nutrient-dense foods rather than energy-dense foods using labeling, fiscal measures, and social media campaigns have had limited success and impact on obesity. Obesity and malnutrition persist, as only a minority of the population is truly interested in healthy eating. Most others have different priorities concerning food, such as taste, price, convenience, family preferences, or simply other problems to deal with rather than healthy food choices – including unemployment, stress, work-life balance, health issues, disabilities, and many more. On top of all this comes the sustainability discussion, with the Sustainable Development Goals putting the focus on agriculture and nutrition – and, indeed, diets that are high in energy-dense but nutrient-poor foods have been highlighted as less environmentally sustainable.⁵ Therefore, a more realistic way forward to address malnutrition, obesity, and sustainability challenges is needed rather than trying to change population behaviors.

“A more realistic way to address malnutrition, obesity, and sustainability challenges is needed”

Reformulation – a solution?

To reformulate existing and commonly consumed processed foods can be a highly realistic approach and opportunity to improve the health of people and the health of the planet, with a substantial estimated positive impact on obesity.⁶

The reformulation of processed foods is defined as changing their content by either reducing the content of negative ingredi-

FIGURE 1: A systematic approach to manufacturing foods for better public health.

ents, such as sodium, saturated fats, trans-fats, and energy, and/or by increasing the content of beneficial nutrients, such as dietary fiber, whole grains, fruits, vegetables, and micronutrients. Reformulation is appealing because it requires the least change in dietary behavior of the consumer. Reformulating foods over time with gradual changes may minimize consumer perception and negative attitudes, if both taste and palatability are preserved, thereby keeping food purchasing and consumption patterns unchanged. The gradual reduction of ingredients that are considered “baddies” (sugar, sodium, saturated and trans-fats) would go unnoticed by the vast majority of consumers and could ultimately reduce individual intakes.⁷ But the nutritional quality of processed foods can be improved not just by decreasing the “baddies”; reformulation can also bring positive nutrients – the “goodies” such as vitamins and minerals – into diets and enable food fortification at low cost to increase nutrient density, which is the ultimate goal of the reformulation process.

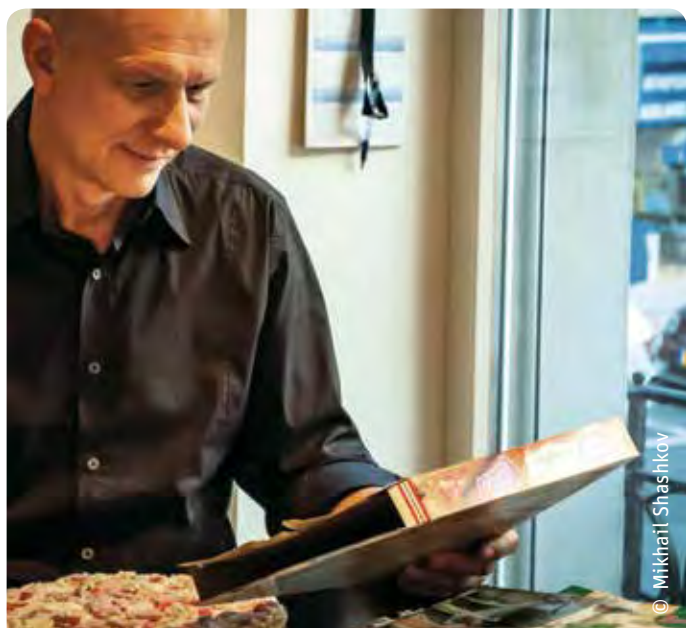
Diets – meaningful targets – nutrient profiling

But where to start and how to do it? **Figure 1** describes a systematic approach to manufacturing foods for better public health.⁸

Processed and prepackaged foods make up an important part of diets across the world, accounting, for instance, for

more than 50% of the calorie intake in the US and Germany, thus playing a pivotal role in the diets of these populations. Research on dietary intake and eating behavior provides a clearer picture of the types of foods that need to be reformulated, first through the identification of the foods that are consumed by the majority of the population and in the largest amounts. This research therefore identifies the foods for which reformulation will have the greatest impact on public health. In the US, among consumers of pizza, 36% of the daily sodium intake in the age range of 6 to 19 stems from this food item alone. With approximately 20% of US children and adolescents consuming pizza on any given day, this food item has a very high contribution to sodium as well as energy and saturated fat intakes.⁹ This clearly highlights the need for sodium reduction in this food category, as the overall sodium intake is well above the recommendations. A similar case can be made for sugar in breakfast cereals, which are often considered a healthy breakfast item by consumers.

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“Nutrient profiling is a tool to guide successful reformulation of foods”



Jörg Spieldenner: "One pizza: is that really 2 to 4 portions?"

In view of these examples, the need for a systematic approach and tools that can guide successful reformulation becomes obvious. "Nutrient profiling" is one such tool. It is described as the science of ranking or classifying foods based on their nutrient composition for the purpose of preventing disease and promoting health¹⁰ (see **Figure 2**).

Some systems¹¹ follow this approach, but nearly all of them struggle with the definition of meaningful reference values for the amount of a specific food consumed. Two examples illustrate this challenge. The serving size of breakfast cereals – between 25 g and 40 g – is defined by food producers in many countries. The actual consumption of a breakfast cereal is, however, higher,

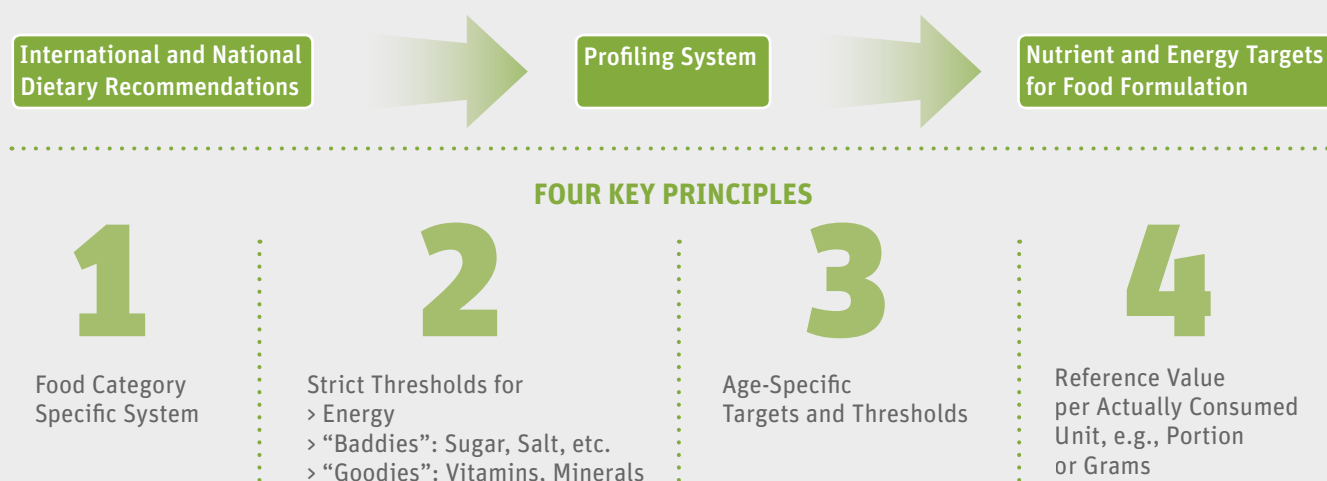
leading to a higher intake of sugar than that mentioned on the label. A more striking example is prepackaged pizza, with most labels reporting 2–4 portions per one whole pizza in a carton package. *De facto*, the pizza (300–500 g) is mostly eaten entirely by one person, resulting in an intake of salt that is severalfold higher than the labeled intake per serving.

Several regulating bodies across the globe have introduced a per 100 g reference value as a concise anchor. This may seem somewhat objective at first sight, but it does not take into consideration the reality of consumption as shown in these two examples: 100 g of cereals/serving is too much, whereas 100 g of pizza is by far too little, making this a complex calculation exercise for the consumer. This calls for clear, transparent, realistic, and binding targets for critical ingredients in critical food categories, in this case sodium and sugar, in foods with high impact on the diet, such as pizza and cereals. Such targets and standards, in combination with mandatory portion or serving sizes reflecting true consumption patterns, will make products easily comparable for the consumer and subsequently drive reformulation efforts and improved food offerings.

Technological challenges and solutions

Reduction of public health-sensitive ingredients such as sugar and salt is one of the "classic" ways to approach reformulation. The reach of this is, however, limited, as reduction alone lowers volume and weight and this is perceived by the consumer as "less for more." Some regulations may define volumes, weight, or even composition (product identity standards) in certain food categories. Possible solutions include replacement, for example of sugar with other "fillers" to keep volume and weight stable. However, fillers such as maltodextrin have similar physiological effects as sugar and are not recommended, even if permitted by

FIGURE 2: Nutrient profiling principles



most regulations. Another possibility is to change the food component itself by changing its physical structure. An interesting example is “hollow sugar,” obtained by hollowing out sugar particles so they dissolve more quickly on the tongue. This creates the perception of an almost identical sweetness as before, but with much less of the ingredient.¹²

Reduction through decreasing the particle size and effecting a different distribution in the food product or the food matrix is another approach. Enhancing taste perception through surface optimization and a more taste-sensitive positioning of the nutrient is another reduction technique. For instance, salt crystals can be placed on the bottom of the crust of the pizza so that the particles touch the tongue immediately for the perception of the salty taste. Improvement of the nutrient as such is another option – for example, sodium through a mix of sodium and potassium chloride instead of sodium chloride only, given the widespread inadequate potassium intake. Another possibility is to replace food components with similar components, as is done with the reduction of palm oil by partly replacing it with other oils or oil mixtures.

Another important reformulation front concerns nutrient absorption. Mixes of minerals and vitamins that are more bioavailable and have higher bioefficacy are being developed and tested. Regulations are still focused on the amount of the nutrient in food content claims but without taking into account its bioavailability, which can be a true game changer in fortification, particularly with iron.

Nutrition and sustainability

Reformulation according to nutritional and sustainable criteria in the spirit of sustainable nutrition is still in its infancy. Systematic evaluations of nutrition and sustainability in conjunction are still in the research and concept stage and are yet to be implemented at large scale.

In short, innovative approaches to reformulation do exist but come with a cost increase most of the time. This cost increase will generally be passed on to the consumer, who needs to be convinced to buy a better product. This means a change in the marketing approach to an intelligent way of selling a product with added nutritional and sustainability value – an endeavor that needs to be carefully balanced with silent reformulation and steering clear of the breaking point of consumer acceptance.

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“Reformulation has the potential to improve diets and thus address obesity and nutrition-related diseases”

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Klazine van der Horst: “Although perceived as healthy, cereals contain large amounts of sugar”

Conclusion: The context for a successful implementation

Reformulation has the potential to improve diets and thus address obesity and nutrition-related diseases. The impact on nutrient intake in the diet is immediate without consumers needing to change their eating habits in a profound way. However, reformulation will not replace a healthy diet, and some food products can never be considered healthy options. Only a combination of voluntary measures and regulations alongside individual behavioral changes can achieve effective dietary shifts. Voluntary reformulation based solely upon the good will of the food industry is not sufficient. Why should a food company invest in and lower its margins for better nutrient density in the absence of consumer demand or clear-cut regulation if the competition is not doing it? It is for national authorities to set regulations, creating a level playing field based on their population’s diet and nutrient-density needs. These regulations (nutrient and composition targets) need to be smart, encouraging food producers and retailers to increase nutrient density while nudging consumers to increase their purchasing of reformulated foods. Smart regulations as well as consumer demand will drive innovation and investment into the food sector that otherwise would not be generated. Research investment in food technology, behavior science, effectiveness evaluation (e.g., health economics in nutrition), and at the crossroads of agriculture, nutrition, and sustainability will foster interdisciplinary knowledge generation and innovative solutions. Certainly, a mandatory “quiet” improvement of processed foods through reformulation will create quite some noise from farmers to food manufacturers to retailers – yet it is a *sine qua non* for improved nutrition.

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Innovation and Human-Centered Design

Unlocking public health and food science for the 21st Century

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Key messages

- > Innovation is both a process and its outcomes: it transforms and implements insights, ideas, and inventions into applications that have either incremental or radical impact and hence create value for the relevant unit of adoption.
- > Innovation is challenging in general and specifically in nutrition and public health; the path from idea to impact is full of challenges and pitfalls.
- > Human-Centered Design has evolved from an approach to new product development in design firms to become the dominant philosophy and methodology for innovation and creative problem-solving across industries and sectors – and is particularly relevant to food innovation and public health problem-solving.

Innovation in public health and nutrition: strategy or cliché?

Innovation is hardly a new phenomenon in the fight against malnutrition. Undernutrition and, now, overnutrition remain some of the most challenging domains of public health – requiring novel strategies that integrate a deep understanding of the

affected populations, risk factors, and contextual insights on how interventions might “fit” and be sustained. As populations continue to grow and the urgency of meeting the Sustainable Development Goals becomes more pressing, deconstructing the science and serendipity of innovation has become more important – often taking a central role on the agenda of institutions dedicated to solving intractable nutrition and public health challenges.

The term *innovation* is sometimes considered blurry, fuzzy, nebulous and even empty.^{1,2,3} The absence of a comprehensive yet simple definition of the term, its overuse and misuse, and the hype around it have eroded, for many, its meaning.⁴ Still, we are continuously reminded that innovation is thriving when disruptive items like the incandescent bulb, barcodes, electric vehicles, or even smartphones move from science fiction to market reality.

What is “innovation”?

Plenty of attention has been given to this question in the academic literature and the media.^{5,6,7} Let us begin with a few dominant definitions of “innovation” from which we will work towards our own interpretation of the term.

- > Innovations have a substantial economic impact. An innovation is something that changes the marketplace in a profound way. The innovating organization is, therefore, likely to become the new market leader and to gain a substantial advantage over its competitors.⁸
- > Innovation is “the generation, acceptance, and implementation of new ideas, processes, products, or services.”⁹
- > Innovation is something different that has impact.¹⁰

Taken out of context, these definitions seem to focus on innovation as an “end”, that is, innovations being the end product. A deeper analysis is necessary to grasp the fact that the term

innovation is a paradox: Does innovation refer to the outcome of, or to the *process* of, innovation?^{2,11} We argue that the conceived new is not only what matters, but also the *process* which leads to the *new*. If we consider that, according to Rogers and Aderhold, an innovation is only validated when it has been *commercially* successful, defining innovation becomes more complex.^{12,13}

Johannessen and colleagues postulated that in order to isolate a useful definition and measure of innovation, it is necessary to address three dimensions of newness: *what is new*, *how new*, and *new to whom*?¹⁴ Innovation can thus be seen as “three-dimensional.”¹⁵ When explicitly specifying *what is new* (i.e., the actual result of the innovative process), many of the indicators used measure the innovative *process*, not its *outcome*. For example, the total expenditure in R&D, number of patents, or number of product launches are just proxies that have limited face value and promote a narrow view of innovation.¹⁶ To illustrate this, simply consider that, by some estimates, only about 3% of new consumer product launches generate revenue exceeding US\$50 million¹⁷ and the vast majority fall short of their original sales projections.

Incremental vs. radical innovations

If something is deemed new, the seemingly obligatory question is: *how new* is it? The answer will be proportional to how “revolutionary” or disruptive of the status quo the new is: incremental innovations usually refine the meaning of an industry by focusing on doing things *better*, within the paradigm, and are often the re-implementation of a practice seen somewhere else. On the other hand, radical innovations represent a paradigm shift: they change the course of action by forcing people to do things differently.^{18,19,20}

New to whom?

The degree of newness of the object is a relative concept because it will depend on whose opinion is solicited. Previous research suggests that it depends on what is known as the “relevant unit of adoption” – i.e., the domain/field/universe/population by which the innovation is adopted.¹⁴ Within the context of this article, the relevant units of adoption might be populations suffering from malnutrition or who have impaired access to an adequate, nutritious diet. Context, in this situation, matters deeply – given the diversity in background levels of access to what might be considered radical innovation. Information technologies, such as the mobile phone and the internet, are heterogeneous in their global distribution. Whereas over 50% of the population in most Latin American countries enjoy internet access, that percentage drops to less than 10% in several sub-Saharan Africa countries.²¹ What might be radical today in one setting is already “last week’s news” in another.

“What might be radical today in one setting is already ‘last week’s news’ in another”

What innovation is not

Having acknowledged the complexities of articulating a comprehensive, working definition of innovation, it is also important to describe what it is not.

> **Innovation is not invention.** In most cases, invention precedes innovation (because it is possible to innovate *without* inventing); however, not all inventions become innovations.¹ How many useless inventions do you know of? This is somehow expected as inventions are usually focused on technical and technological outputs, and *value creation* is often a secondary focus.¹

> **Innovation is not creativity.** Idea generation is definitely an important aspect of innovation, as ideas are the seeds from which innovations will be harvested. However, ideas must be tested for feasibility of execution, and even when feasible, aspects related to their economic viability, cost-benefit ratio, congruency with institutional values, and consumer acceptance are further hurdles that an idea must clear to demonstrate its potential for innovation.

> **Innovation is not just a process.** Methodologies and tools are obviously important to create an effective discipline and repeatable patterns for innovation. But at its core, innovation is a people-driven and people-centric phenomenon that relies on the mind, heart, soul, and creative spark of individuals and teams aspiring to create a better world.

We propose that “innovation” transforms and implements insights, ideas, and inventions into applications that have either incremental or radical impact and hence, create value for the relevant unit of adoption.

Challenges in mobilizing innovation

Notwithstanding the rapid proliferation of maternal, newborn, and child health innovation initiatives and substantial funding, innovation has yet to be fully integrated within global health. Emerging solutions rarely pass the pilot stage or else they get siloed within single organizations, unable to achieve scale and impact.²³ This is not surprising since, by definition, innovation seeks to reorder society (or sections thereof): it quickly comes into conflict with the need to maintain continuity and inevitably



Golden Rice (right) next to regular white rice.

runs headfirst into institutional inertia. Thus, the challenge and resistance to innovation is in direct proportion with the value and entrenchment of whatever the innovation makes obsolete.²⁴ Humans are creatures of habit.

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**“People are very open-minded
about new things – as long as they’re
exactly like the old ones”**

Charles Kettering

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Innovation in public health is particularly challenging, as the interrelationships between culture, politics, legislation, social habits and practices, and economics are subtle yet highly reactive to change. Many worthwhile nutritional interventions have failed to show impact not because of their intrinsic potential, but because of a lack of recognition of the above tensions. Few projects assess the potential **threat** inherent in a radical innovation. We shy away from acknowledging the beneficiaries of **dysfunction** – health system actors who benefit from low levels of scrutiny or accountability. These beneficiaries are not, however, necessarily malevolent – they may be tacitly relying on system inefficiencies to afford them financial or other advantages (e.g., per diem for travel to submit a weekly report, which may be displaced by an innovative digital data system).

The Golden Rice case: challenges and pitfalls of innovation

Golden Rice is unusual in that it was conceived in 1999 as a nutritionally enhanced food, with a biosynthetic pathway engineered to produce β -carotene in the rice endosperm. β -carotene is a vitamin A precursor, and the hope was that this novel variant of a global staple would mitigate vitamin A deficiency (VAD), which in extreme cases can cause blindness or death in young children.

Golden Rice offers an interesting case study of the challenges and pitfalls of innovation relevant to nutrition and global health. While industry representatives, scientists, and media voices argue that children are being left vulnerable to blindness or even “murdered” by Golden Rice critics, those critics counter by calling Golden Rice a foreign, overrated and misguided technology and a “Trojan Horse” meant to promote genetically modified crops in low- and middle-income countries (LMICs).^{26,27,28} Opponents have at times resorted to fear tactics by questioning its safety, while advocates have not always shown due appreciation for the local contexts – with their social, agricultural, economic, and cultural dimensions – which this innovation is designed to benefit.

Although Golden Rice may yet improve nutrition outcomes in LMICs in the long run, possibly aided by the growing recognition of the role biofortification can play in addressing micronutrient deficiencies, significant challenges persist. Consumers in many cultures have a strong attachment to the organoleptic properties of the rice they are used to consuming and may resist the idea

of consuming rice of a different color.²⁹ Questions remain about β -carotene retention over long storage periods and cooking, given its sensitivity to oxygen, light, and heat.³⁰ Last but not least, competing approaches to address VAD might ultimately prove more cost-effective, even in countries where rice is a primary staple.

Human-Centered Design: a potential game-changer in public health nutrition

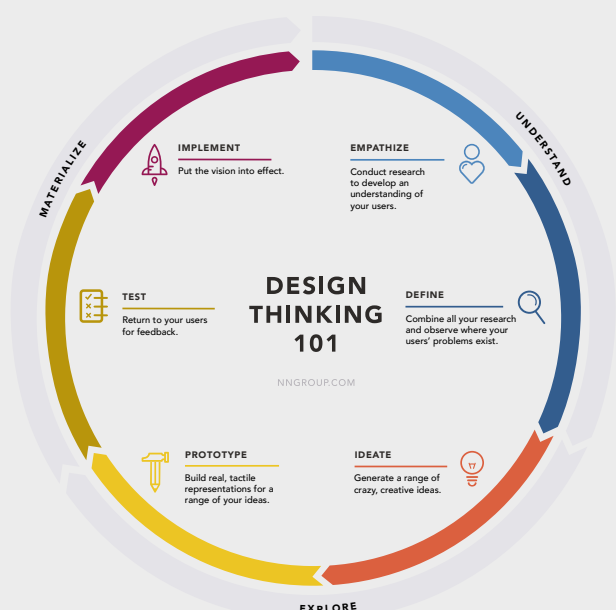
Because public health interventions inherently rely on human interactions at multiple levels in their design and implementation, any innovative solution-finding approach that places humans at the core of its process can thrive in the public health space. One such approach, Human-Centered Design (HCD) or Design Thinking (DT), was developed in Silicon Valley by designers who are credited with creating many of the naturally intuitive and compelling products that have revolutionized how consumers live – from something as simple as the first usable computer mouse to the precursor of the modern laptop computer.^{31,32} One proposed model suggests that the process consists of empathizing, defining, ideating, prototyping, testing and implementing (Figure 1); another argues that it consists of inspiration, ideation, and implementation.^{33,34}

Whereas qualitative research may be used in the context of a large-scale field trial to assess the acceptability of an intervention to increase adherence, HCD proposes that these methods should inform the design of the intervention itself.³⁵ Interviews and observations paint a picture of how stakeholders operate in their environments and how they perceive or interact with the problem being studied. In many circumstances, stories may reveal more about a problem than responses to structured interview questions. This multidisciplinary, predominantly qualitative process uncovers different angles that complement each other and create a holistic picture of a problem in its native context.

The qualitative nature of HCD is specifically aimed at understanding how consumers interact with a given problem, in their natural context; findings are then synthesized and common themes emerge. A critical point of the process is to translate themes into insights – statements that precisely identify the challenges and tensions that make up the design problem, and to flip insights into the opportunities that guide the right ideation process.^{34,36} These insights are incredibly valuable because they often generate non-obvious, relevant avenues for intervention that inform the development and implementation of other interventions beyond the minimum viable product or the original problem definition. An ideation stage is then entered to generate possible solutions (while also withholding judgment) and a rapid prototyping process then produces low-fidelity tangible manifestations of such solutions.³⁴ As prototypes are tested, feedback informs future, higher fidelity, generations of prototypes.³⁴ This process is illustrated in Figure 2. In terms of improving nutrition maternal and child nutrition in resource-poor settings, such an approach can be used, for instance, to design micronutrient supplements for pregnant women, or develop culturally-appropriate strategies to promote and facilitate exclusive breastfeeding.

HCD has evolved from an approach to new product development in design firms to become the dominant philosophy and methodology for innovation and creative problem-solving across industries and sectors. HCD is particularly relevant to food innovation given the deep contextual and sociocultural aspects of food, as well as its complex attribute patterns and the multiple roles food plays for consumers.³⁷ The public, social, and academic sectors stand to become more effective in their innovations for health, socioeconomic, and environmental impact as they fully incorporate HCD in their worldview and practices.

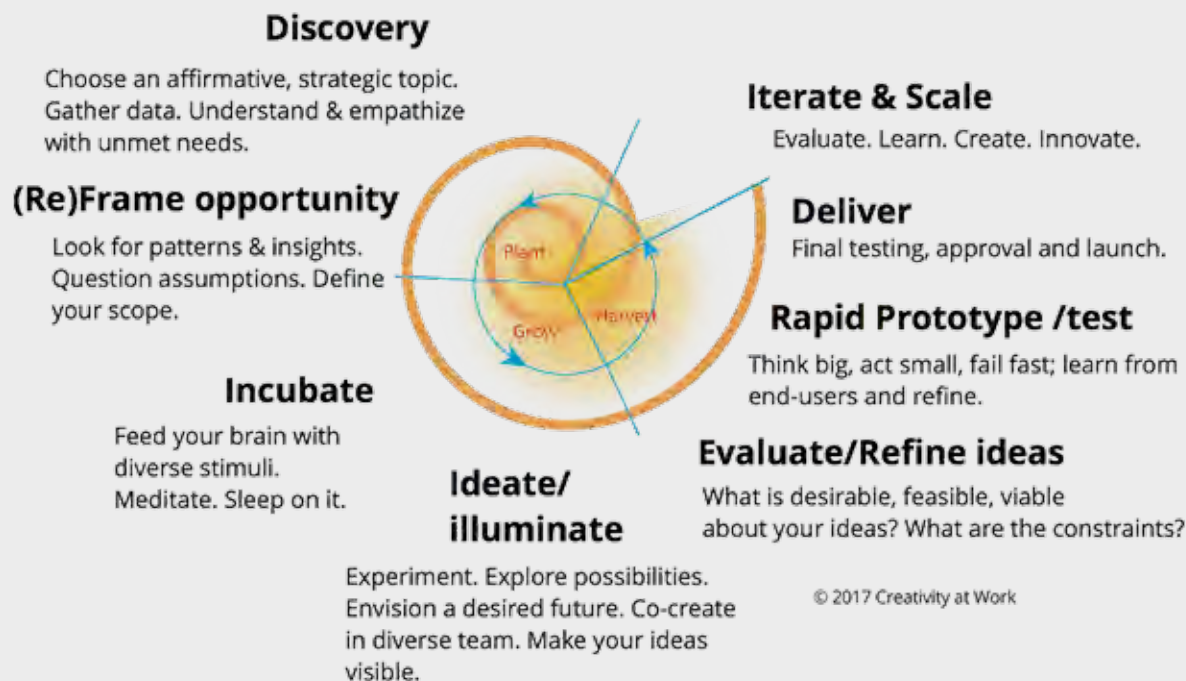
FIGURE 1: A cyclic framework of Design Thinking proposed by XYZ



Source: Gibbons S. Design Thinking 101: Nielsen Norman Group; 2016 (4 June 2018).

Available from: www.nngroup.com/articles/design-thinking/ (as per reference 33).

“Human-Centered Design is a highly relevant approach to public health problem-solving”

FIGURE 2: The iterative process of Human-Centered Design

Source: With permission from Linda Naiman © 2016 CreativityatWork.com

HCD is, in particular, a highly relevant approach to public health problem-solving. Global health programmers remain frustrated by the slow pace of adoption of proven innovations, of solutions of known efficacy. Despite growing mountains of data, evidence-based practices seem to take years, if not decades before they are mainstreamed – especially in populations where these practices are likely to have the greatest impact. Scaling up innovations is unquestionably a complex problem – with challenges that range from enabling policy to financing. However, the imperative of a systematic, scientific approach to understand and incorporate contextual and human factors at the very earliest stages of problem-solving and innovation is addressed by this emergent, formal approach. Although earlier incarnations of formative research (e.g., participatory development, embedded design) may seem similar, today's HCD offers to the public health world systematic tools and processes that have been honed over decades in the private sector. Like their commercial counterparts, public health innovations should seek to be not only feasible and viable in the context they are to be deployed, but also **desirable** by those who are to use and benefit from the interventions being proposed.

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New Maps for Healthy Dietary Trajectories and Food Product Innovation

A Perspective

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Key messages

- > The food world is going through a period of intense innovation driven by the burden of malnutrition and changes in consumer demographics, preferences, and knowledge.
- > Food product developers and consumers can both benefit greatly from approaching nutrition as a journey that should balance five principles: convenience, health, experience, function, and sustainability.
- > Tools such as the Nutrient Balance Concept enable one to map one's dietary trajectories to ensure a healthy diet that meets all of these five principles.

Crisis fuels innovation

The food world is in crisis. On the one hand, we are seeing an increase in the double burden of malnutrition in populations through undernutrition and obesity, with their co-morbidities of type 2 diabetes, cardiovascular diseases, cancers, and cognitive impairments causing public health concerns. On the other hand, shifts in demographics (aging populations), changing consumer trends (preference for fresh, local, and organic foods), and access to new nutritional knowledge (health claims, health impact of disqualifying nutrients – see **Box 1**) have opened up gaps between necessary food solutions and existing product offerings. This crisis primes the food world for disruptive innovations.

Food start-ups have sprung up everywhere. The surprising rush of Silicon Valley's venture capital into food projects led this wave, which peaked at US\$5.7 billion in investments in 2015, a dramatic surge from US\$288 million in 2013.¹ As a consequence, the big players in the food industry have woken up to this trend. They began to increase their investments by harvesting early-stage start-ups with new ideas.² Despite their drive for disruptive innovations, food start-ups still create their solutions focusing on the supply side of the problem space. They follow the ingrained thinking that consumers do not find the right products for healthy diets. They search for novel ingredient solutions, such as cultured meat. They employ digital technologies, machine learning, and data science to increase convenience and ubiquitous access to food (e.g., home delivery, personalized recipes).

Nutrition is a journey

Single-product or single-service solutions miss the *time* domain of health and disease. Metabolic deregulation grows over time through the repeated consumption of nutrient-poor food products. Consumers have trouble with nutritional labels because buying food involves more than comparing different lists of ingredients. Current initiatives are still sticking to the single-prod-

BOX 1

- > **Qualifying nutrients** are essential nutrients that must be provided by the diet, since the human body cannot produce them. They must be consumed in amounts equal to or above the daily recommended requirements to avoid malnutrition.
- > **Disqualifying nutrients** are those that have a negative health impact when regularly consumed above the daily maximal reference values (for reference values see Fern et al).⁴



Consumers need more help in navigating their way toward healthy diets

uct profiling paradigm. “Traffic light” labels are supposed to help the consumer make healthy choices. However, traffic lights regulate the orderly crossing of waypoints but not the planning and completion of a voyage.

Consumers are responsive to five food design principles: Convenience, Health, Epicurean/experience, Function, and Sustainability. These C.H.E.F.S. principles translate all other product attributes into decision criteria for the consumer. The C.H.E.F.S. principles are distinct by virtue of their inseparable interconnectedness. Favoring one principle will implicitly affect all others. The experience of the last 50 years pushing convenience and taste over health proves this point. Moreover, consumer trends and new nutritional knowledge have increased the need to place the health design principle at center stage. The insight that food, not ingredients, is the fundamental unit of nutrition supports this notion.³

“Food, not ingredients, is the fundamental unit of nutrition”

If we take the C.H.E.F.S. principles seriously, we need an approach that enables product development guided by the health principle and empowers the consumer to respond to the design appropriately. However, the demands of each side are different. While the product developer is interested in how the product fits a high-quality diet, the consumer needs feedback on what the food will do to him or her. Both demands can be satisfied by an analogue of a “Google Map” for diets. There is a need for a pre-

dictive tool assessing the quality of food trajectories composed of repeated meals and products.

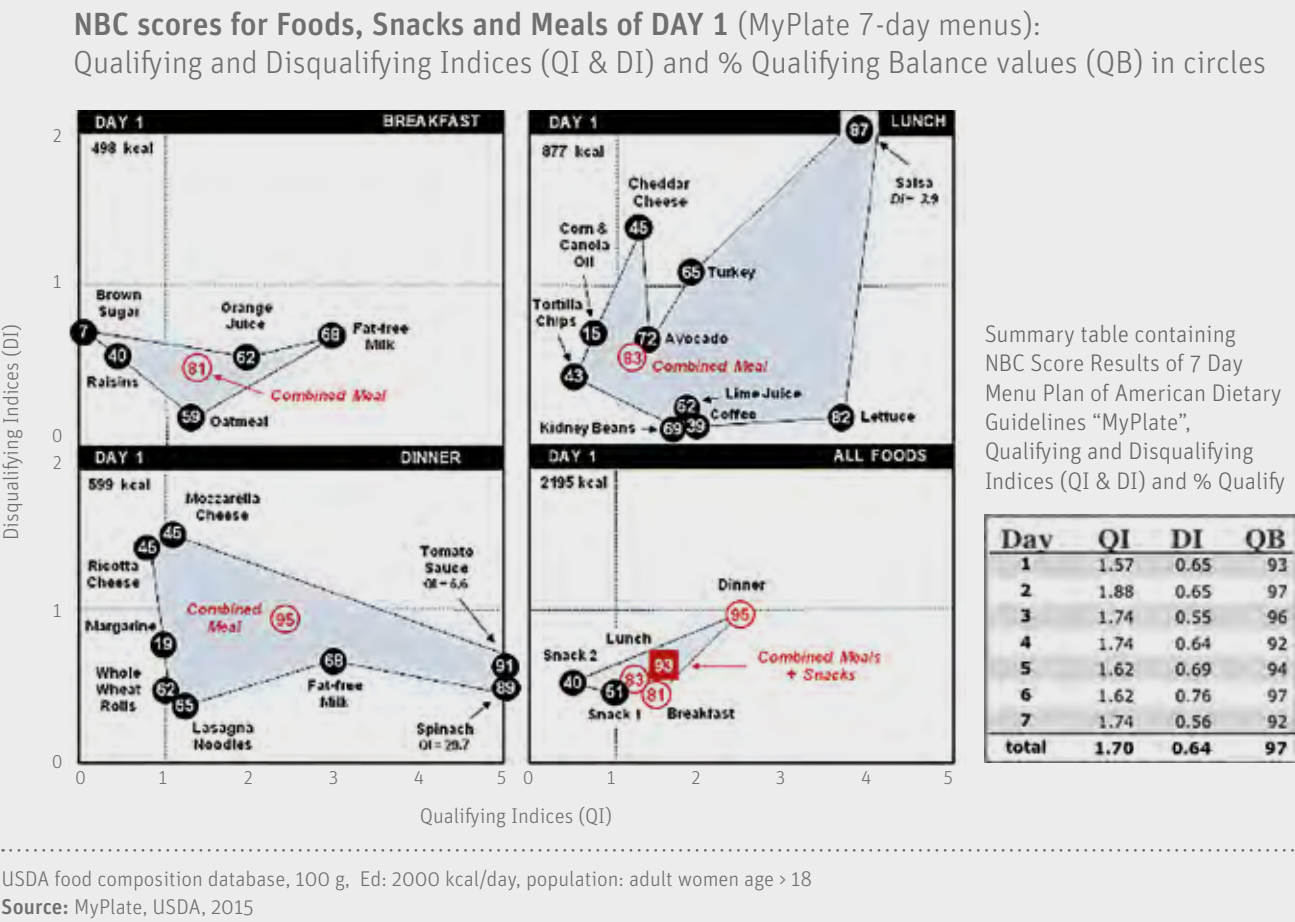
Using the Nutrient Balance Concept to chart dietary trajectory

To envision this type of nutritional chart, let us apply the Nutrient Balance Concept (NBC) to a weekly diet.⁴ This exercise combines both demands: finding adequate food items and seeing how they fit together into a high-quality diet over seven days. Using the American Dietary Guidelines⁵ and the MyPlate



Consumers are responsive to five food design principles: Convenience, Health, Epicurean/experience, Function, and Sustainability

FIGURE 1: NBC applied to the American Dietary Guidelines “MyPlate” covering meals for seven days



7-day menu⁶ allows us to follow such a dietary trajectory toward high-quality nutrition.

Figure 1 presents the first day of the seven-day diet. We see the three main meals (breakfast, lunch, and dinner) charted onto the qualifying/disqualifying index chart. The indices describe the coverage of essential (qualifying or “good”) and public health-sensitive (disqualifying or “bad”) nutrients against the energy contribution of every single meal component. The reference values are only valid for a given population (female, aged over 18 years, daily energy needs of 2,000 kcal). The vertical line at 1.0 of the qualifying index marks the sufficient coverage of essential nutrients.

The charting of the meals creates strange-looking areas. The position of a resulting meal for both types of nutrient resides in the interior of those shapes. The red circle sits at the location of the meal’s qualifying and disqualifying indices. The numbers inscribed in the circles express the qualifying balance, meaning how fully the essential nutrients fulfill the minimum requirements (in %). For the list of nutrients, the term definition, calculation of the indices, and selection of reference values, see the article by Fern et al.⁴

The graph in the lower right corner collects the results from the three meals and snacks. Following the meals step by step (breakfast through dinner) creates the dietary trajectory circling the final nutritional quality of the day. We also see that the qualifying balance steadily increases to reach 93% after dinner consumption. Most importantly, the two snacks have “diluted” the high result of the day through their low balance contributions. Another interesting observation is the result of the proposed lunch meal. The salsa sauce has a high qualifying index (good coverage of essential nutrients), while at the same time carrying a substantial trade-off in disqualifying index (mostly due to fat and salt). On the other hand, it exhibits the highest qualifying balance (87%). However, the combination of all meal components brings the final meal result to an acceptable value (QI≈1.2, DI≈0.7, QB≈83%). The table at the bottom right of Figure 1 summarizes the whole week.

Aligning food product developers and consumers

Many of the meal components in the Dietary Guidelines for Americans are processed foods. A product developer would be interested in seeing how an improvement of the product will im-

prove the overall meal. A consumer could use the trajectory to select a suitable product to enhance the whole dietary path. The two efforts – to make a product nutritionally better and to determine the best product within a dietary trajectory – will converge under such conditions.

“NBC analysis can be applied to whole databases to yield insights about the general nutritional quality of the available products and ingredients”

An exciting aspect of NBC analysis is the fact that it can be applied to whole databases to yield insights about the general nutritional quality of the available products and ingredients. Such a study establishes the basic food basket from which the consumer can choose. Moreover, NBC allows combining other indicators like environmental life cycle indicators to assess si-

multaneously the dietary quality and the environmental impact of food systems and markets.^{7,8,9}

Figure 2 summarizes the position of food groups in the Danish food composition database. The NBC scores spread across a large area of qualifying and disqualifying values. It is clear that there is a trade-off between nutrient-rich and energy-rich food items. The wide range of qualifying balance values (inside the circles) indicates that only a high diversity of foods can together generate a high-quality diet. Confinement to specific groups reduces the possibilities for achieving high nutritional quality.

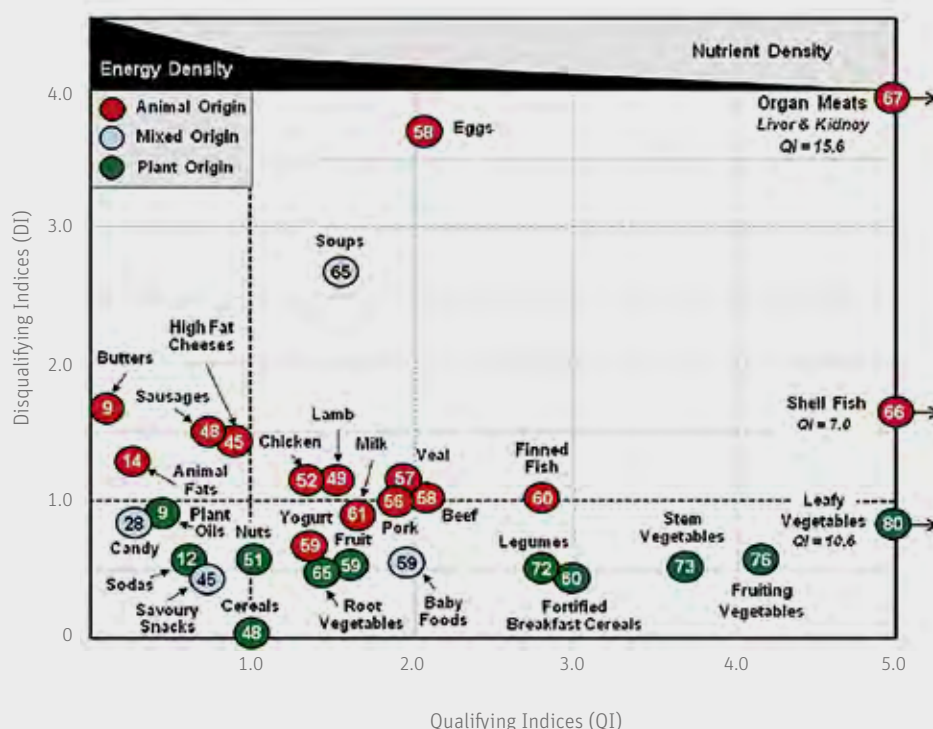
Using NBC to ensure adequacy of specific nutrients

The NBC examples presented thus far use the entire set of essential nutrients to determine the quality of an ingredient, a product, a meal, or a diet. However, specific micronutrients play crucial roles in degenerative diseases associated with aging and cancer.¹⁰ Systems nutrition has established a link between particular micronutrients and chronic diseases through cofactor-protein-gene network analysis.¹¹ This fact highlights that micronutrients also play a specific disease-related role besides their role in the efficient running of metabolic processes.

FIGURE 2: Distribution of qualifying and disqualifying indices of selected food groups from the Danish food composition database

NBC Scores for familiar food groups.

Qualifying and Disqualifying Indices (QI & DI) and % Qualifying Balances (QB) values in circles

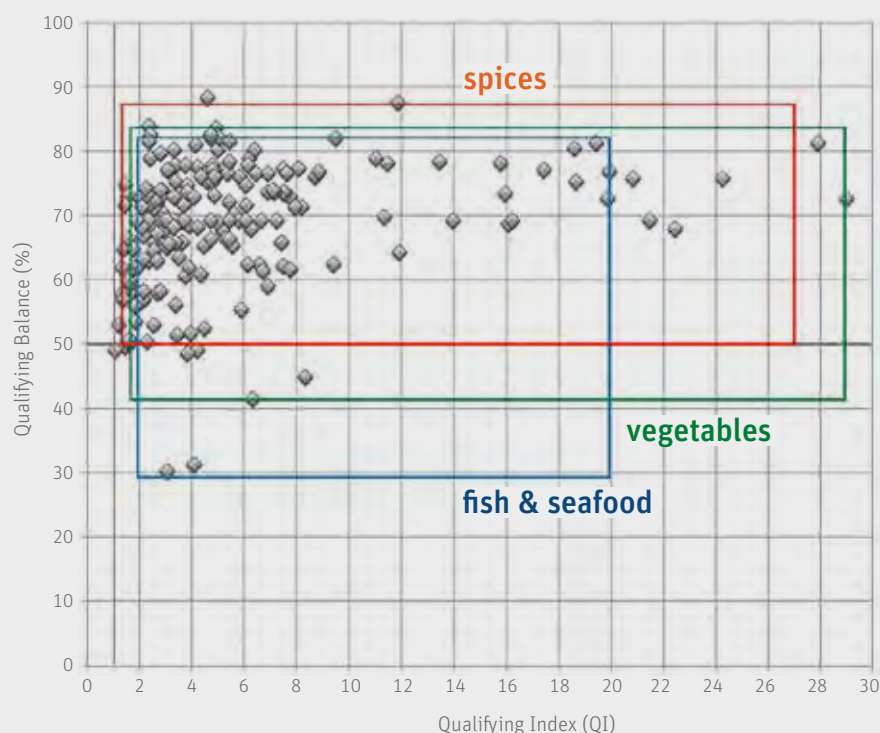


Danish food composition database, 100 g, 2000 kcal/day, population: adult women age > 18

Source: DTU National Food Institute, Technical University of Denmark, 2009

FIGURE 3: Comparison of qualifying index versus qualifying balance for 211 food items from the French food database ANSES_CiquaL_2016

Food Items containing cofactor micronutrients having $qi_{cfm} \geq 1.0$ (Qualifying Index (QI)) versus Qualifying Balance (QB) values in %



French food composition database - ANSES_CiquaL_2016, 100 g, 2000 kcal/day, population: adult women age > 18

Source: © H. Watzke, Lausanne 2018.

“We can use this new knowledge to establish a ‘foundational food basket’”

We can use this new knowledge to establish a “foundational food basket,” as it were, in which we collect food items providing a steady source of optimized nutrient coverage. Scott-Boyer et al.¹¹ have established a list of 11 minerals and 13 vitamins in their systems-nutrition work that links to 15 chronic diseases ranging from obesity to inflammatory bowel disease to arthritis. For illustration purposes, we have chosen 6 minerals from the list of the 11 appearing in their network analysis: calcium, copper, iron, magnesium, manganese, and zinc. Additionally, we have selected 5 vitamins from their vitamin list: vitamin C, B₁, B₂, B₅, and B₆. Deficiencies of all these micronutrients are strongly related to chronic diseases.

Figure 3 presents 211 food items from the French food composition database ANSES_CiquaL_2016 that contain this subset

of micronutrients with higher amounts per kcal than required. Moreover, their qualifying nutrient index values are all above a value of 1.0. Interestingly, their qualifying balance is higher than 50% for the vast majority of the items.

The inserted boxes indicate the major food groups bearing the complete set of cofactors. It might not come as a surprise that the foods (raw and cooked vegetables, herbs, spices, fish, and seafood) are all part of the Mediterranean Diet. Searching for complementary food groups (for examples meats, dairy products, and cereals) would further improve the qualifying balance of the final recipes. This “food basket” creates a source of meal components assuring a high qualifying balance close to 100%. As a bonus, these micronutrients are essential for the fight against chronic diseases and aging.

Conclusion

In this perspective, we have argued that we need to map our dietary trajectories to ensure a healthy diet. NBC allows predictive analyses of recipe variations and records the cumulative values of the nutritional journey. The two-dimensional



We need to map our dietary trajectories to ensure a healthy diet

charting of the qualifying and disqualifying values enables one to steer clear of poor diets.

NBC can be a powerful tool for food product innovation and healthy nutrition. Using NBC analysis, food developers can check the nutritional fit of their product for a balanced and healthy diet. Furthermore, NBC-supported recipe developments can be envisioned in the food service sector. Consumer applications supporting quality food choices and eating patterns can enable alimentation along a healthy dietary trajectory. The fact that energy intake is a reference for index calculations makes the NBC concept useful for weight management applications. It is also relevant for ensuring an optimized coverage of essential nutrients.

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Network-centered Innovation to Fuel Food System Change

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The journey of a single grain of rice

A single grain of rice seems so simple, but zoom out to a terraced field of rice paddies and you start to see the complexity of food and its interconnectivity with every component of our lives.

At LAUNCH, we are working to understand how the puzzle pieces within and around our food system interact. To create the food system of the future, one that is healthy, sustainable, and just, we challenged ourselves to create a worldwide network anchored and inspired by cutting-edge innovations.

Our story is not about rice – but the journey of a single grain can demonstrate how a change in our food system impacts climate, water, energy, politics, culture, global markets, and more.

For over a thousand years, the farmers of the terraced fields pictured here have relied on an irrigation system that funnels rainwater from the hilltop forests down to their fields. Imagine what would happen if the amount of annual rainfall continued to decrease, or if the hilltop forest were clear-cut for livestock or palm oil production. Water scarcity might lead to consecutive poor harvests, which could cause food insecurity, economic instability, and often, as a result, mass urban migration.



Rice Farmer in Batad, Philippines

A minor change within the food system can have massive implications. An increase in urbanization can alter what customers demand from multinational food companies, add stress on a government's health care system, and create additional environmental stress.

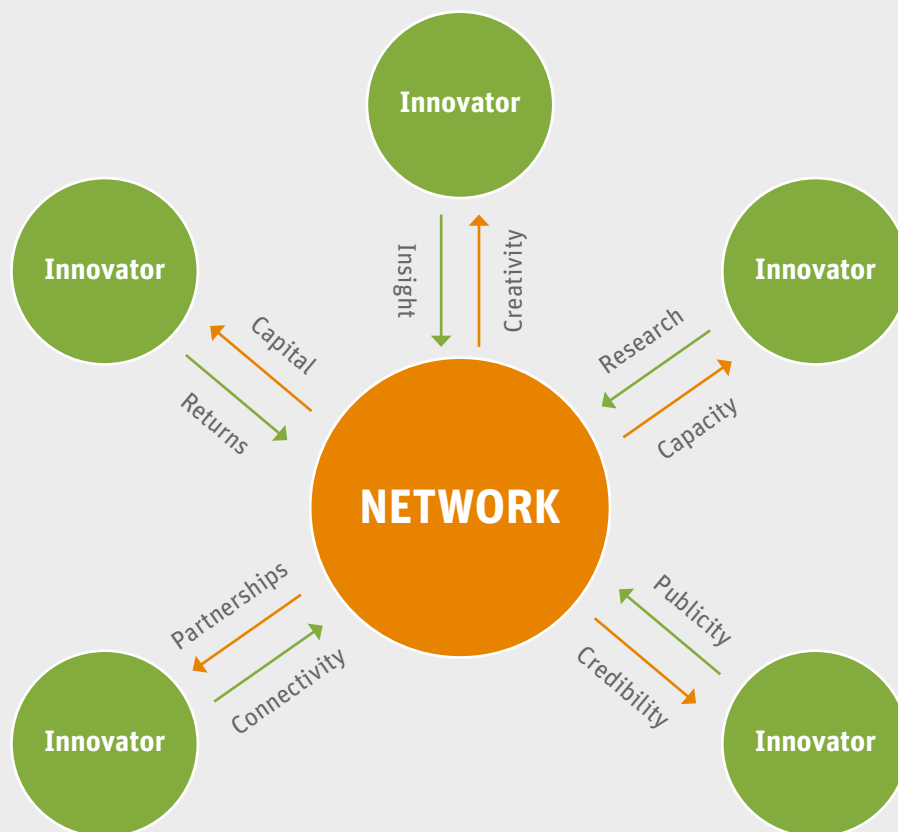
LAUNCH was constructed to source and accelerate solutions to the challenges faced not only by the rice farmer, but also by the institutions, governments, and companies surrounding them. Many of the innovations that we need in order to adapt to the current challenges and opportunities of our food system already exist. In the first year of working to improve global food systems, LAUNCH sourced 280 of these innovations. Our key challenge is not to source more innovations, but rather to capture the full potential of existing ones.

“Many of the innovations that we need in order to adapt to the current challenges and opportunities of our food system already exist”

LAUNCH

Network-centered innovation is the backbone of LAUNCH. Ten years ago, the LAUNCH platform was developed in partnership with NASA, Nike, USAID, and the US State Department, motivated by the shared belief that understanding and tackling the world's greatest sustainability challenges requires unprecedented coordination and cooperation. At LAUNCH, we have found that innovation is a valuable fuel in fostering a safe, creative, and collaborative environment to unite different actors with a common cause.

Another key ingredient of the LAUNCH process is aligning economic actors in a collaborative orientation. We have witnessed LAUNCH innovators transcend market pressures to compete with each other, opting to coexist instead. Where effort was previously dedicated to competing, we help in recapturing and enhancing each other's efforts, resulting in higher potential for innovations and greater systemic efficiency. LAUNCH innovators have opted to work side by side with potential competitors within their cohort to create “collaborative

FIGURE 1: Network-centered innovation

equilibriums” that have proved beneficial to both the individual company and the ecosystem as a whole.

The agriculture and food sector carries inherent risks that may prevent the investment gap between it and other sectors from ever closing. If investors do continue to shy away from the sector, it will be even more critical that we look to new models like network-centered innovation and collaborative equilibrium to support food system innovators.

Fostering network-centered innovation

The current innovation space is driven largely by individual players focused on predetermined outcomes that deliver benefits for a few, elite beneficiaries. Innovation has not traditionally focused on improving things; it has largely been about winning in the market. This kind of innovation is inherently limited and limiting: it is not designed to meet emerging global challenges that are by definition too complex to be understood, resourced, and addressed by any one individual actor.

However, if framed from a broad enough set of perspectives, “innovation” – the process of introducing new ideas products, services, and methods – still carries the potential to impact these global challenges. Imagine a network focused on collectively incubating innovations that could help all of humanity. What

LAUNCH has created is a collaborative process that promotes innovation as a catalyst for transformational change, attracting and aligning a network in support of a common challenge.

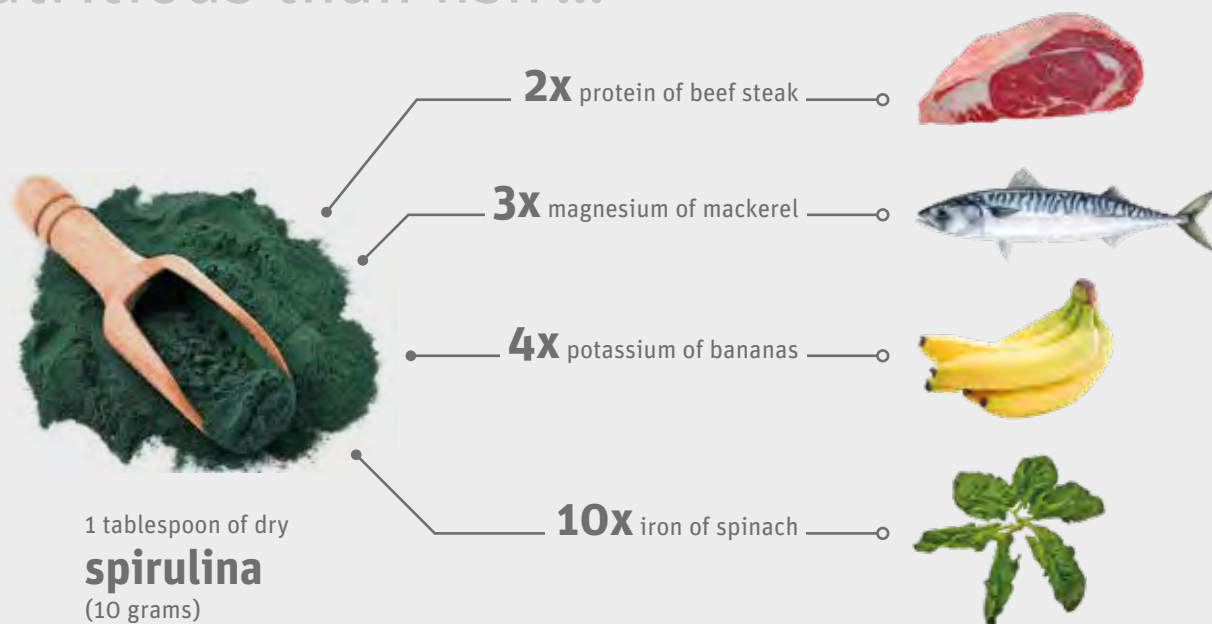
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“Imagine a network focused on collectively incubating innovations that could help all of humanity”

Network-centered innovation uses innovation to convene and align diverse networks to act collectively. This need for network collaboration is especially evident when addressing development challenges, which are expressed locally but often have global dependencies and ramifications. The idea that development challenges somehow sit outside the domain of business is a fatal fallacy. Supply chains, especially in food, are truly global, and the way we source and deliver products around the world is not separate from the development agenda: it is the development agenda.

Network-centered innovation recognizes that innovation can come from anywhere and anyone, and considers the voices of beneficiaries to be as valuable as those of powerful organiza-

FIGURE 2: Nutritional benefits of dried spirulina

By growing something more nutritious than fish ...



© EnerGaia

tions. It reduces costs and risks because it connects ideas with resources and generates the momentum and commitment necessary for innovations to succeed. In network-centered innovation, the network is a critical innovation in itself. The network, a collective of people empowered to drive transformational change, is a pipeline through which multiple innovations, ideas, and partnerships are generated. We believe that networks are the way to solve the most pressing challenges of our time.

“We believe that networks are the way to solve the most pressing challenges of our time”

Case study: EnerGaia

The Blue Economy Challenge (BEC), modeled after LAUNCH, brought together unlikely partners from across the Indian Ocean for ideas that would change the relationship between seafood and ocean health. Winning BEC Fellow EnerGaia entered the program with five years of experience operating their innovative spirulina production system across rooftops in Bangkok. Their system produces a healthy and sustainable food source while avoiding the negative environmental impact caused by tradition-

al open-pond spirulina production. EnerGaia’s rooftop spirulina was being used as a primary ingredient in pastas and chocolates, but the company was more concerned with the population at the base of the pyramid, who were already facing the brunt of the inequality within our food system. EnerGaia envisioned taking their growing systems from rooftops to communities where spirulina could enhance local livelihoods and improve the global food supply chain.

The company was already on track for success before participating in LAUNCH’s network-centered innovation process. What changed for EnerGaia was the speed with which they could reinvent their company and the impact they had on other institutions. Over the course of the BEC Accelerator, EnerGaia partnered with NGOs, donor groups, and aid agencies to introduce a new contract farming model particularly tailored to women farmers in rural areas of South and Southeast Asia. These farmers started growing spirulina, which provided a supplemental source of income as well as a nutritious source of food. As illustrated in **Figure 2**, 10 g of dried spirulina has twice as much protein as a beef steak, four times the potassium of a banana, and ten times the amount of iron found in spinach.¹ By strategically increasing spirulina production, EnerGaia’s impact is now demonstrated by improved regional food security, a reduction of spirulina’s environmental footprint, and additional economic opportunities for smallholder farmers.

Network-centered innovation is not a simple one-way street; more accurately, it is a complex interconnected series of high-ways. In the process of supporting EnerGaia, the BEC network, made up of more than 800 individuals, was tinkering with how they could integrate EnerGaia's innovation into their own work. Major noodle-makers started to think of new spirulina lines, fair trade organizations initiated the first steps for spirulina certification, and at the United Nations Environment Programme (UNEP), Donna Kwan connected the dots between spirulina and the dugong conservation program she manages.

The beauty of emphasizing innovator support that goes beyond providing capital is that creative collaborations emerge. Donna Kwan met with Saumil Shah, the founder of EnerGaia, at the BEC Kickoff Summit. Over the four-day summit, Donna and Saumil designed an initiative for UNEP's program in Southern Thailand. Economic and food insecurity were driving local fishermen to hunt the endangered dugong. Donna believed that engaging the fishermen as contract farmers for EnerGaia would provide a necessary alternative to dugong poaching. The web of collaboration went one step further. Together, Donna and Saumil brought in a local hotel to participate in the conservation initiative and start utilizing spirulina in their restaurants.

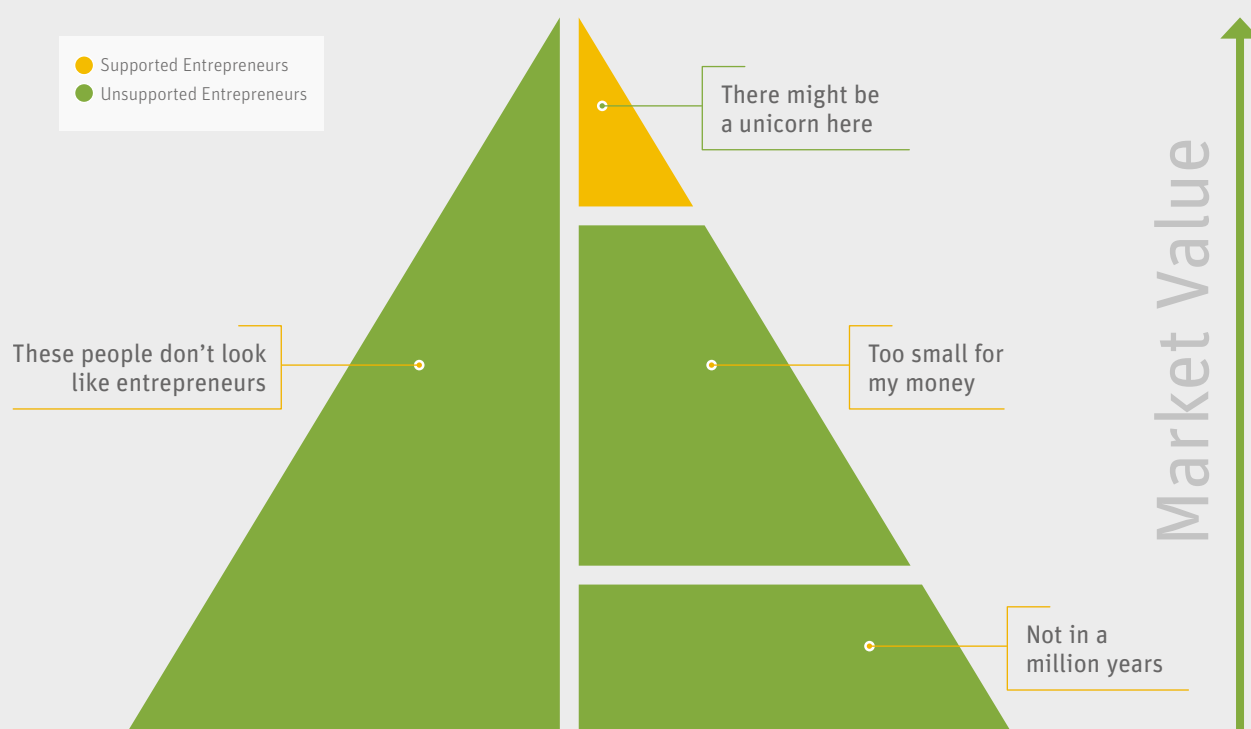
“Entrepreneurs are arguably the most important protagonists in spawning innovation in an economy”

Creating collaborative equilibrium

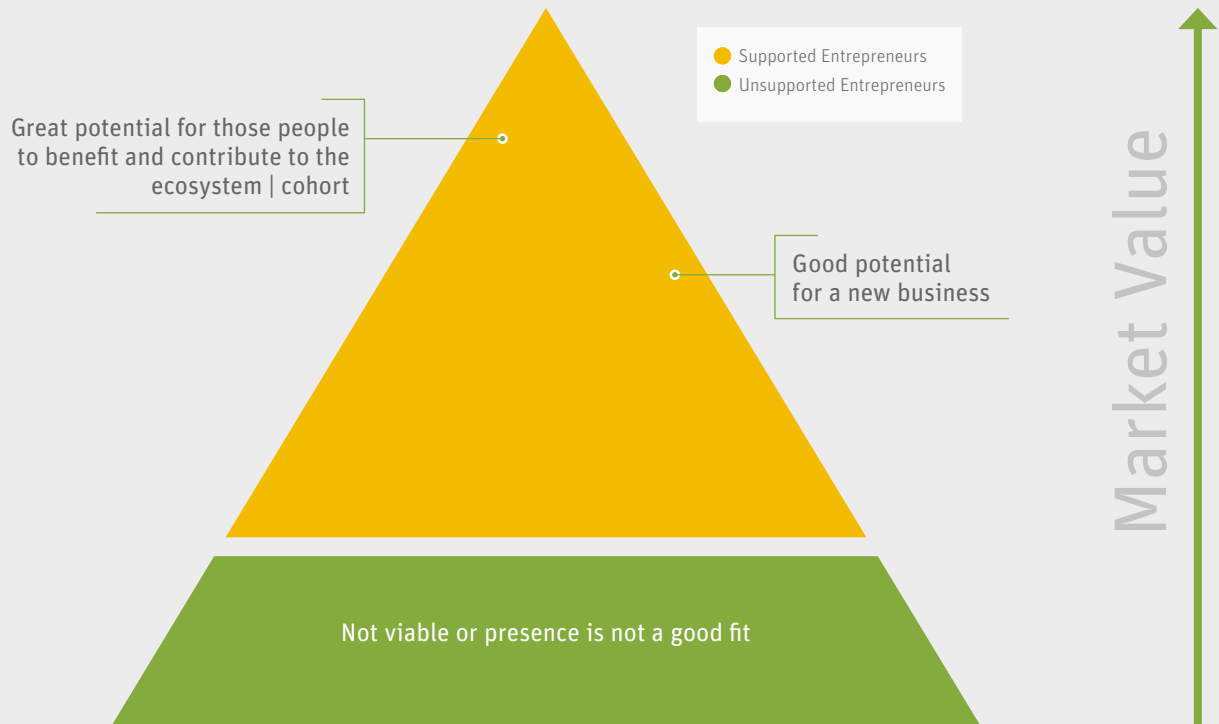
Entrepreneurs like Saumil are arguably the most important protagonists in spawning innovation in an economy. They are also the most economically vulnerable innovators and are conditioned to compete with one another for survival. In conventional economic arrangements, they are required to expend substantial resources – time, strategy, and capital – defending their position and dominating or even undermining their competitors.

Although economies have benefited tremendously from this competitive equilibrium, which has spawned numerous large-scale, highly profitable enterprises, competitive equilibrium is structurally limited. Its beneficiaries are not the generality of entrepreneurs, but a small handful who survive the crucible of innovation. **Figure 3** shows that this structure arbitrarily excludes those who cannot afford to take on significant personal financial risk or do not have access to the right networks, as

FIGURE 3: Landscape model visualizing the exclusive nature of a competitive equilibrium



Only a small percentage of entrepreneurs fit a mold and have the prerequisite knowledge and skills to receive traditional support.

FIGURE 4: Landscape of opportunities for an entrepreneur in a collaborative equilibrium

In contrast to **Figure 3**, the landscape of opportunities for an entrepreneur in a collaborative equilibrium is much greater. Economies and sectors flourish when the number of thriving, interdependent businesses increases.

well as those who have to acquire business acumen through their own efforts rather than as part of their knowledge capital endowment from birth.

Interdependence over independence

Collaborative equilibrium is founded on the hypothesis that maximizing the interdependence of businesses both with each other and with the broader social and economic context is what leads to thriving economies (**Figure 4**). Competitive equilibrium, by contrast, seeks to establish and maintain maximum *independence* of individual businesses in order to consolidate economic power.

Collaborative equilibrium focuses on nurturing the entrepreneurs themselves. We posit that economies flourish as the number of thriving businesses within an interdependent ecosystem increases, regardless of their size. This requires minimizing friction in the exchange of knowledge, ideas, goods, and services within a local context, while maximizing the agency of entrepreneurs. Instead of priming them to engage in a battle for survival, entrepreneurs are instead seen as indispensable agents of innovation, knowledge, and investment, enhancing their capacity both individually and collectively. Investing in

the human and social capital of entrepreneurs as the basis for innovation is, at its core, a resilience strategy: when an individual venture fails, this does not spell the demise of the entire sector, and the capacity developed in the interim is retained by the ecosystem and can be redeployed.



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“We posit that economies flourish as the number of thriving businesses within an interdependent ecosystem increases, regardless of their size”

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LAUNCH innovators

Even before we started to build programs around collaborative equilibrium, we saw our hypothesis play out organically within the cohorts of LAUNCH innovators. A cluster of companies working on alternative fish feeds (both plant- and insect-based) worked together to raise awareness, as well as capital, for the subsector. A group of four companies, producing ingredients ranging from coffee flour to cricket powder, started a monthly meeting in which they shared best practices and ideated around a joint product to pitch to consumer product companies. Now, with more intentionality around fostering collaboration, we have been able to go to scale. In New York City, through SecondMuse's Futureworks program, 85 companies are interconnected in the common pursuit of building up the city's advanced

manufacturing and hardware sector. Our ambition is to replicate Futureworks's collaborative equilibrium model for sectors like aquaculture, alternative proteins, and green technology, starting in Indonesia and quickly expanding to Vietnam, Tanzania, and across the United States.

Never before have we had the knowledge, technology, and capacity to solve the world's most pressing problems. Through innovation, and the collaboration that it can fuel, we have the ability to create the food system of the future – one that is healthy, sustainable, and just.

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Enabling Entrepreneurship in Nutrition

The fuel to feed 9 billion in 2050

Simone K. Frey

Nutrition Hub, Berlin, Germany

Key messages

- > A new generation of entrepreneurs is driven by shaping how we produce, sell, and buy food.
- > Various venture capital firms have identified food and nutrition businesses as profitable investment opportunities.
- > Development organizations are working more closely with businesses than ever before.
- > Incubators are useful partners for entrepreneurs to help shape their ideas and develop their business models.

Introduction

In many of our societies, the entire food value chain has been commercialized since the 1950s – from buying fruits and vegetables to home delivery services. The industrialization of food has gained momentum and led to a focus on profit to shareholders.¹ This commercialization of the food value chain has happened in a way that is detrimental to our societies: two billion of the world's population is overweight and another billion is underweight. That is the bittersweet reality. Although we cannot stop the industrialization of the food value chain, we can participate in it and shape it by fostering an enabling environment for entrepreneurs. In fact, there has never been a better time to start a business with the purpose of improving human nutrition – whether in Europe, the US, Africa, or Asia. The world of nutrition is changing at a fast pace, and this is due to the following three factors:

1. **Advances in nutrition:** Scientific advances have revealed the importance of nutrition to human health. This understanding has diffused among the population, and consumers are more and more mindful about what they eat.

2. **Attitude of millennials:** Millennials – the generation born between 1981 and 1996 – want healthy, transparently sourced and produced, and sustainable food. They are passionate about changing how we produce, sell, and buy food, and are forcing companies to adapt.²

3. **Capital:** Food companies have realized that developing disruptive products within their core business is challenging and often not successful. Therefore, many have decided to invest into venture capital funds to be part of start-up companies offering healthier or more innovative products.³

These three factors have enabled start-ups to accelerate and scale up their businesses – some of them having even scaled to a size that they were acquired by large food producers. The start-up Beyond Meat received US\$72 million to develop and market plant-based burger patties.⁴ The start-up Plenty, which develops plant science for crops to flourish in a pesticide- and GMO-free environment using vertical farms, received US\$226 million in funding.⁵ The company RXBAR, founded in 2013, manufactures and distributes whole fruit and nut energy bars that are rich in protein. The company was acquired in 2017 for US\$600 million by Kellogg's.⁶ Gardein was founded in 2003 and produces and markets dairy- and meat-free products and recipes, including barbecue wings and a meatless meatloaf. It was acquired by Pinnacle Foods for US\$154 million in 2014.⁷ These examples indicate that it is possible (and much easier compared to 10 years ago) for food start-ups to receive venture funding. In addition, development organizations active in low- and middle-income countries (LMIC) increasingly invest in financing models for small to medium-sized enterprises.

“There has never been a better time to start a business with the purpose of improving human nutrition”

Glossary

Incubator

Incubators support start-ups entering the beginning stages of building their businesses by offering expert membership and resources such as office space, legal counsel, and even seed money – typically in exchange for a small amount of equity. Usually, they have an open-ended timeline.

Accelerator

Accelerators offer three- to six-month programs for rapid-growth companies that already have a minimum viable product (MVP) and connect these with mentors, guidance, resources, and funding. Example: Good Food Accelerator (www.goodfoodaccelerator.org).

Angel investor

An angel investor is a private investor (typically a very experienced, often retired executive) who wants to support entrepreneurs with funding and mentoring. In contrast, institutional venture capitalists invest other people's money and usually larger amounts than angel investors.

Bootstrapping

Bootstrapping of a start-up means that the entrepreneur is financing the business from their own generated revenues (cashflow). By doing that, the entrepreneur keeps control (the equity) of the company but might lack the capital to scale the business rapidly.

Coworking space

A place offering cost-effective office space, a community of like-minded entrepreneurs, and access to many of the same benefits that accelerators offer.

Crowdfunding

Crowdfunding is the practice of funding a project or venture by raising many small amounts of money from a large number of people, typically via the internet.

Venture capital

Venture capital (VC) is a form of financing that is provided by firms or funds to small, early-stage, emerging businesses that have high growth potential or that have demonstrated high growth (in terms of number of employees, annual revenue, or both) and that would not receive funding from traditional banks due to the risk of failure.

Impossible Foods and share: two examples of rapid innovation

Recently, I met Nick Halla, Chief Strategy Officer at Impossible Foods (www.impossiblefoods.com), who has been with the company from its inception. Founded in 2011, Impossible Foods develops a new generation of meats and cheeses made entirely from plants, and it has received US\$388 million in total funding so far. One of their first funding rounds was backed by Khosla Ventures with US\$9 million.⁸ Their burger patty, which looks and tastes like meat (it even “bleeds”), is already served in many restaurants around the world. Within the span of seven years they have achieved something that seemed, indeed, impossible.

Another team of founders, among them Iris Braun and Sebastian Stricker, had the idea of sharing “consumption” and founded a start-up called share. share markets nut bars, hand soap and water, and with each purchase a person in need receives a comparable product. Within just one year, the team has developed three product lines, organized distribution in over 5,000 retail stores, and sold over 1.4 million products during share's first six weeks in the market. With the purchase of each of the 1.4 million share products, around 300,000 people in LMIC received donations of food, water, and personal hygiene products. How did Braun, Stricker, and their team get there?

It started several years ago with the founders working at the United Nations and being frustrated about how nontransparent their work was to the general public. This frustration made Stricker develop the ShareTheMeal app. With the click of a button, you can “share your meal” and donate a day's worth of food to a project of choice, all for a cost of €0.40. Today, ShareTheMeal has over 1 million active users worldwide and provides a channel for small donations of US\$0.40, which are sufficient to help a person in need. To develop and scale ShareTheMeal, no investors were required, and bootstrapping worked well for this business model.

That was in 2015. Two years later, the team wondered whether they could increase the donations if they had a solution for people who do not use apps. After brainstorming and incubation, the idea for share and its 1+1 principle were born: each product purchase in Germany donates an equivalent product in an LMIC, with each donation being fully transparent and trackable.⁹ The team was excited and fully aware that this company – in contrast to ShareTheMeal – required capital to get started. The founding team decided to scale this social enterprise through raising traditional venture capital. The team found out that many investors are interested in social enterprise and a workable, scalable business model. For the team, it was important that the investor fits well with the team and its purpose. It was, however, not so easy to close the investment deals: despite the immediate interest, it took about half a year to find the right partner, get the seed



Picture from share's press kit

funding, and set up the founding team. The seed round was provided by Atlantic Food Labs, a food- and nutrition-specialized early-stage investor in Berlin. Atlantic Food Labs connected the founders with a strategic investor from the industry, Döhler. This was helpful, as Döhler is a specialized ingredient producer and brought in its product development expertise.

Once the funding process was running, the founders built a team and advisory board that would fill expertise gaps. Although the team had plenty of experience in management consulting, non-profit work, development research, and food start-ups, additional expertise was required. Once the team and advisory board were in place, the founders felt ready to take on the challenge to bring share's products to the largest retailer in Germany.

"We knew that in the tough world of German food retail, which is particularly known for its price sensitivity and low margins, we had to reach scale fast to make our special cost model workable. Hence, we devised an audacious plan: develop a turn-key solution for the big German retail chains that they can then throw their weight behind and urge them to take us national. We managed to get that 15-minute meeting with the CEO of REWE, a large German retailer. He was immediately attracted by the simplicity and clarity of our 1+1 principle: each product donates an equivalent product. With their go-ahead, we were able to also convince Europe's biggest drugstore chain to support our launch and stock us," says Braun.

Another example of a food company combining social impact and business is the start-up 45RICE in Singapore.¹⁰ 45RICE

fortifies rice with essential vitamins and minerals. Its team is dedicated to improving lives through nutrition. 45RICE is backed by BoP Hub Ltd., a Singapore-based accelerator for social entrepreneurs.¹¹

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 "To start a business, a good idea,
 a powerful team, a network
 of mentors, and funding are
 critical requirements"



Photo from the Impossible Foods press kit



© Viktor Strasse

Picture from share's press kit

The financing cycles of start-ups follow a typical pattern

Both start-ups, Impossible Foods and share, used venture capital to develop their products and bring these to market. To start a business, a good idea, a powerful team, a network of mentors, and funding are critical requirements. For the funding of newly founded companies, various options are available: the initial funding, called pre-seed or seed funding, can be provided by incubators, angel investors, crowdfunding, or specialized investors. In later stages, once revenues have been generated and the risk of failure has decreased (at least a little), venture capital or private equity firms offer capital.¹² Figure 1 presents this financing cycle of start-ups and shows that in the initial seed phase there are no revenues, but financing is available, e.g., from angel investors.

Incubators from around the world focusing on food and nutrition

Usually, each investment firm sets a focus on a specific financing cycle in addition to focusing on specific topics (e.g., alternative protein sources, direct-to-consumer or business-to-business business models). Since I believe that incubators (see Glossary) play a special role in the ecosystem of product innovation, I will describe four incubators specializing in food and nutrition innovation from Germany, Israel, China, and Singapore, respectively.

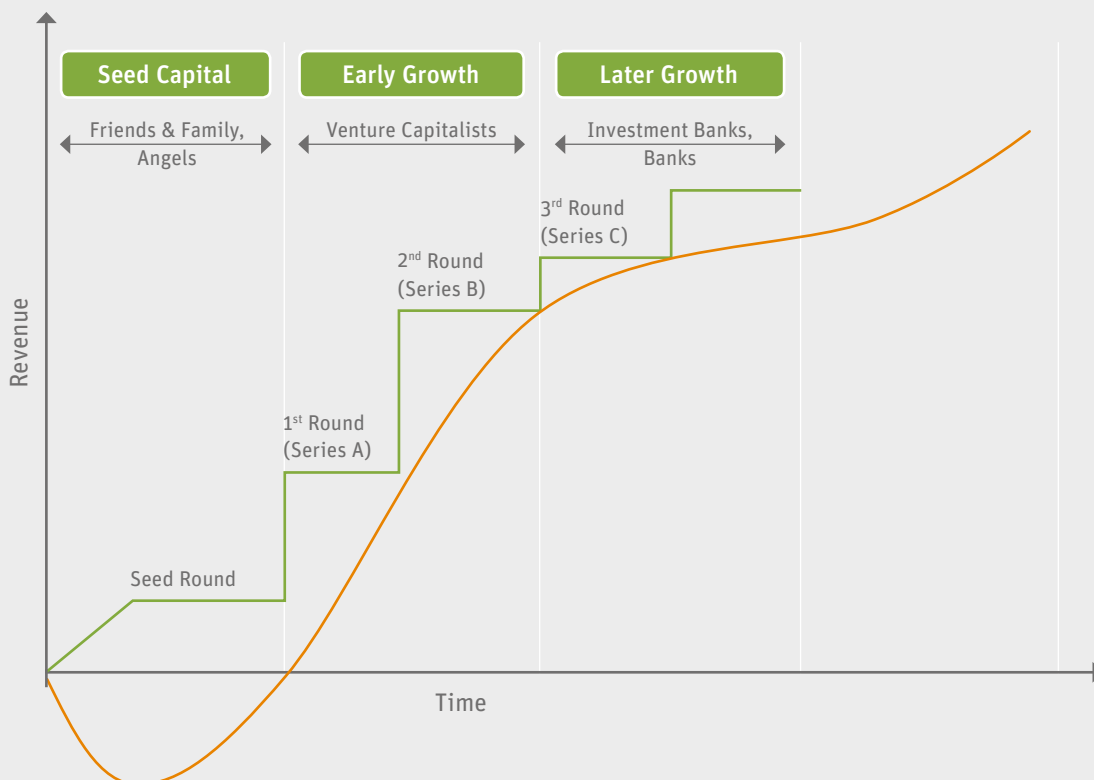
Atlantic Food Labs, Berlin, Germany (www.foodlabs.de)

Atlantic Food Labs (AFL) is an investor based in Berlin, Germany,

specialized in seed-stage investments. AFL was founded in 2015 by angel investor Christophe F. Maire. Founders from around the world are invited to approach AFL with their idea or business concept. Based on the scale of innovation, the potential market size and the strength of the founders, AFL offers seed investment together with support in operations such as sales, business planning, and product development, including scientific and regulatory advice. AFL currently has 25 start-ups in its portfolio, one of which is share. Another interesting start-up AFL supports is mitte® (mitte.co), which is developing a water-purifying system that enables consumers to mineralize their water at home based on their preferences.

The Kitchen – Food Tech Hub, Tel Aviv, Israel (www.thekitchenhub.com)

The Kitchen is Israel's only food tech-focused incubator. It was founded in 2015 as part of Israel's incubator program and is owned by food company Strauss Group. The Kitchen addresses global food challenges by harnessing Israel's renowned innovation ecosystem. It currently has 10 ventures in its portfolio. The Kitchen is looking for entrepreneurs from all around the world, the prerequisite for investment being that the company be founded in Israel. For the investment committee, it is important to see a strong founding team and an innovation addressing an unmet need in a large growing market with high barriers to market entry for potential competitors. Their portfolio includes BactuSense, a sensor that enables rapid detection of pathogens

FIGURE 1: The start-up financing cycle – from idea incubation to profitable business

in food manufacturing lines, and Flying Spark, an insect protein with a high nutritional value and minimal environmental footprint sourced from fruit fly larvae.

Bits x Bites, Shanghai, China (www.bitsxbites.com)

Bits x Bites is China's first food tech acceleration platform and venture capitalist investing in disruptive food innovation start-ups to shape the future of nutritious food. Bits x Bites was founded in 2016 to solve the systematic challenges the world is facing in the food supply chain including food access, food safety, nutrition, and consumer mindfulness. Bits x Bites has invested in nine companies to date, from a company producing meat from animal cells to a food safety start-up bringing nanoscale contaminant detection to the food industry. Bits x Bites is looking for entrepreneurs who share their mission, use technology as the enabler to disrupt the current supply chain, and target China as one of their main markets.

Coffee Ventures, Singapore (coffeevc.com)

Coffee Ventures focuses on investing in early-stage technological start-ups in Southeast Asia. The partners were formerly engineering executives and had been investing in Silicon Valley and Asia prior to starting Coffee Ventures in 2016. They

seek entrepreneurs who demonstrate discipline in developing hypotheses to address a problem, depth of understanding through experimentation, and resourcefulness in taking products to market. Coffee Ventures invests in technology-enabled businesses that have the potential to achieve outsized growth relative to the capital required. A recent investment is Kulina. During each mealtime, millions of Indonesians in the capital city Jakarta face high prices, uncertain hygiene, and traffic that many believe to be the worst in the world. The start-up Kulina solves this problem by offering subscriptions to delicious meals, curating meal options, and optimizing logistic aggregation and routing efficiencies – all this while achieving sustainable unit economics. Currently, Kulina delivers to thousands of people each lunchtime and gives them back 30 minutes of their time every day.

There are various private and corporate venture capital firms who are looking for successful companies to invest in. Examples of private firms specializing in food and nutrition – each with a different focus – include Five Seasons Ventures, Oyster Bay, Freigeist, and New Protein Capital (see also **Table 1**). In addition, many food and nutrition companies have established venture capital units. Usually, these are separate entities that

TABLE 1: Venture capital firms, corporate venture capital units, and crowdfunding platforms, listed alphabetically

Name	Website
45Rice	45rice.com
AccelFoods	www.accelfoods.com
AgFunder	agfunder.com
Anterra Capital	www.anterracapital.com
Atlantic Food Labs	www.foodlabs.de
B37 Ventures	b37.vc
Barnraiser	www.barnraiser.us
BASF Venture Capital	www.basf.com/de/de/company/about-us/companies/BASF-Venture-Capital.html
Bits x Bites	www.bitsxbites.com
BoP Hub Ltd.	www.bopworldconvention.com/about-bop-2
Boulder Food Group	bfgpartners.com
btoV Partners	www.btoV.vc
Capagro	www.capagro.fr
Cherry Ventures	www.cherry.vc
CircleUp	circleup.com
Closed Loop Capital	closedloopcapital.com
Coffee Ventures	coffeevc.com
Cropital	www.cropital.com
CrowdFooding	crowdfooding.co.uk
Danone Manifesto Ventures	www.danoneventures.com
Döhler Ventures	www.we-bring-ideas-to-life.com
Oetker Digital	oetkerdigital.com
DSM Venturing	www.dsm.com/corporate/about/business-entities/dsm-venturing.html
Econa	econa.com
EDEKA foodstarter	www.foodstarter.edeka
FARM2050	www.farm2050.com
Five Season Ventures	www.fiveseasons.vc
Food Angels	food-angels.org
Food-X	food-x.com
Freigeist	freigeist.com
FundTheFood – Kirchner Food Fellowship	fundthefood.com
Future Positive Capital	www.futurepositivecapital.com
301 INC – General Mills	www.301inc.com
GreatPoint Ventures	www.gpv.com
Indiegogo	www.indiegogo.com
InvestEco	investeco.com
Katjes	katjesgreenfood.berlin
Eighteen94 Capital – Kellogg's	www.1894capital.com
Kickstarter	www.kickstarter.com
Metro Group	metroaccelerator.com
NX FOOD – Metro Group	nx-food.com
Middleland Capital	middlelandcap.com
New Crop Capital	www.newcropcapital.com
New Protein Capital	visviresnewprotein.com

Name	Website
Obvious Ventures	obvious.com
Oyster Bay	oysterbay.vc
Nutrition Greenhouse – PepsiCo	www.nutritiongreenhouse.com
PieShell	www.pieshell.com
Rabo AgriFinance	www.raboag.com
S2G Ventures	s2gventures.com
Square One Foods	www.squareonefoods.com
The Family	www.thefamily.co
The Kitchen	www.thekitchenhub.com
The Yield Lab	www.theyieldlab.com
Tyson Ventures	www.tysonfoods.com/innovation/food-innovation/tyson-ventures
Unilever Ventures	www.unileverventures.com
Verlinvest	www.verlinvest.be

Please note: This list is not exhaustive.

focus on either strategic fit with the core business or purely return on investment. Some of the leading corporates are members of Nutrition Capital Network, which connects investors with start-ups in the nutrition and health & wellness industry (nutritioncapital.com).

Embracing cooperation with businesses

In addition to this ecosystem, there is also an important shift in nutrition programs in LMICs: private investment is increasingly combined with public investment, providing more funding options for small and medium-sized enterprises. The Global Alliance for Improved Nutrition (GAIN), for example, is setting up a Nutritious Foods Financing Facility (N3F). The idea is to fill the gap in funding for SMEs to scale up local production of nutritious foods in sub-Saharan Africa. The idea came from GAIN's experience working with small businesses through the GAIN Premix Facility and Marketplace for Nutritious Foods: many of the agrifood businesses they worked with have asked for loans and small-trade financing either as part of, or else independent of, GAIN's ongoing support for existing SMEs. GAIN's Director of Food Policy & Financing, Greg S. Garrett, says of N3F: "Our aim is to help mitigate perceived risk and broker deals between SMEs (investees) on one side, and impact investors, local banks, and other sources of private capital on the other to scale up locally produced nutritious foods in sub-Saharan Africa."

The Bill & Melinda Gates Foundation is investing in financial services in LMICs as well. Their objective is to provide access to formal financial services including sending and receiving payments to improve management of farms and small businesses.¹³ Another national fund managed by the EU and Uganda's International Fund for Agriculture Development

makes investments of between €200,000 and €2 million in agribusinesses. The fund allows 35 private small and medium-sized Ugandan agribusiness enterprises to take advantage of interest-free grants.¹⁴ The organization Ashoka provides seed financing to social enterprises serving the bottom of the pyramid. With this, Ashoka supports companies not operating at scale that are not ready to take on investment.¹⁵ Yunus Social Business (Yunus sb) offers loans to social entrepreneurs too big for microfinance or too risky for commercial funding in the range of US\$100,000 to US\$500,000. Removing the need for fundraising allows social businesses to reinvest profits back into generating sustainable social impact.¹⁶

Now is the right time

Summing this all up: now is the right time to empower founders and small businesses that market nutritious foods or services. Entrepreneurs in nutrition have started to drive change in human nutrition – let's embrace it wholeheartedly.

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Innovating for Sustainability

Life Cycle Assessments and sustainable food systems

Henk Bosch

DSM Nutritional Products, Kaiseraugst, Switzerland

Key messages

- > Feeding the growing global population in a sustainable way is an enormous challenge.
- > Many different approaches to improve the sustainability of food production and consumption are required and are currently being investigated.
- > Choosing the best solutions requires a sound data and methodology foundation; Life Cycle Assessments provide such a foundation.

Sustainable food challenges

Hunger and malnutrition have not been eliminated by any means, but we are slowly making progress, as can be seen from various contributions in *Sight and Life* magazine. We are learning how to improve the global supply of nutritious food and how to reduce the vulnerability of food provision in situations of man-made as well as natural disaster. New challenges have emerged, however. The global population is growing, raising questions about the sufficient availability of arable land for growing crops for food and animal feed. The growth of the middle classes is a great sign of success, but it also increases demand for more nutrient-dense food, such as animal-source protein, which requires more land and water to produce. The threats posed by climate change do not make things any easier. Crop yields and quality may decrease and harvests may fail because of changing rainfall and temperature patterns. On top of this, the fight against climate change increases land use for the production of renewable fuels.

“The production of food has many effects on the environment”

Beyond its impact on the availability of arable land, the production of food has many other effects on the environment. Agriculture introduces nutrients into nature that disturb ecosystems. The demand for phosphate fertilizer is rapidly decreasing the extractable amount of phosphate rock in the world. Crops transpire a lot of water, which is often replenished by irrigation, causing shortages of potable water downstream. The use of pesticides endangers bees, which in turn are critical for agricultural production. Production of animal-source protein requires feed from crops; and ruminants, while making efficient use of cellulosic materials (vegetable matter that is not digestible by monogastric animals or humans) emit significant amounts of methane, which is a much more powerful greenhouse gas than carbon dioxide. The ocean is a rich resource for healthy seafood, which has a very low carbon footprint, but for many fish species, the regenerative capacity of the oceans is already fully exploited or even overexploited, seriously threatening marine ecosystems and biodiversity. Aquafarming is only a partial solution, because it still requires wild-caught fish as input and has significant effects on water quality and the availability of other resources.

The awareness of consumers, especially educated and wealthy ones, about the healthiness and sustainability of food is growing, and is already leading to changes in consumption patterns, which do not always improve the situation. Trendy “superfoods” such as quinoa, which are nutrient-rich, usually cannot deliver the yield

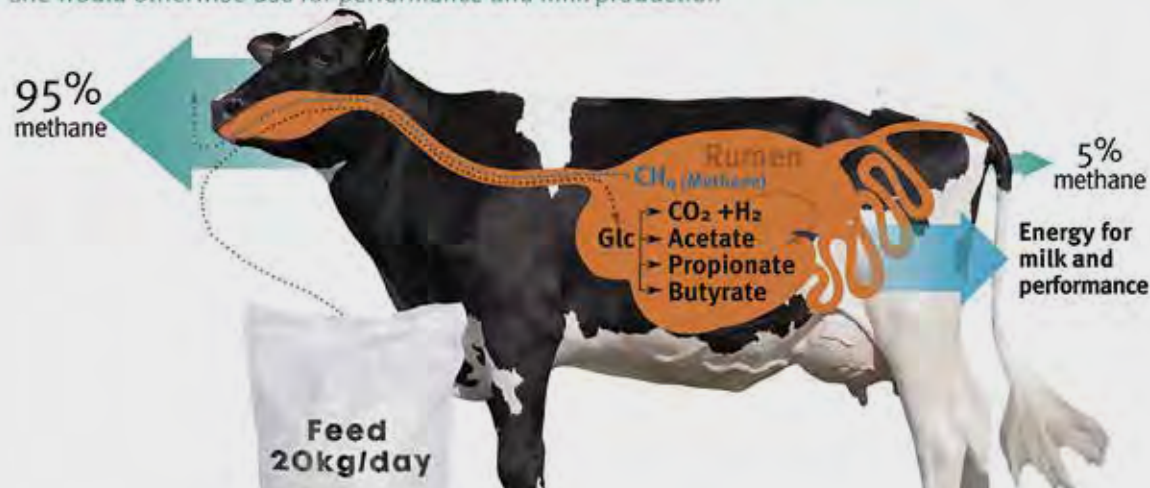


Pack-Age® from DSM is a moisture-permeable, breathable membrane for ripening cheese, without the risk of mold and yeast growth. Using it helps reduce food loss.

Methane Reduction Project

- how to reduce methane emission by a minimum of 25%

A cow emits 500l of methane per day, which is equivalent to 10% of the energy she would otherwise use for performance and milk production



Clean Cow from DSM: an innovative feed additive that reduces enteric methane emission in ruminants

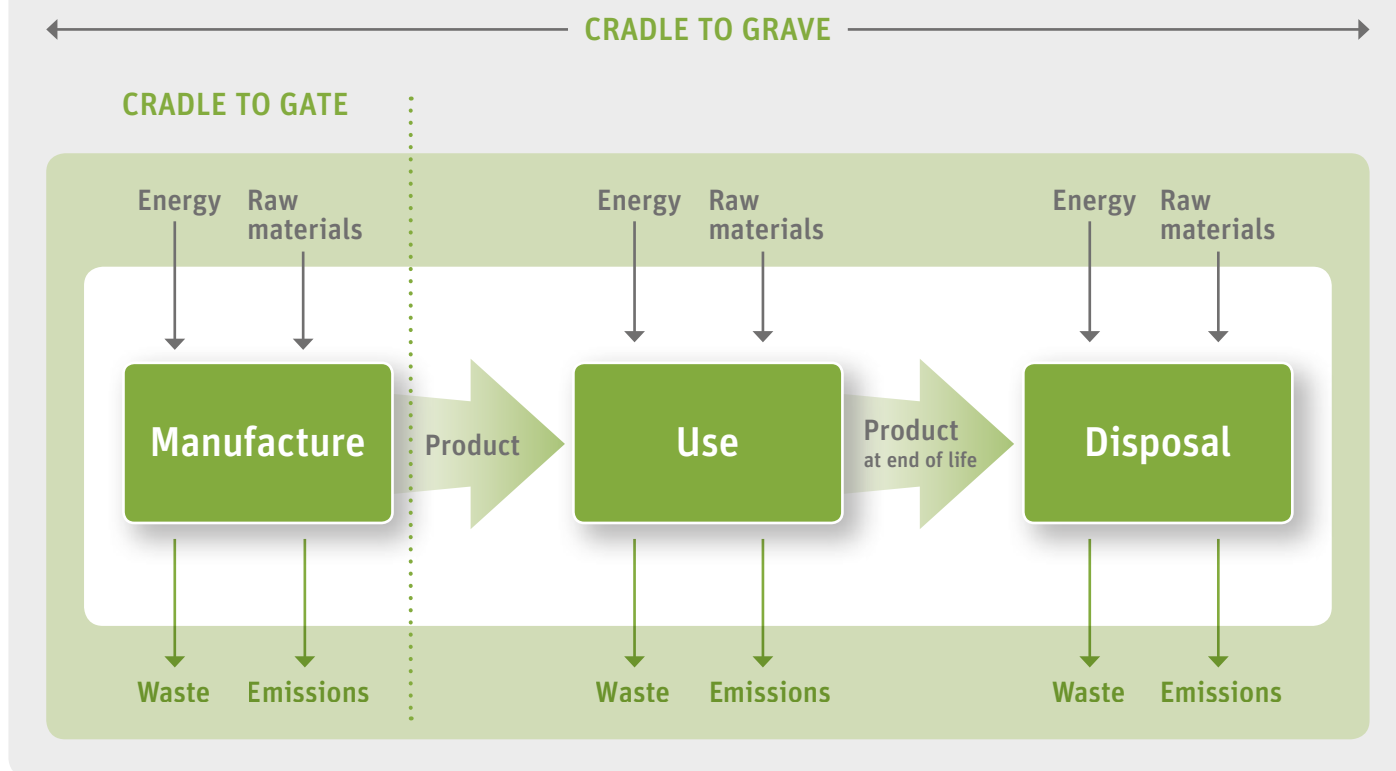
levels of common crops, and therefore call for extra land. They are typically transported over long distances, thus increasing their environmental impact. In addition, such cash crops may reduce the food security in the countries in which they are grown by replacing crops meant for local food purposes. Organic products are increasingly popular and reduce many of the impacts of farming, but they certainly increase land use, at least in the short term. Animal welfare also receives a lot of attention, but increasing animal welfare usually boosts environmental impact as well. Genetically modified crops offer great potential to improve yields in various ways and thereby reduce land use, water dependence, and pesticide use. Acceptance of genetic modification varies strongly geographically, depending partly on the public perception of its potential effects on consumer health and ecosystems and partly on the public perception of the economic power of suppliers. There is a strong trend toward switching to vegetarian, vegan, or flexitarian eating patterns. This has the potential to reduce the environmental impact of the food consumed, but it creates new challenges to shape a healthy balanced diet. In the process, some of the potential benefits of switching from animal- to plant-based protein will be sacrificed, because we cannot survive on staple foods with low nutrient density.

.....
**“We cannot survive on staple foods
 with low nutrient density”**

Many consumers are truly engaged and want to make the right decisions. The trade-offs are unfathomable to most, and in the media, there are abundant contributions highlighting one solution or the other, often with conflicting information. Scientists, authorities, non-governmental organizations and commercial companies try to help by developing and providing knowledge and new solutions. They also work together in platforms such as EAT¹ and FReSH.²

There are many approaches to tackle these challenges, and we need them all. Many of them require innovation. Starting on the consumer side, dietary shifts are required to replace foods with high environmental impact and low nutritional value with items with higher nutritional value and lower environmental impact. This requires more transparent and also simpler information for consumers. Nutrition scientists around the globe are developing easy parameters to capture the nutritional value of food items, while others are trying to combine nutritional value and environmental impact in comprehensive parameters. At DSM, we are interested to see whether and how micronutrients used as supplements or fortificants can help shrink the environmental footprint by providing nutrients that can otherwise only be sourced from food items with a large footprint. For example, we industrially produce quantities of vitamin C that cannot be produced on realistically available land by growing oranges or the currently popular source crop acerola.

Closer to the consumer, innovative techniques are applied to better preserve food quality and prevent waste caused by food

FIGURE 1: The scope of Life Cycle Assessments

being thrown away because it is spoiled, expired, or no longer looks attractive. Retailers should develop ways of presenting and pricing products such that they do not have to throw away leftovers or expired food. Logistic chains must be optimized to reduce time from primary production to consumption. Improved storage and transport condition control will also contribute to the solution.

Throughout the value chain, improvements in energy efficiency and shifts to renewable energy will reduce energy-related impacts. Improvements in animal nutrition will improve animal feed efficiency and reduce emissions from animals and manure. These include, for example, the application of enzymes to improve the digestibility of proteins, phytates, and carbohydrates, also enabling shifts to lower-quality (residual) feed ingredients with a smaller footprint. Precision farming and improved manure management (more precise fertilizer and pesticide application, stable exhaust air washers, manure injection instead of spreading) will reduce inputs into, and emissions from, farms. Improved breeding techniques will increase the efficiency of livestock and crops.

Sustainable fishery schemes will improve, and will ensure that fish species are not exploited beyond their regenerative capacity. Fishing techniques will become more precise, reducing the amount of bycatch of endangered species. Aquaculture dependency on fish will be reduced by developing alternatives for essential

feed ingredients for aqua-farmed fish, such as long-chain omega-3 fatty acids,³ which today are still mainly sourced from fish.

Despite the many potential solutions mentioned above and many more that are around the corner or will be developed in the future, it is by no means certain that we will be able to meet the challenges we face. Moreover, these solutions have environmental impacts of their own and may have impacts on areas which are not immediately apparent. Finally, not all these solutions can be combined without reducing their effectiveness, or even making the situation worse.

So how can an innovator know that his or her solution is really improving sustainability?

Sustainability in innovation

For many companies, the commitment to sustainability focuses on creating competitive advantage, new markets, and business opportunities. For DSM, however, it goes beyond that. It is also about ensuring that the company fulfills its mission to create brighter lives for people today and for generations to come.

Through a long-standing commitment to sustainability-driven innovation, DSM is at the forefront of addressing the challenges of rising consumption, resource scarcity, overexploitation of ecosystems, and climate change.

DSM realizes the potential value of meeting its customers' sustainability criteria: over 80% of its innovation portfolio consists

of *Brighter Living Solutions* – products that are environmentally or societally superior to competing mainstream solutions. Because of these initiatives, DSM has been consistently recognized as an industry leader by the Dow Jones Sustainability Index.

“A Life Cycle Assessment identifies the material, energy, and waste flows associated with a product or process over its entire life cycle”

Life Cycle Assessment (LCA)

DSM’s sustainability strategy is supported by the use of Life Cycle Assessments (LCAs). An LCA identifies the material, energy, and waste flows associated with a product or process over its entire life cycle to determine environmental impacts and potential improvements; this full life cycle approach is also referred to as “cradle to grave.” It is also possible to assess a partial life cycle of a product or process, with the most common type being the “cradle to gate” assessment, which focuses on the environmental impacts of a manufacturing process without accounting for the use phase or end-of-life impacts (Figure 1). There are many different environmental impact categories that can be assessed using LCAs; at DSM, the standard approach is to evaluate the carbon footprint and the eco footprint.

Carbon footprint (CFP) and eco footprint (EFP)

The carbon footprint (CFP) is the weighted sum of greenhouse gas (GHG) emissions and GHG uptake of a process or a product system, expressed as kg CO₂ equivalents. GHGs include carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆). The CFP is a very important parameter because it is directly correlated to global warming and climate change.

The eco footprint (EFP) is a more complete summary of the impact of an activity on the environment. The EFP is divided into three categories: (1) human health, e.g., carcinogenic and respiratory problems; (2) ecosystem quality, e.g., biodiversity and land occupation; and (3) resource depletion, e.g., minerals and fossil fuels.

Performing an LCA

LCAs are iterative processes in which the goal must be clearly defined at the beginning (Figure 2).

The goal of the LCA determines what to include in its scope. Typically, the LCA will assess environmental impacts from cradle to gate or cradle to grave, although different scopes are sometimes required. For example, the scope of a cradle-to-gate LCA of a product requires first a cradle-to-gate footprint of the individual raw materials used. These partial LCAs are used as the input for the cradle-to-gate LCA of the product. In a similar way, the scope can be expanded to cradle-to-grave by including downstream products, distribution processes, retail, use by consumers, and end-of-life treatment. *Inventory analysis* is a thorough bookkeeping of a production process, i.e., what quantities of raw materials, energy, and water are used. The impact assessment is the actual calculation of the CFP and EFP of the production process according to the selected method.

During the entire LCA process, continuous interpretation of the data and the results is required to ensure the data gathered and results obtained are in line with the goal and scope. DSM uses SimaPro software and internationally standardized assessment methods to conduct LCAs.

“LCAs are a powerful tool with many applications and benefits”

Using LCAs

LCAs have many applications and benefits. They can be used in innovation and development processes as a decision support tool to highlight the most sustainable options. They can also be used to analyze the efficiency and environmental impacts of existing products and processes to identify hot spots where impacts can be mitigated. Comparative LCA studies can determine

FIGURE 2: The LCA process

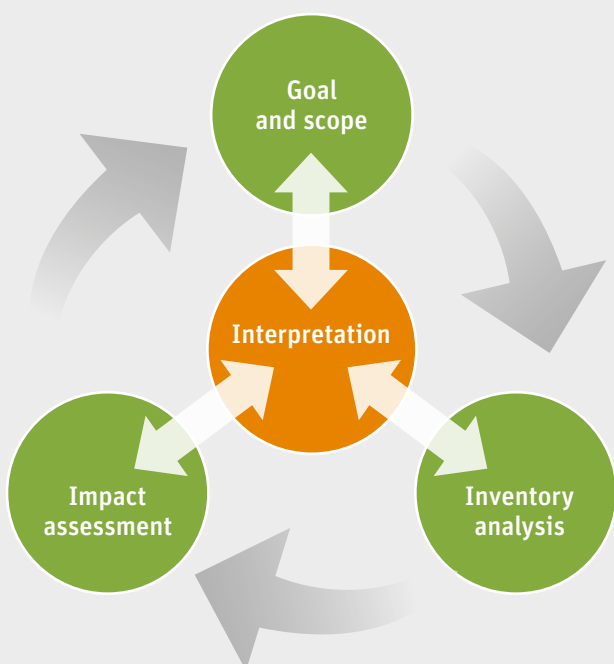
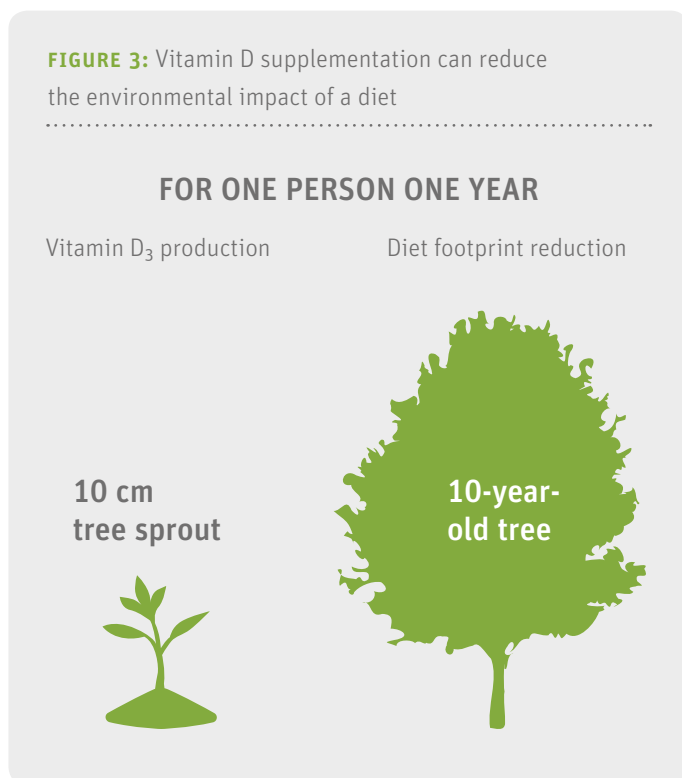


FIGURE 3: Vitamin D supplementation can reduce the environmental impact of a diet



whether a competing product has a better or worse environmental footprint, highlighting opportunities for good environmental performance to be communicated to stakeholders.

To illustrate, not long ago DSM looked at the potential of vitamin D₃ supplements to provide a full recommended dietary allowance (RDA) of this nutrient with a reduced footprint. Under ideal conditions, the human metabolism can produce sufficient vitamin D₃ from direct exposure to sunlight. However, with a modern lifestyle at higher latitudes, particularly during the winter, this is not sufficient, so the RDA has to be consumed to prevent deficiency. It turned out that the footprint of a fully sufficient diet can be reduced by using supplements. This is because vitamin D₃ is not present in many foods. Its main sources are fish, eggs, and milk. For a sufficient intake of vitamin D₃, most people would need to increase their consumption of these foods. Even though fish has a very low footprint compared to other animal

proteins, its footprint is still higher than that of plant-based protein. By using supplements, less animal-source food has to be consumed and more plant-based protein can be utilized, thus reducing the overall footprint. The environmental impact avoided by this menu change is 70,000 times greater than the added impact resulting from producing the supplement. In **Figure 3**, the effect for one person for one year is illustrated in terms of the amount of carbon dioxide embodied in a growing tree.

Conclusion

Providing sustainable, nutritious food to the growing world population is a tremendous challenge. Many solutions are currently under development. To determine if these indeed have a net positive contribution and to select the best ones, sound methods are needed to assess sustainability. The Life Cycle Assessment is the preferred method. It is a powerful tool for quantifying the trade-offs involved.

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Further reading and many references can be found on

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We are dedicated to accelerating
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Sizanani Mzanzi Marketing Mix – Product & Price

**Kesso Gabrielle van Zutphen
and Madhavika Bajoria**

Sight and Life, Basel, Switzerland

What is the Marketing Mix?

Neil Borden, of Harvard Business School, used the term “marketing mix” to describe the set of activities comprising a firm’s marketing program. He noted how firms blend elements of this “mix” into a program and how firms competing in one and the same product category may have dramatically different “mixes” at work. As shown in **Figure 1**, the 4 P’s of Product, Price, Promotion, and Place are often used to set out the marketing mix in an easy-to-recall way.¹

This is part four of our ongoing Sizanani Mzanzi series (for part one, please refer to Vol. 29(1) 2015 of this magazine; for part two, Vol. 31(1) 2017; and for part three, Vol. 32(2) 2017). In this first part, we will focus on product and price. The two remaining P’s, place and promotion, will be covered in the second edition of the *Sight and Life* magazine for 2018.

FIGURE 1: The 4 P’s of the marketing mix



Malnutrition in South Africa

The burden of malnutrition in South Africa is immense. One in five children in South Africa is stunted, and malnutrition is a major underlying cause of death in 64% of children under five years of age. Additionally, nearly half of children under five suffer from vitamin A deficiency, and one-third of women of reproductive age are anemic. Iodine, folate, and zinc deficiency are also extremely common in South Africa. It is estimated that South Africa loses over US\$1.1 billion in GDP annually to vitamin and mineral deficiencies.²

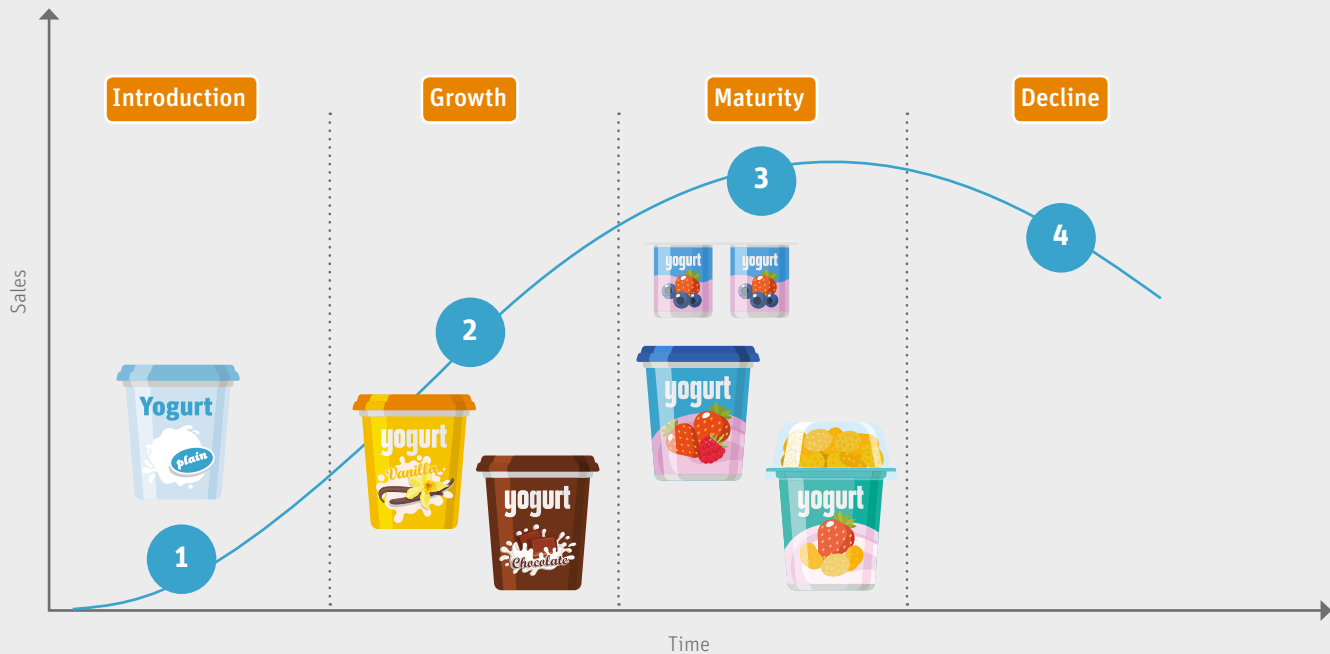
There are a number of factors contributing to this dismal scenario:

- > Low-income communities lack access to the goods and services they require in order to enjoy healthy and productive lives.
- > Public health programs are underfunded and need more support if they are to eliminate malnutrition.
- > Humanitarian and community projects, funded by grants only, have **limited reach** and **limited intervention** periods.

“South Africa is estimated to lose over US\$1.1 billion in GDP annually to vitamin and mineral deficiencies”

Hence, there is a need for **continuity, sustainability, and scale** to effectively address malnutrition in South Africa. In this context, Sizanani Mzanzi – founded by *Sight and Life* and DSM South Africa in 2014 – was created as a social business aiming to

- > **improve access** to quality, affordable, and frequently consumed nutritious foods that are currently not available in low-income communities;
- > **increase awareness of the importance of good nutrition** by training microfranchisees to deliver messages to the community;
- > **co-create income-generating** opportunities and build

FIGURE 2: The product life cycle curve – the example of yogurt

- capacity within communities that need them the most;
- > **improve equality** by empowering women in communities with high unemployment levels; and
 - > **ensure economic sustainability** by generating surplus from sales and reinvesting it into the business to benefit those being served.

What is a product?

In marketing, a product can be defined as a good, service, or idea that satisfies a want or need in exchange for money or another unit of value. A product can be tangible (a physical item that can be perceived by touch) or intangible (can only be perceived indirectly) and is produced at a cost and subsequently made available to the right audience at a price. Whatever the nature of the product, it will follow a life cycle that includes the introduction phase, the growth phase, the maturity phase, and the sales decline phase³ (see Figure 2). It is important for marketers to reinvent a product to stimulate more demand once it reaches the sales decline phase. A successful product has to fulfill a specific need in the market. It must be able to perform its function as promised. There also needs to be clear communication to users and potential customers regarding its benefits and features.³

- 1 **The introduction phase** – This is when the new product (e.g., yogurt) is brought to the market and is available in health food stores, for instance. Its packaging is functional and plain, and the product is promoted as a health food. In this phase, the price of the yogurt is often higher, as distribution is limited. Sales are low and increase slowly.⁴

- 2 **The growth phase** – The yogurt is now available in supermarket chiller cabinets, for example. Its packaging gets a makeover and new flavors are introduced (chocolate and vanilla). In this phase, demand increases rapidly, and with volume, the price declines. Distribution increases and promotion focuses on product benefits.⁴

- 3 **The maturity phase** – Here, the product is reinvented with added chocolate, muesli, and/or fruit, and the packaging changes into different shapes and sizes. The product competes with alternatives and the price drops. Distribution becomes intense (the product is available everywhere) and promotion focuses on the differences to competitors' products, such as the fact that this particular yogurt is now promoted as a fun snack and luxury treat.⁴

- 4 **The decline phase** – The product is reaching the end of its life and faces fewer competitors. The product begins to lose consumer appeal, and sales drift downward. Promotion aims to remind customers of its existence.⁴

FIGURE 3: The two fortified products being offered by Sizanani Mzanzi**Product 1: MixMe fortified instant powdered beverage**

Flavors: Orange | Pineapple

Pack size: 30 g – makes 1 L

**Product 2: MixMe fortified instant maize | soy blend porridge**

Flavors: Original | Vanilla

Pack size: 250 g, 750 g, 10 kg

**How do Sizanani Mzanzi's fortified products address the malnutrition challenges in South Africa?*****Solution 1:** Improve access to quality, affordable, and frequently consumed nutritious foods*

While staple food fortification has been shown to be one of the safest and most cost-effective measures to improve the nutritional value of a diet and address micronutrient deficiencies, one food vehicle alone cannot offer a complete portfolio of micronutrients, and thus can only partly address essential micronutrient deficiencies. In fact, while the fortification of foods is relatively easy in the case of some micronutrients (e.g., iodine), it is not so easy for others (e.g., iron).⁵ The MixMe fortified instant maize/soy blend porridge and fortified instant powdered beverage are two nutrient-dense products, offering 13 vitamins, 4 minerals, and 11% protein, and 13 vitamins and 5 minerals, respectively.

In the economically disadvantaged townships of Ivory Park and Soweto, consumer research has revealed that instant porridge and beverages are the most frequently consumed convenience foods. Consumers who buy instant porridge do so because it is a filling breakfast and saves time during the morning rush. Likewise, juices are regularly consumed and form an integral part of their diet. Consequently, both MixMe products (juice and porridge) and the product flavors (vanilla, orange, and pineapple) were chosen in light of these contextual dietary habits and

in accordance with consumer preferences. They are the easiest vehicles through which the required nutrients can be delivered to consumers on a regular basis.

***Solution 2:** Increase awareness of the importance of good nutrition*

After the microfranchisees were recruited, they underwent a five-day training where they learned the required skills for the job. The first day of the training focused specifically on nutrition. Trainees were provided with basic micronutrient and nutritional information, a public health nutrition flipbook, and a product portfolio, as well as information on the role and benefits of the products.

***Solution 3:** Ensure economic sustainability*

By generating surplus from sales and reinvesting the surplus into the business to benefit those it serves, Sizanani Mzanzi offers an appealing model to ensure economic sustainability, continuity, and scale in contrast to grant-funded humanitarian and community projects with limited reach and limited intervention periods. Currently, Sizanani's commercial viability has not yet been fully attained – only product, distribution, and marketing costs are recovered at present. The ideal level of cost recovery, whereby there is a complete break-even including overheads, is expected to be reached by December 2018.

Solution 4: How to co-create income-generating opportunities within communities that need them the most?

The social business model empowers low-income women franchisees to make a living and provide for their families. Sizanani Mzanzi works with women who are either unemployed, employed part-time, or pensioners. It actively recruits and hires low-skilled workers.

How is the offer defined?

A product or a service is an offer made by a marketer that can answer the desires and needs of customers. The *three levels of a product* are a way to pull apart what the consumer perceives

the product to be and its importance to the customer. The three levels of a product consider (1) the core product development, (2) the tangible product development, and (3) the augmented product development.⁶ As Sizanani Mzanzi products were new to the porridge and beverage markets, there was a need to increase awareness, visibility, and confidence regarding the brand and products. To this end, in 2017, BMI Research conducted consumer research through food diaries, shopping tours, and in-depth interviews to understand purchasing and consumption habits for instant porridge and juice concentrate. The results of the research provided answers to the product design and, more specifically, to the product-related questions above.

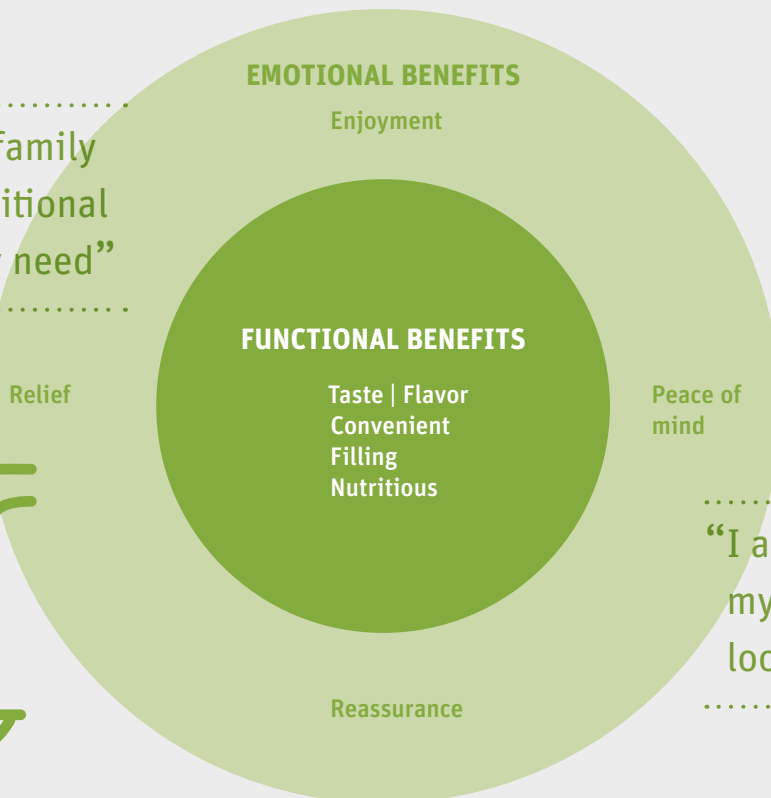
TABLE 1: Key characteristics of Living Standards Measure (LSM) 5–7⁹

LSM 5	LSM 6	LSM 7 (low)	LSM 7 (high)
Demographics			
Gender: No gender bias	Gender: Female bias	Gender: Female bias	Gender: Female bias
Age: 15–34	Age: 25–49	Age: 25–49	Age: 25–49
Education: Some high school	Education: Some high school/	Education: Matriculation and higher	Education: Matriculation and higher
Location: Small urban/rural house, matchbox/matchbox improved	Location: Large urban house/ townhouse, cluster house	Location: Urban	Location: Urban
Average monthly household income in South African rand (ZAR)			
ZAR 5,636	ZAR 7,876	ZAR 12,280	ZAR 14,588
Media			
> Commercial radio, mainly African Language Services (ALS) stations and community radio	> Wide range of commercial and community radio	> Wide range of commercial and community radio	> Wide range of commercial and community radio
> TV: South African Broadcasting Corporation (SABC) 1, 2, 3, e.tv, Pay TV	> TV: SABC 1,2,3, e.tv, Pay TV, Community TV	> Accessed internet in past 7 days	> Accessed internet in past 7 days
	> Any All Media and Products Survey (AMPS) newspaper	> Outdoor	> Cinema & outdoor
	> Outdoor		
General			
Facilities:	Facilities:	> Full access to services	> Full access to services, including checking and savings accounts
> Electricity, water on plot, flush toilet outside	> Electricity, water in home, flush toilet in home	> Savings accounts	> Increased ownership of durables plus DVD and motor vehicle
> TV set, hi-fi/radio set, stove, fridge	> TV set, stove, fridge/freezer, microwave oven	> Increased ownership of durables plus DVD and motor vehicle	> Participation in all activities
Activities: singing, baking for pleasure, going to nightclubs, attending gatherings, buying lottery tickets	Activities: hiring DVDs, going to nightclubs, having a take-away meal in the past 4 weeks, attending gatherings, buying lottery tickets, going to the gym	> Participation in all activities	
Life stages:	Life stages:		
> 31.5% personally make use of a South African Social Security Agency (SASSA) card	> 27.4% personally make use of a SASSA card		
> 52.9% have a savings account	> 61.3% have a savings account		

FIGURE 4: The emotional and functional benefits of MixMe products

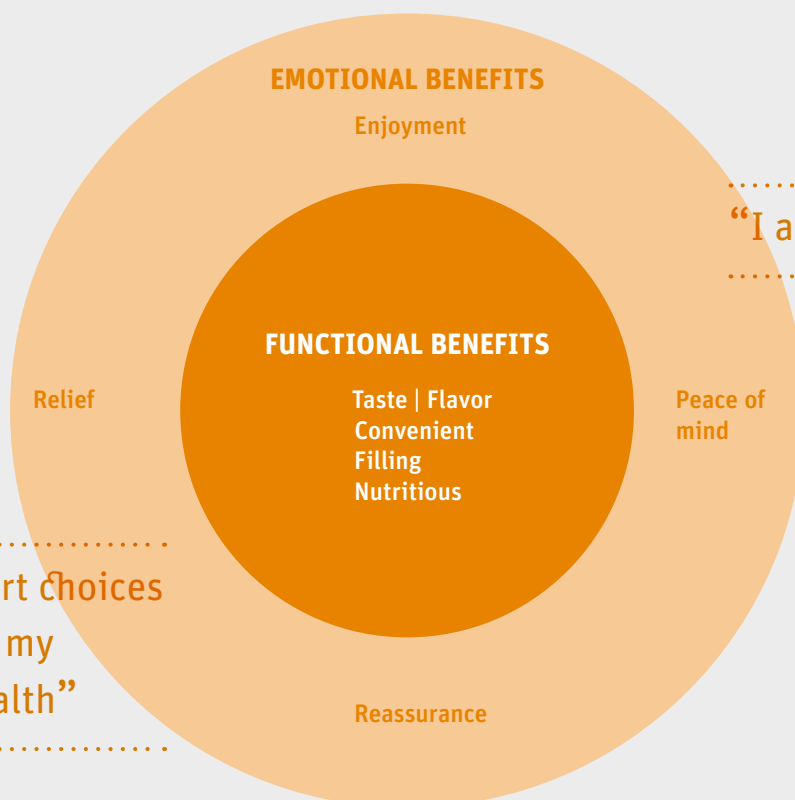
PORRIDGE

“I ensure my family gets the nutritional benefits they need”



“I am a good mother: my kids are well looked after”

JUICE



“I make smart choices concerning my family’s health”

“I am a good mother”

TABLE 2: Summary of the characteristics of the MixMe tangible products

	Consumer needs	Marketing implications
Quality	Quality of the product is the most important driver after taste.	Vitamins and minerals are supplied by DSM Nutritional Products, a recognized leader in the manufacture and supply of micronutrients blends. DSM offers high safety standards and meets relevant regulatory requirements.
Features	Taste and flavor are the key drivers for brand choice.	The flavors had to be culturally relevant and chosen based on what is already available in the market in order to keep down marketing costs. The porridge is available in original and vanilla flavors, while the juice has either an orange or a pineapple flavor.
	Product had to be easy to prepare. Consumers who buy Instant Porridge do so because it is a filling breakfast and saves time during the morning rush. Mothers in particular feel reassured that they are giving a good meal to their child.	Instant porridge is easier to prepare (add warm water and mix) compared to regular fortified maize meal.
	Mothers needed a juice with less sugar to give to their children.	The juice, containing vitamins and minerals and less sugar, offers a better beverage alternative to more sugary options.
Packaging	Packaging generally communicates the quality of the product, underpinning taste expectations.	Packaging thus had to be interesting and appealing in order to communicate quality ingredients.
	Women are extremely price-conscious and generally want a large pack size. The packaging needs to enhance consumers' perception of value for money.	Porridge is offered in sizes of 250 g, 750 g, and 10 kg. Sizanani will need to consider increasing value perceptions about packaging by offering a resealable Instant Porridge pack and attempting to align pack sizes to market needs, if financially viable.
	The package size needs to promote use of the entire package for one mealtime to avoid attracting rats.	The 30 g juice pack enables consumers to use the entire package as it makes one liter, which is the usual quantity of juice bought.
Branding	Shoppers have a small repertoire of brands that they know will be consumed by the family. They are very unlikely to buy an unknown brand for fear of wasting money in case the family dislikes the product.	This meant having to increase brand activity to familiarize consumers with the brand. Extensive presence in public areas would stimulate interest and trigger people to try it out. Chosen openings were: radio, billboards, community centers, and newspaper adverts.
		Currently, Sizanani Mzanzi products are undergoing a rebranding exercise, which will be completed in mid-2018. The exercise will include a new name for the products and improved packaging.
		This will be discussed in greater detail in the second part of this article, to appear in the second issue of the magazine in 2018.

Core product development

A core product provides benefits that correspond to the needs specified by consumers. These benefits are of two types, namely: (1) functional benefits and (2) emotional benefits. The consumer research carried out by BMI Research led to valuable findings concerning the forms and functional utilities consumers were demanding, as well as their latent needs and desires. This information further framed and informed the marketing mix strategy. The illustration at left (**Figure 4**) describes the emotional and functional benefits of porridge and juice consumption among consumer research respondents. Respondents were all women aged 24–60 and had a living standards measure of 5–7 within

the SAARF (South African Audience Research Foundation) Living Standards Measure (LSM). This is the most widely used and unique segmentation tool in South Africa.⁷ Instead of segmenting the population according to race, age, gender, and other variables, it groups people according to their living standards, using criteria such as degree of urbanization and ownership of cars and major appliances.⁷ The population is currently divided into 10 LSM groups, from 1 (lowest) to 10 (highest). LSM 1–5 contain the poorest of South African citizens, followed by a middle-income group within category 6–8, and the wealthiest South Africans within LSM 9–10.⁸ **Table 1** depicts the characteristics of LSM groups 5, 6, and 7, with each having an average

FIGURE 5: MixMe product instructions for use**MixMe instant maize/soy blend porridge****MixMe Flavored Powdered Drink**

monthly household income, in South African rand (ZAR), of ZAR 5,636, ZAR 7,876, and ZAR 13,434, respectively.⁹ Some of the women worked full-time, while others were part-time workers, housewives, or unemployed. They all resided in the township of Soweto.

Tangible product development

The product concept becomes visible and operational when psychological needs are specified in physical terms. Any product has five characteristics: (1) quality, (2) features, (3) design/style (note: design/style is not included here, because the juice product itself is a premix powder formula that looks like any other powder, and the same applies for the porridge, which looks

like normal oat flakes), (4) packaging, and (5) branding.⁶ It is in terms of these five characteristics that a consumer expresses the benefits he or she desires. Marketers have to look at how important each characteristic is to the consumer (consumer needs) and how much of each characteristic is to be incorporated in product design (marketing implications).⁶

Augmented product development

As defined by the management theorist Peter Drucker, the augmented product is none other than the total package of benefits obtained by consumers (in our case, consumers of Sizanani Mzansi products).¹⁰ These benefits are outlined in Table 3. Marketers should have the vision to look at the specific needs of

TABLE 3: MixMe augmented products

What MixMe Instant Porridge offers	What MixMe Flavored Powdered Drink offers
Instant – just add water or milk and mix	Instant – just add water and mix
17 vitamins and minerals added – high in 13 and a source of 4; 11% protein per 100 g serving	18 vitamins and minerals added – high in 13 and a source of 5
Sells at a lower price compared to similar instant protein porridges with added vitamins and minerals	Currently the only known easy-to-mix powdered drink with added vitamins and minerals
A range of three package sizes – 250 g, 750 g, 10 kg	Incomparable value for money for the combination of a drink and a source of 18 vitamins and minerals
Shelf life: 12 months	Shelf life: 18 months
Delivered to your door	Delivered to your door

TABLE 4: Types of product line planning decisions for Sizanani Mzanzi

Product line planning decisions	Sizanani Mzanzi
Product line breadth:	
How many different lines a company offers	a. MixMe Instant Porridge b. MixMe Flavored Powdered Drink
Product line length:	
How many items there are in a line covering different price points	a. MixMe Instant Porridge > 250 g > 750 g > 10 kg b. MixMe Flavored Powdered Drink > 30 g
Product line depth:	
How many types of a given product there are	a. MixMe Instant Porridge > Vanilla > Original b. MixMe Flavored Powdered Drink > Orange > Pineapple

consumers and also at their related requirements in order to obtain a complete picture of their consumption to attract them with the right offer.⁶ Table 3 summarizes the value proposition of the Sizanani Mzanzi products in question.

Do we need a portfolio of products? New products?

A product line is a group of related products under a single brand sold by the same company. For Sizanani Mzanzi, the product line consists of the MixMe brand of Instant Porridge and Flavored Powdered Drinks in their various sizes and flavors. There are three major types of product line planning decisions marketers need to make: product line breadth, product line length, and product line depth (Table 4).

For Sizanani Mzanzi's future product line planning, decisions on individual items need to be considered within the context of the firm's full product line due to individual item interrelationships. The consumer research carried out by BMI Research in 2017 shows that MixMe Instant Porridge is marketed as an alternative to a time-consuming breakfast, even though people use it as filler and even a meal replacement for dinner. This gives the marketer a chance to **strengthen the positioning** of the Instant Porridge by offering different flavors for different times of the day. This means that the **product line depth** for the MixMe Instant Porridge line could be increased to include more nutritious flavors for breakfast and more indulgent flavors for dinner. The original would be considered more nutritious since it has no added flavors, whereas banana, strawberry, and vanilla would be considered more indulgent.

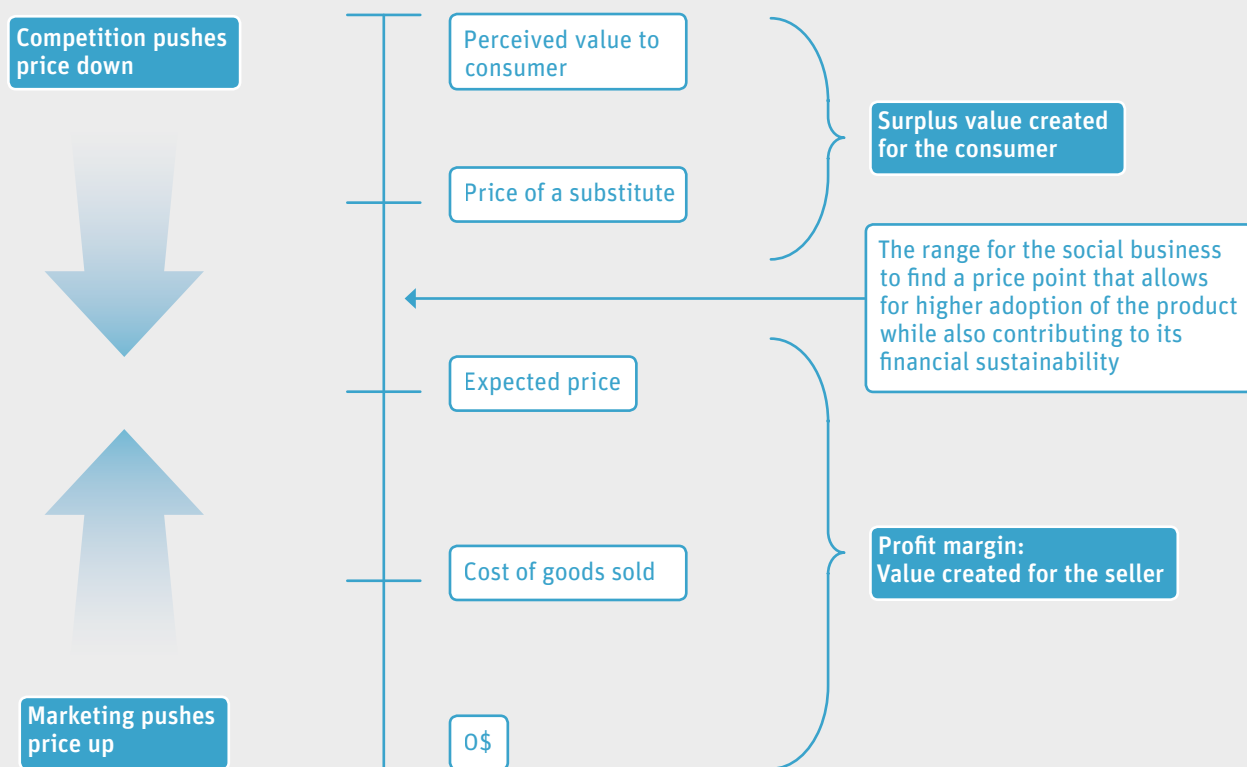
Similarly, the MixMe Flavored Powdered Drink is a cost-effective alternative for fresh fruit juices and carbonated drinks and could be **repositioned** by offering different flavors for different occasions during the day to stimulate consumption. Thus, the **product line depth** for MixMe Flavored Powdered Drink could also be increased.

.....

“The combination of product, place, and promotion determines the target customer's perception of the value of the firm's product”

.....

In the coming year, Sizanani Mzanzi is also planning to increase its **product line breadth**. Mageu is a non-alcoholic drink made from fermented mealie meal, a relatively coarse flour made from maize, which the native populations of South Africa have used for centuries and is now mostly used as a quick and affordable snack, available in most supermarkets and shops across the country. Mageu will be tested with a fruit drink in the community, along with a chocolate spread. A product tasting questionnaire and the cost structure for these new product lines are being developed. The new products follow the guiding principle of making affordable nutritious foods available to low-income communities and thus fit perfectly into Sizanani Mzanzi's plans for expanding the breadth of its product line.

FIGURE 6: Price-setting guidelines for marketers

Price

The combination of the 3 other P's – product, place, and promotion – determines the target customer's perception of the value of the firm's product. This perceived value represents the maximum **price** the consumer is willing to pay. This is the primary guide for pricing the product.

Base-of-the-pyramid (BoP) consumers are ready to pay more for nutritious products they value and there are two key contextual insights from South Africa that are important to pricing decisions:¹¹

- > Luxury brands are up to 20 times more expensive than traditional non-fortified foods.
- > People are ready to spend up to seven times the price of local non-fortified foods on affordable fortified products.

TABLE 5: Benchmarking analysis for pricing MixMe Instant Porridge

Brand Type	Price
Non-fortified brands	x
Healthy and nutritious luxury brands	6x

To determine the price for any new product, the benchmarking analysis should include looking at available brands and conducting a cost-plus pricing analysis, which means that the costs of delivering the new product to the consumer should be recovered. The guiding principles for price-setting that a marketer needs to follow are summarized in **Figure 6**.

By way of example, before pricing the MixMe Instant Porridge, two categories of instant porridge brands in the market were investigated:

- > Non-fortified brands
- > Healthy and nutritious luxury brands

“Sizanani Mzanzi products should be positioned as an investment in the family's health”

From this benchmarking analysis, the marketer will be able to ascertain that the ideal pricing for Sizanani Mzanzi's MixMe Instant Porridge should be between x and 5x, at a point below the customer's perceived value and above the producer's cost of goods sold.

Recent consumer research by BMI Research tells us that price, though important for this price-conscious market, is a relatively weak driver of brand choice. However, if the consumer uses a repertoire of brands, most consumers will opt for the cheaper of the two brands. This means that the health and nutritional benefits of Sizanani Mzanzi products will have to be accentuated in the pricing communication if the pricing premium is to be maintained. For the price-conscious consumer, Sizanani Mzanzi products should be positioned as an investment in the family's health.

Additionally, consumers are non-compromising on price for taste and quality across both product categories and only compare prices across brands they use on a regular basis (and few use multiple brands within the two categories). Thus, an approach to pricing similar to or cheaper than competing brands is currently being considered.

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Appropriate Eating: The Mediterranean Diet in Homer's *Odyssey*

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“There is no boon in life more sweet, I say,
than when a summer joy holds all the realm,
and banqueters sit listening to a harper
in a great hall, by rows of tables heaped
with bread and roast meat, while a steward goes
to dip up wine and brim your cups again.”¹

At a first glance, these six lines from Homer's *Odyssey* lack apparent drama. They do not possess the epic tension that characterizes so many of the Ancient Greek poem's more famous passages – the scene of Odysseus bound to the mast and listening to the sirens' song, for instance, or the description of Odysseus blinding the Cyclops and fleeing his cave together with his surviving men. Yet they are as fundamental to *The Odyssey*'s moral vision

as any of Homer's more famous scenes. For *The Odyssey* is not just about adventuring. It is not just about homecoming. It is, in a profound way, about eating. More than this: it is about a journey from inappropriate to appropriate eating.

The above-quoted lines are addressed by Odysseus, King of Ithaka, to King Alkínoös of Phaiákia, during the course of a banquet at the hall of Alkínoös. The Phaiákian king has given Odysseus temporary refuge as the Greek warrior makes his tortuous way home from the Trojan War, persecuted at every turn by Poseidon, god of the sea. Odysseus's words are spoken just before he is about to recount the tale of his wanderings so far: they represent a brief moment of respite, as Odysseus reflects on the dangers of a journey that is far from finished. And they are spoken, crucially, within the context of organized eating and drinking. In this sense at least, they are spoken within the context of what has come to be called the “Mediterranean Diet.”

“All deaths are hateful to us,
mortal wretches, but famine
is the most pitiful, the worst end
that a man can come to”²

The sociology of the Mediterranean Diet

Much has been written about the Mediterranean Diet since the term was first coined by the American physiologist Ancel Keys in the 1950s.⁴ Today it is generally recognized as a diet “characterized by high consumption of olive oil – its hallmark – and vegetables, fruits and nuts, legumes, and unprocessed cereals; low consumption of meat and meat products; and low consumption of dairy products (with the exception of types of cheese that keep for long periods).”⁵

Occurring traditionally in parts of the world that enjoy a Mediterranean climate, and not just in the geographical region of the Mediterranean itself, the Mediterranean Diet offers widely attested health benefits, especially for cardiovascular health.⁶ It



Head of Odysseus from a sculptural group representing Odysseus blinding Polyphemus. Marble, Greek, probably 1st century CE. From the villa of Tiberius at Sperlonga. Museo Archeologico Nazionale in Sperlonga, Italy.



Mediterranean salad dishes. The PREDIMED trial showed that among persons at high cardiovascular risk, a Mediterranean Diet supplemented with extra-virgin olive oil or nuts reduced the incidence of major cardiovascular events.³

also has an important social component: UNESCO's 2010 Candidate Dossier proposing the recognition of the Mediterranean Diet as part of the Intangible Cultural Heritage of Humanity expressly describes it as a "social practice" (*pratique sociale*).⁷ The Dossier even goes so far as to underline this point by quoting the Ancient Greek philosopher Plutarch: "We do not sit down at table to eat, but to eat together" (*Nous ne nous asseyons pas à table pour manger, mais pour manger ensemble*).⁸ Thus Homer from the perspective of the 8th century BCE and UNESCO from today's perspective agree that the Mediterranean Diet is not just about *what* we eat but also about *how* we eat.

This view is supported by the fact that the Ancient Greek word *diaita* (δίαίτα), from which the English words 'diet' and 'dietetics' are derived, was taken in ancient times to refer not just to alimentary intake but also to exercise. The food-drink-exercise triad was indeed also sometimes expanded to include bathing and even sexual practices, giving the word *δίαίτα* a much broader meaning than 'diet' in the modern sense, and closer perhaps to the concept of 'regimen of life', 'way of living', or even 'lifestyle'.⁹

The hall and the suitors

"I don't know about you," writes American author Michael Pollan in his 2013 book *Cooked: A Natural History of Transformation*,

"but I always skipped over the big eating scenes in Homer, barely even stopping to wonder why there were so many of them, or why Homer took the trouble to spell out so many seemingly trivial details: the ins and outs of butchery ('They flayed the carcass... and divided it into joints'), fire management ('When the flame had died down, [Patroclus] spread the embers, laid the spits on top of them'), the parceling out of portions ('Achilles served the meat'), table manners ('Face-to-face with his noble guest Odysseus ... he told his friends to sacrifice to the gods'), and so forth. But according to *The Cuisine of Sacrifice Among the Greeks*, there was good reason for Homer to dwell on these ritual meals. The sharing of cooked meat constituted *the* communal act among the Ancient Greeks, as indeed it has done in a great many other cultures before or since. And doing it right takes some doing."¹¹

There is in fact an even more significant reason for Homer to dwell on these scenes. For Odysseus is not just any man, or any soldier or mariner. He is the King of Ithaka, the lord of his own hall and his own land. Had he not participated in the Trojan War, the "master mariner and soldier"¹² would never have left that home, and could have spent his life feasting in peace and dignity with family, friends, and guests in the manner evoked by his words to King Alkinoös, "listening to a harper / in a great hall, by rows of tables heaped / with bread and roast meat."



The ritual cooking of meat depicted on an Ancient Greek vase. “Cooking in the analyses of social anthropologists such as Claude Levi-Strauss and Mary Douglas resembles language. It is a form of narrative that marks out our ‘culture’ and our separation from ‘nature.’ It allows us to weave elaborate culinary stories with which to shape and consolidate our social worlds.”¹⁰

Odysseus is far from home, however. Surprisingly, the narrative of *The Odyssey* commences with an account not of the eponymous hero's trials and tribulations in strange lands but of the devastation being wrought on his house and home by the suitors – men who did not go to the Trojan War. These opportunists have camped in his hall and are vying with one another for the hand of Odysseus's wife Penelope, in the belief that Odysseus will never return to Ithaka.

When reading classic literature, it is always worth remembering that scenes that have long been familiar to us are the result of the author's choices, and have only acquired their sense of immutability with the passing of the years. Odysseus in bed with the nymph Kalypso might be a very good starting point for a modern telling of the tale. Odysseus being washed up on the shores of Phaiákia, naked and half drowned, might be an equally good one, and just as much in keeping with modern tastes. But Homer commences his story in Ithaka, and within a few lines, we have a description of the suitors feasting in Odysseus's hall:

“Now came the suitors,
young bloods trooping in to their own seats
on thrones or easy chairs. Attendants poured

water over their fingers, while the maids
piled baskets full of brown loaves near at hand,
and houseboys brimmed the bowls with wine.
Now they laid hands upon the ready feast
and thought of nothing more.”¹³

Abuse of “guest-friendship”

This is the situation that Odysseus must reverse, with the help of his son Telémakhos and the goddess Athena. It is the precise inverse of the Ancient Greek notion of *xenia* (ξενία), ‘guest-friendship’:¹⁴ the suitors have turned up uninvited, and are eating the absent Odysseus out of house and home as they vie with one another for Penelope's hand. It is an abuse of everything civilized: the sanctity of the body, the bonds of matrimony, the integrity of the family, and the privacy of the home. From the other side of the world, Odysseus awakens out of his infatuation with Kalypso to return home, confront the suitors and restore the correct order of things.

Given the centrality of correct and incorrect feasting to the moral architecture of the narrative, it is therefore no surprise that food plays such a significant part in the story of Odysseus's return home. We encounter for example, the effects of narcotic foods on the lotus-eaters (Book IX), the poisoning of food by

the witch Kirkê (Book X), and the actual eating of guests by the Cyclops Polyphêmos:

“O Kyklops! Would you feast on my companions?
[cries Odysseus]
Puny, am I, in a Caveman’s hands?
How do you like the beating we gave you,
you damned cannibal! Eater of guests
under your roof! Zeus and the gods have paid you!”¹⁵

“The pork of slaves”

There are, as observed by Michael Pollan, many descriptions of feasts in *The Odyssey*, and of the ritual slaughter that precedes them. The details are always significant. As Martin Jones observed in his 2007 consideration of the phenomenon of feasting, “There are many ways of taking an animal apart. It can be fairly randomly hacked into meal-sized chunks, or systematically, into component meats. The vertebral elements may all be sliced in two, an indication of the division of ‘sides’ of meat for transport and storage, or cut laterally to prepare rib steaks. In recent centuries, when butchery practices have actually been written about, it is clear that they reflect not just preferences for particular cuts and joints of meat on the table, but the actual context of those preferences in narratives of social hierarchy and religious belief. Certain cuts may be considered impure, and forbidden; other cuts may be reserved for sacrifice to the gods.”¹⁶

One of the most subtly moving passages in *The Odyssey* describes a meal prepared for Odysseus by the swineherd Eumaios. Odysseus has returned incognito to Ithaka and needs to find a way to get into his hall and take the suitors by surprise: he knows

that if he encounters them in the open, he will be no match for their numbers. Eumaios has been looking after Odysseus’s swine in the king’s absence and himself suffering the abuse of the suitors. The swineherd has not yet recognized his master. He speaks movingly of his absent king, then offers the unknown guest what hospitality he can:

“This being told,
he tucked his long shirt up inside the belt
and strode into the pens for two young porkers.
He slaughtered them and singed them at the fire,
flayed and quartered them, and skewered the meat
to broil it all; then gave it to Odysseus
hot on the spits. He shook out barley meal,
took a winebowl of ivy wood and filled it,
and sat down with him, a gesture, saying:

“There is your dinner, friend, the pork of slaves.
Our fat shoats are all eaten by the suitors,
cold-hearted men, who never spare a thought
for how they stand in the sight of Zeus.”¹⁷

The fat shoats (young pigs) are eaten by the suitors; Odysseus’s dinner is “the pork of slaves” because the two young porkers are by implication not fat, and may make tough eating. Eventually “the great tactician”¹⁸ Odysseus will, together with his son Telémakhos, kill the suitors, remove their corpses from his hall, cleanse it, and feast there again in peace with his wife, family, friends, and guests.

.....
“Bless you, stranger, fall to and
enjoy it for what it is.
Zeus grants us this or that, or else
refrains from granting, as he will;
all things are in his power.”¹⁹
.....

And the vegetables ...?

It will be noted that none of the passages quoted make any mention of fruit or vegetables – an omission that would appear to make a mockery of any comparison between the diet consumed by Ancient Greeks as described by Homer and the Mediterranean Diet as originally identified by Ancel Keys. The matter may be more multifaceted than it seems, however. It is known that the Ancient Greek diet made extensive use of olive oil and wine, and that it consisted primarily of cereals, grains, and legumes, with red meat a luxury (usually limited to feasts), pork and poultry a staple for the wealthier classes, and a range of vegetables



Modern-day depiction of the blind poet Homer outside the Albert Ludwig University of Freiburg, Germany. Many scholars nowadays believe that *The Odyssey* and *The Iliad* are the product not of a single poet, but of an entire culture.²⁰



Modern-day Ithaca – an island in the Ionian Sea in Greece, and the longed-for home of the wandering King Odysseus

commonly consumed by the common people (onions, garlic, turnips, radishes, lettuce, artichoke, cabbages, leeks, celery, and cucumber).²¹

The absence of fruit and vegetables in most of *The Odyssey* might be partly because discussion of food often takes place in contexts of dire need while traveling far from home, when game (hunted food) might be the only readily available source of sustenance. It might also be because, in the context of the many well-organized feasts, fruit and vegetables are too basic a component to merit special description. They do not possess the ritual significance of meat.

Certainly the description of the advanced horticultural arrangements in the well-ordered kingdom of Alkinoös would suggest that the Mediterranean world of ancient times was a sophisticated agrarian economy:

“To left and right, outside, he saw an orchard closed by a pale – four spacious acres planted with trees in bloom or weighted down for picking: pear trees, pomegranates, brilliant apples, luscious figs, and olives ripe and dark. Fruit never failed upon these trees: winter and summer time they bore, for through the year

the breathing Westwind ripened all in turn – so one pear came to prime, and then another, and so with apples, figs, and the vine's fruit empurpled in the royal vineyard there. Currants were dried at one end, on a platform bare to the sun, beyond the vintage arbors and vats the vintners trod; while near at hand were new barely formed as the green bloom fell, or half-ripe clusters, faintly coloring. After the vines came rows of vegetables of all the kinds that flourish in every season, and through the garden plots and orchard ran channels from one clear fountain, while another gushed through a pipe under the courtyard entrance to serve the house and all those who came for water. These were the gifts of heaven to Alkinoös.”²²

Alkinoös is the just ruler of a peaceful land, and has thus received “the gifts of heaven” in the form of fruits, vegetables, and vines. Certainly this view of the ancient integrity of the Mediterranean Diet is borne out by the Greek poet Hesiod, considered by scholars to have been a near contemporary of Homer. In his *Works and Days*, Hesiod writes:

“When the Atlas-born Pleiades rise [i.e., in the first half of May], start the harvest – the plowing, when they set. They are concealed for fourteen nights and days, but when the year has revolved they appear once more, when the iron is being sharpened. This is the rule for the plains, and for those who dwell near the sea and those far from the swelling sea in the valleys and glens, fertile land: sow naked, and plow naked, and harvest naked if you want to bring in all Demeter’s works in due season.”²³

“Belly must be filled”

Certainly food has a more obvious centrality to *The Odyssey* than to many other great works of literature. It has ritual and symbolic power, as well as being essential to all life and crucial to the good order of society. This quintessential quality is well evoked by Odysseus himself in an observation to his host Alkínoös before he starts his accounts of his journeyings:

“You will indulge me if I finish dinner –?
grieved though I am to say it. There’s no part
of man more like a dog than a brazen Belly,
crying to be remembered – and it must be –
when we are mortal weary and sick at heart;
and that is my condition. Yet my hunger
drives me to take this food, and think no more
of my afflictions. Belly must be filled.”²⁴

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Phyllis Elaine Bowen (1940–2018)

Nutrition scientist and humanitarian Phyllis Bowen dies at 78

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Dr. Phyllis Bowen, the innovative, thought-provoking nutrition researcher and educator, passed away on March 19, 2018, from surgical complications. In 2009, Phyllis retired and was named Professor Emerita in the Department of Kinesiology and Nutrition at the University of Illinois at Chicago. She received a BS in Experimental Foods from Iowa State University, and an MS and a PhD in Nutrition from Cornell University, the latter with minors in biochemistry and physiology.

First, it is important to remember her pedagogy. She was a remarkably inquisitive and effective educator and communicator. Through her lectures, she inspired me to pursue a research career in nutrition, as she probably did for so many. Phyllis received many awards for teaching excellence: twice the Excalibur Award (in 2006 and 2008), the University of Illinois at Chicago (UIC) Teaching Excellence Award, the Amoco Silver Circle Award for undergraduate teaching at UIC, and numerous certificates of teaching excellence at Virginia Polytechnic Institute and State University, where she taught and conducted nutrition research before coming to UIC in 1983. These same skills were also manifest in many presentations at various scientific conferences and workgroups. She was a critical thinker and a tremendous contributor to scientific conferences and to students and fellow researchers alike, but with a humility and integrity that are rare to find.

**“Her contributions to
nutrition science were vast”**

Her contributions to nutrition science were vast. Her pioneering research on the pharmacokinetics of carotenoids and other bioactive ingredients in foods with respect to eye biology and function and to cancer biology (especially for prostate, colon, and breast cancers) is well known. She ran several human feeding trials meticulously. One exemplary effort was a tomato-based feeding study she designed to understand carotenoid metabolism in men at risk for prostate cancer, and specifically to identify possible surrogate endpoint biomarkers for cancer regression or progression for future clinical trials.^{1,2} Those experiences were communicated in a key book chapter she coauthored on designing dietary intervention studies.^{3,4}

Phyllis modeled innovative professional services to the nutrition science field; she had incredible creative energy! She was the founding member of, and served for many years on, the Scientific Advisory Board for the California Dried Plum Board. She authored several publications on nutrition policy, including the role of commodity boards in nutrition research.⁵ She was the founding member of the Carotenoids and Retinoid Interaction Group (CARIG) and was the Chair of CARIG for several years. She also helped establish the International Society for Carotenoids Research and was a founding and advisory committee member for the Plant Phenolics in Health Research Interest Group (PhenHRIG). She was honored for her work when she was named an International Carotenoid Society Fellow in 2017. Phyllis also founded and co-directed the Functional Foods for Health Program jointly between UIC and University of Illinois at Urbana-Champaign. She served on the Board of Scientific Counselors, Division of Cancer Prevention and Control at the National Cancer Institute; on the Arteriosclerosis, Hypertension and Lipid Metabolism Advisory Committee of the National Heart, Lung, and Blood Institute (NHLBI); as an external reviewer for the Dietary Reference Intakes; and as a National Institutes of Health (NIH) State-of-the-Science panel



Dr. Phyllis Bowen: "A remarkably inquisitive and effective educator and communicator"

member at the Preventing Alzheimer's Disease and Cognitive Decline Conference.⁶ She was also on numerous editorial boards (*Journal of Nutrition*, *Nutrition Today*, *Nutraceutical Research*, and *Integrative Cancer Therapies*) and on the Data and Safety Monitoring Board (DSMB) of several trials. Moreover, she served as Assistant Dean at the UIC College of Applied Health Sciences (2003–2006), as well as Associate Head of the UIC Department of Human Nutrition and Dietetics (1988–1994).

Phyllis's contributions to her community were also numerous. She served as the first board chairperson of the Alliance of Hope, a support organization for survivors of family suicide. She was the editor of the 2017 and 2018 *Journal of the Conference of Global Transformation for the Landmark Education* annual conference. She is survived by her loving husband and partner, Sam, her son Jeremy, her brother Norman, and three grandchildren and their mother, Jeannine. Phyllis was an equalizer. As her son said of her: "A gardener [not only of plants] but of people," she wanted to help you grow and flourish! She will be missed by all who knew her.

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A Day in the Life of Mark J. Manary, MD

Helene B. Roberson Professor of Pediatrics
at Washington University in St. Louis, MO, USA

Sight and Life (SAL): *Mark Manary, you are a medical doctor by training and also Professor of Pediatrics at Washington University in St. Louis. What inspired you to study medicine when you were younger?*

Mark Manary (MM): I've always been a couple of standard deviations out there on wanting to make the world a better place! I originally studied chemical engineering at MIT, and my first job was at an aluminum company. The company was planning to lay people off, however, and just at that time I got a call from somebody at Washington University asking if I might consider studying medicine there. The university was looking to boost numbers on its medicine course, and prospects at the aluminum company weren't particularly appealing, and so I decided to give it a try. It was a leap in the dark, because I'd never really studied biology, but I'm a person who is very focused on the present, and I tend to think more about what I'm doing in the here and now than what I might be doing in five or 10 years' time. So I took the opportunity.

It was incredibly hard at the beginning, and I got substandard grades for my didactic work, but I stuck with it because I found it so fascinating and rewarding. Seven years later, I was working in pediatrics, and I moved on from that to become a food producer in Africa, which hadn't been planned at all, of course. I'm a generalist by nature, and I like to think that I can put my mind to anything if I really want to.

SAL: *What drives your especial interest in pediatrics?*

MM: It comes from the choices I had to make while at medical school. The first couple of years of my studies were very challenging, not least because I had to work alongside people who had an entirely different background and mindset from my own,

but by the third year I was working in a hospital. Eventually I had to decide on an area of specialization. I was aware that I lacked the deftness to be a surgeon, but it struck me that if children are ill and receive appropriate treatment, then they have a very good chance of getting better. This appealed to me because I wanted to make a positive difference in people's lives.

So I spent two years in pediatrics, after which my wife Mardi, who is a registered nurse, suggested that we go to Africa – which was quite an unusual decision to make in that day. By 1985, I was working in a mission hospital in Tanzania, and the HIV epidemic was under way. I was the only doctor in a 400-bed hospital, and I dealt with over 300 surgery cases in my first year there – by which I mean that I did the actual surgery!

It was a very different era from today, of course. We kept the hospital running with the aid of medical students from the US and the UK, and my wife and I fell completely in love with Africa. For us, it was a place where we could make a life-or-death difference through minor surgery and the administration of drugs such as antibiotics and antimalarials. It was a hugely rewarding experience for us both.

SAL: *And so did you stay in Africa from that point on?*

MM: No, we returned to the US for some years. My wife and I had a son in Africa, but he tragically suffered cot death. This had enormous ramifications not just for the two of us, but for our respective families as well. Mardi and I therefore felt it would be appropriate to move back to the US.

I spent two years on the Cheyenne Indian Reservation in South Dakota as acting Clinical Director with the U.S. Public Health Service. There were many health and societal problems to address on the reservation, but the Native American population was mistrustful of the Public Health Service, and I found this a very difficult experience. Africa had been very different, for people there had reacted so positively to our attempts to help them. Mardi then became pregnant again, and in 1989 I moved back to Washington University as an emergency doctor. We both



Dr. Mark Manary



© Megan Manary

Evaluation of a child with severe malnutrition at the Chikweo clinic in Machinga, Malawi

felt so passionate about Africa, however, that we arranged to get sent back out there, moving permanently to Malawi in 1994 to work in a new government medical school.

SAL: *How did you become involved in nutrition, and specifically in the development of the first ready-to-use therapeutic food (RUTF)?*

MM: I've always believed that if you want to have a positive influence on the world, you should try to work on the biggest problem you can find: it's better to chip away at a really big iceberg than to spend your whole life looking for a little bit of thin ice that you can melt. Levels of malnutrition were very high in Malawi in the 1990s. I was actually advised by my boss at the time to steer clear of nutrition because it was "just too grim," but Mardi and I are willing to take challenges, and we felt we had to do something in the face of the suffering we were witnessing.

So we took on the biggest problem: pediatric severe acute malnutrition (SAM). At the time, one in three children diagnosed with malnutrition in Malawi was dying despite our best efforts to treat them. After about eight months, we got that figure down to one in ten, but just one in four recovered. That meant that there were still significant numbers of children dying, however, and that the milk-based nutrition they were being offered was

clearly not adequate. We felt that a new approach was necessary – some form of home-based therapy that would allow us to break through that "ceiling" on recovery.

SAL: *So how did the breakthrough come about?*

MM: We were working on a different project involving zinc nutrition at the time, in a small village where simply getting through



© Jeff Davis

Children being measured to determine nutritional status in Chipalonga, Malawi

the day involved a huge amount of manual labor for the locals, starting with drawing water and collecting firewood for cooking. It was clear to us that any ready-to-use therapeutic food would have to fulfill four criteria if it were to be effective in this context. It had to be edible without needing to be cooked, it had to provide adequate levels of protein and fats, it had to be stable in hot conditions, and it had to be resistant to the growth of bacteria on it.

Shortly after the zinc project in that village came to an end, I happened to get an email from a French colleague, the pediatric nutritionist André Briend, who was interested in the subject of therapeutic food and wanted to compare notes with me. André had been looking into fortified biscuits and other delivery mechanisms, but I'm an American, and so my thoughts went naturally to peanut butter: it sits on the shelf for ages without going off, because 50% of its content is fat. The oil won't allow bacteria to grow, even in warm conditions. It's therefore ideal for use in a hot country such as Malawi.

With the help of the French company Nutriset, which had been founded in 1986 to feed vulnerable populations in developing countries and provide humanitarian workers with effective nutritional products, we developed the first RUTF, which was based on peanut paste, milk powder, vegetable oil and sugar. The results from the initial clinical trials were very positive, and so we decided to take the leap and manufacture it locally.

SAL: *What were the challenges in making that happen?*

MM: There was a challenge at the level of nutrition policy, for the World Health Organization was initially against ready-to-use therapeutic foods. On the ground in Malawi, however, it was clear that although our initial attempts at local manufacture were promising, we lacked the local capabilities to manufacture at the scale necessary. Fortunately, we managed to obtain the financial support of humanitarian donors, which enabled us to set up the NGO Project Peanut Butter in 2004. Nutriset was also extremely supportive, supplying us with the necessary manufacturing machinery and also training a Malawian as factory manager. This allowed us to significantly scale up our output, after which agencies such as WHO, UNICEF and WFP came on board, providing another much-needed boost to our efforts.

SAL: *Much of your work has focused on combating malnutrition in children. Based on your experience, do you think that the UN Sustainable Development Goal of Zero Hunger is practicable?*

MM: I do. I'm convinced that we can beat hunger. It's just about food. We've halved levels of malnutrition in the past 15 years. The government of Malawi endorsed homemade therapy in 2007 and put in place local health workers to promote its use. These



Mark Manary: "It's about connecting with mothers"

efforts have cut the rate of infant mortality from malnutrition from 23% to 6%, even though Malawi remains one of the poorest countries in the world, with most of its population dependent on subsistence farming.

SAL: *You've gone on record as saying, "In situations of chronic poverty, you're definitely going to get more mileage out of something you can embed in the local fabric." What does **embedding in the local fabric** mean in this context?*

MM: It's about connecting with mothers. You have to get right to the people who need the help. Village health workers have an important role to play here, because they have valuable local knowledge and are held accountable for their actions by the entire village where they live. This is not the case with health workers, who don't have the same kind of local accountability and may be open to corruption. It's important to manufacture locally and deliver to mothers via the minimum number of intermediaries. In Ghana, for instance, we manufacture RUTF locally and deliver it to local retailers. These retailers want to get paid. The mothers want the food the retailers produce, and so they pay the retailers for the food they receive. Cutting out the warehouses and middlemen means that the RUTF gets to the people who really need it. That's what I mean by "embedding in the local fabric."

SAL: *RUTFs are still a relatively new public health intervention. Are there ways in which they could be improved?*

.....

MM: We've developed linear programming tools that allow us to replace some of the original ingredients with locally produced foods, reducing costs at the same time. We're currently looking at changing the balance of polyunsaturated fatty acids (decreasing the omega-6 content and increasing the omega-3 content) and are also exploring the potential use of other oils, such as high oleic soy oil.

We also need to improve the quality of the protein content of RUTFs and to find ways of replacing the stabilizers and emulsifiers currently in use. It's been found that these can dissolve the mucus layer of the gut, providing harmful bacteria with easier conditions in which to attack the body. We're therefore currently looking into the use of whey-based emulsifiers as an alternative.

SAL: *You have received many awards and distinctions, from the CIBA Award of Community Service that you received in 1980 to your appointment to the WHO Expert Advisory panel on the Management of Malnutrition in Children in 2012. Is there one of these recognitions that gives you especial pride, and if so, which one and why?*

MM: I'm very honored by all the commendations I have been lucky enough to receive, but the two that mean the most to me come from General Mills and Hershey, both of which provide financial support to Project Peanut Butter. The fact that these commercial organizations wanted to help food producers in Africa, and that they've been able to do it via Project Peanut Butter, is hugely important to me.

SAL: *What would be your advice to aspiring pediatricians reading this article, Mark?*

.....

MM: I would counsel anyone interested in pediatrics to be an empiricist rather than a philosopher. By this I mean that if you want to bring about positive change, it's essential to try things out, find out what happens, and believe in the result. Base your work on realities rather than ideas. And always, always, go after a really big problem.

SAL: *Thank you, and the best of luck with all your future projects*

.....

MM: Thank you.

.....

Mark Manary was interviewed by Jonathan Steffen

For a world free from malnutrition.

share
best practices

We are committed to increasing
the knowledge of nutrition's value
in health and development.



Sight and Life is a
nutrition think tank
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The 10th Asia Pacific Congress on Clinical Nutrition

Adelaide, Australia, November 26–29, 2017

Noel W. Solomons

Center for Studies of Sensory Impairment,
Aging and Metabolism (CeSSIAM),
Guatemala City, Guatemala



The University of Adelaide hosted influential thought leaders at the 10th Asia Pacific Congress on Clinical Nutrition

The 10th Asia Pacific Congress on Clinical Nutrition (APCCN) was held in Adelaide, Australia, in conjunction with the annual meetings of the nutrition societies of Australia (NSA) and New Zealand (NSNZ). The meeting attracted 537 enrollees, including 253 participants from Australia and 125 from China. Many other nations of southern, southeastern and eastern Asia, North America and Europe were represented, alongside Latin America and Africa. An extraordinary amount of valuable and contemporary information was compressed into the platform and poster offerings of the three-day congress.

A total of 19 speakers were programmed across seven plenary sessions as listed in [Table 1](#).

TABLE 1: Plenary sessions at the APCCN

Conference Opening Plenary

Plenary session 1: Sustainability: Challenges and Solutions

Plenary session 2: Dairy Australia Lecture

Plenary session 3: Pediatric and Maternal Nutrition

Plenary session 4: Nutrition Crossroads

Plenary session 5: Nutrition and Chronic Diseases

Plenary session 6: Diet and Diabetes

Biomarkers and the future of nutrition

Clearly the plenary talk most relevant to the topic of micronutrients (to which *Sight and Life* has historically made significant contributions) was that of Prof. Robert Gibson in his dissertation on the theme of measuring assorted biomarkers of fatty acids and vitamins on samples collected as dried body fluids on filter paper. This requires minimal amounts of blood, in the form of drops, which can be dried and then stored and shipped at room temperature, without any need for a cold-chain for transport. In some cases, no major physical or chemical extraction is needed for the microsample. Whole blood is the principal substrate, but human milk can also be applied to this system. Perhaps the most intriguing discourse came in the plenary session on Sustainability by Julian Cribb, Australian author and science communicator. He spoke on the futuristic theme of “the future of nutrition.” His vision is one of a radical departure in current agricultural and farming practices, with intensification by means of crop modification and the utilization of urban gardening and even cropping. With a more sedentary lifestyle in a crowded world, the nutrient density of everything that is raised or grown for consumption will need to be designed to satisfy human nutritional needs.

“Nutrient density will need to be designed to satisfy human nutritional needs”

In addition, four thematic symposia were presented in plenary fashion. Each had a distinct message:

1. Global Nutrition: One Belt, One Road (a research initiative from China involving the countries comprising the Silk Road of Antiquity)
2. PEN: Practice-based Evidence in Nutrition (a presentation of the Dietitians Association of Australia)
3. Establishing Norms and Standards in Public Health Nutrition – from Science to Policy (assessing the origin and application of WHO recommendations for the region)
4. New concepts for Dietary Reference Intakes (DRIs), hidden hunger and fortification using Nutriomics knowledge

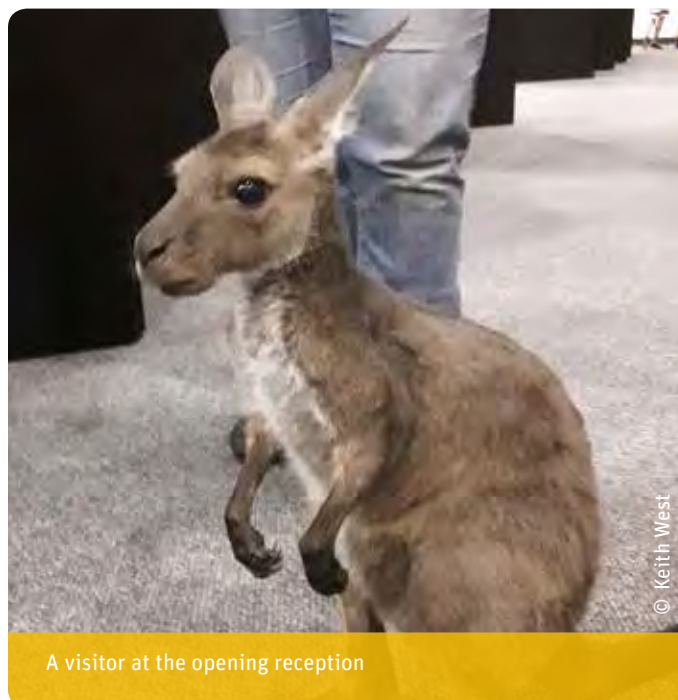
Focus on 'omics

The last of this series had special relevance to the micronutrient aspects of human and clinical nutrition, with a broad and novel 'omics focus. Two presentations provided overviews. Klaus Kraemer of *Sight and Life* critiqued the current manner in which specific nutrient recommendations are derived and projected how 'omics-based biomarkers of status might refine the process in addition to finding potentially more valid approaches to assess nutritional status in surveys and monitoring of interventions. Communicating by video from Bethesda, Maryland, USA, Dan Raiten of the National Institute of Child Health and Human Development (NICHD) called for the integration of nutritional assessment by the most advanced technology as a controlling variable in basic and clinical research protocols to better interpret and generalize the findings.

Practical examples of application of 'omics technology in nutrition were provided in the other two presentations. Keith West of Johns Hopkins University illustrated how nutriproteomics provided functional assessment of two antioxidant nutrients (selenium and vitamin E) among children in Nepal. Finally, Michael Fenech of the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Adelaide postulated that cellular damage was a concomitant of nutrient deficiency, illustrating how multiomics and systems biology tools might be applied to detect deficits and monitor correction.

Oral presentations and free papers

Aside from the invited participation, as represented in the plenary and symposium sessions, the congress featured an extensive free-paper program. Taken as a whole, the predominant



A visitor at the opening reception

concerns in the research and review themes presented at this tripartite congress related to obesity, energy density, metabolic disorders and non-communicable diseases, and to some extent their prevention and management. The oral presentation program included 161 papers arranged across 12 categories, with participation ranging from graduate students to senior faculty members, as listed in **Table 2**. Specific micronutrients were represented in 14 (8.6%) of this series: vitamin D in six, iodine in two, and tocotrienols, omega-3 PUFAs, zinc, zinc and copper, and multiple micronutrient powder across the remaining six. The same 12 organizational categories were used for the total

TABLE 2: Categories of abstract programming and number of offerings per category in the poster program

Obesity	46
Nutrition and aging	24
Cardiovascular nutrition	24
Micronutrients and health	23
Pediatrics	21
Diabetes	20
Nutrition and disease mechanisms	17
Gut health and microbiota	15
Nutrition in genomics	12
Hospital nutrition	10
Nutrition and physical performance	10
Sustainability	6



Keith West (JHU) and Michael Fenech (CSIRO)

TABLE 3: Titles of abstracts in the micronutrients and health poster cluster

The effects of folate supplementation on inflammatory biomarkers in depression: a systematic review
The lack of relationship between chromium and blood glucose concentration in the chromium-deficient and free-living populations
Dietary intake of antioxidant vitamin and mortality: a meta-analysis of 11 cohort studies
Seasonal variation in the phytochemical content of Australian prickly pear (<i>Opuntia ficus-indica</i>)
Potential influences of geographical positioning on phytochemical characteristics of Australian-grown prickly pear (<i>Opuntia ficus-indica</i>)
Prevalence of vitamin D status of Chinese children and adolescents from 2011 to 2012
Adherence to Australian Dietary Guidelines: students' experiences following an individualized diet plan as part of an undergraduate nutrition course
The effect of advanced glycation end-products on bone-quality deterioration and possible prevention with tocotrienol
Prevention of prostate cancer stem cells (CSCs) by Bowman-Birk Inhibitor (BBI) from soybean
Multiple micronutrient deficiencies persist among young children in Malaysia
How should we regulate dietary supplements?
Double burden of iron status in Chinese adult women with iron deficiency and iron overload: a cross-sectional study
Excess iron induced to membrane fluidity decrease and component change of red blood cells in rats
Nutrition knowledge of dietary iron and awareness of iron education in reproductive-age women in New Zealand
Low dietary zinc intake is associated with high psychological distress in Japanese workers
The combination of vitamin-E-homolog-induced cytotoxicity on prostate cancer cells
Second voided early morning urine minerals changed significantly with or without sodium restriction in humans
Fluoride intakes of 9–10-year-old children living in fluoridated and non-fluoridated New Zealand cities: a pilot study
Association between vitamin C and risk of hyperuricemia in American adults
Association of dietary selenium intakes and metabolic syndrome among Malaysian adults in Klang Valley
Decomposition of changes in the consumption of macronutrients in Vietnam between 2004 and 2014
Fish, long chain n-3 PUFA consumption, and risk of all-cause mortality: a systematic review and meta-analysis
Elevated serum ferritin level was associated with higher risk of hyperuricemia in Chinese middle-aged and elderly males: a cross-sectional study

of 228 free papers programmed as posters. The most populated area was obesity with 46 entries, constituting 20% of the field. The titles of the 23 free papers on micronutrients and health are listed in **Table 3**.

“The predominant concerns related to obesity, energy density, metabolic disorders and NCDs”

The micronutrient interest expressed by free-paper contributors at the APCCN was modest but varied and creative. In terms of trace elements, an important historical note is the projection of interest that derived from the Asia Pacific region. The late Eric Underwood was a livestock nutritionist, especially addressing nutrient intake from poor pastures in relation to the quality of Australian wool.¹

His research primarily concerned the gamut of trace elements, but his demonstration of the adverse effects of copper deficiency on the pliability of wool led to an understanding of Menkes kinky hair disease. The New Zealander Marion F. Robinson, from Otago on the South Island, was instrumental in focusing human nutrition on dietary deficiency of selenium, a condition produced by the hyposeleniferous soils of that region.²

Awards

The three-day congress ended with an awards ceremony. Lectures by the winners of the Asia Pacific Clinical Nutrition Society (APCNS) Award were delivered, including the 2016 recipient, Prof. Tee E. Siong of Malaysia, and the 2017 winner, Prof. Anura Kurpad of India. The former expounded on the topic “Contribution to nutrition development in Southeast Asia – a journey of 45 years.” The discourse of the latter was titled “Protein quality and the agriculture-health disconnect.” In the same session, a number of free-paper awards were given to students for excellence in the poster and oral platform presentations by both Prof. Duo Li, President of the APCNS, and Prof. Liza Wood, President of the NSA. The 11th APCCN, next in the series, will be held in September 2019 in Beijing under the auspices of the Chinese Nutrition Society.

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Affordability, Accessibility, and Sustainability Key to Improving Nutrition

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Yannick Foing

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Malnutrition occurs across the globe, but the problem is especially severe in Asia. More than half of all stunted children, almost half of all overweight children and more than two-thirds of all wasted children live in the region, according to a 2017 report¹ by the World Health Organization (WHO), United Nations Children's Fund (UNICEF) and World Bank Group.

A child whose growth was stunted in early childhood is at greater risk of becoming overweight later in life and developing noncommunicable diseases, which in turn limits his or her job prospects. In India, about one in five children is wasted and in Indonesia, one of the world's fastest growing economies, approximately one in ten children is either wasted or overweight. Rapid growth, urbanization, globalization and demographic



Yannick Foing of Royal DSM

changes in the region mean that access to safe, nutritious and quality food – a basic human right – is far from guaranteed. If left unmanaged, the adverse effects of Asia's malnutrition status will not only continue to be felt by individuals. Lost productivity and direct health care costs will have growing social and economic consequences. Low weight, poor child growth and micronutrient deficiencies already result in an average annual GDP loss of 11% across Asia.²

Sustainable strategies for better nutrition

The private sector has an opportunity to support better nutrition for low- and middle-income households in Asia. These consumers make up more than 80% of Asia's population. They have a purchasing power of nearly US\$3.5 trillion and spend some 60% or more of their income on food.³ Today, the packaged foods they can afford are usually calorie-rich and nutrient-poor, contributing to both over- and undernutrition. However, research has shown that low- and middle-income consumers are willing to pay more for nutritious products.⁴

The Nutrition Improvement Program, an initiative of global health, nutrition and materials company Royal DSM, convened a



Regina Moench-Pfanner of ibn360



Delegates give a shout-out to SEACHange at the Grand Copthorne Waterfront Hotel, Singapore

workshop called Sustainable Evidence-based Actions for Change (SEACHange) in Singapore in January 2018. The workshop focused on the health and economic burden of malnutrition in Asia and explored viable strategies to make nutritious foods available to lower-income households.

The meeting was the fourth in the series of SEACHange workshops held since 2013. Previous workshops had addressed different themes such as product development, cross-sector partnerships and innovative finance.

With participation from regional and global industry leaders, government, NGOs and academia, SEACHange 2018 aimed to empower the food industry to adopt sustainable business models to produce nutritious products that are affordable, aspirational and accessible to those Asian consumers who have the greatest need. Attendees also considered how different stakeholders could work together to help achieve Zero Hunger, one of the United Nation's Sustainable Development Goals for 2030.

Unlocking new market opportunities

The key themes of SEACHange 2018 covered four distinct tracks:

1. Product formulation
2. Cross-sector partnerships for affordable nutritious products
3. Marketing and communication strategies targeting low- and middle-income consumers
4. Innovative business models and distribution channels to "reach the last mile"

Academia and private-sector representatives shared insights on successful endeavors and strategies for product formulation.

The use of nutrient profiling emerged as an essential tool for developing nutrient-dense foods and helping to overcome the economic barriers that keep some consumers from being able to access nutritious diets.

The track on cross-sector partnerships for affordable nutritious products showcased innovative partnerships and highlighted the role that large NGOs can play as conveners and social aggregators to stimulate the manufacturing of these products.

The track on marketing and communication strategies explored the difference between reaching high-end consumers and low- and middle-income consumers, and how technology can play an important role here.



In conversation over coffee: Deborah Gildea (Novartis), Yannick Foing and Ramachandran Rajamanikam (DSM) (left to right)



Breakout group session in progress

Stimulating fervent discussions about social enterprises and their operating models, the fourth track focused on innovative business models and distribution channels. A series of panel sessions revealed insights around different business models and distribution channels, and how companies and NGOs can leverage technology-based solutions to reach the base of the pyramid (BoP). SEACHange participants agreed on the need to look at the BoP as consumers who can make their own purchasing decisions

and take control of their health rather than viewing them merely as beneficiaries.

Additionally, panelists from the banking, development and philanthropic sectors discussed different motivations and underlying principles related to investing in nutrition.

In the final panel session, representatives from the marketing and nutrition communities addressed the main challenges of measuring and evaluating the impact of nutrition, including which metrics are currently used and how results could be translated into consumer demand for affordable nutritious products.

Good business for the base of the pyramid

Making products more nutritious, affordable, accessible and appealing is crucial to achieving the Sustainable Development Goals and to helping people in Asia – and around the world – reach their full potential.

SEACHange attendees agreed there is a need to create more local, cross-industry partnerships that focus on developing nutritious products that are tailored to low- and middle-income consumers throughout Asia. They also agreed that more innovative approaches to marketing and communications are needed to increase the understanding of the link between nutrition and health.

People living at the base of the pyramid are the largest untapped consumer group today. Better collaboration between the public and private sectors could lead to very promising and sustainable business opportunities that serve this segment while delivering better nutrition across the region.



Panelists in action: Christiani Jeyakumar Henry (CNRC), Susan Kevork (Nestlé), Anthony Hehir (DSM) and Saskia de Pee (WFP) (left to right)



Participants engage in a spirited exchange during a breakout group session

SEACHange 2018 Sponsors and Organizers:

Royal DSM; ibn360

Event moderation and management:

JB Consultancy; Corporate Media Services

Many companies and other organizations participated in our wide-ranging, multisectoral SEACHange meeting. These included, among others:

Africa Improved Foods, Amul Dairy, Asian Venture Philanthropy Network, Australia and New Zealand Bank, BoP Inc., Clinical Nutrition Research Centre, Danone, Development Bank of Singapore, GSK, Healthy Marketing Team, Hungry Foal, Hystra, Mahidol University, MARS, Nestlé, Next Billion, Novartis, Nutrition International, The Power of Nutrition, 45RICE, Save the Children, SEAMEO RECFON, *Sight and Life*, Singapore Health Promotion Board, Tata Trusts, Tetra Pak, The Breakfast Revolution, Unilever, World Food Programme, World Vision International

Led by Royal DSM, the SEACHange series is a unique, action-oriented coalition of cross-sector partnerships aiming to trigger actionable development of innovative, affordable and accessible nutritional food products in a financially sustainable way. Visit the SEACHange website: seachangenutrition.org. The fifth SEACHange workshop will be held in March 2019.

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The 21st International Congress of Nutrition in Buenos Aires, Argentina

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The 21st International Congress of Nutrition (ICN/IUNS) was held from October 15 to 20, 2017, at the Sheraton Hotel and Convention Center in Buenos Aires, Argentina. In the “City of Design,” the Convention Center is conveniently located in the Retiro District, famous for its impressive architecture and historic monuments, between the Río de la Plata estuary and the lush Plaza San Martín. The Sociedad Argentina de Nutrición (SAN) hosted the congress, which brought together global representatives of nutritional research, industry, and policy to contribute their expertise related to the conference theme “From Sciences to Nutrition Security,” with the goal of connecting nutritional sciences and applied research activities in nutrition and health.

Moderated oral and virtual poster presentations covered eight different thematic tracks: **1)** Advances in Nutrition Research;

2) Nutrition through the Life Course; **3)** Public Health Nutrition and Environment; **4)** Nutrition and Management of Diseases; **5)** Nutrients and Nutritional Assessment; **6)** Functional Foods and Bioactive Compounds; **7)** Food Culture Practices and Nutritional Education; and **8)** Agriculture, Food Science, and Safety.

Topics were as multifarious as the attendees and ranged from molecular pathways in nutrient metabolism to global approaches to mitigate malnutrition in vulnerable populations. As it is impossible to do justice to the breadth of tracks and topics covered at the 21st ICN in a short report, the following presents an illustrative sample of some of the most buzz-generating sessions.

“Topics ranged from molecular pathways in nutrient metabolism to global approaches to mitigate malnutrition in vulnerable populations”



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Editors and contributors to the book *The Biology of the First 1,000 Days*. From left to right: Amanda Wendt, Saskia de Pee, Crystal Karachuk, Tim J. Green, Philip T. James, Klaus Kraemer, Luz Maria De-Regil, Kyly C. Whitfield, Julian C. Lui



An attentive audience at the 21st ICN in Buenos Aires

The first conference day started with a wide-ranging satellite program covering topics such as nutrition in Latin America, food systems, the value of eggs in nutrition, rice fortification, and the implementation of nutrition programs. During the opening ceremony later that evening, light refreshments were offered, along with a musical accompaniment by the sextet Lyrical Gala. This provided a good opportunity to mingle and network with fellow conference attendees.

The opening lecture, “Fit for the future: Aligning nutritional sciences for the service of humanity,” was given by **Andrew**

Prentice from the London School of Hygiene and Tropical Medicine. Andrew emphasized the need “to develop stronger epidemiological methods that can robustly establish causality.”

Monday, October 16, started with the launch of the book *The Biology of the First 1,000 Days*. Editors **Crystal Karakochuk** and **Klaus Kraemer** recounted the path from the initial idea to the development of the book. This was followed by presentations from coauthors Philip James, Luz Maria De-Regil, and Julian Lui, who contributed chapters from their respective areas of expertise covering epigenetics, women’s health, and regulation of linear growth.



Book launch of *The Biology of the First 1,000 Days*, edited by Crystal D. Karakochuk, Kytly C. Whitfield, Tim J. Green, and Klaus Kraemer



Klaus Kraemer speaks at the launch of *The Biology of the First 1,000 Days* alongside (left to right) Crystal D. Karakochuk, Philip James, Julian Lui, and Luz María De-Regil

In her keynote lecture, **Kathryn Dewey** from the University of California elaborated on the effects of lipid-based nutrient supplements for mothers and infants. She emphasized the potentially greater impact of nutrient interventions when integrated into a comprehensive strategy addressing the multiple causes of stunting and poor development.

In a symposium chaired by **Chessa Lutter** (RTI International/University of Maryland) and **Saul Morris** (Global Alliance for Improved Nutrition, GAIN) and sponsored by the Child Investment Fund Foundation (CIFF), the potential of eggs to improve child nutrition and rural livelihoods was debated. To a fully packed symposium hall, Lora Iannotti (Washington University) presented findings from the Lulun Project, a randomized controlled trial in Ecuador where eggs were given to children aged 6–9 months. The trial showed improvement of linear growth after only 6 months and stunting reduction by 47% in the group receiving eggs – a larger effect than any other complementary feeding intervention to date.

Carlos Andres Gallegos Riofrío (Universidad San Francisco de Quito, Ecuador) described the effective social marketing strategies the Lulun team used to increase egg consumption during complementary feeding. **Klaus Kraemer** (*Sight and Life*) presented the findings from a scoping study in Kenya, Ethiopia, Malawi, and India showing the potential of four types of business models viable at scale.

Finally, **Emily Lloyd** (One Acre Fund) demonstrated the importance of rigorous piloting before scaling up to assure the selection of the most appropriate chicken breed in a particular setting, appropriate housing, and vaccinations of chickens. This is to prevent the spread of poultry-related infectious diseases in the participating households, as well as to preclude distribution and financing challenges.

Noel Solomons (Center for Studies of Sensory Impairment, Aging and Metabolism, CeSSIAM) elaborated on the origins and consequences of endemic shortcoming and explained that 40% of stunting arises in fetal life, whereas the most accelerated stunting phase occurs during exclusive or predominant breastfeeding. Noel discussed the theory that the origins of retardation and stunting are due to a failure of utilizing essential nutrients for long-bone elongation, whereas the epidemiological variation of stunting across continents suggests underlying genetic factors, with the actual origins of stunting yet to be discovered.

The role of small-scale aquaculture and homestead food production programs in Cambodia was presented by **Aminuzzaman Talukder** (Helen Keller International). The presentation focused on enhanced homestead food production, with and without fishponds, and how this approach improved household production, income, food security, and women's dietary diversity, while the addition of aquaculture alone had no additional benefit to food security or dietary diversity.

Levente Diosady and **Venkatesh Mannar** from the University of Toronto presented their approach to mitigate both iodine and iron deficiency via double (iodine and iron) fortification of salt. The research team developed a microencapsulation-based technology for producing an iron premix that can be added to iodized salt and which remains bioavailable for at least one year and does not interact with iodine. Two efficacy trials conducted in India confirmed the positive impact on improving iron status and reducing anemia and iodine deficiency. Furthermore, they alluded to a program currently under way that provides double-fortified salt to 24 million people in the lowest-income quintiles in Uttar Pradesh (India) through subsidized food commodity distribution programs. This was complemented by **Jo-Anna Baxter** (Hospital for Sick Children/University of Toronto), who presented a systematic review on the effect of double-fortified salt on iron status markers. She concluded that double-fortified salt could modestly increase hemoglobin concentration, despite a limited effect for those at greatest risk of iron-related poor health outcomes.

Imelda Angeles-Agdeppa from the Food and Nutrition Research Institute presented evidence from rice fortification programs in the Philippines with a focus on iron-fortified rice, which is used in governmental social safety net programs. She emphasized the need to scale up rice fortification in order to provide ample supply of iron-fortified rice nationwide.

Edwin Habeych (Nestlé Research Center) presented the development of a stable double-fortified (iodine and iron) bouillon cube, which is suited for industrial-scale production and commercialization in Central and West Africa. Edwin considered the bouillon cubes to be an effective approach to reduce malnutrition in certain regions, despite various difficulties in implementation. He also recognized potential challenges concerning the cube's micronutrient density and bioavailability.

Bindi Borgh, from the University of Sydney, presented results from a study investigating the efficacy of a locally produced multiple-micronutrient-fortified, ready-to-use supplementary food (RUSF) for Cambodian children below two years of age. Bindi concluded that neither commonly used supplements – such as micronutrient powders or corn-soy blends – nor the novel RUSF prevented growth faltering in the tested population, but that all three, particularly RUSF, contributed to improving nutrient intake.

Dina Aburnishan from the World Food Programme (WFP) recognized the prevailing issue of food waste with regard to cosmetically unacceptable fresh foods (CUFFs). Despite being fit for human consumption, CUFFs do not meet certain shape or color standards that are imposed for resale in international markets and are thus often discarded. Dina emphasized WFP's aim of developing an alternative market for CUFFs via redistribution into school meal programs, and explored the potential for CUFFs to be integrated in Kenyan food systems. She concluded that the Kenyan model could potentially serve as a scalable one with global impact.

The closing lecture, “Our quest for healthy diets: the role of nutrition scientists,” was delivered by the president of the International Union of Nutritional Sciences (IUNS), **Anna Lartey**. She explained how food systems determine foods' quantity, quality, and diversity, and that the nutritional content of foods available to customers, along with the faulty food system, affect the food environment. Anna also emphasized the need “for

all stakeholders and sectors to step up efforts to eliminate malnutrition in all its forms.”

Among the non-scientific highlights was the Conference Gala Dinner on October 19, which featured a tango show by Tango Porteño, impressively recreating the story of Chantecler, the most important and luxurious Buenos Aires Cabaret of the 1940s.

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“The 21st ICN/IUNS was a platform for informative presentations, fruitful discussions, and prolific networking”

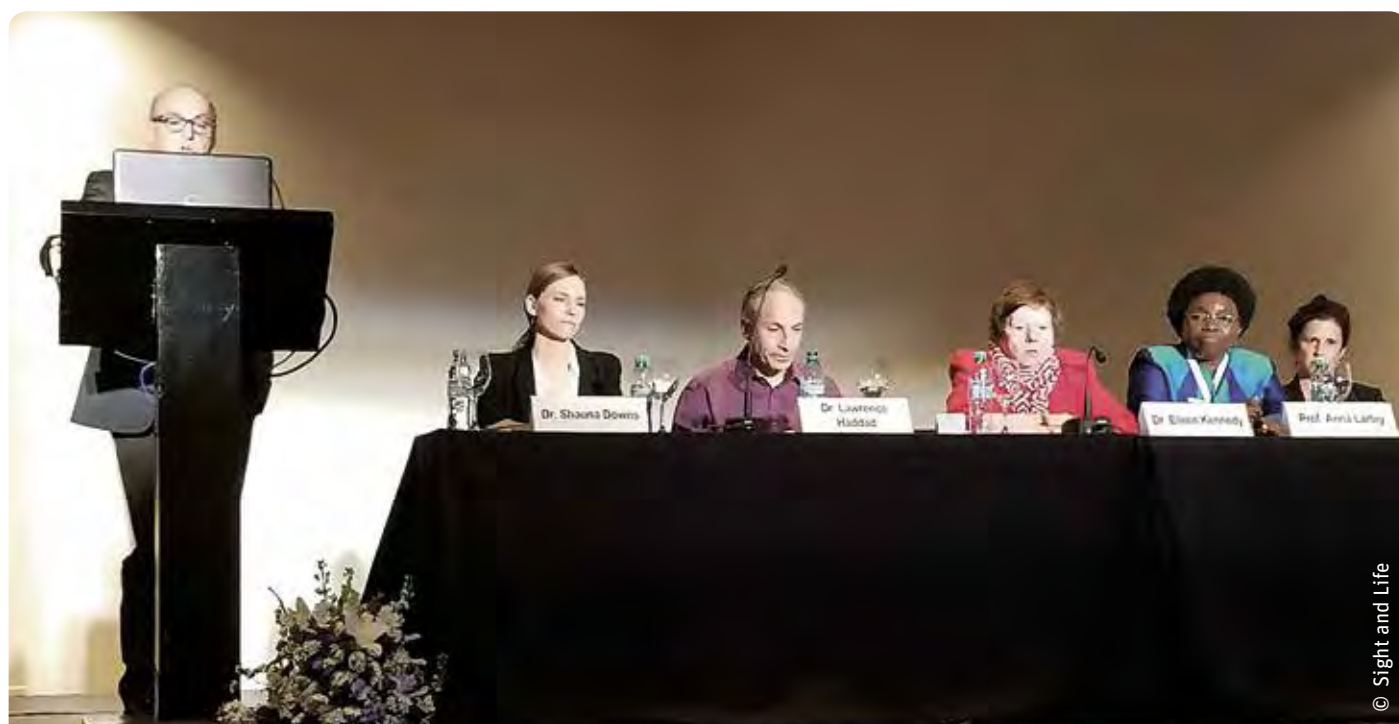
Conclusion

The 21st ICN/IUNS was a great opportunity to listen to and learn from distinguished experts in their respective fields and a platform for informative presentations, fruitful discussions, and prolific networking. The breadth of the program made it unfeasible to attend the wealth of talks of interest, but still made for a very rich knowledge-sharing experience.

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Klaus Kraemer addresses the audience alongside panelists Shauna Downs, Lawrence Haddad, Eileen Kennedy, Anna Lartey, and Jessica Fanzo (left to right)

Leveraging the Food System for Child Growth

A nutrition-focused social enterprise builds a new public-private partnership model in East Africa

Darshana Joshi and Prelen Moodley

Africa Improved Foods, Kigali, Rwanda

Peiman Milani

Sight and Life, Basel, Switzerland

The challenge in Rwanda and beyond

Despite Rwanda's remarkable progress on multiple socioeconomic indicators over the past few years, the burden of malnutrition in the country remains persistently high. While the country boasts the highest exclusive breastfeeding rate in the world at 87%, Rwanda's stunting rate of 38% places it at 110th in a ranking of 132 countries.¹ The country's rate of vitamin A deficiency in children 6–59 months old remains 39%.² Substantial stunting prevalence gaps based on income and urbanization persist.³ The Cost of Hunger in Rwanda report estimates that the equivalent of 11.5% of the country's GDP was lost in 2012 as a consequence of child undernutrition, with more than three million people of working age not able to achieve their potential.⁴

In an effort to address malnutrition, the Government of Rwanda has launched a number of mostly health-system-based initiatives. Although health systems are central to nutritional status in the first 1,000 days of life and also to reversing acute malnutrition, it is the food system – the actors, processes, and infrastructure involved “from farm to fork” in feeding a population – that can play a wide-reaching role in sustainably overcoming the nutritional deficiencies of an entire population. Leveraging the food system for child growth and human development is the next frontier for addressing the global burden of malnutrition, which is reflected in unacceptably high rates of stunting, wasting, micronutrient deficiencies, and overweight and obe-

sity. An end-to-end value chain approach building local supply, consumer demand, and a nutrition-enabling environment can improve nutrition through the consistent consumption of nutritious foods among pregnant and lactating women, children 6–24 months old, and other vulnerable groups.

“Leveraging the food system for child growth is the next frontier in the fight against malnutrition”

Inception of a pioneering social enterprise

Inspired by the vision of a sustainable value-chain approach and with the support of the Clinton Health Access Initiative (CHAI), public and private sector players – the Government of Rwanda, the World Bank's International Finance Corporation, DFID's CDC Group, the Dutch development bank FMO, and DSM, a global science-based company active in nutrition and health – joined forces in 2013 to launch Africa Improved Foods (AIF). AIF is a unique social enterprise based in Rwanda, with the mission to “help people maximize potential through improved nutrition with affordable, high-quality, locally sourced foods.” This social-purpose food processor is located in Kigali's Special Economic Zone. With a world-class facility and state-of-the-art equipment, AIF has an annual production capacity of 45,000 metric tons of fortified specialized food products, which enables it to supply both the domestic market and neighboring countries. Production operations started in December 2016, with AIF's products first reaching the market in early 2017. By the end of 2017, AIF's plant was operating at full capacity and 90% efficiency. AIF has plans for setting up a smaller yet more flexible facility in Ethiopia to serve Horn of Africa markets.



Africa Improved Foods' plant in Kigali, Rwanda

A nutritious portfolio for growth

To create longevity and market success, AIF has also developed a strategic product portfolio, with the company's mission as the guiding star. Porridges are popular in East Africa and are generally perceived as a nutritious food for children, making them a highly appropriate vehicle and AIF's primary product platform. AIF's first products are two corn-soya-blend porridge mix offerings targeting first 1,000-day mothers and children 6–24 months old. These products are distributed to different populations with distinct packaging through three channels: the World Food Programme (WFP), government-operated health centers across Rwanda, and commercial retail outlets. Building on the success of Nootri Toto (the complementary food product) and Nootri Mama (the maternal food supplement), the Nootri range was expanded with the introduction of Nootri Family in January 2018. Nootri Family is a corn-soya-sorghum blend fortified with 13 vitamins and minerals, with a balanced nutrient profile targeting the entire household.

“AIF aims to make its products the nutritious porridge of choice”

AIF's three-year outlook aims to establish the foundation in making AIF's products the nutritious porridge of choice, not

only in Rwanda, but also in neighboring East African Community (EAC) countries. The porridge portfolio is therefore cross-cutting in terms of segments (older infants and children, pregnant and breastfeeding women, families, teenagers, males, and millennials), nutritious offerings (general and balanced health, “high in,” “better for you”), and also price points (pack price strategies). AIF is also exploring a country-specific approach due to varia-



AIF is working with local farmers to improve the quality of Rwandan maize and increase purchase of locally sourced inputs



© Quake Rwanda Ltd.

AIF's commercial product range

tions in consumption habits in the EAC region. The new product development team partners closely with cross-functional stakeholders internally and externally in executing against these strategic opportunities.

Impact beyond nutrition and beyond Rwanda

AIF's business model and its central position in the food system

enable it to create value beyond its intended nutritional impact. Upstream in the value chain, farmers and their families benefit from improved livelihoods and access to process and technology innovations that improve the yield and quality of their crops. With a direct workforce of 300 employees, AIF's own demand for local products, services, and talent contributes to Rwanda's economic development and to higher standards in the country's food and beverage sector. In addition to its substantial contribution to addressing undernutrition, AIF's marketing communications help educate consumers about nutrition and making smart choices for oneself and one's family.

“AIF is creating triple bottom-line value with a model that may be relevant to other regions”

Beyond Rwanda, AIF's products are already consumed in Uganda, Ethiopia, Kenya, Democratic Republic of the Congo, and South Sudan. Some 1.7 million beneficiaries have received AIF's products through WFP's programs in East Africa, as well as over 90,000 mothers and young children in Rwanda through the local government's nutrition program targeting the first 1,000 days. Since AIF's inception, the organization's products have enabled over half a billion nutritious porridge meals to be



© The New Times

AIF's portfolio of products distributed through WFP, health centers, and retail

consumed by mostly underserved beneficiaries and consumers across East Africa.

By purposefully engaging food value chain actors to promote child growth and human development, AIF is both creating triple bottom-line value and experimenting with a model that may yet prove relevant to other countries and regions facing malnutrition, working for a world in which all children thrive.

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AIF's retail presence is boosted by various display units with educational information on nutrition

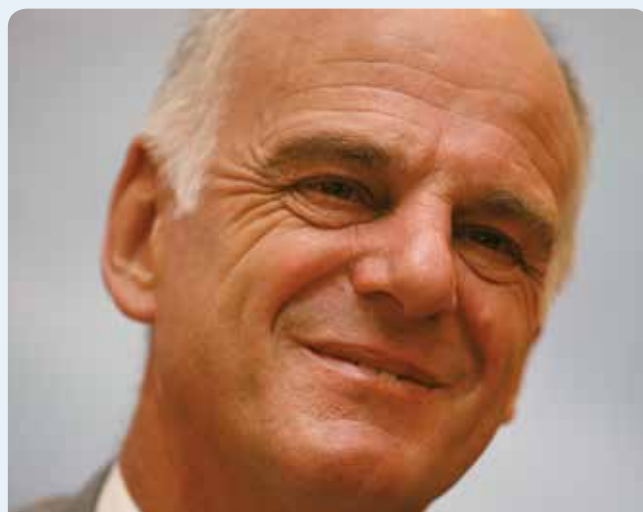
Did you know? You can now visit the *Sight and Life* website www.sightandlife.org on a regular basis to get the latest news about what is happening in the field of nutrition. You can also follow us on **Facebook** and **Twitter @sightandlife**.

World Food Prize 2018 awarded to nutrition champions Lawrence Haddad and David Nabarro



© GAIN

Lawrence Haddad



David Nabarro

On June 25, the World Food Prize Committee announced the award of the 2018 World Food Prize to Dr. Lawrence Haddad, Executive Director of the Global Alliance for Improved Nutrition (GAIN), and Dr. David Nabarro, Strategic Director of Skills, Systems & Synergies for Sustainable Development (4SD).

The 2018 Laureates' work has significantly improved nutrition for mothers and children in the critical first 1,000 days of life. Their relentless leadership and advocacy has also inspired efforts by countless others that collectively reduced the world's number of stunted children by 10 million between 2012 and 2017.

Key facts on the Laureates

A pioneer in food policy research, Lawrence Haddad brought the issue of nutrition to the forefront by using both economic and medical research to convince development leaders to make child nutrition an urgent priority in the global food

security agenda. He persuaded policymakers to place a high priority on global nutrition, particularly since improving nutrition will almost halve child mortality before the age of five. He also developed initiatives for accountability and guidance in global nutrition through the creation of the Global Nutrition Report, which analyzed government advancements in reducing malnutrition. Through Lawrence Haddad's leadership, governments were able to see their progress and allocate resources where these are most needed to combat malnutrition across the globe.

"I am honored to receive this award, which has always focused on the critical and urgent issues of the time. For our generation, I believe the

issue is not only how to feed the world, but how to nourish it sustainably. Six of the top 10 risk factors for the global burden of disease are related to poor diet. This is not surprising because more than one in three people on the planet eat too little food, too little food of the right type, or too much food of the wrong type. Were he here today, I am sure Dr. Borlaug would have been at the forefront of the fight to create sustainable food systems capable of addressing all forms of malnutrition – from wasting and stunting to overweight and obesity”

Lawrence Haddad

David Nabarro coordinated the UN's Scaling Up Nutrition (SUN) Movement, which established the magnitude of child malnutrition through science-based evidence and highlighted the lack of progress towards a solution. Under David Nabarro's direction, the SUN Movement united 54 countries and one Indian state to join forces and implement evidence-based policies and programs, and unified leaders of countries suffering from food issues, donors from charitable organizations, and members of civil society groups. His efforts helped establish agriculture and food issues as a mainstream concern, and the various nutrition interventions he implemented were adopted by national governments.

“As I receive this wonderful award, I reflect on the thousands of courageous women and men who are working at local level for food systems that are well-functioning and just. They have the wisdom needed to reduce levels of malnutrition or

diet-related illness. They can devise food systems that benefit people and the planet and that contribute to the 2030 Agenda for Sustainable Development. They are the transformation leaders of the future.”

David Nabarro

What is the World Food Prize?

The Prize was founded in 1986 by Nobel Peace Prize winner Dr. Norman E. Borlaug. It is the foremost international award recognizing achievements of individuals who have advanced human development by improving the quality, quantity, or availability of food in the world.

The US\$250,000 annual award recognizes contributions in any field involved in the world food supply including, but not limited to: plant, animal, and soil science; food science and technology; nutrition; rural development; marketing; food processing and packaging; water and the environment; natural resource conservation; physical infrastructure; transportation, storage, and distribution; special or extraordinary feeding programs; social organization and poverty elimination; economics and finance; policy analysis; and public advocacy.

Lawrence and David will receive the World Food Prize at a ceremony in the Iowa State Capitol in Des Moines on October 18, 2018. The event is the centerpiece of the Borlaug Dialogue International Symposium, a three-day event that regularly draws over 1,200 people from 50 countries to discuss cutting-edge issues in global food security.

Did You Know?

- > The two winners are very active on twitter! Do follow them to keep abreast with their latest updates: [@davidnabarro](https://twitter.com/davidnabarro) and [@l_haddad](https://twitter.com/l_haddad)
- > Read *Sight and Life's* interview with David Nabarro entitled “A Day in the Life of Dr Nabarro” in the *Sight and Life* magazine 26(1)/2012 edition.
- > Have a look at Lawrence Haddad's reflections on the prize in his recent blog post “The Man Who Nourished the World”: <https://bit.ly/2tvjrXO>

2018 Global Food Policy Report



This year, IFPRI's flagship report reviews the major food policy issues, developments, and decisions of 2017 and highlights challenges and opportunities for 2018 at the global and regional levels. It looks at the impacts of greater global integration – including the movement of goods, investment, people, and knowledge – and the threat of current anti-globalization pressures.

In this edition, leading researchers, policymakers, and practitioners review the changing policy landscape for reducing hunger and poverty and offer a look forward to 2018 through the following range of timely topics:

- How can the global food system deliver food security for all in the face of the radical changes taking place today?
- What is the role of trade in improving food security, nutrition, and sustainability?
- How can international investment best contribute to local food security and better food systems in developing countries?
- Do voluntary and involuntary migration increase or decrease food security in source countries and host countries?
- What opportunities does greater data availability open up for improving agriculture and food security?
- How does reform of developed-country farm support policies affect global food security?

- How can global governance structures better address problems of food security and nutrition?
- What major trends and events affected food security and nutrition across the globe in 2017?

You can read the report here:

www.ifpri.org/cdmref/p15738coll2/id/132273/filename/132488.pdf

“In 2018, the world must maintain its momentum toward ending poverty and malnutrition sustainably. Leveraging the benefits of globalization while minimizing the risks can make a key contribution to achieving this vision.”

Shenggen Fan, IFPRI

Did You Know?

- Check out IFPRI's datasets and analysis on food policy indicators through its global report interactive map: gfpr.ifpri.info/map/
- You can do this 10-question quiz on the report to find out if you are the preeminent authority on all things regarding globalization! Click here to do the quiz: gfpr.ifpri.info/resources/

UNICEF–WHO–The World Bank: Joint Child Malnutrition Estimates – 2018 Edition



In May 2018, UNICEF, WHO, and the World Bank Group released the 2018 edition of the joint child malnutrition estimates for the 1990–2017 period, representing the most recent global and regional figures. A suite of online interactive dashboards was developed to enable users to explore the entire series (1990–2017) of global and regional estimates of prevalence and numbers affected by stunting, overweight, wasting, and severe wasting. These estimates are presented by various regional and income-group country classifications used by a range of agencies including the United Nations, UNICEF, WHO, and the World Bank Group.

These new estimates supersede former analyses published by UNICEF, WHO, and the World Bank Group and use the same methodology as in previous years. Given that country data are at most available from surveys conducted in the year preceding the one when the modeling exercise takes place, the 2018 joint estimates were derived up to 2017 with extrapolation for stunting until 2025.

The joint estimates cover indicators of stunting, wasting, severe wasting, and overweight among children under the age of five, and reveal insufficient progress to reach the World Health Assembly targets set for 2025 and the Sustainable Development Goals set for 2030. The report indicates that in 2017, there were 151 million stunted children and 51 million wasted children, while 38 million children were overweight. The estimates indicate that global progress in stunting has been steady, but not fast enough to reach targets. Meanwhile, the number of overweight children worldwide has seen no decline in more than a decade.

You can read the full report here:

data.unicef.org/wp-content/uploads/2018/05/JME-2018-brochure-.pdf

Did You Know?

- > The detailed methodology used to produce the report is described in the joint publication published in 2012. You can access it here: www.who.int/nutgrowthdb/jme_unicef_who_wb.pdf?ua=1
- > The publication comes with an interactive dashboard. Discover it here: public.tableau.com/profile/unicefdata#!/vizhome/JointMalnutritionEstimates2018Edition/UNICEF
- Click here to read the previous project rounds: www.who.int/nutgrowthdb/estimates/en/

“In 2017, there were 151 million stunted children and 51 million wasted children, while 38 million children were overweight”

Guideline: Fortification of Rice with Vitamins and Minerals in Public Health



Fortification of Rice with Vitamins and Minerals as a Public Health Strategy is the first evidence-based guideline from the World Health Organization (WHO) for this type of intervention using rice as the specific food vehicle.

This guideline provides Member States with evidence-based recommendations on the effects and safety of fortifying rice with micronutrients as a strategy to improve the health status of populations, specifically for the reduction of anemia and the improvement of iron status. The guideline is intended to help Member States and their partners make informed decisions about what interventions are best suited to their context, needs, resources, and ongoing programs, observing existing human rights standards and pursuing health equity.

The key recommendations are as follows:

- Fortification of rice with iron is recommended as a public health strategy to improve the iron status of populations in settings where rice is a staple food (strong recommendation, moderate-certainty evidence).
- Fortification of rice with vitamin A may be used as a public health strategy to improve the iron status and vitamin A nutrition of populations (conditional recommendation, low-certainty evidence).
- Fortification of rice with folic acid may be used as a public health strategy to improve the folate nutritional status

of populations (conditional recommendation, very low-certainty evidence).

This guideline complements the WHO/FAO (Food and Agriculture Organization of the United Nations) *Guidelines on Food Fortification with Micronutrients* (2006) and the Pan American Health Organization publication *Iron Compounds for Food Fortification: Guidelines for Latin America and the Caribbean 2002*.

To download the report, please visit:

apps.who.int/iris/bitstream/handle/10665/272535/9789241550291-eng.pdf?ua=1

“According to the Copenhagen Consensus, the return on investment of food fortification is one of the highest development dividends.”

– Tumusiime Rhoda Peace, African Union Commissioner for Rural Economy and Agriculture

Did You Know?

- Designed by the fortification community, the Global Fortification Data Exchange (GDFx) is a fantastic new tool intended to improve food fortification data availability. Check it out here: www.fortificationdata.org
- *Sight and Life* and partners co-hosted a rice fortification workshop in Senegal in November 2017. The outcomes of the workshop can be read in the previous edition of the magazine (p. 110, “Unlocking the Potential of Rice Fortification in West Africa”). Read the article here: sightandlife.org/wp-content/uploads/2017/12/SALmagazine_TechnologyandEntrepreneurship_UnlockingthePotentialofRiceFortificationinWestAfrica_181215.pdf

Guideline: Implementing Effective Actions for Improving Adolescent Nutrition



This publication is a derivative product summarizing the global, evidence-based recommendations and principles of the World Health Organization that address malnutrition in all its forms in adolescents with the aim of ensuring healthy lives and well-being among this group.

The purpose of this publication is to facilitate the implementation of existing WHO guidelines on nutrition-specific and nutrition-sensitive actions required for improving the health and well-being of adolescents. Implementing these actions should explicitly take into account the heterogeneity of adolescents in general (for instance, in their state of physical growth and social development), as well as the diversity within their country (for instance, in terms of the expected responsibilities within the family, the number out of school or out of work, and existing social norms). In addition, designing and implementing programs to address adolescent nutrition should allow adolescent participation in governance, program design, implementation, monitoring, and evaluation.

You can download the publication here:

apps.who.int/iris/bitstream/handle/10665/260297/9789241513708-eng.pdf?sequence=1

“Empowering our youth will be key if we are to ignite their potential to be the first generation to end poverty and the last to take climate action to stop irreversible damage to our planet.”

*Amina J. Mohammed,
United Nations Deputy Secretary-General*

Did You Know?

- > This derivative guideline is a summary of existing World Health Organization (WHO) evidence-based guidelines specifically addressing malnutrition in all its forms in adolescents. It complements the WHO recommendations.
- > On May 17, the Global Adolescent Health Conference: Unleashing the Power of a Generation, organized by the Canadian Partnership for Women and Children's Health, was held in Ottawa, Canada, and brought together nearly 400 development organizations and representatives from governments, academia, and development from around the world. The conference focused on four issue pillars: Nutrition; Sexual and Reproductive Health and Rights; Mental Health; and Data.

2018 Global Report on Food Crises



The 2018 *Global Report on Food Crises* provides the latest estimates of severe hunger in the world. An estimated 124 million people in 51 countries are currently facing crisis-level food insecurity or worse. Conflict and political and economic insecurity continued to be the primary drivers of food insecurity in 18 countries, where almost 74 million food-insecure people remain in need of urgent assistance.

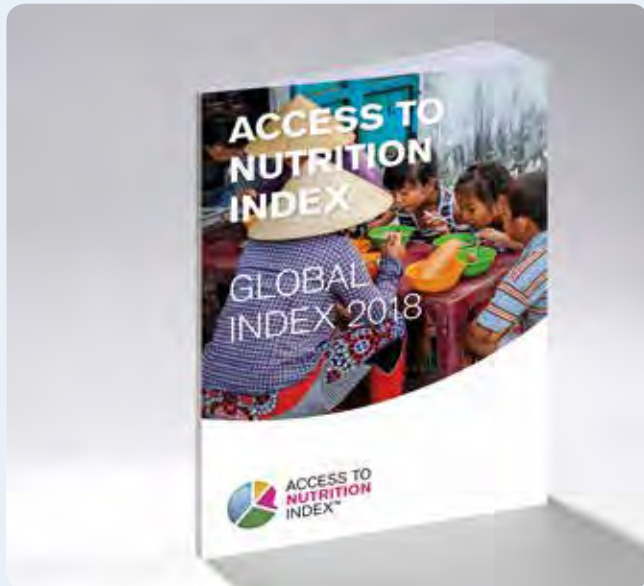
Last year's report identified 108 million people facing crisis-level food security or worse across 48 countries. A comparison of the 45 countries included in both editions of the report reveals an increase of 11 million people – an 11% rise – in the number of food-insecure people across the world who require urgent humanitarian action.

Now in its third edition, the report is not a UN-owned publication but rather a work of public philanthropy, for use by those committed to achieving the objective of minimizing human suffering and eventually ending hunger. Prepared collectively by 12 leading global and regional institutions under the umbrella of the Food Security Information Network, the report provides thematic, country-specific, and trend analysis of food crises around the world.

Did You Know?

- In 2017, almost 124 million people across 51 countries and territories faced crisis levels of acute food insecurity or worse and required urgent humanitarian action. In 2016, the population in need of urgent action was estimated at 108 million across 48 countries.
- Short on time? Read the report's key messages: docs.wfp.org/api/documents/WFP-0000068917/download/?_a=2.191416104.388757964.1528052642-416482493.1523799197

The 2018 Access to Nutrition Index



May 2018 saw the launch of the third Global Access to Nutrition Index (ATNI), published by the Access to Nutrition Foundation (ATNF). The ultimate goal of the ATNI is to facilitate improved diets and a reduction of the serious global problems of obesity and undernutrition. ATNI is founded on the premise that Food & Beverage (FB) manufacturers can make a powerful contribution to addressing poor nutrition and related diseases.

This third, 2018 Global Index ranks the world's 22 largest FB companies on their contributions to addressing the twin global nutrition challenges of overweight- and diet-related diseases and undernutrition. The index measures companies' contributions to good nutrition against international norms and standards. The index also includes a separate ranking of the world's leading manufacturers of breast-milk substitutes (BMS), as well as a newly added Product Profile, which measures the healthiness of companies' product ranges in nine markets.

Key findings of the 2018 report include the following:

- > The world's largest FB companies have stepped up their efforts to encourage better diets, mostly through new and updated nutrition strategies and policies, improved commitments on affordability and accessibility, better performance on nutrition labeling and health and nutrition claims, and more disclosure of information across categories.
- > However, ATNF has serious concerns about the healthiness of the world's largest global FB manufacturers' product portfolios, and the 2018 results show that companies need to improve their act on global health and nutrition. Companies

need to do much more to set transparent nutrition targets, improve the healthiness of their product ranges, comply with the International Code of Marketing of BMS, and develop commercial strategies to tackle undernutrition.

To download the report, click here:

www.accesstonutrition.org/sites/gl18.atnindex.org/files/resources/atni_report_global_index_2018.pdf

“A number of companies are upping their commitments to tackle various aspects of the nutrition challenge [...] However, the results also show companies need to get better at ‘walking the talk’ and in particular need to set clear and verifiable targets for improving the healthiness of their product ranges.” *Inge Kauer – ATNF*

Did You Know?

- > Next to the Global Index, the Access to Nutrition Foundation publishes Spotlight Indexes that score and rate the 10 largest food and beverage manufacturers in each Spotlight Country.
- > You can read the full press release of the 2018 Access to Nutrition Index here: www.accesstonutrition.org/sites/gl18.atnindex.org/files/resources/press_statement_final.pdf
- > Are you a visual person? Check out this short video on the 2018 index: www.youtube.com/watch?time_continue=82&v=IBntnH3DYww

Sight and Life Webinar Series on Behavior Change Communication



sightandlife | webinar series

For details on our **Behavior Change Communication** webinar series visit bit.ly/2IUeQDQ

	Webinar 1 People Eat Food Not Nutrition Integrating BCC into Nutrition Programs		Webinar 2 Assessing the Situation What You Need to Know		Webinar 3 BCC Strategy and Roll Out The Devil's in the Detail		Webinar 4 Monitoring the Process Does it Work?
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Sight and Life proudly presents the inaugural *Sight and Life* Webinar Series focusing on behavior change communication (BCC). In a series of four webinars, we examine the BCC process from the program manager's point of view. This means that we emphasize experiential knowledge combined with research analysis, and identify tools and tips to help the program manager manage the BCC process.

Webinar 1 | People Eat Food, Not Nutrition: Integrating BCC into Nutrition Programs

Watch the webinar and download the slides here:
<http://bit.ly/2KK3HWF>

Webinar 2 | Assessing the Situation: What You Need to Know

Watch the webinar and download the slides here:
<http://bit.ly/2wRWQb8>

Webinar 3 | BCC Strategy and Rollout: The Devil's in the Detail

Watch the webinar and download the slides here:
<http://bit.ly/2sDKuir>

Webinar 4 | Monitoring the Process: Does it Work?

Watch the webinar and download the slides here:
<http://bit.ly/2MPeIXB>

If you are a program manager or health practitioner who understands the need for behavior change and wants guidance as well as practical tips for BCC, then this webinar series is for you!

Did You Know?

- Dr. Eva Monterrosa has 12 years experience in BCC and has been driving the implementation research portfolio at *Sight and Life* for the past five years. Read her biography here: sightandlife.org/blog/eva-monterrosa/
- Yana Manyuk, the presenter of Webinar 3, "The Devil's in the Detail," recently joined the *Sight and Life* team as the Social Marketing Specialist. Read her biography here: sightandlife.org/blog/yana-manyuk/
- Check out *Sight and Life's* essential reading recommendations on BCC: sightandlife.org/blog/essential-reading-behavior-change-communication-bcc/

Elevator Pitch Contest on Disruptive Food / Non-food Solution for an Aflatoxin-free Food System, October 2018, Mumbai



The Elevator Pitch Contest, a competition among entrepreneurial students, is seeking disruptive ideas to remove aflatoxins from our food systems. Our contest allows students to present their ideas in three to five minutes to a panel of experts and potential financiers at the 19th World Congress of Food Science and Technology (IUFoST), to be held in Mumbai from October 23 to 28, 2018.

The Global Alliance for Improved Nutrition (GAIN), in collaboration with *Sight and Life*, Mars Inc. and Post-harvest Loss Alliance for Nutrition (PLAN), is inviting ideas from students and young professionals who can design an innovative product, service, technology, application, or approach for reducing or eliminating exposure to aflatoxin-contaminated foods and feed.

Submissions are to be completed online, and are due by 11:59 p.m. CEST on August 6, 2018. Apply here: <http://bit.ly/2ImhGB5>

Seed money and more!

Three finalists from each category (food and non-food) will win a round-trip flight to Mumbai, including accommodation, to participate in the 19th World Congress of Food Science and Technology (to be held in Mumbai from October 23 to 28, 2018). There they will pitch their idea to a panel of experts and potential investors.

The winner in each category will receive a seed funding of US\$15,000 to further develop the idea.

For additional details and requirements for the Elevator Pitch Contest, visit elevator-pitch-contest.org

Did You Know?

- > Aflatoxins – toxic metabolites of *Aspergillus flavus* and *Aspergillus parasiticus* fungi – are one of the greatest risks to food security in developing countries. Over 4 billion people are at risk of chronic exposure to aflatoxins through contaminated foods.
- > Stay up to date with the Elevator Pitch Contest with the following twitter hashtags: [#PitchGAIN](#) [#Aflatoxin](#) [#Foodsecurity](#) [#Foodsafety](#) [#Foodsystem](#)
- > The seven finalists in the *Sight and Life* Elevator Pitch Contest on Innovations in Nutrition Assessments pitched their nutrition innovations at ASN's Nutrition 2018 conference in Boston in June. Read more: sightandlife.org/news/#announcements&id=4434&f=all

Improving Diets in an Era of Food Market Transformation: Challenges and Opportunities for Engagement Between the Public and Private Sectors



The latest policy brief of the Global Panel on Agriculture and Food Systems for Nutrition (GLOPAN), *Improving Diets in an Era of Food Market Transformation: Challenges and Opportunities for Engagement Between the Public and Private Sectors*, presents evidence and poses a series of questions for policymakers and the private sector to help them develop a common understanding of ways to improve the food environment in order to enable better dietary choices.

In this brief, the Global Panel sets out six key questions that need to be addressed and resolved as part of any new partnership approach. These are intended to be used as a basis to promote dialogue aimed at achieving more ambitious and effective links between the public and the private sectors. The questions are as follows:

1. How can small and medium-sized companies access loans in order to invest in food products that enhance dietary diversity and quality?
2. How can consumer demand for high-quality diets and nutritious food products be created and promoted so that companies have the confidence to invest and take risks in delivering more nutritious foods?

3. How should governments incentivize companies to improve the quality of food products?
4. How can the risks associated with developing, producing, and selling more nutritious foods be minimized?
5. How can governments ensure that engagement with for-profit companies to promote universal access to healthy diets is underpinned by core principles of transparency and accountability?
6. How can infrastructure planning be better geared toward reducing food losses and promoting year-round access to enhanced diets?

Download a copy of the report here: glopan.org/sites/default/files/Downloads/GlobalPanelPrivateSectorBrief.pdf

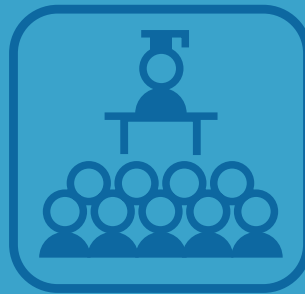
Did You Know?

- GLOPAN is an independent international group of leaders who hold, or have held, high office and show strong personal commitment to improving nutrition.
- The panel's influence is delivered through evidence-based technical and policy briefs, the Foresight Report, and tailored country/regional papers that are produced by the panel's Secretariat, its members, and experts. These documents contain recommendations for potential policy interventions at the national and regional levels. For more information on GLOPAN, check out their website: www.glopan.org

For a world free from malnutrition.

mobilize support

We are dedicated to accelerating
the impact of nutrition-focused
interventions to improve lives.



Sight and Life is a
nutrition think tank
supported by DSM



Our Daily Bread

A letter from the Netherlands



© Laurent Nouwen

A meal in the women's psychiatric ward. What treatment can you give when the first question is: "Doctor, can you give me some bread?"

Laurent Nouwen

Henri Nouwen Stichting,
Rotterdam, the Netherlands

Poverty has many faces around the world. Sometimes it looks at you with vitality and hope, sometimes with indifference and passivity, and sometimes – as when recently visiting a dilapidated building packed with hundreds of psychiatric patients in Ukraine – with despair and abandonment. But the common characteristic on the face of poverty is the painful expression of hunger and malnutrition.

As a small charitable organization, the Rotterdam-based Henri Nouwen Stichting (Foundation) trucked in at our own ex-

pense mattresses for the bare iron-sprung bedsteads, bed linen to replace the worn-out rags on the beds, and some better cooking equipment to replace the rusted, leaking pots that were in use. We even provided training in human-oriented therapies as an alternative preferable to the continuous sedation of patients. But what difference does it make when the authorities lower the daily budget for food to less than EUR 0.24 per patient – just enough for a cup of watery borscht (beetroot soup) and a chunk of bread? What can you do with all your good intentions to bring human dignity to locked-up patients, when by government decree the bread ration is first reduced from 300 grams a day to 200 grams, and then again to 150 grams? What treatment can you give when the first question is: "Doctor, can you give me some bread?" What therapy can you give hypertrophic patients

in the morning who have been unable to sleep through the night because they were so hungry? What can Andrey, a young psychiatric doctor, do but – on the way to work – buy some bread for the patients himself? But Andrey cannot feed all 60 patients in his ward, let alone the 500 in the entire overcrowded barracks. Underpaid himself, he goes to neighboring Poland to work in the fields during harvest-time in order to earn enough money to survive the long winters.

What can one do, when all of this is too little?

.....

**“What difference does it make
when the authorities lower
the daily budget for food to less
than EUR 0.24 per patient?”**

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In mid-February 2018, Klaus Kraemer, a volunteer, and I drove from the city of Lviv in western Ukraine to the middle of a cold snowy nowhere, the trunk of our car loaded with boxes of MixMe, a vitamin and mineral food supplement donated by *Sight and Life*. Doctor Andrey had sent us some alarming findings of anemia levels in his patients. Within an hour of our arrival, Klaus was ready to begin, outlining a 100-day pilot project on a ward housing 60 women. To see the Managing Director of *Sight and*



Klaus Kraemer distributes soup

Life serving bowls of food to patients in such a godforsaken place (sorry, God!) moved me deeply with gratitude. To “improve the lives of the world’s most vulnerable populations,” as the *Sight and Life* mission statement goes, takes caring, practical hands. Thank you, *Sight and Life*, for helping with our deepest human responsibility – to provide others with their “daily bread.”

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Klaus Kraemer, Managing Director of *Sight and Life*, serves food to patients in the psychiatric ward of a hospital in Ukraine

Editor's note: This section contains reviews of books, whether brand new or classic, that we hope will be of interest to our readers.

Book Review

The Biology of the First 1,000 Days

The Biology of The First 1,000 Days

Publisher: CRC Press (September 20, 2017)

Language: English

Editors: Crystal D. Karakochuk, Kyly C. Whitfield, Tim J. Green and Klaus Kraemer

ISBN: 978-1-4987-5679-2

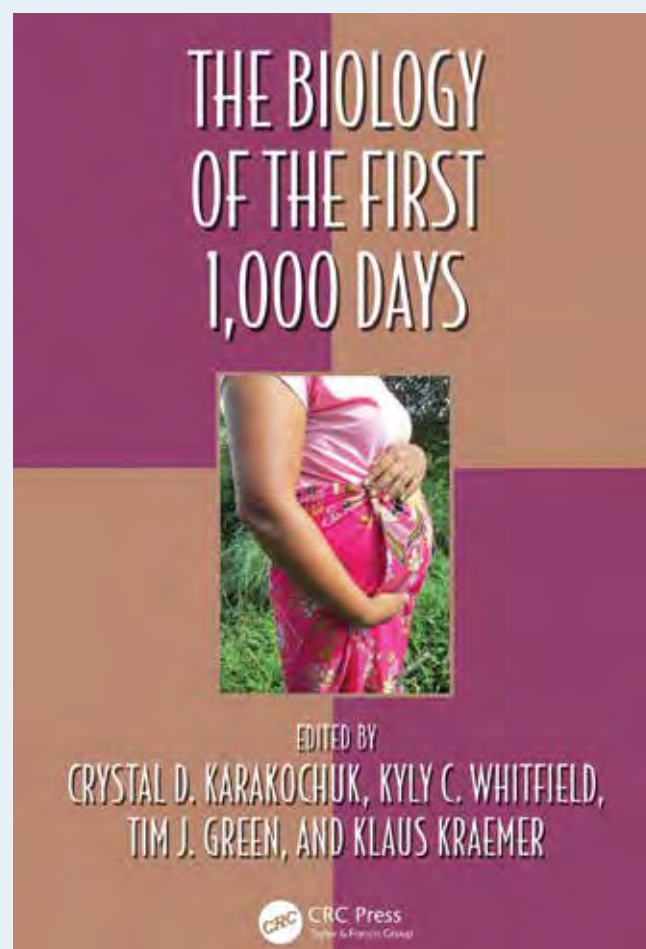
This aptly named book is a long overdue and welcome addition for everyone (researchers, program professionals, and students) active in the area of maternal, infant, and young child feeding. It is a comprehensive resource that brings together, in a single volume of 30 chapters by some 60 authors, contemporary and fundamental knowledge about nutrition in the first 1,000 days of life. It is also a reference book for the future, for which the physical qualities and feel of this 500-page publication are well suited.

The book deals separately with adolescence, pre-pregnancy, pregnancy, lactation, infancy, and young children. This is a wise organization of the subject matter. The book extends its scope and ideas beyond the usual considerations about nutrition to include epigenetics, the gut microbiome, metabolomics, and proteomics. It contains chapters that examine the physiological and pathophysiological bases of nutrition for the groups of concern, the norms used to diagnose the more prevalent kinds of malnutrition in the developing world, and the epidemiology, determinants, and consequences of malnutrition in both poor and wealthy populations. It also presents the dietary norms required to formulate nutrition interventions.

The chapters are clear and well-structured and often provide information about recent changes in thinking, which explain why some standards are not uniform and are still evolving.

“The chapters are clear and well-structured and often provide information about recent changes in thinking”

Klaus Kraemer, the initiator and one of the editors of the book, is a prime mover for implementation research in



nutrition through his publishing of papers in *Sight and Life* magazine (2014).¹ Also, very importantly, *Sight and Life* took the lead in establishing and founding the Society for Implementation Sciences in Nutrition (SISN).

The concern with implementation is represented by Section X – three chapters in the book that deal specifically with the topic. The first chapter, “Effectiveness of Nutrition-Specific Interventions in Pregnancy and Early Childhood,” is an excellent compilation of the biological interventions that have been shown to be effective in decreasing mortality and improving health. This demonstration of effectiveness has mostly been accomplished through randomized control trials that deliver the statistical probability of impact in a population. The design for these trials was first implemented for micronutrients by Alfred Sommer in the late 1970s.² Those trials are the gold standard for presenting impact in populations whose potential to benefit is homogeneous. However, differences in potential to benefit biologically or through access to the interventions result in inconsistent and confusing results.^{3,4} Also, extrapolating the results depends on similarities of potential to benefit both within and across populations.

The second chapter in Section X, “Nutrition-Sensitive Interventions for the First 1,000 Days,” describes interventions that improve the determinants of ingestion and biological utilization of the nutrients reviewed in the first chapter. Calling these interventions “nutrition-sensitive” and distinguishing them from “nutrition-specific” interventions was an intellectual breakthrough because it forced the recognition that assessing impact required taking context and “potential to benefit” into account.⁵ Because it is very expensive to examine potential to benefit in randomized controlled trials, appropriate intervention trials have to depend on high plausibility designs that permit triangulation across contexts.^{6,7} It also requires more understanding about how the pathway from a successful impact on the nutrition-sensitive outcome leads to better nutrition. This methodology remains to be developed and systematized. However, the excellent review of nutrition-sensitive interventions in this chapter presents enough evidence to advocate for selected nutrition-sensitive interventions.

The last chapter in this section is “Global Progress in the Scaling Up Nutrition (SUN) Movement” – the latest iteration in mobilizing countries’ political will and resources to implement policies and programs to improve nutrition. The first iteration, initiated by a UN subcommittee designed to coordinate UN nutrition work, occurred under the leadership of Abraham Horwitz and John Mason. This iteration led to five World Nutrition Situation reports, issued between 1988 and 2010.⁸ The

reports raised awareness but were handicapped by a lack of funding and country-level leadership to initiate action, which SUN is now mobilizing.

Although the chapter on metabolomics and proteomics (Chapter 30), which presents the results of modern scientific laboratory techniques, would appear to be far removed from implementation concerns focused on delivering interventions to improve nutrition in populations, it is highly relevant. This chapter mentions that stunting is associated with abnormalities in protein nutrition. This mention resurrects the well-supported and previously widespread understanding that protein malnutrition is a significant cause of stunting. This understanding was effectively destroyed in 1974 by a paper by Donald S. McLaren entitled “The Great Protein Fiasco.”¹⁰ That paper, whose conclusions were quickly adopted by the nutrition community, purported to show that protein undernutrition was responsible for only a tiny fraction of growth stunting. Unfortunately, the scientific community did not recognize that McLaren’s findings were only true in severely *marasmic* populations in whom energy was more limiting (lacking) than protein. This is a complicated concept and is rarely examined analytically. As a consequence of the wide acceptance of McLaren’s paper, research into promising solutions to find feasible offerings to families to remedy deficiencies in selected amino acids essentially ceased for lack of funding.¹¹ Very recently, new findings, if supported by more sophisticated thinking about limiting nutrients and appropriate epidemiology, are likely to result in new strategies to address stunting.¹² This is particularly important in view of the evidence that many populations have not responded as well as expected to current strategies.

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