

sight and life

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NUTRITION
ENTREPRENEURS

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“Telemedicine, predictive diagnostics, wearable sensors and a host of new mobile applications are transforming how people manage their health”



Welcome

Technology: a tectonic movement

Three tectonic movements are reshaping the world today: technology, globalization and climate change, observes Thomas Friedman in his recent book *Thank You for Being Late*.¹ They are tectonic because their growth no longer takes the linear form that we humans are used to. And they are tectonic because they are exponentially reshaping how we create, how we collaborate, how we think and how we act. They create opportunities for individuals or small groups, even for those with limited resources in remote areas.

Giant leaps in technology have been possible as innovations rapidly built on each other, narrowing the gap between learning and adapting. In most cases, they have been tremendously efficient and beneficial. For instance, the cost of DNA sequencing per genome was US\$100 million in 2001. Today it costs just US\$1,000. It took only 10 years for mobile phones to be used in low-income countries from the time they were first introduced in developed countries. Mobile-phone-based money transfer such as M-Pesa has revolutionized payment systems in a number of low- and middle-income countries. Telemedicine, predictive diagnostics, wearable sensors and a host of new mobile applications are transforming how people manage their health. The eventual winners will be those who can avoid becoming patients at all.

Agriculture innovators too have made significant progress to prepare for the need to feed 10 billion people by 2050 while protecting our precious resources – land and sea. Smart technologies such as low-cost sensors for soil, irrigation and cloud computing have empowered farmers to make data-driven decisions, access best practices in real time, and minimize use of inputs, putting them in a position to conserve resources while improving productivity. Advances in genome sequencing, aerial and satellite coverage, and mobile platforms for precision farming will also benefit smallholder farmers. Further, growing cycles can be reduced and food can be grown by anyone, anywhere – even in tiny urban spaces.

Entrepreneurship: disrupting “business as usual”

Two of these tectonic movements – technology and globalization – have led to a major phenomenon: the rise in entrepreneurship

in all forms in even the remotest areas of the world. Knowledge, capital and resources to launch a new venture are just “a click away.” Today, more than 38 low- and middle-income countries actively report entrepreneurial activities. In the 2017 Global Entrepreneurship Report,² Africa is the region that reports the most positive attitudes towards entrepreneurship, with three-quarters of working-age adults considering entrepreneurship a good career choice. In Burkina Faso, for example, high rates of established business ownership are accompanied by high early-stage entrepreneurial rates; close to two-thirds of working-age adults are starting up or running their own businesses.

Achieving the World Health Assembly targets for nutrition in the sub-Saharan Africa region alone will cost US\$27 billion over ten years, on top of current investments. However, if current investments and approaches continue under business as usual, the targets will not be achieved.³ This is when social entrepreneurs are required to step in, to disrupt business as usual by tackling barriers in reaching the last-mile profitably in many domains such as microfinancing or social franchising at scale. Social entrepreneurs can tackle society’s most complex issues, while functioning like a business.

.....
“Technology plays an increasingly important role in enabling the implementation of high-quality public health nutrition programs”

Joining forces: technology and entrepreneurship

Technology plays an increasingly important role in enabling the implementation of high-quality public health nutrition programs. Similarly, innovative entrepreneurial solutions are required to improve access to proven solutions and ensure sustainability.

We are grateful to the innovators and entrepreneurs who have contributed to this issue, providing ideas and pragmatic perspectives on how to leverage technology and entrepreneurship to reduce the extent of malnutrition facing our world today.

We are inspired to visualize innovative technologies from farm to fork in our infographic. Stuart Gillespie from the International Food Policy Research Institute (IFPRI) provides a refreshing “Food for Thought” contribution entitled Pivotal Movement, a platform that uses fitness tracking technology to turn calories burnt into increased funding for nutrition projects.

Measuring nutritional status and outcomes in low-resource settings has been a complex issue that has prevented nutrition programs from scaling up in the past. Having worked on this challenge for years, David Boyle, Katharine Kreis and Laura Anderson from PATH discuss a new generation of field-friendly diagnostics, screening devices and tools. Sun Eun Lee from John Hopkins Bloomberg School of Public Health provides a compelling example of how to fill gaps in biological knowledge and provide roadmaps to prevention through “omic” technologies that are poised to move from discovery to delivery. An entrepreneur from Germany, Heinrich Katz, and his colleague Winnie Nyakerario Akara provide an example of a technology that can be cost-effectively scaled up in resource-poor settings: the mass processing of insects for protein food or feed.

Robert Hoekman from 510 Global outlines a new direction for using Big Data for aid. He provides examples of data-driven solutions to some of the world’s most difficult and dangerous challenges. Anna Allen and Dejus Abreu from a new social enterprise, Triggerise, eloquently merge technology and entrepreneurship in their “Perspective” article. Triggerise uses a mobile platform to provide results-based incentives for last-mile entrepreneurs while improving access to health and nutrition services for pregnant women. Shreya Bhatt from Medic Mobile provides a simple four-step process and a practical guide to designing, building and scaling up mHealth innovations. Srujith Lingala and I summarize successful social business models from our landscape analysis in East Africa in the article “The Nutrition Entrepreneurs.” Arnold Gloor from Medudem AG describes the future of customized nutrition solutions with an overview of the growth of personalized nutrition in high-income countries, along with examples of digital platforms.

We also feature a range of creative and recent scientific contributions throughout this magazine. Jonathan Steffen connects in a clever manner a 150-year old novel, *The Belly of Paris* by French novelist Émile Zola, to the core elements outlined in the Committee for Food Security’s recently published report on Nutrition and Food Systems. My colleague, Eva Monterrosa, presents findings from formative research on the sociocultural drivers of food choices in India. Jee Hyun Rah from UNICEF and key thought leaders from the Ministry of Health in Indonesia remind us of the gaps in adolescent nutrition in that country. In their roadmap, they describe the role that social media can play in motivating adolescents to improve their dietary behaviors.

In the field reports section, we have case studies and valuable lessons learnt from the use of field-friendly technologies and social business models. Holly McKee and Dr Anna Zhenchuk from BioAnalyt explain the power of portable testing, outlining how they created a miniature lab that can be used by anyone, anywhere. Leah Newman and her colleagues from 3-2-1 Online have repurposed existing technology using Interactive Voice Response, which works as a search engine in contexts where there is no internet, and allows people to use any mobile phone to select and listen to actionable nutrition information, among a range of topics. Kasim Saiyyad, Bhaskar Mittra and Prabhu Pingali from Tata-Cornell Agriculture and Nutrition Initiative provide insights into leveraging self-help groups to mobilize women entrepreneurs in rural areas and create a sustainable supply and consumption of essential micronutrients. Siddharth Tata – a budding entrepreneur – and I discuss the role of entrepreneurship in improving the profits of backyard poultry farmers. This section concludes with a thoughtful analysis of a popular social entrepreneur model, microfranchising, by my colleague Kesso Gabrielle van Zutphen.

Technology and entrepreneurial approaches will together be critical to all aspects of improving nutrition in resource-limited environments, including prevention and education, affordable product interventions, efficient supply chains, and monitoring and evaluation. This is a trend that is expected to accelerate, if not to become actually tectonic, in the next decade.

Warm regards

Kalpana Beesabathuni

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Global Lead – Technology & Entrepreneurship,
Sight and Life Foundation

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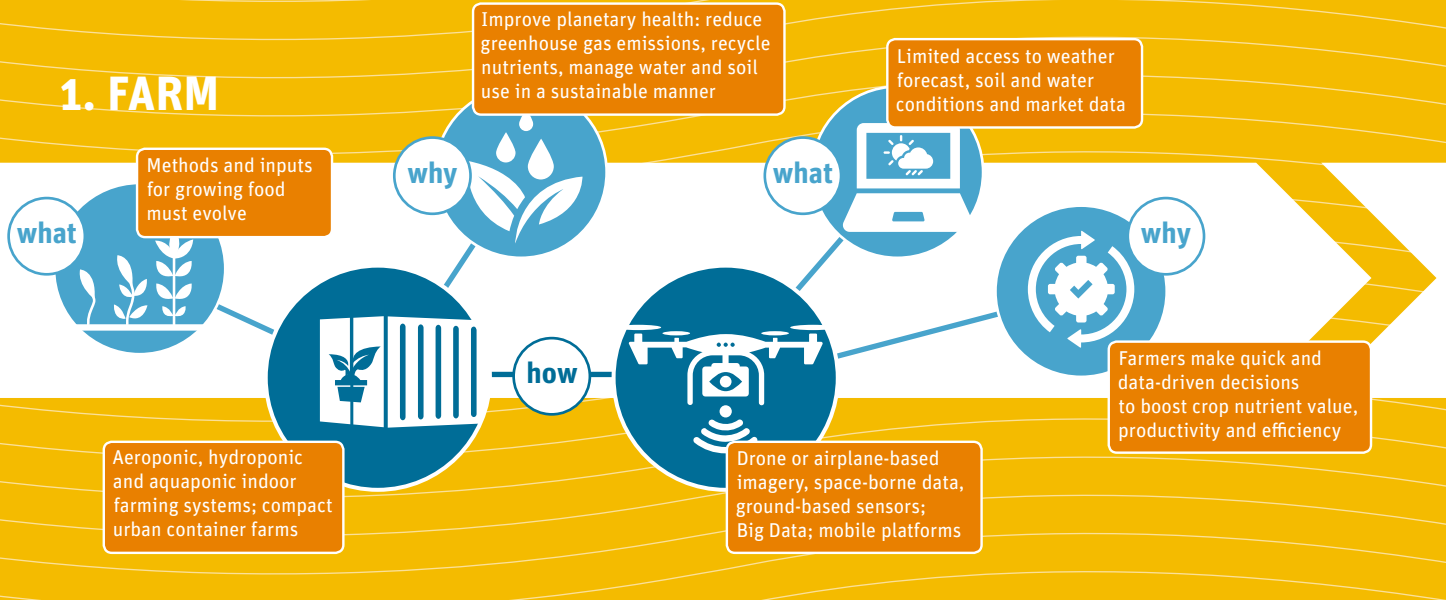
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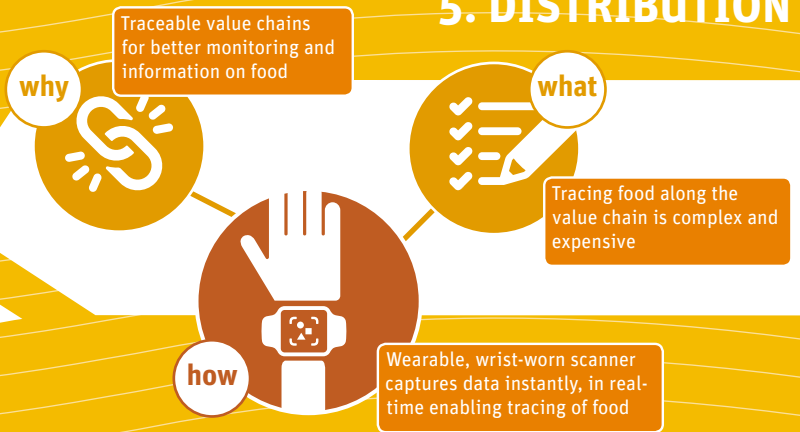


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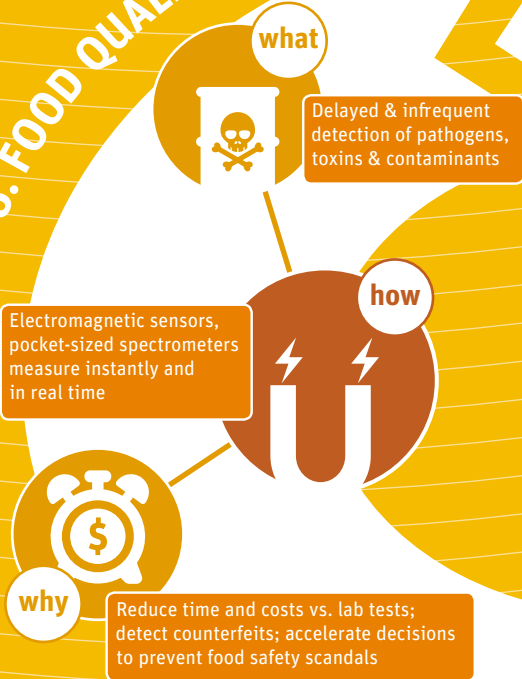


Innovative Technologies from Farm to Fork

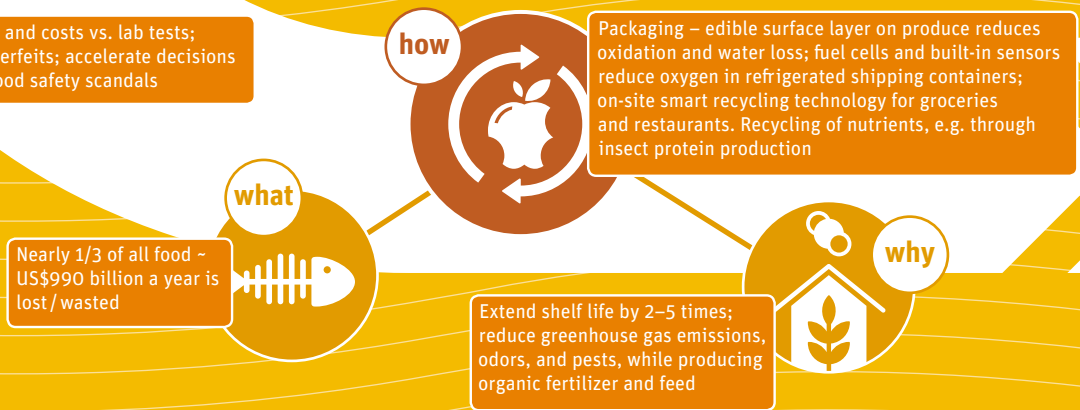
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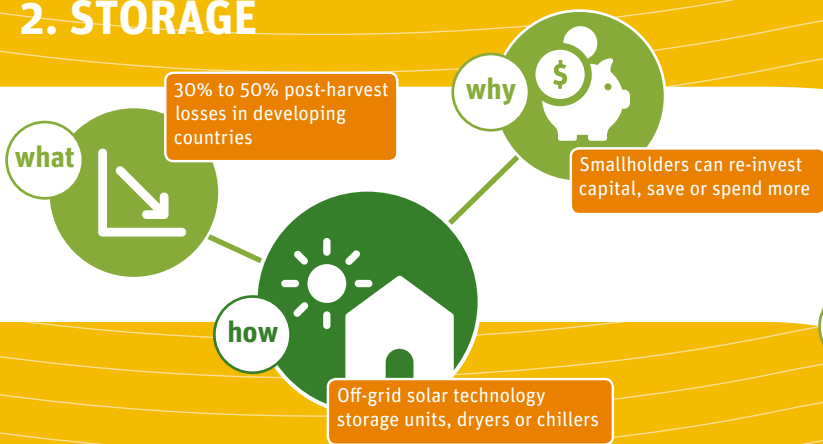
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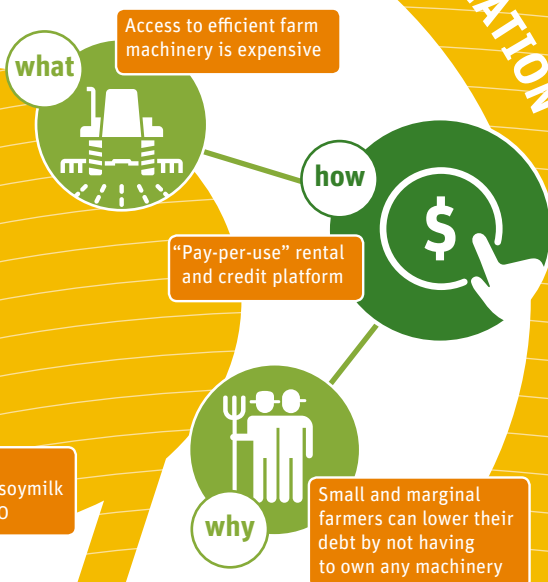
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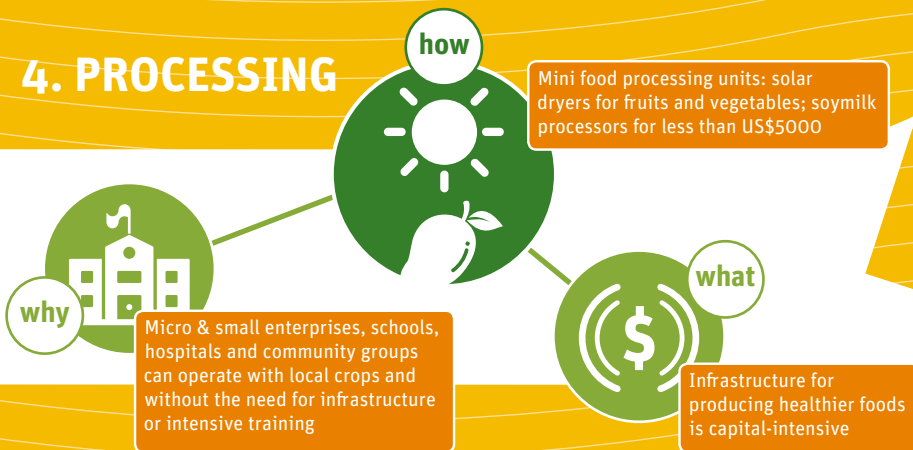
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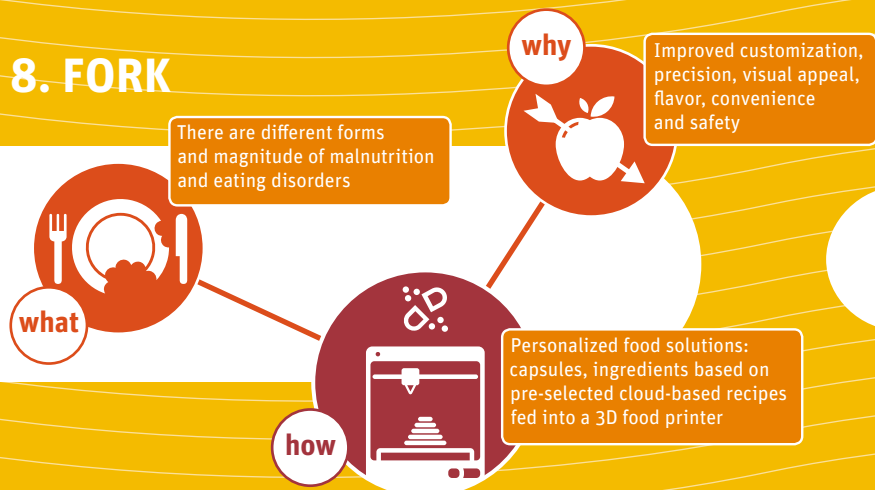
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Big Data: A Gift to the Nutrition Community?

Klaus Kraemer

Managing Director, *Sight and Life Foundation*

With the focus of this issue of *Sight and Life* being on technology and entrepreneurship, it is appropriate to give some consideration here to the potential that the phenomenon of Big Data might have for the nutrition community.

This issue carries a fascinating contribution from Robert Alexander Hoekman of 510 Global on the role that Big Data can play in helping address humanitarian crises (p. 57). Big Data and humanitarian assistance are not usually brought together in the same sentence, but Hoekman's article shows what highly practical benefits can be derived from the systematic management of large data sets. It may be that Big Data in fact has much more to offer, and that future approaches to nutrition should look on Big Data not merely as a tool with interesting possibilities but as a strategic enabler.

“Too large and complex”

That Big Data – defined by Merriam-Webster's dictionary as “an accumulation of data that is too large and complex for processing by traditional database management tools” – should be perceived in such a positive light by the nutrition community today may come as a surprise. Ever since the phrase the “information explosion” was first coined (its initial appearance in print dating from 1941, according to the Oxford English Dictionary), people have been at least as frightened as they have been intrigued by the potential of vast data sets. In 1971, for instance, the distinguished American playwright Arthur Miller wrote in *The Assault on Privacy* that: “Too many information handlers seem to measure a man by the number of bits of storage capacity his dossier will occupy.”¹

Big Brother – and his little brothers

Worries about the invasion of privacy and the erosion of basic liberties characterized the discourse on Big Data for many years – long before the term was minted, in fact. Sceptics feared, quite

reasonably, that Big Data would allow Orwellian regimes to extend their “Big Brother” gaze into the most personal recesses of people's lives. Today, of course, we read continually of the increasingly ugly phenomena of cyber bullying and trolling, and of the mental health problems being caused by addiction to social media, especially among the young. “Big Brother” hasn't quite been incarnated in the form imaged in George Orwell's *1984*, but he certainly has some very unpleasant little siblings.

“Mobile health and personalized nutrition would be unthinkable without Big Data”

Despite these very valid concerns, however, the potential benefits of Big Data – a term first used in *The Economist* as recently as 2010² – are finding increasing numbers of advocates, as doctors, scientists, pharmaceutical companies, health insurers, public health professionals and humanitarian agencies alike start to explore the positive potential of combining, analyzing, mining and deploying vast data sets in innovative new ways.

Beyond mHealth

The trend for mHealth (mobile health, as discussed in issue 1/2017 of this magazine)³ and that for personalized nutrition (discussed in the same issue)⁴ would be unthinkable without Big Data. Big Data offers possibilities for reducing animal experiments in the development of new drug treatments, accelerating the launch of new therapeutic interventions, predicting influenza epidemics and food price crises, and delivering medical and public health services and nutrition guidance in many creative and promising new ways. The question is, how are we as a global nutrition community to deploy Big Data so that it will best serve the needs of the world's population, and especially of those vulnerable and disadvantaged sections of society who have the least influence in the matter but the greatest need of disruptive nutrition solutions?

The nutrition community has acquired a new sense of purpose and (relative) cohesion in recent years, with the rise of the SUN (Scaling Up Nutrition) Movement and the prominent role allocated to nutrition in the formulation of the SDGs (Sustainable Development Goals). Can we unite in our approach to Big Data, and harness the possibilities it affords in creative new ways?

Servant or master?

If we are to do this, it seems to me that we will need to go through the steps many other parts of society, from commercial businesses to intelligence agencies, are going through as they struggle to get their arms around this exponentially expanding beast. We will need first to obtain the relevant data – literally, to know where it sits, who owns it, and how to access it. We will need to analyze it in ways that are efficient and relevant to our purposes. We will need to use it in an appropriate manner, and to measure the effectiveness of its use. And, perhaps most challenging of all, we will need to govern it within the nutrition space in such a manner that it remains our servant and does not become our master.

“We need to find ways of governing Big Data within the nutrition space”

Who should be in charge of this undertaking – or, at least, who should lead the charge, for total control of Big Data is a practical impossibility? Computer scientists, program developers and data analysts will of course have a major role to play. So will providers of infrastructure and middleware, as server farms grow in scale and significance and cloud computing offers new ways of managing the continuously expanding data burden. But I like to think that other perspectives will also be required – from

bloggers and vloggers, from field workers and volunteers, and from people who grow, prepare and consume food, as well as from qualified nutritionists, public health professionals, academic institutions, and think tanks.

Data-driven solutions

Used wisely, Big Data has the potential to help address many of the ills which technological progress has visited upon the world. Used injudiciously, it has the potential to wreak havoc on a scale yet unimagined.

I hope that people in the nutrition space who have the vision to approach Big Data in constructive ways will follow the example of Robert Alexander Hoekman and his colleagues at 510 Global. Let us unite to create innovative, data-driven nutrition communication solutions for the benefit of the planet and those who live on it.

With warm regards,



Klaus Kraemer

Managing Director, *Sight and Life* Foundation

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Making Every Move Count

New “win-win” options for nutrition and health

Stuart Gillespie

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Key messages

- > Inactivity is an increasing problem in the UK: 23% of adults and 81% of adolescents do not do enough regular physical activity.
- > One in three people worldwide are either overweight or obese, including nearly two-thirds of adults in the UK.
- > Conversely, over 150 million children worldwide are undernourished, with multiple serious consequences.
- > Global nutrition targets currently identify a shortfall of US\$4 billion, which needs to be financed using creative and innovative means.
- > A new initiative, *Pivotal Movement*, aims to contribute to addressing these challenges simultaneously in a collaborative and innovative solution which incentivizes both citizens and investors toward the same goal.

Introduction

The world is becoming increasingly connected. Agenda 2030 and the Sustainable Development Goals reflect this connectivity, with action plans citing co-benefits for several goals and targets, in a way that did not happen with their predecessors, the Millennium Development Goals.^a

Working in the multisectoral arena of nutrition, we naturally understand this. Improving nutrition sustainably requires a range of actions from different sectors, while the outcome – improved nutrition – has the potential to generate multiple benefits to populations, societies and economies.

There is significant untapped potential for identifying and implementing “win-win” options that exploit such latent synergies. This applies to the design and implementation of interventions, and it can also apply to their financing.

“Improving nutrition sustainably requires a range of actions – financing them requires creativity and experimentation”

Innovative financing has become a key issue in the current scaling-up drive, given the need to go beyond traditional channels to meet the cost of attaining agreed goals.¹ A recent *Sight and Life* paper reviewed new financing mechanisms, including development and social impact bonds, bridge funds, ticket levies, and impact investment.² One new initiative – The Power of Nutrition – for example, uses an innovative matched-funding approach that effectively quadruples the level of initial funding.

Finding the “win-win” or the “double duty action” needs creativity and experimentation – something that’s not associated with desk-based work – and often not associated with work at all! As a nutritionist, I think of calories (and other nutrients) as inputs. As a cyclist, I gaze at the Garmin tracker on my handlebars and see calories being burnt, as the miles roll by.

Which set me thinking ... How can we put these calories to better use?

Global challenges

First, some key facts about four major challenges:

- 01. Inactivity.** Globally, 23% of adults, and a massive 81% of adolescents (aged 11–17 years), do not do enough regular physical activity^b to meet global recommendations.³ In the UK, walking and cycling as the main modes of commuting are reported respectively by only 11% and 3% of adults.⁴ Insufficient physical activity is one of the leading risk factors for death worldwide,³ accounting for 6–10% of ischemic heart disease, stroke, diabetes, and breast and colon cancer,⁵ as well as being a modifiable risk factor for dementia.⁶ Globally, physical inactivity is estimated to cost \$54 billion in direct health care.⁷ A mere 5% increase in bicycle trips of less than 7 km could save around \$1.7 billion on health expenditure in Australia.⁸



Cycling to work can help generate funds for non-profit organizations.



Pivotal aims to improve the health of individuals and to leverage finance for nutrition and health projects in the UK and globally

Beyond the health benefits, being active is associated with improved cognition and academic achievement among children,^{9,10,11} along with numerous other social, environmental and economic benefits.¹²

02. Overweight and obesity. Excess body weight affects one in three people on this planet. In 2015, a total of 107.7 million children and 603.7 million adults were obese worldwide.¹³ Since 1980, the prevalence of obesity has doubled in more than 70 countries and has continuously increased in most other countries, with the rate of increase among children twice that of adults. Nearly two-thirds of all men and women in the UK are overweight or obese. No country has yet succeeded in reversing this trend. High BMI raises the risk of premature death (accounting for four million deaths globally in 2015),¹³ and for various non-communicable diseases (including diabetes, heart disease and cancer). Drivers of this spiraling epidemic include poor diet and a sedentary lifestyle.

03. Undernutrition. Over 150 million children globally are undernourished and three million die every year as a result of undernutrition.¹⁴ The multiple consequences are well known to this readership, and not reiterated here.

04. Financing. To reach global nutrition targets, \$11 billion per year is needed. Of this, estimates suggest \$4 billion will be needed from innovative financing and household contributions.¹

Can we contribute to addressing all these challenges in ways that are as simple as riding a bike, or walking to work? Is it possible to envision an approach to fundraising that *in itself* generates benefits to nutrition and health?

We think it is, and the rest of this short paper outlines one such approach that is currently being explored in the UK: *Pivotal Movement*.

What is Pivotal Movement?

Pivotal is a new initiative that aims to achieve two mutually reinforcing goals – to improve the health of individuals (“calorie-burners”) and to leverage finance for nutrition and health projects in the UK and globally.

.....
“Pivotal Movement uses fitness tracking technology to turn calories burnt into increased funding for nutrition and health projects”

At the same time as the adverse trends, previously discussed, play out, we have seen a ramp-up in the use of fitness tracking technology and in gym membership in the UK and around the world. Many more people are joining gyms, riding bikes, and using fitness devices and platforms such as Strava, Garmin and Fitbit. In the UK, there was a 44% increase in gym membership in 2015 alone. According to Parks Associates data, wearable fitness trackers are predicted to be worth \$5 billion by 2019 (up from \$2bn in 2014). In 2020, unit sales of connected fitness trackers will reach 24.5 million, and sales of smart watches will exceed 20 million.¹⁵

There are a growing number of new initiatives aimed at getting people “off the couch” – Couch to 5K, parkrun, Good Gym, Can Too, Re-Cycle and Zwift are just a few great examples. These are hugely important, and they should be supported. But we think these ideas can be taken further. Currently most sponsorship money comes from specific events. *Pivotal* is aiming to capture the energy expended in everyday activity – and to leverage that for extra funding.^c

How does Pivotal work?

Pivotal uses fitness tracking technology to turn calories burnt in cycle rides, evening jogs, weekend swims, gym workouts, and walks into increased funding for nutrition and health projects. It revolves around the strength and links among three core communities:

01. The first community comprises individuals who become **calorie-burners**. While wearing a tracker, they

FIGURE 1: The *Pivotal* model



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burn calories (by walking, running, cycling or working out) which are measured. As well as improving their own health, their “calorie logs” can also generate funds for nutrition and health projects.

02. This is where the second community comes in: the **investors** – organizations (or individuals) who seek to improve the nutrition and health of populations within and beyond the UK. Individual calorie-burners can “donate” their calorie logs to a pool and/or directly raise funds by seeking sponsorship (from friends and relatives) for calories burnt. Calorie pools are the drivers of an innovative funding scheme. Selected investors agree to “match-fund” these pooled calories according to pre-determined ratios (e.g., every 100,000 calories burnt may generate a donation of GB£100 [approx. \$135]). The ratios can be agreed with the investor.

03. The third community comprises **non-profit organizations** who will put these funds to use in order to further improve the nutrition and health of the wider population through projects they support.

These links are what sets *Pivotal* apart. We aim to leverage movement, and to multiply its effects for the greater good, as illustrated in **Figure 1**.

Why sign up to *Pivotal*?

Any individual or organization can become involved by moving

or investing – or both. In fact, any *Pivotal* member is a dual investor, investing in personal health as well as in global change for good. Here are some illustrations of incentives for engagement in these three communities:

Why move?

- > Beyond the obvious health benefits (described above), a calorie-burner will become a member of a growing movement that is driving change in the UK and globally.
- > Calorie-burners may seek sponsorship for one-off events (bike rides, sportives, marathons, fun runs etc.), but *Pivotal* will allow them to also generate benefits from their day-to-day activities, simply by strapping on a Fitbit, or switching on a Garmin, and uploading their stats from their routine exercise.
- > Physical activity is of course influenced by multiple factors beyond personal characteristics and preferences (including family and the cultural, economic and physical environments that shape the availability, access and provision of safe opportunities for walking, cycling, active recreation, sports and play).

Why invest?

- > Investors who normally donate to/invest in nutrition and health projects can generate greater value for money by channeling their funding through *Pivotal* – because the *very process of raising these funds* (via exercise) is intrinsically beneficial to the nutrition and health of many individuals.
- > Investors can choose the type of projects or organizations they fund, as they would normally, and they can choose the



Pivotal uses technology such as smart watches to help people get off the couch

terms under which they donate (e.g., through agreeing on the £/kcal or \$/kcal ratio), and agreeing on percentage allocations to different types of project.

- > Some investors could generate higher visibility in the movement by agreeing to higher ratios of funding (e.g., becoming silver, gold or platinum level donors).
- > Again, there are win-wins to be exploited. WHO's new draft Global Action Plan on Physical Activity (GAPPA) recognizes this, for example, in recommending governments to "*advocate for a percentage of funds from taxing unhealthy foods and beverages, alcohol, tobacco and other traffic management schemes to be reinvested in physical activity promotion, emphasizing the co-benefits of investment in physical activity across social and development priorities.*"

Calorie-burners and investors may have a degree of choice in what they support – they may choose to go “*a la carte*” and target a specific beneficiary organization, or they may choose to support an organization such as Sports Relief which itself donates to a variety of causes. Or again, they may do both, pre-allocating a set percentage to both options. They may also have a chance to rotate their support (e.g., every six months) to different target organizations (similar to an actively managed investment fund portfolio).

Incentives for beneficiary organizations

- > A steady stream of funding that may be additional to other funding streams.

- > Being part of a wider movement and a growing proportion of the population who are taking control of their own nutrition and health status.

Pivotal is open to all. Any individual with a fitness tracker or smart watch can sign up as a calorie-burner. Any investor/donor (from public or private sectors) that meets simple, transparent eligibility criteria that are aimed at avoiding conflicts of interest can become involved. Similarly, beneficiary organizations need to be focused broadly on *Pivotal's* core objectives. *Pivotal* is developing a menu of organizations, differentiated by their geographical focus (e.g., UK, global) and/or ultimate goal (e.g., school sports, cycling networks, healthy breakfast clubs in the UK, and community nutrition, water and sanitation, school feeding programs in low-income countries overseas).

How to grow *Pivotal*?

Pivotal's key coordination role will be to facilitate connectivity between the three communities – acting as the pivot and catalyst (as shown in **Figure 1**). This role will be delivered by the development and maintenance of a digital platform (website/application/community, etc.) allowing the mechanics of the transactions to be supported and enhanced.

In this, *Pivotal* will also work with facilitators and promoters. Partnerships with organizations who manage sportives and fun runs/marathons will be explored, for example. Such events could be periodically run to launch and further publicize the

initiative and to burn more calories *en masse*. Partnerships with gyms and fitness centers could also incentivize gym membership, while aggregating the calorie-burn of its clients. Investor organizations could encourage staff to join up, by discounting gym membership, new bikes and fitness trackers and/or reducing health insurance premiums. City bike hire companies could include sign-up sheets in which *Pivotal* “membership” is included as an “opt out” mechanism in agreements.

“*Pivotal* will facilitate connectivity between the calorie-burners, the investors, and the non-profit organizations”

In terms of promotion, a range of approaches can be adopted – including engaging with potential ambassadors of *Pivotal* (e.g., sports stars) who can inspire a wider population of potential calorie-burners. Periodic campaigns or challenges can be run.^d Finally, it will be important to provide regular feedback to calorie-burners on the use of funds, for example via “stories of change”, focusing on impact on the ground.

In sum ...

Pivotal is an “idea in motion” – an experiment and an example of a potential “win-win” whereby people’s energy transforms their own health while benefiting others. In its exploratory phase, we aim to start a conversation with potential members of *Pivotal*’s three communities to elicit their views on what could work and what may not. We need to understand where the tipping point lies for different individuals and organizations to get involved – either as calorie-burners, investors or implementers – and the key incentives and disincentives for engagement. We need to know what it would take for someone to strap on a fitness tracker, forget the short cut, and walk or cycle the long route to work.

Pivotal is just one approach to generating “win-win” options – using one “good” to generate another. We are still in the exploratory phase with this initiative, and want to hear from you. Please visit the website and send a message (www.pivotal-movement.org), and follow us on Twitter @PivotalOrg, or on Facebook www.facebook.com/pivotalorg/.

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are grateful to all who have shared their views and ideas on this approach and on the wider issue of getting more people moving, while generating additional benefits along the way.

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Notes on the text

- a. A recent example is WHO's draft Global Action Plan on Physical Activity (GAPPA), launched in August 2017, which aims to get 100 million people more active by 2030. Grounded in four strategic objectives (creating an active society, active environments, active lives and active systems), GAPPA states: *“harnessing synergies and building coherence between different but related policy agendas is critical for maximizing the opportunities for joint action and effective, efficient use of limited resources.”*
- b. WHO recommends adults do at least 150 minutes of moderate-intensity physical activity per week.
- c. *Calorie Cloud*, started by the founders of MANA Nutrition, is a similar initiative in the US that seeks to raise funds for scaling up the production and distribution of ready-to-use-therapeutic food.
- d. One example: Assuming one adult could burn 20,000 kcals per month in moderate activity, 50 can burn 1 million calories per month. Groups can self-organize (on Strava, for example) and go for the “Million Calorie Challenge” each month, or “Million Mile Months.” One million burnt calories could trigger donations of £10,000 [\$13,500], for example (100 kcals = £1/\$1.35), and this could be taken further by showing what £10,000 can do (e.g., it will deliver 200 bikes to health workers in remote communities, or to young girls to help them get to school, etc.).

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James Allen Olson Memorial Lecture Carotenoids and Breast Cancer

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Key messages

- > Carotenoids are hypothesized to have an anticarcinogenic role, via immunoenhancement, antioxidant action, and/or their influence on cellular differentiation; they have been shown to inhibit tumor progression *in vitro*, in breast cancer cells.
- > Epidemiological studies thus far have generally observed inverse associations between circulating carotenoid concentrations and breast cancer risk, though significant carotenoids have varied between studies.
- > A recent pooled analysis of eight previously published studies found significant inverse associations between quintile of circulating carotenoid concentration and breast cancer risk for α -carotene, β -carotene, lutein and zeaxanthin, lycopene, and total carotenoids.
- > Carotenoids appear to reduce risk of recurrent and lethal breast cancers, highlighting a potential role for dietary intervention to reduce the burden of disease.

Carotenoids and cancer

Carotenoids are a group of over 600 fat-soluble plant pigments ranging in color from yellow to red that are essential for plant photosynthesis.¹ In humans, they serve as key micronutrients in development and disease prevention.¹ Just six represent 90% of carotenoids found in circulation,^{2,3} all of which can be obtained from the diet: α -carotene (carrots), β -carotene (sweet potatoes and leafy greens), lutein and zeaxanthin (leafy greens), lycopene (tomatoes), and β -cryptoxanthin (citrus fruits). Given the prominent role of oxidative stress and damage in carcinogenesis,⁴ the antioxidant properties of carotenoids are thought to lend them an anticarcinogenic role.⁵ Further, the provitamin A carotenoids, α - and β -carotene, and β -cryptoxanthin, may protect against carcinogenesis through their metabolism to retinoids, which regulate cell growth, differentiation, and apoptosis.⁶ Immune surveillance is also enhanced through carotenoid action, potentially improving cellular responses to block tumorigenesis.^{7,8} Driven by biological plausibility, studies have investigated the role of carotenoids in various cancers, most often including lung,⁹ colorectal,¹⁰ prostate,¹¹ and breast cancers.¹²

Risk factors for breast cancer – why carotenoids?

Breast cancer is the most common cancer among women worldwide.¹³ Major identified risk factors for breast cancer are either not modifiable or else not favorably modifiable, including age, menopausal status, family history, parity, age at first menstruation, and age at first birth. However, studies of offspring of immigrants who move from areas with low rates of breast cancer, such as China, to areas with higher rates of breast cancer, such as the United States, found that they acquired breast cancer at similar rates to the population of the new country, indicating additional lifestyle risk factors in this disease.¹⁴ Modest harmful associations have been noted between breast cancer and alcohol consumption,¹⁵ smoking,¹⁶ and high body mass index (BMI).¹⁷ High fruit and vegetable consumption has been suggested to reduce



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the risk of developing breast cancer,^{18,19} and it is hypothesized that carotenoids are responsible for this protection. In fact, early studies using human breast cancer cells in culture demonstrated the ability of carotenoids, including β -carotene and lycopene, to inhibit tumor progression and reduce proliferation in breast cancer cells.²⁰

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“Although many risk factors for breast cancer are not modifiable, carotenoid consumption is one modifiable lifestyle factor that may reduce risk of breast cancer”

Epidemiologic evidence for carotenoids as protective agents in breast cancer

Measurement of circulating carotenoids via serum or plasma provides the most accurate way to explore carotenoids as an exposure in studies of disease. This method resolves flaws of dietary data including recall errors,³ seasonal food variation, altered bioavailability based on cooking methods,²¹ and inability of diet records to capture individual differences in nutrient absorption.

Consistent with the reported risk reduction from fruit and vegetable intake uncovered via dietary data, most prospective studies evaluating the association between circulating levels of carotenoids and subsequent breast cancer observed inverse associations between at least one of the primary carotenoids and breast cancer, though specific carotenoids differ.^{22–31} While demographics may account for some differences found between cohorts, nested case-control studies conducted within demographically similar cohorts have also found inconsistent results. For example, a study of 969 women with breast cancer and matched controls, drawn from the Nurses' Health Study (NHS), a large prospective cohort primarily composed of Caucasian women, reported a 25–35% decreased risk of breast cancer when comparing the highest to lowest quintiles of α - and β -carotene, lutein/zeaxanthin, and total carotenoids, but no change in risk with increasing quintile of β -cryptoxanthin concentration.²⁶ In contrast, a study conducted in the New York University Women's Health Study (NYUWHS), a similar cohort of primarily Caucasian women living in New York, reported a non-null, inverse association for β -cryptoxanthin, with a 40% decreased risk comparing high to low quintiles of concentration.²⁴ Yet another study of Caucasian women living in Missouri found a significant inverse association for lycopene, but null associations for α - and β -carotene, in conflict with observations of NYUWHS and NHS.²²

To resolve inconsistencies between studies, data from eight previously published nested case-control studies, all with carotenoids measured before disease onset, were combined in a pooled analysis. Evidence of potential measurement error based on inexplicably large variations in carotenoid levels among demographically similar cohorts led to standardization of all laboratory-obtained carotenoid samples following re-assay and recalibration of plasma or serum samples.

Combining the evidence: pooled study results

In total, 3,055 women with breast cancer diagnosed after blood collection, and 3,956 matched controls, between the ages of 51 and 66 years, were included in the analysis, from eight prospective studies: Columbia, Missouri;²² Umea, Sweden;²³ New York University Women's Health Study (NYUWHS), New York, NY;²⁴ CLUE I and CLUE II, Washington County, Maryland;²⁵ Nurses' Health Study (NHS), United States;²⁶ Women's Health Study (WHS), United States;²⁷ Shanghai Women's Health Study (SWHS), Shanghai, China;²⁸ and Multiethnic Cohort Study (MEC), California and Hawaii.²⁹ To ensure accurate comparisons, the pooled analysis was adjusted for established breast cancer risk factors: menopausal status, age at menarche, parity, age at first birth, exogenous hormone use, BMI, current smoking status, race, personal history of benign breast disease, and family history of breast cancer.³²

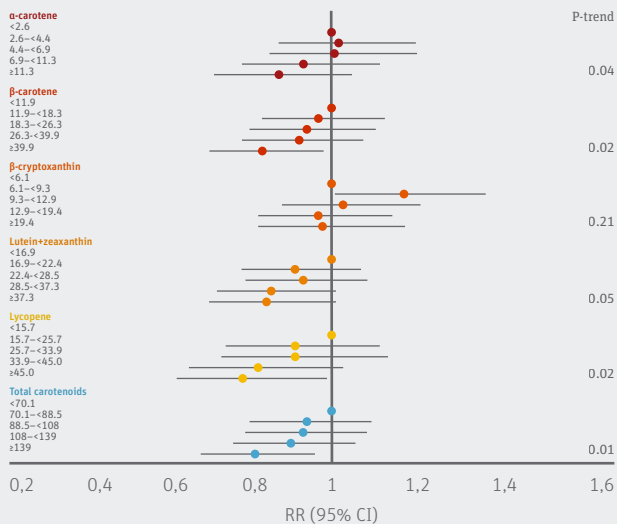
Comparing the highest quintile to the lowest quintile of carotenoid concentration, significant inverse associations were observed for α -carotene (RR=0.87, 95% CI=0.71 to 1.05), β -carotene (RR=0.83, 95% CI: 0.70 to 0.98), lycopene (RR = 0.78, 95% CI = 0.62 to 0.99), and total carotenoids (RR = 0.81, 95% CI = 0.68 to 0.96) (**Figure 1**). Trends in the association were significant when moving across the concentration continuum from the first to last quintile for each carotenoid, with the exception of β -cryptoxanthin. These results agree with inverse associations, either significant or suggestive, reported in studies published after this pooled analysis.^{30–31, 33–34}

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“Most prospective studies observed inverse associations between at least one of the primary carotenoids and breast cancer risk”

Disease heterogeneity and risk assessment

Breast cancer is a heterogeneous disease, often described by five primary tumor molecular subtypes.³⁵ Because each subtype of breast cancer acts uniquely in disease initiation and progression,³⁵ it is best to evaluate exposure-outcome relationships

FIGURE 1: Relative risk of breast cancer according to quintile of plasma carotenoids ($\mu\text{g}/\text{dL}$)



Lines indicate 95% confidence intervals. P-trend tests significance of increasing quintiles.

within tumor subtypes, though it is not always possible to do so based on rarity of certain subtypes. For simplification purposes, tumors are categorized as either estrogen receptor positive (ER+) or estrogen receptor negative (ER-). Breast cancers that are ER- typically occur in younger women and have a poorer prognosis than ER+ breast cancers,³⁶ in part due to the inability to treat these subtypes with hormonal therapies.

Following stratification by ER expression, the inverse associations between circulating carotenoid levels and breast cancer observed in the pooled analysis appeared much stronger for ER- versus ER+ breast cancers. For example, the relative risk comparing the highest quintile with the lowest quintile of β -carotene was 0.52 (95% CI = 0.36 to 0.77, p-trend = 0.001) for ER- breast cancers. The same comparison was only suggestive of an inverse association in ER+ breast cancers (RR=0.83, 95% CI=0.66 to 1.04, p-trend=0.06).³² A large analysis of 1,502 breast cancer cases and matched controls within the European Prospective Investigation into Cancer and Nutrition cohort similarly found that carotenoids were associated with ER- but not ER+ breast cancers.³⁴ It is possible that carotenoids are protective in both subtypes, though because other hormonal risk factors play a stronger role in determining risk of ER+ versus ER- breast cancer,³⁷ the additional reduction in risk from carotenoid intake is simply too small to detect in the ER+ subtypes.

Interaction with other lifestyle factors

Women with higher levels of oxidative stress are hypothesized to benefit more from higher carotenoid intake due to the antiox-

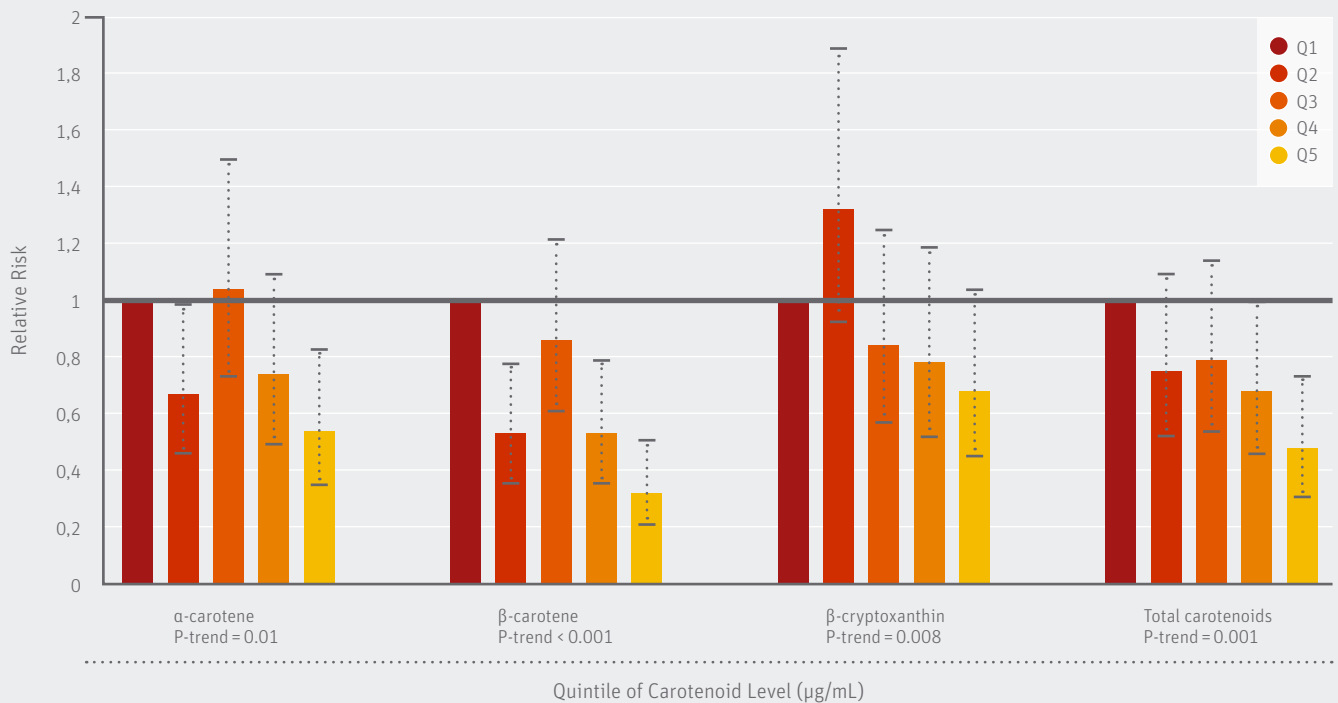
idant properties of carotenoids. Investigation of common lifestyle risk factors that induce oxidative stress, including alcohol consumption, smoking, and high BMI,^{38,39} revealed modification of associations between carotenoid levels and breast cancer by smoking and BMI.³² As expected, stronger inverse associations were seen among current smokers. In conflict with this hypothesis, women with higher BMI did not experience protection from increased carotenoid intake. Animal models have demonstrated the possibility that carotenoids act as pro-oxidants if in very high concentrations, which may account for this contradictory result in women with high BMI, as carotenoids are stored in adipose tissue.⁴⁰ However, the validity of this theory has not been investigated, leaving the influence of BMI in the carotenoid–breast cancer association unclear.

Exploring mechanistic action: gene scores and exposure timing

Use of a genetic marker as a measure for exposure is advantageous in epidemiologic analyses to (a) avoid the potential of unmeasured factors mixing with and altering the exposure-outcome relationship, and/or (b) parse apart the biological mechanism responsible for an observed association. The enzyme β -carotene 15,15'-monooxygenase, BCMO1, cleaves provitamin A carotenoids as a first step in vitamin A production.^{41,42} Because single nucleotide polymorphisms (SNPs) in this gene are responsible for poor conversion of carotenoids to retinol, gene scores can predict carotenoid levels based on the presence or absence of such SNPs. This technique was applied to 9,226 breast cancer cases and 10,420 controls within the National Cancer Institute's Breast and Prostate Cancer Cohort Consortium (BPC3). Five weighted gene scores were created for separate carotenoids, based on SNPs with confirmed associations with circulating carotenoid levels, rs12934922 and rs654851.^{43,44}

Despite the ability of the gene score to predict carotenoid levels, there was no association between quintile of gene score and breast cancer risk in BPC3.⁴⁴ While this null finding does not clarify mechanistic action of carotenoids, it also does not disprove the primary hypothesis. The distribution of carotenoid levels by proxy of genetic scores was limited compared with the much wider distribution of directly measured serum or plasma carotenoids, which may inhibit the ability of the genetic score to capture the relatively modest association seen among studies using plasma carotenoids.

Menopausal status at the time of carotenoid measurement can also reveal details about the timing of exposure. Among cases and controls who were premenopausal at blood collection, from the Nurses' Health Studies, no clear associations between carotenoid levels and breast cancer risk were observed.⁴⁷ However, there were significant or suggestive inverse associations between lycopene, α -carotene and total carotenoids, measured

FIGURE 2: Relative risk of lethal or recurrent breast cancer by quintile of plasma carotenoid. Bars represent 95% CIs.

prior to menopause, and breast cancer diagnosed after menopause. This may support the notion that carotenoids are more influential in the early stages of breast cancer given the time difference between premenopausal collection and postmenopausal diagnosis; on the other hand, more nuanced hormonal interactions with carotenoid intake may be responsible for this influence on postmenopausal, but not premenopausal, breast cancer risk.

Carotenoids reduce risk of aggressive and deadly disease

Improved survival due to advancements in screening and surgical treatments, alongside continued high prevalence of disease, emphasizes a need to examine how to improve breast cancer outcomes, including recurrence and death. In an extended analysis in the Nurses' Health Study, carotenoids appeared to protect against these adverse outcomes. Inverse associations were stronger when evaluating pre-diagnostic carotenoid levels with respect to risk of lethal or recurrent breast cancer, than those observed for risk of non-lethal breast cancer.⁴⁷ For example, β-carotene levels corresponding with the highest quintile resulted in a 68% reduction in the risk of lethal or recurrent breast cancer, compared with levels corresponding with lowest quintile (RR=0.32, 95% CI: 0.21, 0.51, p-trend=0.001). The inverse trend for risk of lethal or recurrent breast cancer by quintile of intake was

also significant for α-carotene (RR=0.61, 95% CI=0.40, 0.93, p-trend=0.04), β-cryptoxanthin (RR=0.68, 95% CI=0.45, 1.04, p-trend=0.008), and total carotenoids (RR=0.48, 95% CI=0.31, 0.73, p-trend=0.001) (Figure 2). In addition to these analyses, which were based on pre-diagnostic carotenoid levels, other studies have reported lower risk of recurrence and death among women with higher carotenoid levels at the time of diagnosis and after diagnosis,^{48,49} suggesting a role for carotenoids in prognostic improvement as well.

“Evidence points to a consistent inverse relationship between circulating carotenoids and risk of incident breast cancer”

Conclusion

Overall, current evidence points to a consistent inverse relationship between circulating carotenoids and risk of incident breast cancer, including aggressive and lethal tumors. While direct supplementation of carotenoids is not advocated given harmful effects of high-dose β-carotene supplementation, especially among smokers,⁵⁰ breast cancer risk reduction may be possible through dietary changes. Further studies are needed to

uncover intricacies behind the timing of carotenoid action and the distinct role of carotenoids in ER+ versus ER- breast cancers. Additionally, investigators should continue to explore carotenoids measured at diagnosis and after diagnosis, in relation to subsequent prognosis. Future research targeted in these areas will enable a better understanding of the mechanistic action of carotenoids in breast cancer initiation and development.

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The Sociocultural Drivers of Food Choices

Formative research among pregnant and lactating women in Rajasthan

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Key messages

- > Addressing maternal undernutrition is not just about the nutrient profile of the foods women eat; it also requires an understanding of the social norms and beliefs that guide eating practices during pregnancy and lactation.
- > Pregnant and lactating women (PLW) in Rajasthan consume on average 30% less than the Indian Medical Research Council's recommended intakes for calories and for protein in the third trimester of pregnancy or during exclusive breastfeeding.
- > Formative research was conducted to identify how key social influencers shape the decisions of PLW in Rajasthan on what and when to eat and to understand important barriers to healthy eating during pregnancy.
- > Food taboos tend to be propagated by mothers-in-law (MIL), whereas husbands may be more accessible to dietary advice in respect of their wives, not least because of the cost of medical care in the event that they fall sick.
- > Key insights of the research are that improving food intake is feasible through non-main-meal occasions, that women need permission to eat more during pregnancy and lactation, and that actionable dietary advice needs to be relevant, specific, and desirable.

Pregnant and lactating women (PLW) have higher calorie, protein and micronutrient needs than other women. These increased nutritional needs can be met through various changes in eating

habits during pregnancy and lactation. For example, to increase calorie and protein intake, women can increase food portion sizes, choose foods with more calories, with more of those calories coming from protein, or eat more frequently. Nutrient density can also be achieved via these strategies, as well as by choosing food with a higher nutrient content. For some nutrients (e.g., iron and folic acid), simply eating more food will not cover nutrient needs, so a supplement is required. However, addressing maternal undernutrition is not just about the nutrient profile of the foods women eat. It is also about understanding their eating culture and the social norms and beliefs that guide eating practices during pregnancy and lactation.¹

Maternal nutrition is critical for fetal growth and development² and for optimizing nutrient levels in breast milk.³ In contexts with high prevalence of maternal undernutrition, such as Asia,⁴ the need for scalable strategies to improve nutrient intakes among PLW is an urgent priority. In India, 35.6% of women of childbearing age⁵ have a body mass index below 18.5 kg/m², and women who are below this level are considered undernourished. The Anganwadi system addresses maternal nutrition status during pregnancy and lactation through a take-home ration, either as a ready-to-prepare or hot-cooked meal for the PLW.

In 2017, *Sight and Life* partnered with the Children's Investment Fund Foundation (CIFF) to examine the sociocultural drivers of food intake among PLW in Rajasthan through formative research. At the same time, CIFF also commissioned an Optifoods study to the Indian Institute of Health Management Research (IIHRM) to better understand how the nutrient gap could be filled through the existing food system. Analysis of the dietary recall data showed that PLW in Rajasthan dietary intake is approximately 30% lower than what is currently recommended by the Indian Medical Research Council for calories and for protein in the third trimester of pregnancy or during exclusive breastfeeding. The nutrient gap is even more pronounced than the calorie and protein gap, with the recommendation for fat, calcium, iron, zinc, vitamin A and vitamin C falling 50–70% below the ICMR (Indian Council of Medical Research) recommended levels in the third trimester of pregnancy. According to Opti-



A fruit vendor selling apples, grapes, parsimons and pomegranates. Fruit is an expensive and highly valued item, and doctors will often “prescribe” fruit to pregnant women.

foods, these gaps could be reduced if women were to consume pulses, vegetables, and milk on a daily basis, and to increase their weekly consumption of fruit and eggs. These dietary recommendations, however, would still not meet calcium, vitamin A, and iron intakes during pregnancy. Affordability of this diet is a genuine concern because pulses, vegetables, fruit, and eggs are purchased as often as the household economy allows.

Even if it was affordable to meet the dietary recommendations outlined in Optifoods, we do not have the social evidence (a) on whether it is acceptable and practical to eat 600 extra calories of nutrient-dense food per day; (b) to what extent women are motivated to eat more of the same food; and (c) to what extent women and their influencers understand the benefits of eating more. Of relevance is the highly gendered eating context in Rajasthan, with various gatekeepers monitoring women’s food access, and women often the last to eat. Also, the acceptability of food recommendations is influenced by beliefs about foods and their impact on pregnancy and milk production and quality. These factors together influence how and *where* and *what* one communicates to motivate a change in dietary practices among PLW in Rajasthan.

“Of relevance is the highly gendered eating context in Rajasthan, with women being often the last to eat”

The objectives of the formative research were to:

1. Identify how key social influencers shape PLW’s decisions on what and when to eat;
2. Identify the benefits / outcomes that are most valued by women during pregnancy and breastfeeding;
3. Discover the most appropriate vocabulary to describe these benefits / outcomes; and
4. Understand important barriers to healthy eating during pregnancy.

We report a summary of the formative research findings and their implications for behavior change intervention to improve nutrient intakes among Rajasthani women.

Methods

Study design. We followed an emergent approach to the research, whereby new lines of inquiry were pursued based on the data emerging from the interviews and observations. Debriefing calls were held biweekly with project partners to hear insights from the field team and discuss whether any adjustments to content of discussion guides or data collection methods were required for the subsequent field site.

Setting and participants. We selected four districts that reported 50% female literacy. In the east we selected Tonk, located in a semi-arid region. Pali, in the mid-west, is located in a semi-arid, sub-humid region with below-average rainfall. In the South we selected Udaipur, in a humid region, and Baran in a very humid region, both with average rainfalls. Baran district has at least 20% of the population as scheduled tribes and castes. All participants sampled were from low-income communities. We used a convenience sampling approach (Table 1). Women were excluded from participating in this study if they were illiterate. Eligible participants were married women and had at least one child, or were expecting their first child. We sampled a broad range of participants, from women living in nuclear homes to those in multi-family homes; women with a university degree to women who had low literacy levels.

Data collection methods. Kantar TNS, a market research agency from Gurgaon, was hired to conduct the formative research. Data collection occurred from February to March 2017. In-depth interviews were conducted with PLW. A variety of interview techniques was used to elicit responses, including open-ended questions, concept testing (different types of dietary advice; positive or negative outcomes related to eating more in pregnancy and lactation; Sita-Gita story about twin sisters that are expecting), and evaluation of images of women. In these same communities, we conducted home observations

TABLE 1: Sample size description for data collection based on district and respondent-type

Data collection methods	District				Total
	Udaipur (urban)	Baran (rural)	Pali (urban)	Tonk (rural)	
Interviews (PLW)	5	6	6	6	23
Observations (PLW)	2	2	2	2	8
Focus Group Discussions (n=8–10)					
Husband	1	1	1	1	4
Mother-in-law	1	1	1	1	4
Frontline workers (ASHA/ AWW/ ANM)	1	1	1	1	4
	10	11	11	11	43

PLW: Pregnant and lactating women. ASHA: Accredited Social Health Activist; AWW: Anganwadi worker; ANM: Auxiliary-nurse midwife

with PLW, focus group discussions (FDG) with MIL, husbands, and frontline workers (FLW) (Table 1).

Data analysis. Transcripts were translated to English and underwent content analysis by a TNS. A research specialist based at the University of South Carolina conducted an in-depth text analysis of the English transcripts with ATLAS.ti software (v.7, Germany) to identify factors that affect food access and eating norms in this sample of women. The text analysis was a mix of pre-defined and emergent codes. The pre-defined codes were taken from a review of the literature that revealed that Indian women's eating practices are influenced by social support networks, beliefs about food (i.e., taboos), access to information, biological factors (i.e., appetite, life stage), and personal factors (i.e., preferences, emotional wellbeing, confidence/self-efficacy, and status in home).

Results

The PLW in our sample were relatively young and on average women in our sample had completed primary school (Table 2). The median number of family members (excluding the PLW) in the households was 6 and the inter-quartile range was 3 and 8.

We identified 19 factors that drive food choices in this sample of pregnant and lactating Rajasthani women (Figure 1). These factors act at various levels, from the individual to the sociocultural, interacting in multiple and complex ways. The results described here are organized around key insights. For each insight, we begin with a brief explanation of why this line of questioning was pursued, then we present evidence from the formative research that supports the insight, and we conclude by identifying the implications for programs.

Insight A. Improving food intake is feasible through non-main-meal occasions

Typically, practitioners give dietary advice that centers on foods consumed as prepared meals. In Rajasthan, the calorie and nutrient gap between current and recommended intake is quite large. To explore the viability of meal-based dietary advice to cover the nutrient gap, we examined the PLW and household eating and meal patterns, as well as eating norms.

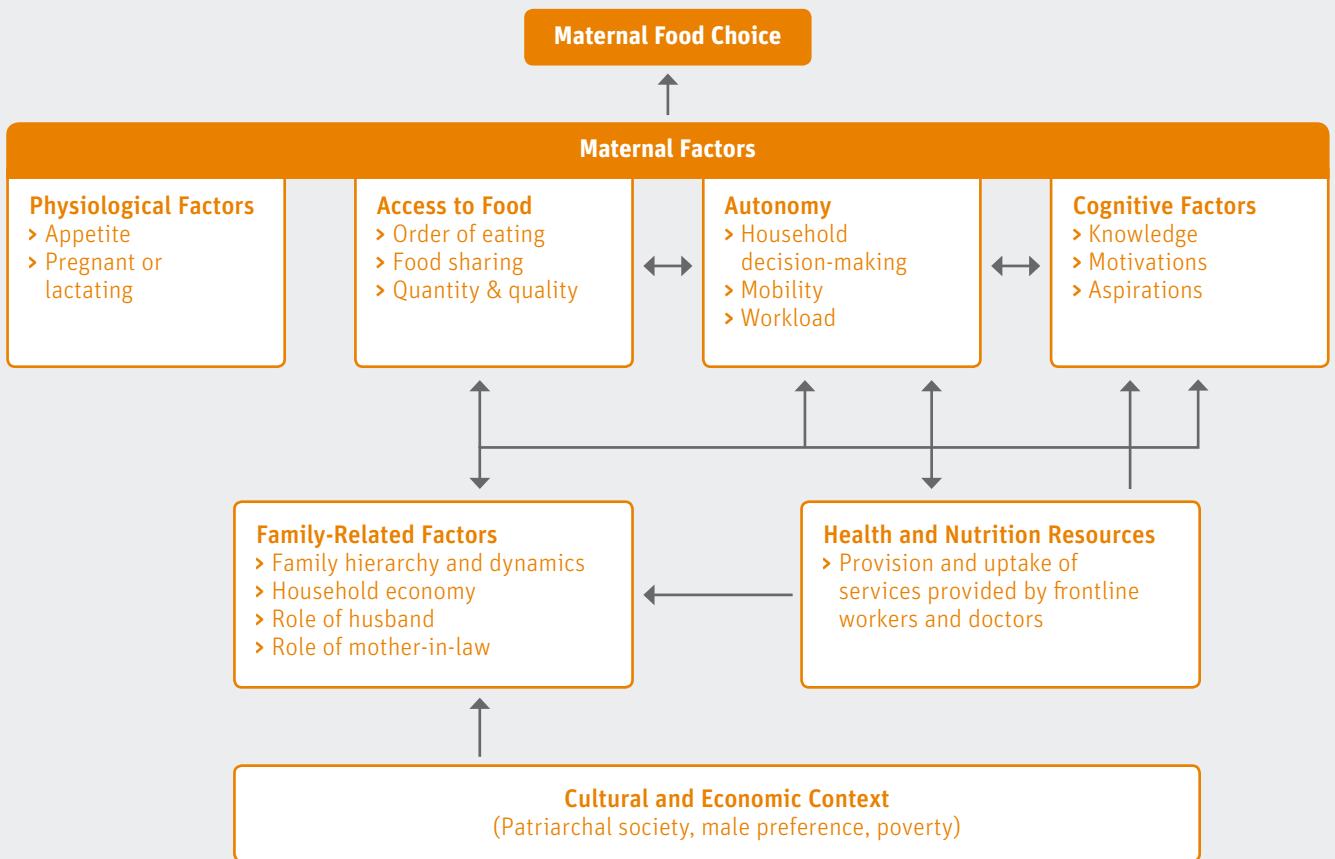
Evidence from formative research

The typical eating patterns for these communities consisted of two meals, one late morning and the other between 6 and 7 pm,

TABLE 2: Sociodemographic characteristics by location

Location	Mean age of PLW (years), (SD)	Mean years of schooling (years), SD
Udaipur	25.7 (2.6)	9.7 (3.0)
Baran	22.8 (2.1)	9.4 (3.3)
Pali	24.9 (3.6)	8.1 (3.3)
Tonk	24.3 (3.2)	9.6 (1.6)
Overall mean	23.6 (3.0)	8.8 (3.0)

FIGURE 1: A conceptual model of the factors influencing food choice for pregnant and lactating women in low-income communities in Rajasthan



and a tea taken at home, early in the morning. These meals consisted of chapatti, vegetables and/or *dal*, which is lentils cooked with soup-like consistency and made with spices. Morning teas (prepared with milk) could be taken alone, or with toast, biscuit, or left-over roti from the previous evening meal.

Maternal diet is described using Passim and Bennett's⁶ food classification of core, secondary core, and peripheral foods (Table 3).

Eating occasions outside of meal times were variable in their practice: an afternoon tea, or drinking milk, buttermilk/*lassi/rabdi* [buttermilk with cereal (corn or pearl millet)] or eating a fruit at mid-morning or sometimes in the afternoon. These foods taken outside of mealtimes can be characterized as small, single-serve portions, and in many cases are prepared or bought and then stored for family consumption. PLW with greater opportunities for non-main-meal occasions were those who **a)** were the homemaker; **b)** had a young child, because they could eat the treats or fruit bought for the children; **c)** lived in a single-family home.

Eating norms revolve around shared foods, mostly through shared meals. Eating food by oneself or for oneself is selfish, un-

acceptable behavior. *"It does not look good also that only I sit and eat. I will cut one apple and give her [sister-in-law] half and have half myself."* PLW did not consider it normal or appropriate to eat more food than others at meals, especially because it challenged their notion of a good wife, a good daughter-in-law, and a good mother. Thus, dietary advice for a PLW would have to "apply" to all household members. For example, if a PLW is advised four small meals per day, this advice would mean increasing household food expenditure. As one husband noted, *"if she is eating four times, then the rest of them [family] are also eating four times. So for that you have to earn a lot."*

.....
"PLW did not consider it appropriate to eat more food than others at meals, because it challenged their notion of a good wife, daughter-in-law, and mother"

TABLE 3: Food classification of maternal diet

Category	Foods	Frequency
Core foods	Chapatti/Roti Vegetables (sautéed or curried) such as spinach, fenugreek leaves (<i>methi</i>), eggplant, onions, tomatoes, cauliflower, carrots, potatoes, peas	Daily
Secondary foods	Dal, halwa, khichidi, milk and milk products,* fruits, biscuits, toast	2–3 times a week
Peripheral foods	Sweets, desserts, meat, eggs laddoo specifically for lactating women, daliya (broken wheat porridge)	Occasion-specific

* Use of milk and milk products varied among those interviewed. Those families with livestock noted regular consumption of milk and milk products such as yogurt and buttermilk (chaas) which could be categorized either in the core or secondary foods. For those that did not have livestock, milk use was limited to making tea or adding milk while cooking other dishes such as halwa.

Food access is determined by the position in the home, and autonomy to leave the house and make food purchases. Because of their earning power and freedoms to travel independently, men buy food, and male food preferences often influence what is prepared at meal times. PLW cook the food and may recommend what to buy when food stocks are low, but normally the PLW is not responsible for food purchases. The MIL, as the manager of household food resources, decides what to prepare, when, and who prepares the meals. She may occasionally buy the food. PLW need direct permission from the MIL to prepare foods (lighting a fire or the stove) and to eat foods in the kitchen.

PLW longed for the freedoms of their maternal home, where they could consume whatever they wanted. “At maternal home, I used to have [fruits] daily and there was no tension. Here, there is

irritation.” Thus one can infer that women with the lowest autonomy are likely to be newlywed, 17–25-year-old, primipara living in multi-family households.

When financial resources were scarce, a PLW prioritized others’ needs over her own. “If everything is okay at home then I will take for myself, but if there is need at home, then I will use it for my house.” In multi-family homes, competition for food resources was evident. “Sometimes apples come home for me, as the doctor has told me to have them. But my sister-in-law will snatch them, saying, ‘I do all the hard work and she [PLW] gets to eat apples.’”

Implications for nutrition interventions

In this context, there are various barriers to a meal-based dietary recommendation. Another pathway to explore might be non-main-meal occasions (or snacking occasions), given that they align with existing norms and eating practices for women. First, most non-main-meal foods do not require a stove/fire, so permission from the MIL is not explicitly needed. Also, “not having to cook” means that one does not take time away from other chores to prepare and eat these foods, creating less friction between the PLW and the MIL. Second, foods consumed outside of meals are often “snack size”, a small, single-serve portion, which aligns with the belief that to avoid lethargy, women must consume small amounts of food (see Insight C). Third, recommending foods that are already prepared or bought and then stored for family consumption, which women have access to, may alleviate guilty sentiments of having scarce resources diverted to the PLW and not to others.

Insight B. Women need permission to eat more during pregnancy and lactation.

Given the limited autonomy of low-income Rajasthani women, food-sharing practices, and financial possibilities of families,



Kitchen shelf with spices and other dry goods for cooking meals

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A pregnant woman has prepared a typical mid-morning meal: a vegetable sabzi (curry), containing tomatoes, onions, and spices, which she will accompany with roti (flatbread).

women require permission from gatekeepers to act on dietary advice. We examined the permissiveness of husbands and MIL for granting food access.

Evidence from formative research

There are certain cases when women are granted permission to consume foods only for them. One example is when the doctor prescribes foods as treatment. For example, when pregnant women are diagnosed with anemia, they are advised to eat fruit or take supplements, or when women show inadequate weight gain, the doctor's prescription may include a protein powder to be taken with milk. Another case when women are granted permission is when pregnant women "crave" a sweet treat or fried food. In both the medical and craving situation, it is the husband who buys and sanctions eating such foods, within the limits of household finances.

In our sample, the husbands exhibit behaviors of being the provider, protector and a medium to the outside world. Our data show that he is, at times, warm, appreciative, and does things to gain her affection, though on the sly, satisfying her cravings or buying treats like *kachori* or *pakora*. Women expressed that they found the occasional smuggling of food by the husband exciting and romantic. Husbands are balancing the demands of the patriarchy with being more emotionally available to their wives. While household food management is still a woman's domain, men were eager to know the links between foods and better health, given that they pay for medicine and doctors. "They do not tell us of such advice and then when things go wrong we need to spend." PLWs also discussed the ways in which husbands support them:

"Yes, even he [husband] takes care of me a lot ... During my first pregnancy, he was not always there with me, but now during my second pregnancy he was always there all the time ... He took me to the Jodhpur hospital and we did all the tests on time. He took care of my food also." (Lactating mother, Pali)

"He scolds me, and tells me to eat this and that ... If I don't eat food on time he scolds me because I haven't eaten food or had milk on time." (Pregnant woman, Udaipur)

In contrast to the husband, the MIL tends towards restricting food access, but this restriction is related to food beliefs and pregnancy. The MIL is concerned about a "smooth delivery" and avoiding the need for C-section, so MIL encourage eating down in the last trimester and avoiding sticky foods (bhindi, banana, ghee, okra) because these are thought to make the baby stick to the womb. MIL were adamant that pregnant women should remain physically active (continue doing housework or field work) to ensure an easy delivery. MIL with a more "traditional view" thought that today's pregnant women were too delicate and "required" too many luxuries, such as special food (protein powder and milk) and rest.

"The MIL tends to restrict food access on account of food beliefs and pregnancy"

Implications for nutrition interventions

Dietary advice given only to women has a very low likelihood of having an impact on a PLW's dietary intake. Advice must also be given specifically to gatekeepers, such as MIL and husbands, so they can understand and sanction any dietary changes. Husbands, in particular, are a promising route for improving food access, because a husband is the woman's link to knowledge resources and food access. Furthermore, husbands offer an avenue for emotional support and care to PLW, but may be reluctant to do so if it means openly defying their mother's authority in food and household management.

Insight C. Actionable dietary advice is advice that is relevant, specific, and desirable.

PLW discussed the type of diet advice received by FLW, and FLW shared the advice they provide to the women and sometimes the MIL. The current advice in pregnancy centers on meal-based foods (*dal*, green leafy vegetables, four small meals), milk, and fruits.

Lactating women did not report having received any specific dietary advice from the FLW. After giving birth and during the first 40 days post-delivery, it is customary for women to take rest from household or field work and to consume a special diet

consisting of *ladoos* (macaroons made with ghee, almonds and dried fruit). During this time, the PLW is often isolated from the rest of the family and remains under the care of the MIL (or mother, if she has travelled home to deliver), who supervises the foods consumed by the PLW.

We also tested various concepts to understand the relevance and motivations for dietary changes.

Evidence from formative research

Perceived Relevance of dietary advice. It should be noted that pregnancy is perceived as a normal state of womanhood. “All women get pregnant, why should it be considered special?” We also found no measurable increase in dietary intake between the pregnant and non-pregnant state. “I will eat as much as I can, what’s the point of extra eating?” Moreover, the main preoccupation for a pregnant woman is to deliver her child alive and “healthy”, so dietary changes (or lack thereof) are motivated by the wish to avoid miscarriage, stillbirth, complications at delivery, and maternal death. The food taboos common among PLW are related to these fears. When asked about eating larger portions, women did not perceive themselves as eating small portions.

.....

“Food taboos among PLW are motivated by the wish to avoid miscarriage, stillbirth, complications at delivery, and maternal death”

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It’s quite common for women to hang up posters or pictures of smiling, happy children because it helps the pregnant mother to visualize having a happy child. This woman had her images inside a display case.

In lactation, a key motivational driver is boosting milk production and recovering the PLW’s strength post-delivery. During the 40-day rest period, women generally consume one meal per day: roti with ghee alone or roti and green vegetables, and *dal* is consumed frequently, 2–3 times a week. In between meals, lactating women consume significant amount of *ladoos* and some may consume *halwa* or *daliya*. Lactating women avoid heavy foods and sour foods (buttermilk, curd) to prevent colic in the baby.

We found that the MIL readily referenced practices to prevent loss in pregnancy and the food restrictions during lactation were related to the child’s health or the mother’s recovery from childbirth. These ideas represent the traditional view. We can infer from the data that PLW living in rural areas and PLW with less education are more likely to rely on food beliefs in support of dietary restrictions. PLW are fearful when they (or a close relative) have had a previous experience with miscarriage or other complications in pregnancy.

Personal desires. We asked PLW to comment on images of other women (this was one of our interview methods) to discuss their aspirations for the future. Women expressed a desire to be more independent and contribute to the family income, and aspired to the betterment of their children. They also wished to learn new things. “I feel I could have also studied till the 10th [grade]. Maybe now I could have studied further ... If you study more, your GK [general knowledge] increases and you become more aware ... I could probably have brought up my children in a better way.”

Specificity of the advice. In the formative research, we tested various dietary concepts framed as loss (weak child, weak milk) or gains (strong child, strong milk, good diet). The concepts that were perceived to be most relevant were the ones with a tangible *positive* benefit (gain) for the child, along with learning new information. Ideas that resonated well, as judged by expressions of body language and positive comments, were:

- > Children’s brain, blood, bone and eye development mostly happens around **three months before birth**.
- > Doctor-recommended food helps the **woman stay healthy and strong**. This helps her take better care of her family and child.

When our research staff shared only generic dietary advice, PLW justified their current food choices by citing the importance of eating-down, food taboos, or the scarcity of food.

Implications for nutrition interventions

Dietary advice has higher action efficacy among better educated women, particularly among women who have the financial resources to act.⁷ However, it appears that among this sample of low-income women, technical and new dietary suggestions coupled with child development milestones seem to pique in-



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Pregnant woman showing coconut she keeps in a shiny steel jar, tucked behind the plastic containers. Her husband buys this for her. “This is only for me to eat,” she boasts.

terest in taking action. It was not about eating more for the sake of consuming more food (and risk being viewed as selfish), but eating more as a means to achieve the health and development of the PLW’s (unborn) child. Our data also suggests that creating a consumption vocabulary⁸ for pregnancy and lactation might be one way to motivate less educated women towards better dietary choices, given the foods available to them. The need for self-actualization, self-improvement, and family betterment are powerful motivators for changing behaviors.

.....

“Dietary advice has higher action efficacy among better educated women, particularly among women who have the financial resources to act”

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Designing a behavior change intervention

We have used formative research to identify the factors influencing dietary intakes among pregnant and lactating women. If one was planning a dietary intervention, one behavior goal would be to increase the proportion of women that are eating more frequently throughout the day, consuming food that is both energy-dense and nutrient-dense. Translating formative research insights into a behavior change strategy is both a science and an art.

From a scientific point of view, we have used research to identify the sociocultural intervention pathways and contextualized

strategies to achieve our behavior goal. One can also apply social cognitive insights to further elaborate intervention strategies. For example, social roles and social desirability^{8,9} are two principles that are relevant for behavior change. In our data, social roles and social desirability are recurrent variables (or factors), with each key influencer having a unique responsibility in granting food access and encouraging food intake for women. Accordingly, a nutrition intervention that signals to gatekeepers that providing additional food to PLW is helping them fulfill their moral expectations, is less likely to encounter social resistance.

Drawing from the field of social cognition (i.e., behavioral economics), we humans use heuristics (or shortcuts) for decision-making, especially under uncertain conditions. One can deduce that pregnancy is largely an uncertain endeavor and it would not be unlikely for heuristics and “hunches” to influence decision-making. For example, we found that a past negative experience (example of availability heuristic) with the pregnancy dominated the mood and dietary practices within families. Also, fear of losing pregnancy or not recovering fast after delivery (examples of loss aversion bias) tended to be given as answers for not making any dietary changes or for exhibiting restrictive dietary behaviors. When we tested dietary concepts, we found those framed as a gain resonated better than those framed as a loss. It seems that strong imagery (i.e., mental stimulation⁸) centered on optimistic possibilities of eating healthily might help families envision positive rather than negative outcomes with improved nutrition.

Because emotions are important pathways for motivating dietary changes, our data collection and analysis focused on identifying the emotional states that PLW might experience. Our evidence shows that there is fear of poor pregnancy outcomes; women feel guilty for thinking about their needs; the PLW wants to contribute to her family’s betterment; she finds exciting and romantic the occasional smuggling of food by husband; she feels cared for by the FLW; and she is highly motivated by a tangible *positive* benefit (gain) for the child. The positive emotional states in the PLW are opportunities for intervention.

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“Positive emotional states in the PLW are opportunities for intervention”

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Michie et al¹⁰ note that behaviors are a function of three elements: capability, motivation, opportunity. If one combines the formative evidence, social cognitive lens, and the COM-B model proposed by Michie et al,¹⁰ then we can organize a mechanism of action (impact pathway) through key intervention tactics as follows:

1. Persuade the husband and MIL (gatekeepers) to sanction and purchase foods for PLW. The key motivational payoff is the future of the child, one that achieves something better than what they have currently achieved. There is an opportunity to educate the gatekeepers on the importance of nutrition and help husbands visualize that they are fulfilling their moral duties, as a husband and a father. This signaling can happen in a number of ways, such as through a logo, key visuals, narratives, and slogans that help develop the program's identity; deliberate targeting of husbands via community events can be used to celebrate care- or nutrition-seeking behaviors. **Behavior determinant addressed:** Create social and physical *opportunity* for food access for PLW; create *motivation* for husbands.

2. Persuade women and MIL that gains related to dietary change outweigh the potential fears. Include messages that contain facts, with an argumentation from consequence; use storytelling and metaphors to explain more difficult concepts.¹¹ Positive testimonials (social proof) and social modeling can be deployed as tactics to dispel fears and encourage eating more food. **Behavior determinant addressed:** Reflective *motivation* for women and their social influencers.

3. Offer tangible, actionable advice for foods that can be taken at non-main-meal occasions, do not require cooking, can deliver calorie and nutrient density in a relatively small portion, and are readily available in the home. Frame the advice around the benefits that matter – a healthy pregnancy and strength to go about their day. A box to be filled with snack options would shift the locus of control of food resources from the kitchen (and MIL) to the woman, and would allow the husband to fulfill his duty by providing special foods for his wife. **Behavior determinant addressed:** Increase the self-efficacy (or *capability*) of women to act on their own food choices and improve physical *opportunity* to access food.

That was the science part. The artistic part is best left to the experts. Our project partners include Cartwheel Creative Consultancy, whose creative masterminds led the translation of facts into artistic, appealing project elements. Please watch this space for more reports or articles on this project.

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New Allies Accelerate the Fight against Malnutrition

A discussion of field-friendly diagnostics, screening devices, and tools

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Key messages

- > Despite progress, malnutrition remains a major health concern worldwide.
- > Effective efforts to address malnutrition, in all its forms, have long been hindered by a lack of affordable, effective, and field-appropriate diagnostics, screening devices, and tools to measure and track nutritional status.
- > Thanks to entrepreneurs from across sectors, a new crop of innovative products promises to dramatically improve field-based measurement of nutritional status, particularly in low-resource settings.
- > This article introduces five exciting products; outlines their use and potential impact; and highlights the continued need to champion the partnerships and investment that make breakthrough health innovation possible.

The challenge of field-based nutrition measurement

Despite tremendous progress, malnutrition remains a major barrier to health and wellbeing worldwide. Undernutrition among children and mothers remains the leading underlying cause of child morbidity and mortality, contributing to 3.1 million child deaths each year.¹ Globally, 155 million children under five are

stunted due to chronic undernutrition, and 52 million suffer from wasting from acute malnutrition. Concurrently, a growing epidemic of overweight and obesity affects an estimated 40.6 million children under age five.²

Recognizing the prevalence and persistence of this burden, the global health community is increasingly striving to identify and address the complex causes and impacts of malnutrition. Yet measuring and assessing nutritional status and outcomes in low-resource settings (LRS) has often proven expensive, time-consuming, and difficult.

Fortunately, a new generation of field-friendly diagnostics, screening devices, and tools is poised to help address these challenges. Here, we present a sample of these promising innovations. We hope that greater familiarity will increase interest in these and other products; prompt greater use and better health outcomes; and inspire leaders to champion the partnerships and investments that make innovation possible.

“There is a new generation of field-friendly diagnostics, screening devices, and tools for assessing nutritional status and outcomes in low-resource settings”

1. Pooled enzyme-linked immunosorbent assays: A fast, affordable test for multiple biomarkers of nutritional status
Although global leaders rely on population-level testing to build a broad picture of community health and develop coordinated





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The Q-Plex™ Human Micronutrient Array can simultaneously measure up to seven biomarkers for vitamin and mineral status in a sample of human serum derived from a finger-stick.

and effective responses, vitamin and mineral deficiencies in particular have proven challenging to assess.

To close this gap, PATH, a leading global health organization (Seattle, WA, USA), the University of Washington (Seattle, WA, USA), and private-sector manufacturer Quansys Biosciences (Logan, UT, USA) collaborated on the Q-Plex™ Human Micronutrient Array, currently available from Quansys.³ The tool is more affordable and efficient than current technologies because it can simultaneously measure up to seven biomarkers for vitamin and mineral status in a sample of human serum derived from a finger-stick. This minimally invasive sampling method facilitates easier field collection than most current methods for micronutrient surveillance. Using pooled enzyme-linked immunosorbent assays (ELISA), the Q-Plex™ detects biomarkers of iodine (thyroglobulin), iron (ferritin, soluble transferrin receptor), and vitamin A (retinol-binding protein 4) deficiencies, as well as inflammatory status (C-reactive protein, α_1 -acid glycoprotein) and malaria infection (histidine-rich protein II). Currently packaged in up to a 7-plex configuration, the tests can be customized, allowing researchers to choose which tests to include. Iterations in development will add biomarkers for vitamins B₁₂ and D, environmental enteropathy, and exposure to infectious diseases. For more information, visit: www.quansysbio.com.

2. Automatic anthropometry:

A rapid scan for accurate and objective body measurement

Health workers use anthropometric measurements to assess the nutritional status of children during their early years of development. In most LRS, the current standard for measuring child length or height to monitor stunting and wasting is the ShorrBoard®. When users are trained appropriately, board measurements are accurate,^{4,5,6} but the board is cumbersome, requires multiple people to use, and is often uncomfortable for children. This can limit correct use by researchers and health workers.

To address this challenge, the private company Body Surface Translations (BST, Athens, Georgia, US), has developed AutoAnthro. This technology derives child stature (length/height), head circumference, and mid-upper arm circumference (MUAC) from 3D scans and a 3D model. An occipital structure sensor, attached to a smart phone or tablet, generates a series of 3D images to create a model, and then generates measurements from the scans using custom software.

BST, in collaboration with Emory University (Atlanta, Georgia, US), has evaluated the tool in a 500-child study within the United States. Early data are promising and suggest the option may be easier to use, more accurate and consistent, and more efficient for large-scale data collection and analysis. Now, the team will field validate AutoAnthro in LRS with a goal of making



Gene Alexander. Photo courtesy of Gene Alexander

AutoAnthro, a new mobile device from Body Surface Translations (Athens, Georgia, US), derives child stature, head circumference, and mid-upper arm circumference from 3D scans and a 3D model.



© Brittany Fiore-Gartland. Courtesy of Brittany Fiore-Gartland

With its lower cost and accuracy specifications, the portable handheld Pronto® developed by Masimo (Irvine, CA, USA) may help expand reliable access to hemoglobin screening.

it commercially available by late 2018. For more information, contact: Gene Alexander, PhD: gene.alexander@gmail.com.

3. A noninvasive tool for point-of-care hemoglobin screening

Iron deficiency anemia is one of the most common and widespread global nutritional disorders, causing fatigue, dizziness, headaches, and shortness of breath, and contributing to chronic infections.⁷ Pregnant women with anemia (low hemoglobin [Hb]) are at increased risk of complications and death if they experience uncontrollable bleeding (hemorrhage) during childbirth.⁸ Among children, low Hb levels can hinder brain development.⁹

The amount of Hb in whole blood, expressed in grams per deciliter (g/dL), is commonly used to diagnose anemia and is relatively easy to assess using a blood sample. Blood draws, however, can be difficult and painful for patients and increase the risk of infection and disease transmission. Effective screening programs have been hampered by the lack of a safe, accurate, and affordable solution.

Noninvasive Hb measurement devices, such as the portable handheld Pronto® developed by Masimo (Irvine, CA, USA), may help. Using wavelengths of light, a sensor placed on a patient's finger provides readings of total Hb (g/dL), oxygen saturation, and pulse rate. The sensors are pre-loaded with spot-check measurements in quantities of up to 1,000. Simple and easy to use,

Pronto® provides accurate results in as little as 40 seconds and measures through motion and low perfusion conditions. With its lower cost and accuracy specifications, and because of the safety of noninvasive measurement, Pronto® may help expand reliable access to Hb screening.^{10,11} For more information, visit: www.masimo.com.

4. Dried matrix spots (DMS):

A new look at dried blood spot sampling

Dried blood spot (DBS) testing is currently used to test infants for HIV, phenylketonuria, and other diseases. Using this method, drops of whole blood are collected from a finger- or heel-stick on a special type of card stock. Once dried, these samples are biosafe, small, and lightweight. Most do not require refrigeration or electricity to remain viable, so they can easily be transported or stored for testing. Although DBS is widely accepted by clinical communities, it continues to face gaps in accuracy and stability.

Now, researchers are developing more sophisticated sample collection approaches for dried matrix spots (DMS), which can test more than just whole blood, for example, blood serum or breast milk.¹² This opens the door for new uses – including nutrient biomarker testing. To explore this potential, Craft Technologies Inc. (CTI, Wilson, NC, USA) is evaluating sample collection



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Innovative products hold promise to dramatically improve field-based measurement of nutritional status. New measurement tapes for mid-upper-arm circumference, shown in use here, are one example.

devices by measuring the accuracy and stability of 11 nutritional biomarkers in blood samples.¹³ The group has been working with ViveBio (Alpharetta, GA, USA) to optimize a collection card (PRISM™) to separate plasma and red blood cells. CTI is also evaluating collection and analysis methods for biomarker stability and reliability in LRS.¹³ For more information, visit: www.crafttechnologies.com and www.vivebio.com.

5. Enhanced tape measures to improve health

Not every new innovation is complex. MUAC tape measures are considered the standard tool to identify moderate or severe acute malnutrition and elevated mortality risk among children six months to five years old.¹⁴ Yet although MUAC tapes are simple tools, health workers need training and practice to use them properly. Common errors, such as placing tapes incorrectly along a child's arm or pulling them too tight, limit the reliability of measurements, hindering referral and treatment.

These challenges have prompted two teams to develop improved tapes. Intellectual Ventures' Global Good Fund (Seattle, WA, USA) has developed a wider tape that reduces pressure applied to the arm and corrects for error incurred by the strap's thickness.¹⁵ Another effort, led by *Médecins Sans Frontières* (MSF), in collaboration with Brixton Health (Llawryglyn, Wales) and a group of nutrition experts, has developed a "Universal

MUAC" (uniMUAC) strap that is double-sided for both adults and children. This adaptation also has a broader strap width, a triple-slit design for greater stability, and a wider reading window.¹⁶ Both designs require less training to use than previous iterations. For more information, contact: Global Good, David Bell, MD, PhD (dbell@intven.com); MSF, Bhargavi Rao, MD, PhD (bhargavi.rao@london.msf.org).

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“Today, the nutrition community has an unprecedented opportunity to champion innovative approaches and tools to measure nutrition outcomes”

Conclusion

Even as a new generation of diagnostics, screening devices, and tools reach commercial markets, others are undergoing development and revision for accuracy, affordability, and ease of use. These products have the potential to save lives by helping the public health community better assess and track mal-

nutrition, predict trends, and create and target more effective programs and policies.

Just as exciting is the increasingly global – and cross-sector – nature of health innovation. Today, the nutrition community has an unprecedented opportunity to champion innovative approaches and tools to measure nutrition outcomes, and to participate actively in their use and improvement.

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Omics Innovations and Applications for Public Health Nutrition

An integrated view

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Key messages

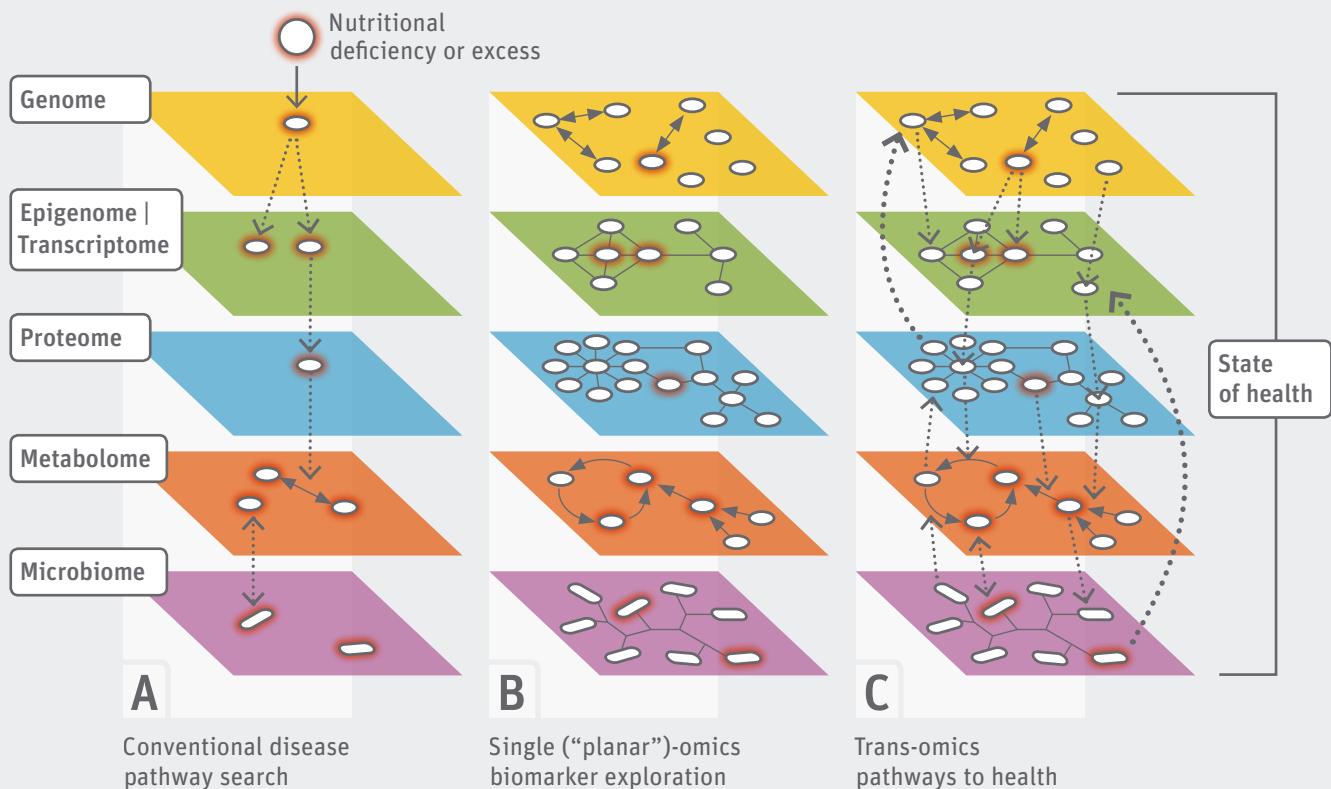
- > Omics technologies comprise sets of molecular mapping tools that can help us understand and navigate to or from states of health, including nutrition.
- > Single omics studies explore sets of genes, epigenetic marks, transcripts, proteins, or metabolites, as well as microbial communities, in an unbiased manner.
- > Trans-omics studies offer opportunities to connect, integrate, and map a group of molecules across multiple omics layers to identify pathways, interactions and feedback loops that may more fully reveal the biology and, likely, suites of diagnostic markers, therapeutic targets and pathways to and from disease states.
- > Omics approaches are transitioning from the theoretical level to the level of practical application to benefit vulnerable populations.
- > Human studies need to be greatly expanded in number and breadth and rigorously designed to overcome methodological, analytical and biological complexities in omics data.

Introduction

Let's assume that you have been taken to a place you have never been before, and are not sure how you got there. The first thing you might do is look at a Google map, which may reveal several roads leading to the place, each with outlying intersections and roads from other towns. Different overlays may reveal varying terrain, weather or road conditions throughout the region leading to your destination. Now, imagine a health problem affecting a population at your destination, and the plexus of pathways (routes), biochemical networks (towns), function (traffic flow) and other influential conditions (terrain, road upkeep, weather, etc.) that may lead to the health problem, overlaid on the map. Omics technologies comprise sets of molecular mapping tools for each overlay that can help us understand and navigate to or from states of health, including nutrition. This breakthrough approach has become possible due to advances in the development and application of high-throughput technologies, which allow us to analyze large-scale biological data to form new molecular maps to health and disease.

“Omics technologies can help us understand and navigate to or from states of health”

Conventional hypothesis-driven studies typically focus on a few specific molecules of interest based on prior knowledge: a nutritional deficiency or excess may set into motion a genomic aberration or epigenetic change that affects RNA expression, protein synthesis, metabolite production, or certain bacterial growth (Figure 1A). Single omics studies explore sets (individual *overlays*) of genes, epigenetic marks, transcripts, proteins, or metabolites, or microbial communities, in an unbiased manner. They are data-driven and provide opportunities to discov-

FIGURE 1: Simplified frameworks in molecular nutrition studies

Each layer represents the genome, epigenome, transcriptome, proteome, metabolome, or microbiome, and circles or rounded rectangles indicate genes, epigenetic marks, transcripts, proteins, metabolites, or microorganisms, depending on the layer. Solid and dashed arrows represent associations within and across layers, respectively. Please note that the epigenome and transcriptome, which are separate omics-layers, are combined for the sake of simplicity.

Modified figure from Yugi et al.¹ Reproduced with permission obtained from the publisher.

er unknown factors and biological networks at each molecular level associated with a phenotype (Figure 1B).

A limited but increasing number of trans-omics studies offer opportunities to connect, integrate and map a group of molecules across multiple omics layers to identify pathways, interactions and feedback loops that may more fully reveal the biology and, likely, suites of diagnostic markers, therapeutic targets and pathways to and from disease states (Figure 1C).¹ Omics technologies are now poised to fill gaps in biological knowledge and provide roadmaps to prevention strategies in public health nutrition.

In the "Frontiers in Nutrition" edition of *Sight and Life* (1/2015), the principles of each omics technology and emerging opportunity were discussed. The aim of this article is to highlight some of the recent progress and innovations in omics, mainly focusing on infant and child nutrition and health (Table 1). In addition, this review will project the translation of omics-based discovery into potential public health applications, drawing on *plasma proteomics* as an example.

Genome

There has been a growing interest in understanding effects of genetic variation on child health, enabled by genotyping single nucleotide polymorphisms that may predispose biological pathways to misfire. For example, a genome-wide association meta-analysis study reported that the secretor genotype of the *FUT2* gene, which encodes an enzyme for histo-blood group antigen production (a host defense mechanism), portends a higher risk of diarrheal disease in children.² The finding illustrates the potential importance of genetic variants in the *FUT2* gene that may identify children susceptible to enteropathogenic organisms.

In contrast to inherited genetic predispositions, studies of DNA damage biomarkers have revealed genome integrity can be modified by nutritional status and diet early in life. Micro-nucleated cells, which indicate missing genetic information and chromosomal damage, have been observed more frequently in malnourished than well-nourished Egyptian children.³ Large birth size has also been associated with increased cytogenetic

DNA damage biomarkers in the cord blood lymphocytes of otherwise well-nourished Australian infants.⁴ Telomere length attrition is considered a genomic marker of chromosomal instability and future disease risk. In Latino preschool children, exclusive breastfeeding and infant obesity were respectively negatively and positively associated with telomere shortening.⁵ In the same study, soda consumption was associated with shortened telomere length. Thus, nutritional imbalance – leading to deficiency or excess – may be deleterious to genome health early in life. Among future challenges are the need to establish causal relationships between nutritional exposures and DNA damage, efficacies of dietary interventions to attenuate or reverse DNA damage, short- and long-term health effects of early-life genome damage, and wider use of genome health assays in nutritional epidemiology and population science.

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“Nutritional imbalance may be deleterious to genome health early in life”

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Epigenome and Transcriptome

Gene expression is regulated by chemical modifications of histones and DNA without changing the underlying DNA sequence. Maternal nutritional or other exposures during embryo-fetal development can lead to epigenetic changes in fetal DNA that may influence disease risk later in life. The hypothesis of diet-epigenome interaction was tested in a rural Gambian population, examining seasonal variations in maternal levels of nutrients involved in methyl-donor pathways. The study revealed that DNA methylation of infants differed by season of conception at specific metastable epialleles, which reflect systemic (tissue-wide) epigenetic development in early life.⁶ In the same cohort, gestational aflatoxin exposure was associated with differential DNA methylation in a set of genes, including growth-promoting and immune-modulating genes, suggesting potential biological mechanisms of compromised host defense and growth impairment by aflatoxin exposure in utero.⁷ Another epigenome-wide association study conducted in the United Kingdom showed that both maternal pre-pregnancy obesity and underweight were associated with differential DNA methylation in the fetus, shown to mediate intergenerational adiposity transmission.⁸

Among transcriptomics studies, which explore the complete set of RNA molecules, Yu et al examined the pathogenesis of environmental enteric dysfunction (EED), an asymptomatic condition of intestinal inflammation, malabsorption and barrier dysfunction, by profiling the human intestinal transcriptome isolated from fecal samples of Malawian children.⁹ Transcripts associated with EED suggest that EED can be characterized by

numerous immunologic responses and impaired mucosal repair. This study provides potential biomarker candidates of gut function and a noninvasive approach that can be used in the future to elucidate host-microbiota dynamics in the gastrointestinal environment.

Proteome

A plasma proteomics project using tandem mass spectrometry was initiated, motivated by the need for a strategy to assess multiple nutritional deficiencies in populations on a single analytic platform.¹⁰ Assuming that nutrient metabolism is coordinately associated with a network of measurable proteins, and that such proteins possess sufficient variability to predict nutrient status, plasma nutriproteomes have been reported to date for vitamins A, D, E and K and selenium, comprising plasma transporters, immune and tissue repair proteins, and numerous metabolic homeostatic factors in a population of school-aged Nepalese children.^{11–15}

The utility of plasma proteomics has been further extended to quantify clusters of proteins associated with attained stature and arm muscle mass, but not fat mass, reflecting a lean, generally undernourished phenotype.¹⁶ Proteins associated with child height have included insulin-like growth factor (IGF)-1 and its three binding proteins, likely reflecting the major role of IGF regulation in linear growth. Nearly 100 plasma proteins originating in the liver and peripheral tissues involved in host defense, nutrient metabolism, and tissue repair have been linked to α_1 -acid glycoprotein, a generalized inflammatory biomarker, revealing a dynamic and informative proteome of subclinical inflammation.¹⁷ Six stable and constitutive protein biomarkers of inflammation have been associated with intelligence test scores measured a year after blood collection, possibly reflecting both chronicity and consequence of low-grade inflammation.¹⁸

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“Plasma proteins have a capacity to reflect short- and long-term biological linkages to nutritional and health status”

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The findings collectively suggest that plasma proteins have a capacity to reflect short- and long-term biological linkages to nutritional and health status. With biological validity of identified biomarkers, widespread population use of proteomics methods will depend on targeted, portable, low-volume, and inexpensive analytic methods (**see box**, *A Proteomics Technological Transition: Biomarker discovery to public health application*).



A and B: Children in Sarlahi, Nepal were visited in their homes for assessment of nutritional and health status including anthropometric measurements and blood sample collection.



C: Blood samples were processed by trained technicians at a local laboratory in Sarlahi.

D: Our initial proteomics work was based on two-dimensional difference in-gel electrophoresis analysis of serum samples from pregnant Nepalese women.

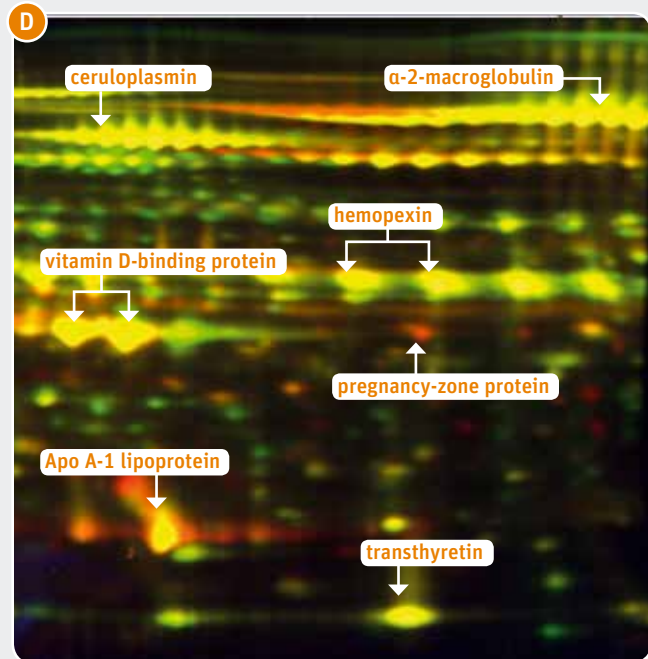


Photo credits: Keith P West Jr. (A, B, and C) and Robert N Cole (D)

Metabolome

Metabolomics is now being applied to elucidate the pathogenesis of childhood undernutrition and identify associated metabolic signatures using mass spectrometry or nuclear magnetic resonance spectroscopy. Bartz et al revealed remarkable changes in concentrations of amino acids, fatty acids, acylcarnitines, hormones, growth factors and cytokines in response to dietary regimens among severely malnourished Ugandan children.¹⁹ In this study, fatty acids played a central role in metabolic response to acute malnutrition and case fatality was predicted by a low concentration of leptin, reflecting the importance of fat storage and metabolism for energy supply and survival.

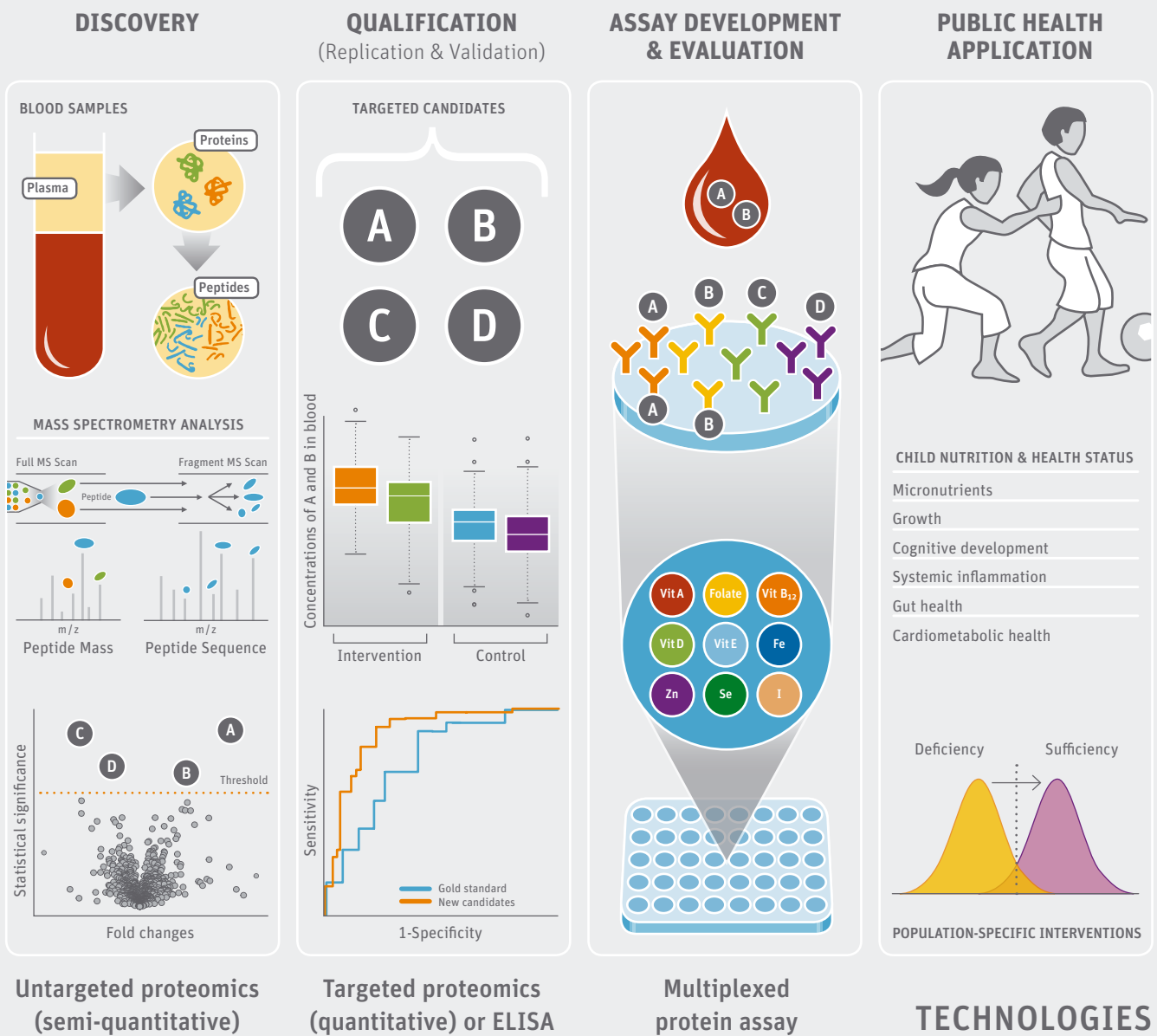
In Malawi, alterations in the serum metabolome were found to be more prominent in children with kwashiorkor than marasmus.²⁰ Nutritional rehabilitation stimulated the recovery of most amino acid profiles but sphingomyelins and phosphatidylcholines were incompletely restored, suggesting metabolic deficits remained after clinical stabilization. Alterations in amino acids and choline have also been observed in stunted children,^{21,22} possibly reflecting common metabolic and nutritional disturbances in wasting and stunting syndromes. Among amino acids, tryptophan metabolism has been consistently perturbed in studies of malnutrition and EED.^{20,22,23}

As nutritional metabolomics studies expand, it is likely that common metabolites will be identified as specific biomarkers for diagnostics, and used for monitoring specific pathway effects of therapeutic and public health interventions.

“As nutritional metabolomics studies expand, it is likely that common metabolites will be identified as specific biomarkers for diagnostics”

Microbiome

Microbiome studies are steadily revealing the importance of gut microbiota for child growth and health, achieved by combining high-throughput gene sequencing technologies with innovative experimental designs, including use of germ-free animals. Subramanian et al have, for example, created relative microbiota maturation indices from “age-discriminatory” microbial signatures from fecal samples of healthy Bangladesh children.²⁴ The indices have shown that severe acute malnutrition was associated with relative microbiota immaturity, which was only incompletely and transiently restored by conventional nutritional therapies. Blanton et al have shown that immature microbiota transplanted from undernourished Malawian children resulted in reduced weight and lean body mass gain and metabolic abnormalities in mice, and this negative effect was ameliorated by an invasion of “age and growth-discriminatory” microbiota from healthy donors.²⁵

FIGURE 2: Conceptual workflow of the proteomics-driven development of nutrition and health assays for populations

Sialylated oligosaccharides, functioning as prebiotics, were depleted in the breast milk of Malawian mothers of severely stunted infants relative to that of mothers of healthy infants.²⁶ Supplementing purified sialylated bovine milk oligosaccharides to a typical local diet improved lean body mass gain, bone morphology and metabolism in tissues of animal models colonized with microbiota from a stunted infant. Collectively, these studies provide preclinical evidence that immature development of gut microbiota is a cause of growth impairment and suggest that probiotic or prebiotic strategies may be needed to promote microbiota maturity and child growth.

Challenges and Opportunities

Omic technologies hold promise to reveal intermediate pathways, mechanisms, and interactions of growth, development, functional health, and disease, and thus to advance knowledge, change thresholds of action, and transform public health practice. Each omics poses technical, logistical, implementation, and cost challenges that impede rapid progress in discoveries and applications. Human studies need to be greatly expanded in number and breadth and rigorously designed to overcome methodological, analytical, and biological complexities in omics data. Interdisciplinary collaborations and training opportunities should be enhanced to promote interactions across fields

of biomedical science, nutrition, bioinformatics, biostatistics, computational biology and epidemiology. Effective communication across diverse stakeholders including academia, funders, biotechnology firms and governments will ensure common understanding in this fast-changing field of science and facilitate dissemination and utilization of omics research findings.

“Embracing the complexity of omics will offer novel strategies to address key challenges in global health”

Conclusions

Studies in the omics field have demonstrated the complexity of biological response to suboptimal nutritional status. These approaches are transitioning from theoretical to practical application to benefit vulnerable populations. Appreciating healthy skepticism around the utility of omics, our vision remains clear that embracing the complexity will offer novel strategies to address key challenges in global health. Because health promotion and disease prevention are a long public health journey, omics approaches have potential to serve as a roadmap that assists travelers in exploring new territories or identifying the most expeditious routes.

A Proteomics Technological Transition: Biomarker discovery to public health application

Vision and goal: Micronutrient deficiencies are a global health problem but remain hidden for lack of assessment tools in low-resource settings. The vision of a plasma proteomics project, supported by the Bill & Melinda Gates Foundation, was that clusters of proteins predictive of micronutrient status, and possibly inflammation and other functions, could be discovered, targeted for quantification, and measured, eventually, within a single, inexpensive assay.

Process: The conceptual workflow (Figure 2) illustrates ongoing efforts to promote discovery^{11–13,15} and transition to quantification, a future inexpensive assay, and public health application.

Discovery: The aim of discovery is to quantify the direction and strength of association between protein biomarkers and conventional nutritional indicators (e.g., micronutrient, anthropometry) and inflammation status. Proteins are digested into peptides for detection and relative quantification.

Statistical analysis is performed to select correlated proteins with low chance of false discovery.

Validation: The goal of this phase is to establish candidate proteins, replicated across populations and measured in assays that determine absolute concentrations in plasma samples (e.g., enzyme-linked immunosorbent assay [ELISA] or targeted proteomics). Randomized trials or longitudinal studies are desirable to establish both correlations and responses to nutritional supplementation.

Assay development and evaluation: This stage sets out to produce a protein assay that simultaneously quantifies multiple protein biomarkers. For example, the technology of antibody-based multiplexed protein measurement can be used to develop an array that has antibodies attached to capture various proteins in each single cell of a plate.²⁷ Multiplex ELISA assays with customized combinations of biomarkers have been already tested for vitamin A, iron, iodine status plus inflammation, and malaria markers.^{28,29} High biological sample and analyte throughput is desirable compared to conventional immunoassays.

Application: The feasibility of using a multiplex protein assay as an advanced tool for nutrition research and public health practice is established. Depending on the purpose of studies, the assay can be utilized to (1) characterize nutritional status of populations (e.g., micronutrients), (2) evaluate effects of nutrition-specific or nutrition-sensitive interventions on nutrition or health status (e.g., growth and gut health), and (3) provide prognostic insights into health and disease burden (e.g., cardiometabolic health). The assay will provide invaluable information about nutritional and health status of target populations that can promote more context-based program development and policy decisions.

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TABLE 1: Summary of selective recent omics studies on infant or child health

Study population	Biospecimen	(Omics) technologies	Study design	Exposure outcome
Genome				
Children in 8 developed countries (0–18 mo and 12–30 mo)	Blood samples	High-density single nucleotide polymorphism (SNP) arrays	Genome-wide association meta-analysis	Reported or diagnosed diarrhea
Egyptian children (2–60 mo)	Peripheral red blood cells	Flow cytometric micronuclei assessment	Case-control	Malnutrition (kwashiorkor vs. marasmus) and bacterial pneumonia
Australian infants (at birth, 3 and 6 mo)	Peripheral blood (cord blood) lymphocytes	Cytokinesis-block micronucleus cytome assay	Prospective cohort	Birth anthropometry (weight, length, and head circumference)
Urban Latino children in the US (from birth to 5 yr)	Dried blood spots	Quantitative polymerase chain reaction	Prospective cohort	Obesity, abdominal obesity, breastfeeding, and dietary intake
Epigenome				
Gambian mother-infant (2–8 mo) dyads	Peripheral blood leukocytes and hair follicles	Quantitative bisulfite pyrosequencing	Prospective cohort	Dry (“harvest”) or rainy (“hungry”) season of conception
Gambian mother-infant (2–8 mo) dyads	White blood cells	Bisulfite pyrosequencing and Infinium HumanMethylation450 BeadChip	Prospective cohort	Aflatoxin exposure during early pregnancy
British mother-offspring (at birth, 7.5 yr, and 17.1 yr) pairs	Cord blood and childhood and adolescent peripheral blood	Infinium HumanMethylation450 BeadChip	Prospective cohort	Pre-pregnancy obesity or underweight
Transcriptome				
Malawian children (12–61 mo)	Feces	High-density microarray (GeneChip Human Transcriptome Array)	Prospective cohort	Environmental enteric dysfunction (EED)
Proteomics				
Nepalese children (6–8 yr)	Plasma	Isobaric tag for relative and absolute quantitation (iTRAQ) mass spectrometry	Cross-sectional	Vitamins A (retinol), D (25-hydroxyvitamin D), and E (α-tocopherol), copper, and selenium
Same as above	Plasma	iTRAQ mass spectrometry	Cross-sectional	Anthropometric measurements including (1) height-for-age z-score, (2) arm muscle area, and (3) arm fat area and triceps and subscapular skinfolds
Same as above	Plasma	iTRAQ mass spectrometry	Cross-sectional	Inflammation (α ₁ -acid glycoprotein)
Same as above	Plasma	iTRAQ mass spectrometry	Prospective cohort	General intelligence test scores (7–9 yr)

Biomarkers | main findings

Reference

The SNP rs8111874 at chromosome 19q13.33 reached a genome-wide significant association with diarrheal disease around 1 year of age. Children with the A allele of the causal variant rs601338 in the FUT2 gene (non-secretor phenotype) had lower risk of diarrhea.

Bustamante et al²

Micronucleated-reticulocytes and erythrocytes were more frequently observed in malnourished children with pneumonia than well-nourished children with/without pneumonia. The frequencies of micronucleated cells were higher in children with kwashiorkor than children with marasmus.

Elsayh et al³

Birth weight and length, and maternal weight and BMI during pregnancy were positively associated with the frequency of one or more of DNA damage biomarkers including micronuclei, nucleoplasmic bridges and nuclear buds. Head circumference at birth was negatively associated with the frequency of apoptotic cells.

Dass Singh et al⁴

Exclusive breastfeeding at 4–6 wk of age was associated with longer telomere length, while early exposure to foods other than breast milk before 4–6 wk of age and infant obesity at 6 mo of age were associated with shorter telomere length at 4 and 5 yr of age. High soda consumption at 3 yr of age was associated with shorter telomere length.

Wojcicki et al⁵

CpG methylation rates at six metastable epialleles in peripheral blood leukocytes and hair follicles were consistently higher in infants conceived in the rainy season compared to those conceived in the dry season.

Dominguez-Salas et al⁶

Differential DNA methylation was observed in 71 CpG sites including growth factor genes such as FGF12 and IGF1, and immune-related genes such as CCL28, TLR2, and TGB1. One aflatoxin-associated methylation region (miR-4520b) was identified.

Hernandez-Vargas et al⁷

Twenty-eight and 1621 CpG sites were differentially methylated in fetuses of pre-pregnancy obese and underweight mothers, respectively, compared with fetuses of normal weight mothers; differentially methylated sites associated with maternal over- or undernutrition tended to be associated with offspring adiposity.

Sharp et al⁸

Fifty-one transcripts encoding a broad range of immune response, epithelial cell adhesion, and mucin production were associated with and differentially expressed by EED. Among these, 17 transcripts (AQP9, CLEC7A, FCGR2A, FCGR3B, IFTM1, IFITM2, IFTM3, LYN, LYZ, MND4, MSN, NCF2, PLEK, PROK2, S100A8, SAMS1, and SELL) were associated with change in height-for-age z-scores over the 3 months after stool collection.

Yu et al⁹

Retinol-binding protein 4, vitamin D binding protein, apolipoprotein C-III, ceruloplasmin, and selenoprotein P were correlated with plasma retinol, 25-hydroxyvitamin D, α -tocopherol, copper, and selenium, respectively ($r=0.58-0.88$). Adding newly identified second-tier proteins explained additional variation in nutrient concentrations.

Cole et al¹¹

(1) (+) IGF-1, IGFALS, IGFBP3, afamin, tetranectin, apolipoprotein L1, carnosinase1, and vasorin; (-) S100A12 and IGFBP2; (2) 17 proteins including extracellular matrix proteins were associated with arm muscle area; (3) no proteins were associated with fat mass measurements.

Lee et al¹⁶

(+) 41 proteins including positive acute phase proteins, complement factors, protease inhibitors, and intracellular signaling molecules; (-) 58 proteins involved in transporting or binding to micronutrients, lipids, growth factors, and sex hormones, and homeostasis of extracellular matrix.

Lee et al¹⁷

(+) APOA1, APOA2, APOC1, APOC3, APOM, APOD, IGFALS, IGFBP3, and transthyretin; (-) AGP1, C2, C5, C9, CFI, ACT, LRG1, RCN1, TIMELESS, LBP, PKM, DNAAF1, and EVI5; Six proteins (AGP1, C9, CFI, CFHR5, ACT, and RCN1) involved in inflammatory response remained negatively associated with general intelligence test scores in fully adjusted models.

Lee et al¹⁸

Study population	Biospecimen	(Omics) technologies	Study design	Exposure outcome
Metabolome				
Severely malnourished children admitted to hospital in Uganda (6 mo–5 yr)	Serum	Tandem mass spectrometry (targeted), gas chromatography/mass spectrometry (non-targeted), and conventional chemistry assay	Clinical nutritional rehabilitation	Inpatient and/or outpatient nutritional treatment (milk-based formulas and/or ready-to-use foods)
Severely malnourished children admitted to hospital and community controls in Malawi (9–59 mo)	Serum	Liquid chromatography-tandem mass spectrometry (targeted)	Clinical nutritional stabilization; case-control	(1) Kwashiorkor vs. marasmus (2) Nutritional stabilization (3) Severe acute malnutrition vs. community control
Malawian children (12–59 mo)	Serum	Liquid chromatography-tandem mass spectrometry (targeted)	Cross-sectional	Stunting
Brazilian children (6–26 mo)	Urine	¹ H-nuclear magnetic resonance spectroscopy	Case-control	(1) Undernutrition (stunting, wasting, and underweight). (2) Changes in HAZ (2–5 mo)
Malawian children (12–59 mo)	Serum	Liquid chromatography-tandem mass spectrometry (targeted)	Cross-sectional	Environmental enteric dysfunction
Microbiome				
Bangladesh children with severe or moderate acute malnutrition (6–20 mo)	Feces	16S ribosomal RNA gene sequencing	Randomized intervention trial and post-intervention follow-up	Food interventions (ready-to-use therapeutic food or a locally produced food combination)
Healthy or undernourished Malawian children (fecal donors) (6 and 18 mo)	Feces	16S ribosomal RNA gene sequencing, Targeted mass spectrometry	Animal experiment (5-week-old germ-free mice)	Fecal microbiota from healthy or undernourished children
6-month postpartum Malawian mothers from two birth cohorts	Human milk (from mothers); Feces (from a 6 mo-old stunted Malawian infant)	Liquid chromatography time-of-flight mass spectrometry, 16S ribosomal RNA gene sequencing, Microbial RNA-Seq, Targeted MS/MS, and GC/MS	Animal experiment (germ-free mice and piglets)	Purified bovine milk oligosaccharides supplementation

(+) and (-) indicate positive and negative associations with exposures/outcomes, respectively

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Biomarkers | main findings

Reference

(+) Albumin, amino acids, propionyl carnitine, leptin, IGF-I, insulin, and phosphorous;	Bartz et al ¹⁹
(-) Fatty acids, ketones, even-chain acylcarnitines, growth hormone, ghrelin, cortisol, IL-6, glucagon-like peptide-1, and peptide YY; A low concentration of baseline leptin was most strongly associated with child mortality.	
(1) Albumin, lysine, methionine, threonine, aspartate, tryptophan, kynurenine, acylcarnitines, and phosphatidylcholines were more depleted in children with kwashiorkor than in those with marasmus.	Di Giovanni et al ²⁰
(2) Albumin, amino acids, biogenic amines, phosphate, potassium, and some lysophosphatidylcholines increased, while most sphingomyelins and phosphatidylcholines were not improved.	
(3) Metabolic profiles of severe acute malnutrition remained different from those of community controls, even after nutritional treatment.	
(-) All essential amino acids (tryptophan, isoleucine, leucine, valine, methionine, threonine, histidine, phenylalanine, lysine), conditionally essential amino acids (arginine, glycine, glutamine), non-essential amino acids (asparagine, glutamate, serine), and biogenic amines and sphingomyelins; alterations in glycerophospholipids	Semba et al ²¹
(1) Alterations in choline and tryptophan metabolisms, reduced energy expenditure, and increased proteolytic activity of the gut microbiome; (2) urinary N-methylnicotinamide and β -aminoisobutyric acid predicted short-term growth among undernourished children.	Mayneris-Perxachs et al ²²
(-) Tryptophan, citrulline, ornithine, phosphatidylcholines, and sphingomyelins;	Semba et al ²³
(+) Glutamate, taurine, and serotonin	
Children with severe and moderate acute malnutrition had microbiota immaturity relative to healthy children of similar chronologic age; food interventions improved microbiota maturity, but the effects were not sustained after cessation of treatment in severely malnourished children.	Subramanian et al ²⁴
Mice colonized with microbiota from undernourished children gained less weight and lean body mass than mice colonized with microbiota from healthy children, and showed alterations in bone morphology and metabolic abnormalities; invasion of age- and growth-discriminatory strains from mice with healthy donor microbiota or specific species (<i>Ruminococcus gnavus</i> and <i>Clostridium symbiosum</i>) into the microbiota of mice with undernourished donors improved growth and metabolic phenotypes in mice.	Blanton et al ²⁵
Sialylated human milk oligosaccharides were more abundant in the breast milk of mothers of healthy infants than that of mothers of stunted infants; adding sialylated bovine milk oligosaccharides to a typical Malawian diet improved lean body mass and nutrient metabolisms in liver, muscle, and brain in mice and piglets colonized with bacterial strains from a stunted Malawian infant.	Charbonneau et al ²⁶

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Insect Rearing for Processing Protein in Animal Feed

A scalable technology

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Key messages

- > Due to a rising global population, there is a corresponding rise in demand for food, including sources of protein, for both humans and animals.
- > Using fishmeal for traditionally farmed animals and growing soya are both extremely resource-heavy approaches, and intensification is not sustainable.
- > Nutrition scientists are instead turning toward alternate sources of protein, whether as animal feed or as a source for human nutrition.
- > A German biotech company, Hermetia Baruth, advocates using large bioreactors as incubation hubs for harvesting the protein and fats from insects.

Introduction to the world of insects

Insects are by far the class of animals with the most species. About one million insect species have been named and classified, but it is estimated that between two and five million insect species are yet to be discovered. The weight of all insects on the planet is four times the combined weight of all other animals, including mankind. To date, the most dangerous member of the animal kingdom is an insect, the mosquito – transmitter of malaria, and a parasitic vector responsible for more than 400,000

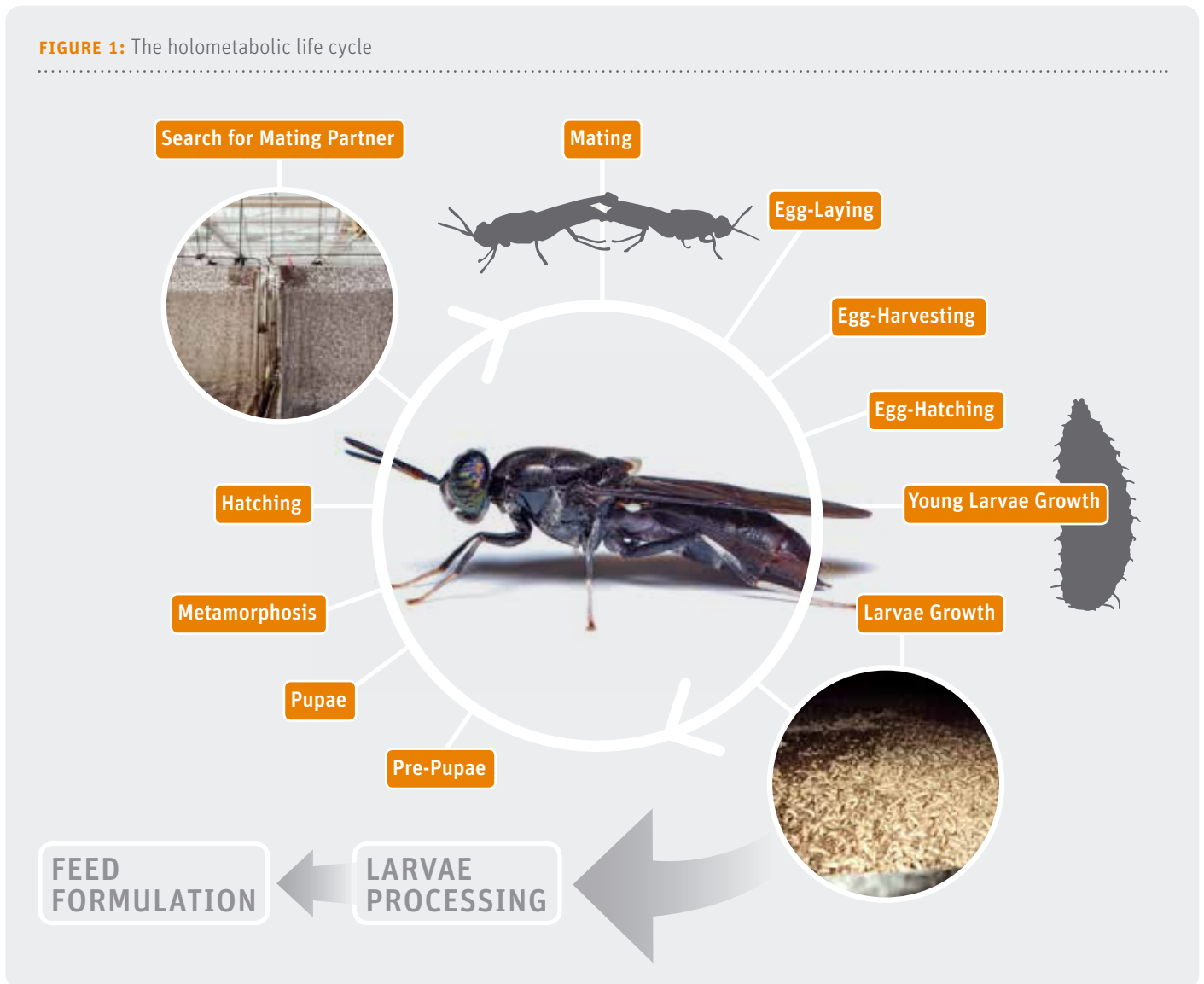
casualties per year.¹ The diversity in the insect group ranges from typically beautiful species such as butterflies, through uglier ones such as cockroaches and useful ones such as bees, to pathogenic ones like the deadly mosquito.

“Nature is a perfectly circular economy and does not know waste – something we should all aspire to”

For centuries now, mankind has been known to benefit from insects. For example, the silkworm, larvae of the butterfly *Bombyx mori*, is used to produce silk fabric. This practice originated in China, but is a common tradition and economic practice in Western Africa. One major beneficial role of insects, specifically the larvae of some fly species, is their innate ability to convert rotting material into valuable protein for other members of the animal kingdom as feed. The enzymatic processes used to convert organic matter (dead bodies, plant material, feces, manure, catering waste, biological waste, etc.) into something valuable are amazing. Nature is a perfectly circular economy and does not know waste – something we should all aspire to – and a large portion of decomposition happening on the planet is due to insects.

Insects as a source of valuable proteins for food and feed

One of the major nutritional requirements of all animals is protein. Proteins consist of amino acids, but the essential amino acids tryptophan, isoleucine, leucine, valine, methionine, threonine, histidine, phenylalanine, and lysine cannot be produced by our bodies, or by the bodies of other species with single-chambered stomachs (monogastric species), such as pigs, poultry and fish. Instead, these must be acquired through the diet. Globally, the major protein sources for farmed animals are soya and fishmeal. Due to the increase in the world's population,

FIGURE 1: The holometabolic life cycle

there is a corresponding demand for dietary meat sources, and therefore the demand for protein supplies to feed these animals is also increasing. The surface area of the planet used to grow soy beans is extended every year, while over-fishing continues to be a major issue. One third of all the fish caught in the world's oceans is processed into fishmeal. Neither procedure is healthy for our planet, and they are not sustainable for the future.

Larvae of flies are able to produce essential amino acids and store them in their bodies. All known carnivorous animals that naturally come into contact with insects eat insects, and for some, insects are even a significant part of their diet. Wolves eat insects of all stages (eggs, larvae, pupae, and adults) whenever they can. Fish such as salmon or trout jump out of the water to catch flies in the air, while the archerfish spits a high-pressure burst of water over four meters above the surface to hit insects – they fall in the water and can be easily swallowed. Boars plough the soil in search of larvae, which sometimes leads to significant damage to agricultural areas – this nutritional protein is a real

treat for them, and they invest a lot of effort to make this food source available.

Various feeding trials with fish, chicken, turkey, pigs, and dogs from universities in Germany (Berlin, Göttingen, Kiel) and other European countries (Torino, Italy; Aarhus, Denmark), from private research institutes (feedtest, Dr Scharch), and from several feed-producing companies show the absolute eligibility of insect meal as a replacement for soya and fishmeal. In some areas, the nutritional value of insects is considered superior to soybean protein, e.g., in the feeding of young poultry, piglets and dogs.

Insect rearing vs. wild catches

Migratory locusts are known as the eighth biblical plague. A locust swarm consists of more than a billion insects and weighs more than 1,500 tons. A swarm has to eat its bodyweight each day, and the damage it causes to agriculture can be tremendous – there are no means of protecting against such a swarm. Some tribes in

Africa – for example, those in Madagascar – catch as many as they can, which they then fry or roast for people to eat. At least here the devastating swarms are used to supplement nutrition and can act as a replacement for losses or for lack of agricultural products. In Central Africa, techniques such as concrete traps are used to catch insects, with the insects then processed through sun-drying, and light nets are used to deter mosquitoes.

However, there are significant disadvantages to wild catches. This approach often involves a large amount of effort to collect a decent yield of biomass, and the supply chain is not consistent. The volatility is high, whereas the feed production industry needs a constant supply. From a swarm of locusts, you get a lot of biomass, but then questions arise concerning processing capacity (e.g. drying), storing, and transportation, etc. Further, you don't know what the insects fed on before capture; and a lot of toxic chemical pesticides and fungicides are used in agriculture. These toxic substances may accumulate in the bodies of the insects and bring subsequent harm to the consumers.

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“The ability to rear the larvae of the black soldier fly is the basis for producing high-value insect protein in large quantities”

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Insect rearing can be done just like animal farming: on a small scale with boxes and manual work, or on an industrial

scale through highly automated processes. The major advantage is the control over the entire process from the input of substrate to the final product.

Bioreactors as a technology to rear insects

The process to get insect protein and fat is threefold:

- > control of the holometabolic life cycle;
- > mass rearing of larvae; and
- > larvae processing.

Control of the holometabolic life cycle

The holometabolic life cycle is common throughout various species of insects, and refers to the life cycle of the insect, which consists of four stages: egg – larva – pupa – adult. Total control of the holometabolic life cycle is critical for insect farming, as you need to ensure that you always have enough adult flies to keep the population going. The objective is to allow 10% of an egg harvest to complete the total life cycle and to process 90% of the larvae into protein and fat.

Mass rearing of larvae

The ability to rear the larvae of the fly *Hermetia illucens* (black soldier fly) is the basis for producing high-value insect protein in large quantities. The challenge is to bring the freshly hatched larvae of the “Queen of waste transformation” together with the feed substrate and to cultivate the optimal habitat in terms of temperature, humidity and oxygen supply. The solution designed by Hermetia Baruth GmbH, a biotech company from Berlin, Germany, is a bioreactor. These bioreactors are around the

FIGURE 2: The mating of two adult black soldier flies

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same size as a 20-foot shipping container, with a production area inside of at least 75 m², over ten levels with two trays on each level. They take up about 12 m² on the ground.

The scalability is obvious. If enough ground space is available, you can line up the bioreactors, and it is even possible to stack them if necessary. The young larvae remain in the bioreactor for about 10 days until they are harvested. Some agricultural skills are required to run a bioreactor, but this is not difficult and can be learned with training. Some farming background in terms of rearing pigs or poultry is helpful, but not a prerequisite.

The ethics and sustainability of the mass rearing of farmed animals is the subject of intense discussion in developed countries, but the mass rearing of insects does not have the same problems, either from a biological or an animal welfare point of view. The larvae always seek each other out and congregate together, even when they are actively separated. *Hermetia Baruth* now has over 10 years' experience in the mass rearing of black soldier fly larvae, with no problems encountered.

Black soldier flies are used to living in rough environments – they are robust and able to deal with high and low pH values, and can deal with both microbes and mold. However, it is necessary to clean the trays with hot water after each cycle, and the input substrate should be treated with heat to kill any bacteria. The source of the substrate should also be known, and if there is reasonable suspicion of heavy metals or dioxin-polluted material, the substrate should be declined.

The advantages of the bioreactor technology are that the containers are easy to transport, either locally via trucks or internationally via cargo ships. They are also very easy to run and to maintain, very robust in their operation, and their life span should exceed 20 years.

“Scientists are now studying the nutritional value of insects and their potential for mass production”

Larvae processing

The processing starts with the separation of the food substrate, the insect frass, from the larvae. Frass is a good fertilizer. The larvae are killed via heat and dried. Next, the fat is mechanically separated from the protein of the larvae – the fat consists of a high proportion of lauric acid (C12) and palmitic acid (C16). C12 comprises around half the fatty acid content in coconut milk, and C16 is a major component of palm oil. By means of high pressure, the cells are cracked and the protein (along with its essential amino acids) is extracted. In the whole process there is no waste, as all the products can be used, and none need to be disposed of.

Outlook

In the year 2016, the international trade in animal feed had an estimated turnover of almost US\$1,000 billion.² Africa currently produces less than one percent of global animal feed, despite having a large demand for the product itself – making the production of insect-based protein for the animal feed industry a huge business opportunity for African entrepreneurs. Scientists across the continent and abroad have therefore dedicated time and effort to studying the possibilities behind their nutritional value and their potential for mass production. Insects could help address the global challenges of food security and sustainability. This creates room for entrepreneurship, and business opportunities can be incubated in the food and feed systems and the pharmaceutical sectors,² which in turn can lead to job creation. The possibilities are endless.

This potential however, remains largely untapped. Many countries on the European mainland are eagerly searching for an alternative protein source for animal feed. This is particularly notable in the fish and poultry sector, where there is growing scarcity of the resources needed to produce healthy and nutritious feed. This has created a rise in feed prices, yet the solution is simple: the evidence clearly supports the fact that insects can provide a viable and sustainable solution.

The elephant in the room, however, is perception. In order for us to uncover the real value of insects, powerful education programs are needed. This can be done through structured frameworks covering invention, technology, upscaling, safety, processing, and legislation – similar to what *Hermetia Baruth* and their specialization in the breeding of the black soldier fly has established in Europe. If it were possible to replicate their model in Africa, it would most certainly create an impact in the animal feed sector and quite possibly, on the human population as well.

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Big Data: The New Face of Humanitarian Aid

Data-driven solutions to some of the world's most difficult and dangerous challenges

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Key messages

- > Big data is data at a scale beyond what most traditional processing applications can handle.
- > In humanitarian organizations, big data can empower the responses to disastrous events with greater precision and speed.
- > 510 Global is the data initiative of the Netherlands Red Cross (NLRC), which uses data analysis across a wide range of humanitarian activities.
- > Analysis by 510 Global of an actual typhoon – Typhoon Haima in the Philippines – indicates that it is possible to use machine learning to construct reliable damage predictors.
- > 510 Global operates with several institutions and corporations and is developing an arsenal of tools to assist with today's and tomorrow's humanitarian needs.

Turn on CNN or stream a Ted Talk, and chances are it won't take long to hear the phrase "big data" mentioned in all sorts of contexts. It has become impossible to avoid the term when looking at the horizon of technological development and discussing our sociotechnical future. Its presence is also felt in humanitarian organizations, where big data can empower the responses to disastrous events with greater precision and speed. All this buzz is for good reason, for data gives us the opportunity to more fundamentally understand our surroundings. For those of us who observe the world from a data-driven perspective, it

quickly becomes apparent that there are inherent patterns to most things in life. One must simply set the right boundaries and conditions to see them. Chaos is indescribable until observed – and like an atom, once observed, its properties are defined and therefore predictable. From "spooky" quantum action to hurricanes and flood dynamics, data is crucial to understanding and predicting the behavior of our external environment, and it is this greater understanding that 510 Global considers its ace in the hole.

“Data is crucial to understanding and predicting the behavior of our external environment”

510 Global is the data initiative of the Netherlands Red Cross (NLRC). In humanitarian work, informed decision-making affects the health and safety of thousands of people, and it was in response to this need that 510 Global was formed. Made up of data scientists, humanitarian experts, information managers and researchers, 510 Global team their skills across a swathe of humanitarian activities.

Big data is simply data, but at a scale beyond what most traditional processing applications can handle, creating challenges for capturing, storing and analyzing it. It can be collated from a variety of sources, including openly available data, crowdsourced data, and private databases. Its most advantageous property is its sheer scale, allowing opportunities for advanced analytics and predictive models. These analytic toolsets themselves are also sometimes referred to as big data today.¹

It is in the decision-making challenges that humanitarian activities face that big data can have significant positive impact. As seen recently with events in the United States with Hurricane Harvey, first responders needed to know the distribution of damage and risks across a vast area. Which communities are hardest hit and most isolated from help, which communities need emer-

gency resources such as food and water, which communities are at most risk, who do they help first and where are they needed most: these aren't questions with simple answers. A community with comparatively low levels of flooding may see high casualty rates due to other factors.² For decision-makers to be empowered, we therefore need to know more, and to know it earlier. This is where big data comes in, as seen in the following case of Typhoon Haima in the Philippines.

.....
“Missing Maps is an open, collaborative project in which you can help to map areas where humanitarian organizations are trying to meet the needs of vulnerable people. The team at 510 coordinates mapathons in The Netherlands, in which volunteers come to map for good causes! We use a tasking manager to select and prepare the areas to be mapped, giving an introduction, helping people with mapping, organizing the validation of preliminary mapping results, and supporting people who live in the mapped area to improve and sustain their local maps.”

Koos Krijnders, Missing Maps

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Fine-tuning big data for success:

A case study in the Philippines

When the worst happens and a natural disaster strikes, it is crucial that local institutions and organizations have information on the resulting damage. To this end, any information given needs to be as accurate as possible while also being timely and directly appropriate for use. This is a clear example of the utility advantages of big data, as it can increase both the accuracy and speed of delivery of this information. Some of the work 510 Global does in this area can be seen in the creation of a Priority Index Model (PIM) which was tested in the case of Typhoon Haima, in the Philippines. Here, the main challenge to rescue and response operations was found to be the scarcity of personnel and resources.



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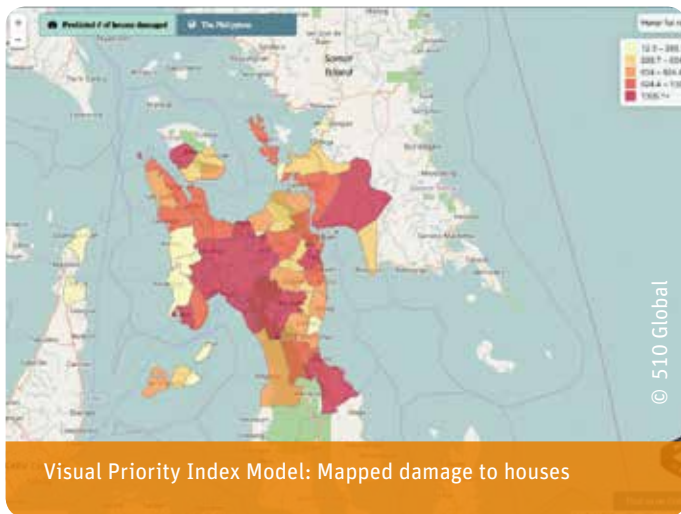


Collecting data with Missing Maps. First responders often lack the necessary information to make effective decisions about resource allocation and location.

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“One of the challenges with disaster response is scarcity of resources: not each affected family can be helped. Therefore it is essential to identify priority areas, by assessing damage and finding vulnerable people that are affected the most. Currently, damage assessments and identification of the most vulnerable is a time-consuming process, which can take weeks to complete, due to logistics, safety constraints, or workload.”

Maarten Van der Veen, 510 INITIATOR

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To meet this challenge, 510 developed a methodology by which we can identify areas at greatest risk and therefore most urgently in need of humanitarian response. This methodology is reliant on largely open secondary data (received through collaborations with UCL, NASA and others) from affected areas as well as *in situ* data (rainfall, wind speed). Data from previous events is also considered. The aim is to integrate machine learning, which can be used to generate fast and accurate damage predictions for various events and countries. It does this by automatically applying what has been learned in past events to new incoming data on a current disaster. Through testing the effectiveness of the “machine”, we can fine-tune its prediction capacity in order for it to get smarter. In the case of Typhoon Haima, data included population, poverty, house wall and roof type, and geographical features, as well as direct impact data from the event (rainfall, typhoon path, wind speed.) To assist in generating a valid index for damage, data from four previous typhoons was used.

The completed priority index model (PIM) was successfully released only 24 hours after the typhoon first hit the coastline. Four days later, the first official (non-PIM) damage counts were released and shared. Further analysis led us to conclude that it is indeed possible to use machine learning to construct reliable damage predictors. There is still work to be done – for example, by addressing the coping capacity of communities accurately, and by obtaining more accurate data on building damage. These elements impact the total accuracy of the model, and fine-tuning and further research are underway to address these. The process still needs to be scripted end-to-end. Eventually our goal is to scale up this methodology and have it available for PIM-generation in numerous countries.

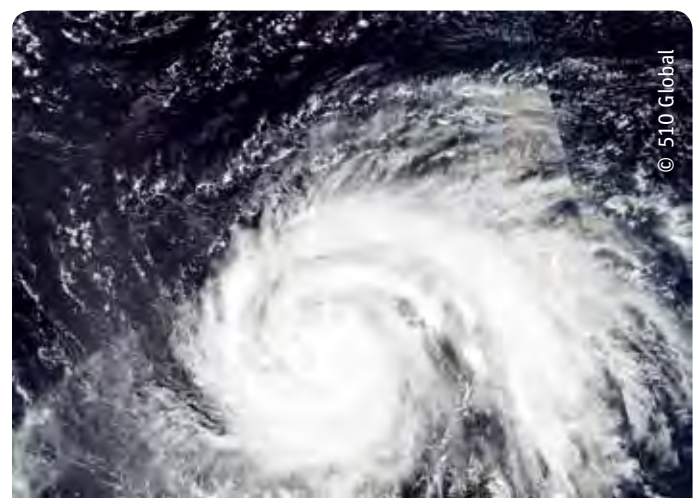
Operating securely with big data and compliance with GDPR

New developments such as the PIM used for Typhoon Haima require the use of large amounts of data. Though currently personal data is not used, there will likely be some cases where

data that we use will contain sensitive or personal information. We therefore have to address the challenges of using data in our work and avoid the potential dangers inherent in the new information age. The wide-ranging adoption of data-driven projects means new organizational frameworks and structures to ensure data privacy and security. With open data, remote-sensed satellite data, assessment data, and privately sourced data, the vast scope of information creates its own management and regulatory challenges. First and foremost, we must ensure that our foundational principles are upheld through the ethical and safe treatment of the information we gather ourselves and through external parties. In addition, new regulations and initiatives such as the EU General Data Protection Regulation (GDPR) are coming up on the horizon, and these bear an increasing relevance to humanitarian work as we come to depend increasingly on our predictive capacities to push the barriers of success. To this end, we need to future-proof our project structures in order to be prepared and in a position to handle the data we need without placing individuals or communities at risk.

Other projects with the 510 team

The 510 team is composed of volunteers, students and staff in a startup environment with the space and support to develop and test innovative technologies and ideas. Once ideas have been developed and tested successfully, they can be brought back into the Red Cross operations in the form of products or services. 510 operates with several institutions and corporations, ranging from Missing Maps to NASA Jet Propulsion Laboratory (NASA JPL), collaborating on, as well as supporting, research development and implementation. We are creating and developing



Radar satellite data: Using radar, we can penetrate dense cloud coverage and obtain an unobstructed view of the topography of a flooded area. This is crucial to understanding and predicting future floods.

an arsenal of tools to assist with today's and tomorrow's humanitarian needs. Among our ongoing projects, we are creating predictive damage modeling of floods and earthquakes, which should be able to identify at-risk areas and provide an indication of potential damage and areas of safety. We work to this end with NASA JPL, which provides radar satellite data capable of breaching cloud cover and gathering crucial intelligence on the topography of the flooded area. This project also involves several Dutch universities, from which our students are drawn.

Another large coverage project we are developing is the creation of a Community Risk Assessment (CRA) tool. This collates open data on a selected group of indicators based on vulnerability and coping capacity alongside geo-climatological data to prioritize areas in need for first responders should a disaster strike. With support of the Dutch Coalition for Humanitarian Innovation (DCHI), 510 is exploring in partnership with DSM how nutrition data can be integrated into this tool. We use the INFORM risk framework as a well-established index, and so have a standardized means of measuring risk and a consistent understanding of which communities need to be targeted for relief or for ongoing humanitarian programs.

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“We have an opportunity as a data-literate society to provide increasingly responsive and ‘smart’ relief and aid”

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Migrating projects and institutions into a data-driven world

We are beginning to understand why data-driven solutions are not just where we are headed, but where we need to go. We have an opportunity as a data-literate society to provide increasingly responsive and “smart” relief and aid. The new direction of big data usage, however, does pose certain key questions which affect those indirectly involved in relief work. The implications of accurate and predictive analysis on drought, famine, and agricultural capacity are extensive and should interest anyone from policy-makers to the food security sector. This goes hand in hand with new risks in data storage, processing, and collection, as data responsibility becomes a constant presence in our lives. These are topics that will play a vital role in the success of migrating our projects and institutions fully into a data-driven world, and we must be ready for them.

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Technology-Enabled Incentives for Last-Mile Entrepreneurs

The role of Tiko Miles in the lives of Tiko Pro entrepreneurs

Anna Allen and Dejus Abreu
Triggerise, Amsterdam, The Netherlands

We all have dreams – some big, some small, but dreams that will get us out of the “slump”. Dreams of the guy on the white horse, dreams of more opportunities. Most of these dreams involve access to more money, of course. But how do you get there when everything is already so tough? When you don’t have a degree or even a CV? How can you turn something as abstract as a dream into a tangible reality – TODAY?

Let’s start with true stories of women who had the opportunity to reach and realize their dreams.

Venu, a beautician in Jaipur, India, provides in-home beauty services to help support her family. But things are slow, since the luxury of beauty is not a priority for many of her clients. Venu joined Tiko Pro through a friend. Armed with her phone, she increased her family’s income and now confidently sends her kids

to school, as she can pay for both school fees and school clothes. In addition to selling new products within her community, she added new product items to her salon, as she increased her cash flow because of all the Tiko Miles she had earned.

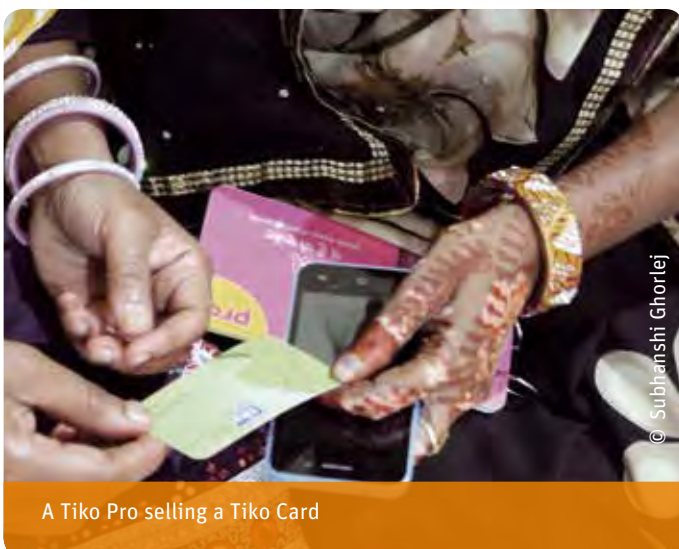
Lakshmi, a housewife and recent widow with 12 mouths to feed and no job opportunities, joined Tiko Pro. She now earns the same as what her husband used to bring home. She is able to provide for her family and is proud to be called a “working woman.” She also loves the training she receives to improve herself.

Neera, a young girl who couldn’t finish her studies once her dad lost his job, joined Tiko Pro, and because she can work whenever she wants, she now has enough money to finish her studies.

Tiko Pro in action in India

Tiko Pro launched in India in October 2015 as the flagship hub with a special focus on improving access to medical services for pregnant women while delivering economic impact to female entrepreneurs. Tiko Pro has since grown to over 1,200 entrepreneurs in four districts of Rajasthan and one in Uttar Pradesh. In addition to stocking products, a Tiko Pro can make health referrals for packages of services by selling one of three targeted Tiko Cards: a general services card for any woman, a dedicated card for pregnant women, and a dedicated card for family planning products and services. The Tiko platform records all interactions, providing a real-time view of Tiko Pro activity and enabling the instant disbursement of Tiko Miles when actions or behaviors have been validated.

“Tiko Pro improves access to medical services for pregnant women while delivering economic impact to female entrepreneurs”



A Tiko Pro selling a Tiko Card



© Subhanshi Ghorlej

A Tiko Pro selling products in her community

As of June 2017, over 1,200 Tiko Pros were active in India, earning on average INR7,215 (US\$110) over the past year. Twenty percent of Tiko Pros earned over INR10,000 (\$150) and 10% earned over INR20,000 (\$300). Tiko Pros have earned an average of 4,300 Tiko Miles, with the top 10% earning over 10,000 Tiko Miles. The most popular products stocked include pregnancy test kits, sanitary pads, oral rehydration salts (ORS), facewash and condoms (see **Table 1**). Tiko Pros have sold over 14,000 Tiko Cards to refer health services since June 2016, of which over 80% resulted in successful clinic visits.

Tiko Pro offers some key benefits for joining the tech network:

1. Easy earning solutions: Tiko Pro offers earning opportunities to anyone who wants to access the network, as there is no upfront investment, education requirement or work experience qualification. Tiko Pros only need an entrepreneurial mindset and a mobile phone. There is also no waiting period: once you join, you can start working immediately.

2. Community and personal impact: The Tiko Pro basket of goods includes access to a range of low- and high-

TABLE 1: Top 5 Products June 2016–June 2017

Top 5 Products June 2016–June 2017			
	Quantity Stocked	Value Stocked (INR)	Value Stocked (US\$)
Sanitary Pads	39,636	1,109,454	16,701
Facewash	18,055	654,682	9,855
Pregnancy Test Kit	29,157	508,047	7,648
Condoms	26,349	241,541	3,636
ORS	13,528	103,920	1,564

FIGURE 1: India Tiko Pro earnings

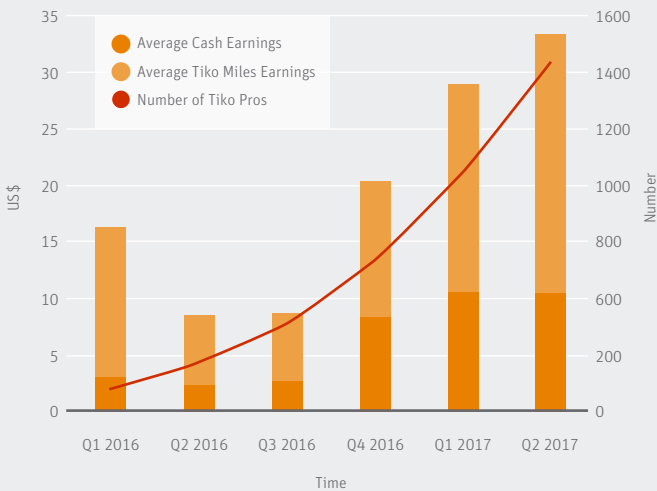
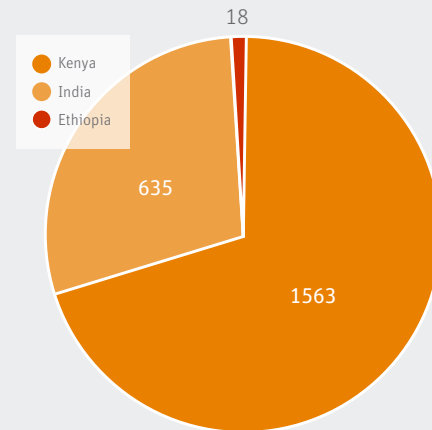


FIGURE 2: Number of Tiko Pros actively earning, July 2017



margin products. Tiko Pros are incentivized to stock and sell impact products relevant to their communities. These include sanitary products, HIV testing kits, non-medical contraceptives, etc. These are easily accessible from local, network-endorsed wholesalers called Tiko Traders. Tiko Pros are proud of the community recognition they receive for the impact they create at a grassroots level

3. Personal control: Tiko Pros are free to work as they please. There are no set working hours, and individuals are their own boss with ultimate control over what they earn. In addition, they are rewarded and recognized for their level of input; they can progress up two tiers with extra earning power and recognition.

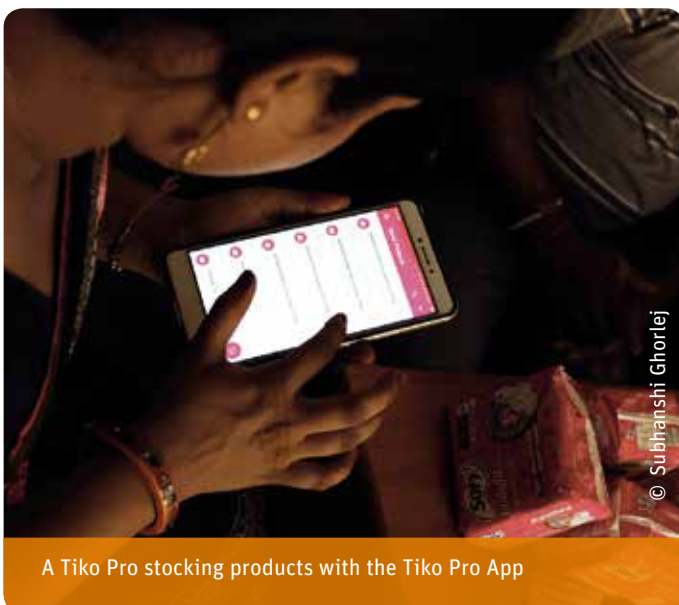
4. Your business, your way: Tiko Pro is driven by technology and the only requirement is a phone (feature or smart). Once Tiko Pros register (with their phone numbers becoming their unique IDs) they can manage their businesses – stocking, purchasing, checking account transactions and balances, and referring clients for services. Tiko Pros can access real-time business information 24/7.

5. Tiko Miles as a currency: Entrepreneurs can use the Tiko Miles or points they accumulate as cash flow to sustain their businesses. If they don't have enough cash to restock, they simply go to the local Tiko Trader and use Tiko Miles to buy whatever they need. This includes personal goods if they can't otherwise cover basic items for the week.

6. Real-time management and coaching: Time is money, so the Tiko Pro network provides real-time data management and monitoring made possible by its real-time validation process. And for those who need a little extra coaching, there are Tikosystem facilitators just a text away for any assistance. Training is available monthly with no limits on attendance.

The Tiko system

As important as Tiko Miles are to a Tiko Pro's business activity, the virtual points would not have as high a value if they could only be spent at a few wholesalers. Triggerise mitigates this risk by recruiting multiple Tiko Traders – small shops that accept Tiko Miles as payment from anyone. Users may also transfer Tiko Miles to another person's account. Tiko Traders can be reimbursed for the Tiko Miles spent at their shop or can spend Tiko Miles with other Tiko Traders – the points are theirs with no



© Subhanshi Ghoshle

A Tiko Pro stocking products with the Tiko Pro App



A Tiko Pro selling Sizanani Mzansi products in South Africa

restrictions. While Tiko Pros tend to spend their Tiko Miles on supporting their own businesses, the concept of being one's own boss and having options is central to Tiko Pro.

“The concept of being one's own boss and having options is central to Tiko Pro”

Reward as motivation for behavior: Some learnings

Formulating the right Tiko Miles incentive structure is key to facilitating a Tiko Pro's emotional independence and economic and social impact objectives. By earning Tiko Miles instantly, Tiko Pros do not have to wait around for a bonus or go anywhere to collect it. A key learning from Tiko Pro implementation is the value and structure of the incentive and the importance of not underestimating the ambition of growing your business. In recognition of this concept, Triggerise began testing a tiered levels system in 2016. After trial and iteration, in 2017 Triggerise finalized the Tiko Pro Bronze, Silver and Gold criteria based on achieving and maintaining certain earnings. At each level, Tiko Pros can earn more Tiko Miles on their activities and celebrate more recognition of their achievements and ambition. Quarterly Tiko Pro celebrations serve to bolster a sense of community, recognize high performers and inspire other members.

In India, Tiko Pro has undergone various iterations to make the Tiko Miles incentive structure as motivating as possible. The critical success factor is to get the equation of motivating the right behavior for both the Tiko Pro and the target audience. For example, the ratio of Tiko Miles earned to estimated cash earnings varied greatly from quarter to quarter in 2016 (see **Figure 1**), as changes were made to encourage different behaviors.

The product basket mix is crucial to have a genuine “retail” proposition for a client, so Tiko Pros are challenged to grow and innovate on this basket at their discretion in order to maintain consumer demand. Almost any product or service can be introduced and distributed through the Tiko Pro network and incentivized with Tiko Miles (with the exception of tobacco and alcohol products). The growth of the network itself is also incentivized – Tiko Pros earn Tiko Miles bonuses and commissions for bringing new members into the network, fueling organic growth to ease scale-up. The resulting impact is twofold: economic enfranchisement of local and individual actors, plus improved access for the target beneficiary to life-improving products and services.

Triggerise launched Tiko Pro in Kenya in October 2016, achieving close to 2,000 Tiko Pros year-to-date. Ethiopia launched in July 2017 and South Africa in September 2017 (see **Figure 2**). The Tiko Pro platform and Tiko Miles incentives and rewards are also used to power existing community health worker and entrepreneur networks in Malawi, Mozambique, Burundi, and Tanzania.

This is Kunj (see **photo below**). Kunj is this young Rajasthani couple's first child. He just turned six months old. His mom was one of the early adopters of Tiko Saathi, a Triggerise product designed to accompany and support women through their pregnancy and reward them for completing important milestones such as antenatal consultations. These cards are only sold through Tiko Pros. Kunj's mother attended eight antenatal consultations at discounted prices and delivered a healthy baby boy. She also used her reward miles to buy baby products for her new arrival. Like her, young mothers want to feel taken care of during the course of their first pregnancy, and the Tiko Saathi card fulfills this promise.

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A happy family assisted by Tiko Pro

Using Mobile Technology for Nutrition Programs

A practical guide for implementers and practitioners

Shreya Bhatt

Director of Special Projects for Asia, Medic Mobile, Mumbai, India

Key messages

- > Over 97% of the world's population has access to a mobile phone signal.
- > However, far too many mHealth initiatives that aim to utilize this mobile network struggle to scale up beyond pilots and sustain impact over time.
- > This article offers a conceptual framework that nutrition practitioners can use to harness the potential of mHealth interventions.
- > The four-step process aims to put people first in designing a framework to help build, implement, evaluate and scale mHealth innovations.
- > As malnutrition continues to overburden many health systems, mHealth offers huge potential for strengthening and improving existing initiatives and outcomes, so long as they can be implemented successfully.

Introduction: The promise of mHealth

Mobile technology has proliferated more rapidly than any other technology in human history.¹ Over 97% of the world's population today has access to a mobile phone signal,² creating unprecedented opportunities to reach remote and disconnected communities. The field of mobile health or mHealth leverages these opportunities, harnessing mobile and wireless technologies such as basic phones, smartphones, tablets and mobile networks to address the coordination and communication chal-

lenges of delivering health care to underserved populations around the world.

This new field shows particular promise in low-resource settings, including in strengthening nutrition programs and improving health outcomes. mHealth interventions have the potential to change nutrition-related behaviors, strengthen malnutrition case finding, improve treatment adherence, manage stock of supplements and micronutrients, and increase the efficiency of health workers, facilities and systems providing nutrition services at the last mile.

“mHealth harnesses mobile and wireless technologies to deliver health care to underserved populations around the world”

Despite its promise, however, evidence suggests that far too many mHealth interventions fail to scale up beyond small pilots or sustain impact over time.³ Bringing human-technology interaction to bear on health systems involves many complexities, and paradoxically can sometimes do more harm than good. This article offers a practical guide for nutrition programs seeking to adopt mHealth innovations. It draws on the experiences of Medic Mobile, a nonprofit organization that uses mobile technology to create connected health systems, as well as those of a growing community of information and communication technology (ICT) practitioners. While neither exhaustive nor prescriptive, this article suggests a conceptual framework within which nutrition practitioners can plan, craft and implement effective mHealth interventions for nutrition programs.

Getting started: Planning for mHealth

The idea of mHealth may seem daunting at first. Many nutrition programs use paper-based information systems, and adopting technology is outside the realm of comfort and expertise of

FIGURE 1: Twelve common mHealth and ICT applications for reproductive, maternal, newborn and child health (RMNCH)

- | | |
|--|---|
| <p>1 Client education and behavior change communication (BCC)</p> <hr/> <p>2 Sensors and point-of-care diagnostics</p> <hr/> <p>3 Registries/vital events tracking</p> <hr/> <p>4 Data collection and reporting</p> <hr/> <p>5 Electronic health records</p> <hr/> <p>6 Electronic decision support
Information, protocols, algorithms, checklists</p> | <p>7 Provider-to-provider communication
User groups, consultation</p> <hr/> <p>8 Provider work planning and scheduling</p> <hr/> <p>9 Provider training and education</p> <hr/> <p>10 Human resource management</p> <hr/> <p>11 Supply chain management</p> <hr/> <p>12 Financial transactions and incentives</p> |
|--|---|

Credit: Labrique AB, Vasudevan L, Kochi E, Fabricant R, & Mehl G.⁵

many health teams. Getting started with mHealth, however, is much like starting any new program, and there are often more questions than answers. The first, especially for practitioners with little or no background in technology, is often “*What can mobile technology really do?*”

The good news is that with over 500 mHealth pilots implemented globally,⁴ the ICT community has gathered insights to help beginners in this process. Drawing on experiences in developing countries, mHealth thought leaders have developed a framework of 12 common mHealth applications for reproductive, maternal, newborn and child health (RMNCH) (Figure 1).⁵ These include using mobile technology for behavior change communication, data collection and provider training, and highlight a range of possibilities that practitioners may consider for their programs and context.

Practitioners also have to answer other questions as they plan for mHealth, including: What human resources are needed to support such a project? Do we build a tool in-house or engage the services of a partner organization? How much will an mHealth system cost to implement and manage? How will we implement the project? How will we measure its success?

These questions can help practitioners objectively evaluate the need and value of mHealth for their program, rather than adopting an mHealth intervention because it sounds appealing, because others have done so or because donors wish to fund it. This process also highlights the nuances of implementing and managing an mHealth program, reveals key human-resource, fi-

nancial and other considerations, and uncovers potential challenges to be addressed. A variety of toolkits have been designed to guide practitioners as they plan for mHealth and other digital health programs. For example, a toolkit from the World Health Organization and PATH lays out an eight-step process that can help practitioners develop their ICT program along with planning tools for each step (Figure 2).⁶

“mHealth toolkits can help practitioners evaluate the need of mHealth for their program and uncover potential challenges to be addressed”

From planning to practice: Medic Mobile’s mHealth process

Toolkits such as these can help practitioners conceptualize their mHealth programs, but even the best-laid plans often go awry once the work of design and implementation actually begins. How then do you get from an mHealth plan to the actual practice of it? In the absence of standardized mHealth processes, we offer our own approach at Medic Mobile, an organization that supports over 16,000 frontline health workers with mobile technology as they provide care to 11 million people in 23 countries. Since 2008, Medic Mobile has worked with clinics, hospitals, non-profit organizations and ministries of

FIGURE 2: An eight-step process to plan for ICT programs

1	Define Outcomes	How will a better information system benefit you? How should you define the scope? How will you measure success?	
2	Form your Team	What skills and roles are required to bring your project to a satisfying outcome?	
3	Define what your System needs to do	How can you define your requirements for the system?	
4	Find the right Solution	Should you buy or build your system? Do you select an open-source or proprietary system? How do you evaluate different systems and select the best one?	
5	Select the right Vendors	How do you make sure you select the best providers of technical services?	
6	Estimate Implementation and Operating Costs	How much will your project cost to pilot, scale and maintain?	
7	Create an Implementation Plan	How long will it take to develop, pilot and scale up?	
8	Understand and Manage Project risks	What can go wrong and how can you plan for that?	

Credit: Grevendonk J, Taliesin B, & Brigden D.⁶

health to create, implement and scale mHealth interventions to improve the last-mile delivery of health care and save lives. While our implementations vary in their use, scope, context and the challenges they seek to address, we adopt the following framework to conceive, build and implement a wide range of interventions (**Figure 3**).

We approach mHealth with a four-step, iterative process firmly grounded in human-centered design. It is an approach to problem-solving that puts people first and offers a practical framework for others to replicate as they design, build, implement, evaluate and scale their mHealth innovations. Here, too, guides such as IDEO's *Field Guide to Human-Centered Design* can

provide practitioners with actionable tools and methods to facilitate this process.⁷

Build empathy with end-users

Our approach to mHealth begins with getting to know the people who will use and benefit from mHealth tools and the resulting improved health system. This means foregoing our familiar perspectives and engaging with stakeholders, particularly end users, to understand their work and home environments, challenges, goals and strengths as they deliver or receive care. In the context of nutrition, this may mean interacting with nutrition health workers, health promoters, mothers, midwives, nurses

and others as they provide nutrition care for families in their community. Using methods such as interviews, role-playing and sketching, and tools such as visual sketch cards, we define our user personas, understand their contexts and begin to co-design with them, so that they are equal creators of the solutions that will impact their futures.

Define and ideate with end-users

Next, we look closely at an existing program and define the most important challenges with users. Several pain points may emerge, with different perceptions of priority among users, practitioners and other stakeholders. You might discover for example, that your foremost challenge as a practitioner is poor breastfeeding practices in the community, but health workers might report that the time taken to maintain paper records each week is their biggest constraint. It may be tempting to solve all of these challenges with technology. However, even straightforward mHealth pilots evolve into complex interventions once underway. A general rule of thumb is to keep things simple, address the most pressing challenge first and later incrementally build on this foundation in future iterations.

Having identified a key challenge, we explore how mobile technology may address it. Technology may not always be the right answer, but if it is, a plethora of decisions need to be made. What technology should the tools harness? For example, should we use text messages, voice communication or multimedia messaging to promote breastfeeding awareness among communities? Should we use basic phones or smartphones, and

why? What are the hardware, language and cellular or internet connectivity requirements of our users? How does the tool fit within the existing workflow of service delivery? How will the tool integrate with other existing technology systems at the local and national level?

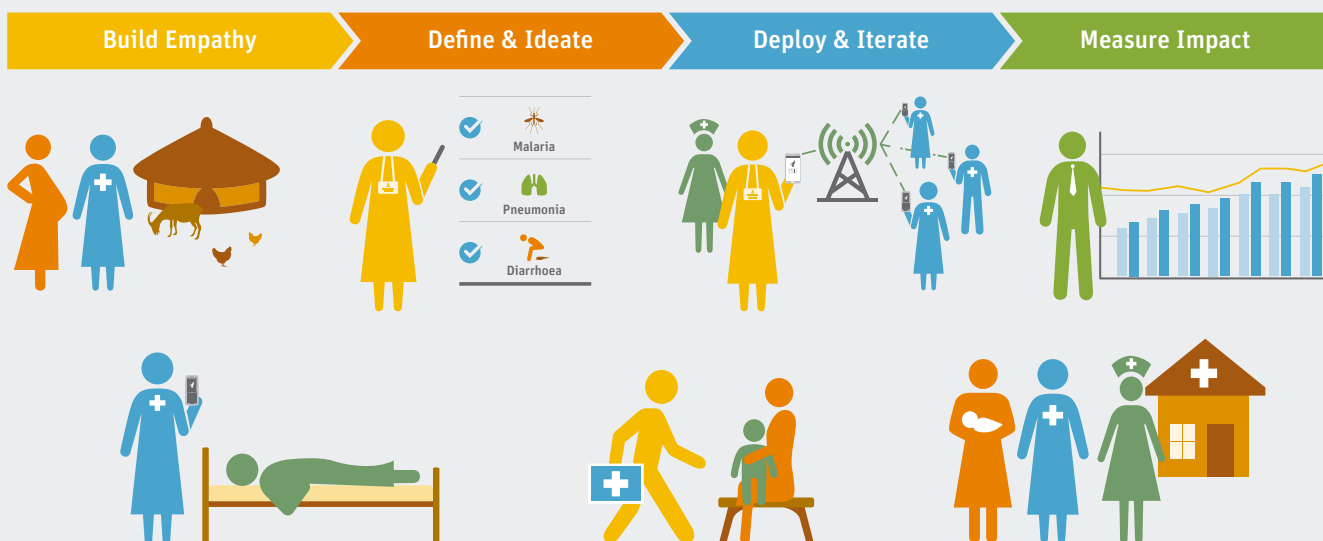
Many of these decisions involve a trade-off, and while there are no “right” answers, some answers are more context-relevant and user-appropriate than others. Adopting a participatory approach to prototyping the envisioned tool with end users is invaluable. Enabling nutrition workers to test out a concept or role-play a situation with the mHealth tool instead of their current systems can reveal key insights, and the best ideas can be refined into even better solutions with the added perspective of end users.

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“Although nutrition programs are well versed in delivering training, mHealth program training can pose unique challenges”

Deploy and iterate

Successful implementation requires a skilled and trained workforce to support the use and maintenance of the tools. Although nutrition programs are well versed in delivering training, mHealth program training can pose unique challenges. Users differ in their mobile literacy or baseline knowledge of mobile

FIGURE 3: Medic Mobile’s mHealth process



Credit: Lester Ng



Health workers in Liberia test out Medic Mobile's mHealth tool along with Medic's sketch cards before implementation.

technology and may have varying technology learning curves, irrespective of their nutrition expertise. Building capacity and planning for continued end-user training after implementation is a non-negotiable investment of resources for the success of mHealth.

Another crucial aspect is management and supervision of the intervention. Designating an mHealth champion to drive the intervention forward, address any implementation challenges and effectively support and motivate end users is vital for the success of any mHealth program.

Implementation may imply finality, but is in fact the completion of *only one iteration* of the entire process. Being open to continuous iteration with users even after implementation is crucial for the tool to evolve into a more enhanced and impactful solution over time.

Measure impact

Once implemented, it is important to monitor how the tools are used and whether they influence key activity and impact metrics as we expect. Are nutrition workers using the mHealth tool as consistently as intended? Has the mHealth tool improved reporting time compared to paper-based systems? Has it helped to reinforce breastfeeding counseling given to mothers and are outcomes improving? Has it helped to reduce stock-outs of micronutrients at the community level? Sharing impact data, not only at the program level but also directly with end users, is key to enhancing motivation, performance and engagement. Moreover, demonstrating impact at pilot level is a prerequisite for future scale-up of the tool more widely with partners at the local and national level.

Overarching principles of digital development

While our framework can help practitioners to design and implement mHealth systems that are responsive to people's priorities

and contextual complexities, mHealth initiatives must address a range of additional factors if they are to be sustained or scaled up. Experience has shown that financing, scaling, sustaining and integrating mHealth interventions as well as building institutional partnerships to support these programs in the long term are crucial components of mHealth success.^{8,9} The international development community has captured best practices for these and other key elements of technology-enabled programs into a set of broader "Principles of Digital Development".¹⁰ These nine core principles and accompanying tools and resources can guide practitioners as they create successful digital programs for nutrition (Figure 4).

Concluding thoughts

As malnutrition continues to overburden health systems, mHealth has tremendous potential to strengthen nutrition programs and improve outcomes, particularly in last-mile settings. mHealth interventions are complex, however, and pose multi-dimensional challenges. Practitioners can meet these challenges by systematically planning for mHealth and adopting an iterative, human-centered approach to understanding users, defining

FIGURE 4: Principles of Digital Development

- 1 Design with the User
- 2 Understanding the Existing Ecosystem
- 3 Design for Scale
- 4 Build for Sustainability
- 5 Be Data Driven
- 6 Use Open Standards, Open Data, Open Source, and Open Innovation
- 7 Reuse and Improve
- 8 Address Privacy and Security
- 9 Be Collaborative

Credit: Principles of Digital Development¹¹

challenges, ideating solutions, implementing and refining prototypes, and measuring impact. Taking the principles for digital development seriously will also help prepare implementers for many of the more common pitfalls. Using these frameworks and principles, practitioners can create innovative and lasting mHealth solutions to transform and save the lives of many suffering from malnutrition around the world.

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Nutrition Entrepreneurs

Accelerating nutrition progress through social business models in Kenya, Ethiopia and Malawi

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Key messages

- > Today, 155 million children under five years of age are stunted and don't get the vital nutrients that their bodies need for optimal growth and development. Nevertheless, a number of barriers exist to scaling up nutrition interventions.
- > To overcome these barriers, *Sight and Life* conducted a scoping study to identify sustainable social enterprises that can integrate nutrition interventions at scale and benefit large numbers of underserved communities.
- > Our study identified five promising business models: microfinancing, social franchising, network orchestration, freemium, and enterprise development.
- > These business models help guide practitioners, policy-makers and influencers in the nutrition sector in designing, replicating and implementing scalable nutrition programs.

Barriers to scaling nutrition solutions

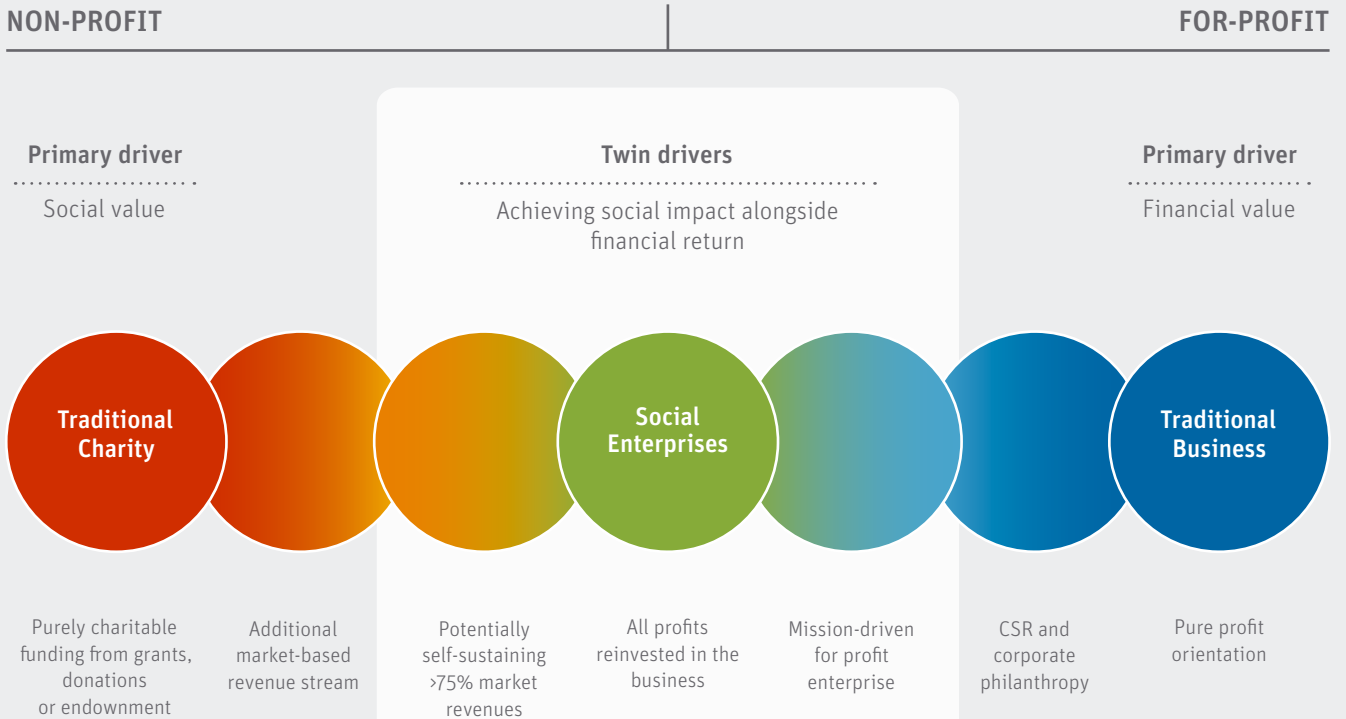
Today, 155 million children under five years of age are stunted and don't get the vital nutrients that their bodies need for optimal growth and development. Recent estimates suggest that almost one in every two children in sub-Saharan Africa suffers from vitamin A deficiency, placing them at a greater risk of dy-

ing.¹ Undernutrition contributes to half of all child deaths each year and costs low-income countries in Africa up to 11% of their GDP. It is often irreversible but always preventable. The issue is not hunger itself; it is about getting children and their mothers the variety of foods, the nutritional supplements, and the services and education they need at the right time.

However, with more than 33% of the population in Kenya and Ethiopia and 70% of the population in Malawi living below the poverty line,² it is unlikely that local diets, which include only small quantities of animal-source foods, can be diversified sufficiently to provide the requisite nutrition. Acceleration of progress in nutrition therefore requires high-quality, evidence-based nutrition interventions that can be scaled to reach large populations effectively.

“Acceleration of progress in nutrition requires high-quality, evidence-based nutrition interventions that can be scaled to reach large populations effectively”

From our experience, we realized that there are six barriers to scaling nutrition solutions. First, grant-funded humanitarian and community projects have limited reach and finite intervention periods. Second, sub-standard-quality products are found in low-income settings, where there is actually a demand for affordable but high-quality products. In addition, prices of public health goods and services are inflated, and counterfeits are rampant. Third, the cost of distribution to reach remotely located consumers is prohibitively high. Fourth, nutrition messages are complex, erroneous and sometimes reinforce prevalent myths (e.g., spinach contains more iron than meat; iron deficiency can be addressed through the use of a cast-iron pan; raw milk is more nutritious than pasteurized milk). Correct nutritional information is often understood only by a few actors and specialists. Fifth, communities at the bottom

FIGURE 1: The social enterprise continuum

Source: J. Kingston Venturesome, CAF Venturesome, and EVPA

of the pyramid struggle with erratic cash flows and extremely low disposable incomes, thus limiting the ticket price of the products. Lastly, there are no enabling ecosystems to support a product or service in low-income contexts. Public health facilities are difficult to reach, underfunded, understaffed and understocked.

Social enterprises in other domains – agriculture, inclusive finance, health, technology, energy and others – were able to overcome barriers in reaching the last mile profitably and sustainably, and in some cases at scale. Social enterprises (Figure 1) tackle challenges facing underserved communities and improve people's lives while functioning like a business. Social enterprises are at the middle of the charity-business continuum and aim to achieve the twin drivers of social impact and financial return. *Sight and Life* conducted a scoping study in Kenya, Ethiopia and Malawi to identify sustainable social enterprises that can integrate nutrition interventions at scale and thus benefit large numbers of underserved communities.

While this article is neither exhaustive nor prescriptive, it attempts to shine a spotlight on business models to help guide practitioners, policy-makers and influencers in the nutrition sector in designing, replicating and implementing scalable nutrition

programs. After analyzing and reviewing more than 100 enterprises, we found five promising models relevant for nutrition. These are:

1. Microfinancing

Resource-constrained communities struggle to provide the requisite collateral to enable them to borrow from traditional banks for the purposes of investment. The remote location of many such communities exacerbates the problem even further. Microfinancing (Figure 2) is a type of banking service that caters to the unmet needs of the rural poor by lending a group of borrowers (usually women) a relatively small sum of money to invest in microenterprises. The model relies on the group's ability to self-select reliable borrowers based on their knowledge of the community.

Microfinance institutions (MFIs) collaborate with banks to provide small business loans to women's groups. In addition, MFIs also provide support services such as business skills and bookkeeping. The women then invest the money in profitable activities, through which they earn enough income to repay the loans and save enough to improve their families' living conditions.

MFIs with a long history of trust and frequent interactions with the community are well positioned to play a cross-sectoral role in improving access for the poor to a range of important nutrition-related products and services. MFIs mostly support women, since they are generally a better credit risk group³ than men and tend to have a higher impact on poor families due to their spending patterns. Interventions with MFIs can therefore reach women in rural geographies with relative ease. Microfinance providers operate at scale (typically, tens of thousands of clients) in order to reduce portfolio risk and leverage economies of scale. This provides an opportunity for nutrition intervention designers to pioneer commercially viable nutrition programs: the well-established distribution networks and routine contact with clients will fuel instant scale among their large client base. Most MFIs also have training teams that can be equipped to impart nutrition education in addition to business skills training.

2. Social franchising

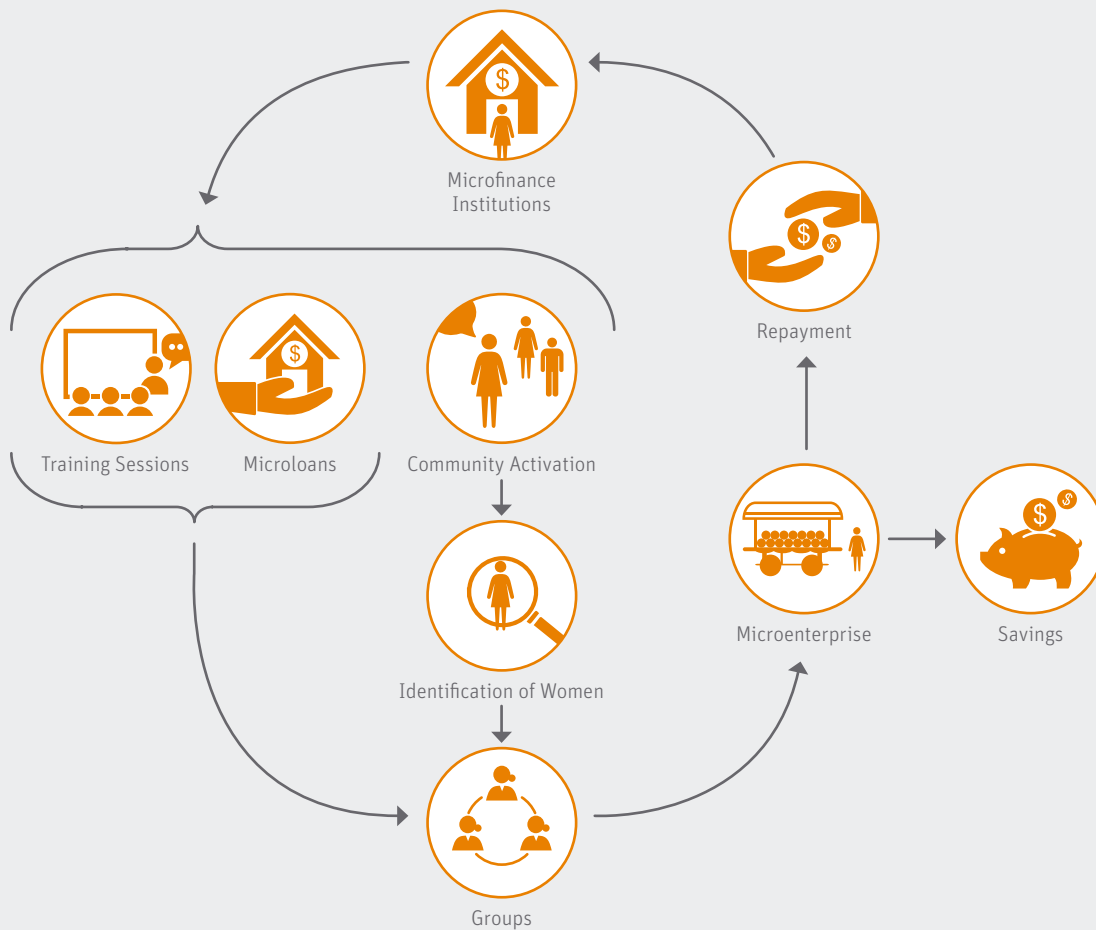
Many private health care providers in developing countries operate with minimal regulation, leading to variable quality in ser-

vices. They operate outside of the network and are not subject to supervision once they are initially certified and licensed. A social franchise network (Figure 3) aims to combat this challenge by linking various private-sector providers through agreements to provide socially beneficial health services under a common social franchise brand. A franchisor (typically a non-profit) provides training and supplies, and monitors the franchisee (private provider) for a fee.

“MFIs are well positioned to improve access to a range of important nutrition-related products and services”

A social franchisor specializes in a particular service (family planning, HIV care and support, maternal and child health, etc.). Community health workers (CHWs) are trained by the

FIGURE 2: Operational model of a microfinance institution



clinics to visit communities and create awareness about health. They also give incentive vouchers to needy patients. When patients visit the clinic and take the voucher with them, they receive treatment at subsidized rates. The franchise network usually has distribution channels and agents through which life-changing products such as contraceptives and water purifiers are sold.

Each franchise network offers specialized services through its clinics and therefore offers an excellent route for reaching specific target beneficiaries in low-income communities. For instance, a franchise network that offers family planning and reproductive health services is an optimal channel for offering affordable nutrition to pregnant and lactating mothers and women of reproductive age.

“The orchestration model stimulates close cooperation with external partners”

3. Network orchestration

The network orchestration business model (Figure 4) coordinates different players in the value chain to distribute products



Cook stove producers in Malawi are supported by a network orchestrator

FIGURE 3: Operational model of a social franchising network

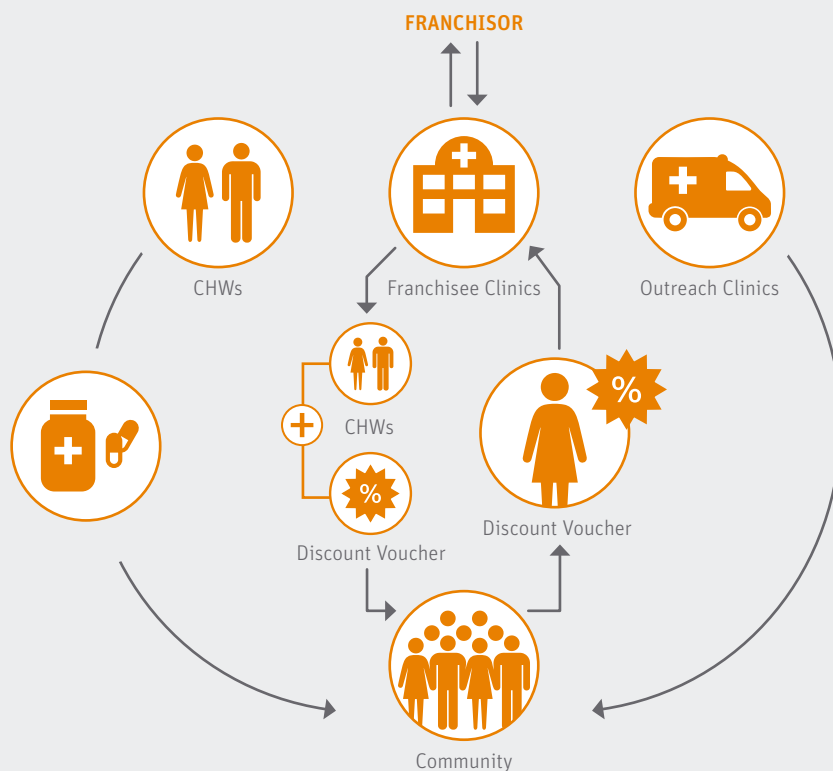
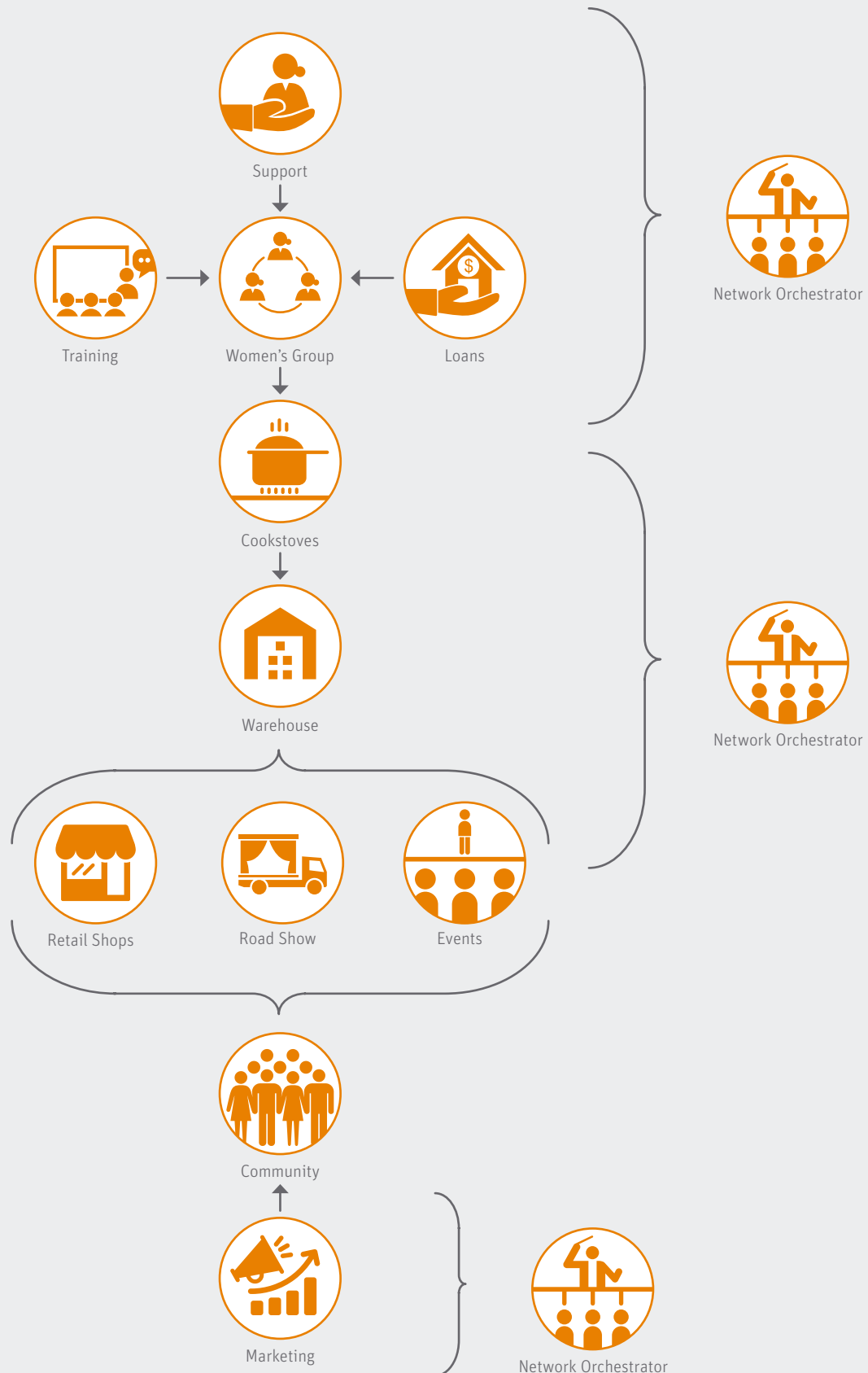


FIGURE 4: Working model of a network orchestrator in Malawi



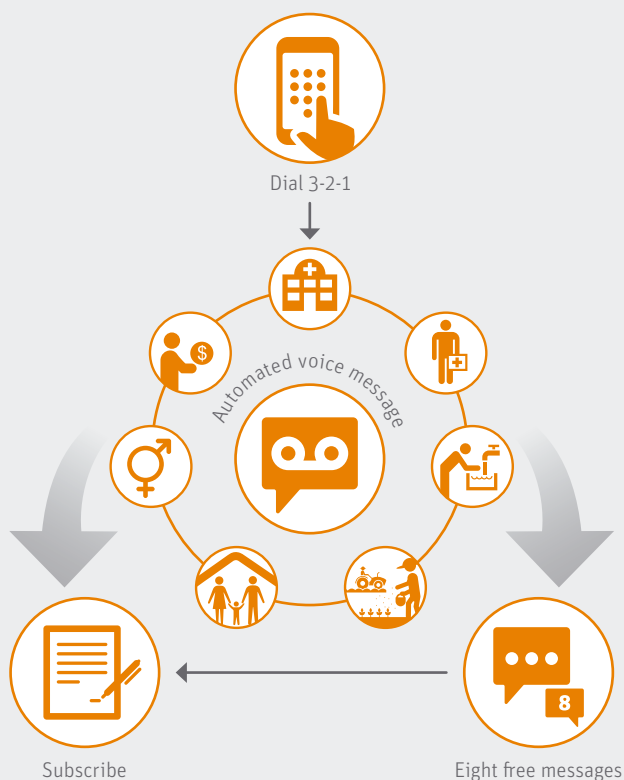
and services efficiently down to the last mile. The orchestrator will spend a significant time managing the activities of various stakeholders in addition to focusing on core competencies. This will help scale the challenge of suboptimal distribution networks that many developing countries face. An important advantage of the orchestration model is that it stimulates close cooperation with external partners, whose specific value creation and innovative capacity can benefit one's own production.⁴

Collaborating with a network orchestrator can help solve the challenges of high distribution costs, inconsistent product availability and missing ecosystems – challenges that frequently plague the nutrition sector. The network orchestrator coordinates with a diverse set of actors involved, from suppliers to retailers at the last mile, to ensure that customers do not suffer due to missing links in the supply chain. In addition, transforming existing stand-alone deliveries into a network of affiliated and synchronized channels helps reduce product costs.

4. Freemium

Freemium – a combination of ‘free’ and ‘premium’ – is a business model that offers a basic version of goods and services for free while charging a premium for additional features or functionality (Figure 5). Free offerings tend to attract a large customer base while expecting to monetize a small percent-

FIGURE 5: Working model of a freemium mobile application



age. This will help the organization build a sustainable revenue base. Freemium models are usually seen in the technology space where the marginal cost of providing upgraded features is usually minimal.

Mobile phones have become ubiquitous even among resource-poor communities in many developing countries. A freemium mobile service set up exclusively to give resource-poor individuals information on how to improve their wellbeing can be a great tool to create awareness about better nutrition practices. In addition to having a large captive audience, such a solution can also be used to explain complex nutrition messages.

5. Enterprise development

Enterprise development (Figure 6) is a model whereby businesses are led by locals at the community level in order to aid economic growth. Successful enterprises are locally rooted, trade for the benefit of the community, are accountable to the local community, and aim to create a broad community impact. In the presence of competent technical partners and experts who function as enablers, community-led enterprises can be supported at scale.

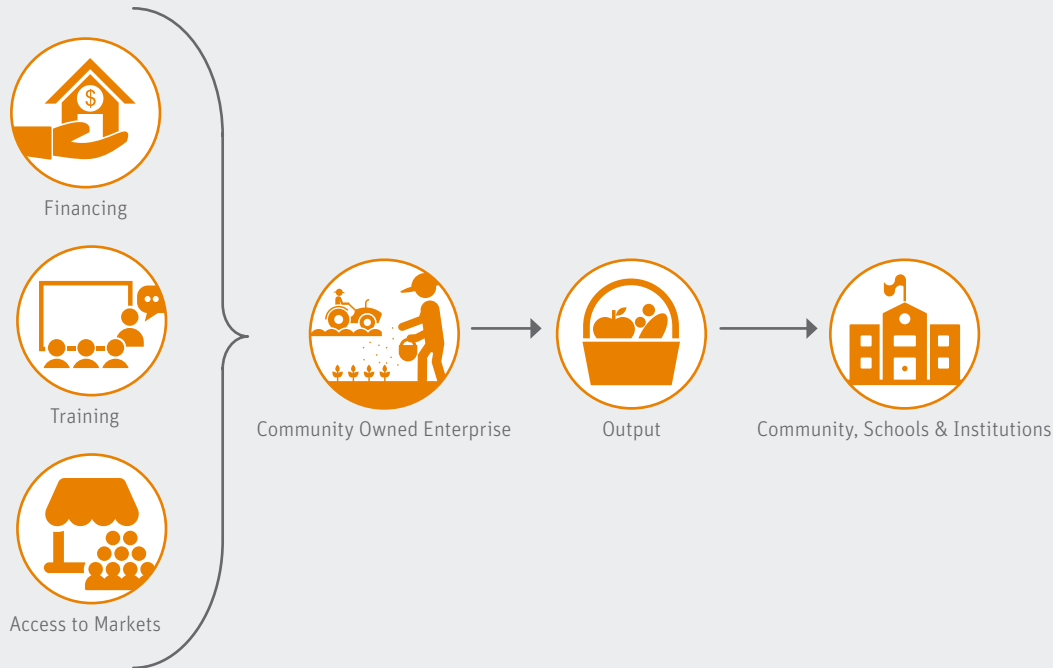
Enterprise development is a common strategy to create local jobs and improve economic wellbeing in the community. In this model, an organization (typically a non-profit) provides access to markets, finance and training for community members who jointly start up a small enterprise in a range of sectors from agriculture through manufacturing to services. The profits earned are divided among the enterprise owners, while community members benefit from jobs created.

Integrating nutrition into community enterprises through the supporting non-profit will create nutritional impact in addition to economic wellbeing.

“Enterprise development creates local jobs and improves economic wellbeing in the community”

Concluding thoughts

The importance of alleviating all forms of malnutrition is well established. However, progress remains slow and uneven in many contexts. Successful social businesses that serve large populations of low-income customers have shown interest in integrating nutrition solutions with their current offering. We therefore need to find practical solutions which are financially viable and easily scalable across a range of sectors including health, food and agriculture, technology and finance. We will share insights about the nutrition entrepreneurs themselves and their pathways to scale in the next edition of *Sight and Life*.

FIGURE 6: Working model of enterprise development**Correspondence: Srujith Lingala,***Manager Technology and Entrepreneurship**Kalpna Beesabathuni, Global Lead Technology and Entrepreneurship, Sight and Life, 9th Floor,**Infinity Towers, DLF Cybercity, Phase 3, Gurgaon – 122002, India.***Email:** srujith.lingala@sightandlife.orgkalpana.beesabathuni@sightandlife.org**References**

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Personalized Nutrition

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Key messages

- > Awareness of the impact of nutrition on health status is constantly increasing.
- > Personalized nutrition offers approaches to tackle both undernutrition and obesity.
- > Investments in digital connectivity are needed to make the delivery of personalized nutrition possible.

Awareness of the impact of nutrition on health status is constantly increasing. This trend has created a growing diversity in attitudes towards food in high-income countries (HICs). Consumers are overwhelmed by the information provided by literature of all kinds, as well as the content made available via social media. Food companies, restaurants and retailers have diversified their portfolios and adapted to the new demands for vegetarian, vegan and organic food, and for foods that take account of food intolerances and health-related trends.

“Consumers are recognizing the link between healthy food intake and the prevention of disease”

Consumers are recognizing the link between healthy food intake and the prevention of disease. Alarm bells are ringing across the globe to signal that much more needs to be done to counter the spread of noncommunicable diet-related diseases such as type 2 diabetes and cardiovascular disease. The burden on health systems is continually increasing. In non-OECD (Organization for Economic Co-operation and Development) countries, health care costs are expected to rise from 2.4% to between 3.1%

and 3.4% of GDP, which is comparable to 50% to 70% of the level expended in OECD countries.¹ Political actors are more and more challenged to find solutions to these problems.

The twofold challenge

Currently, 2 billion people are overweight or obese,² while 2 billion of the world's population still suffers from micronutrient deficiencies (hidden hunger), 40% of women of reproductive age have anemia, and 17% of preschool children are underweight.³

The rise in obesity levels in the low-income countries (LICs) largely follows the same patterns as in high-income countries and is caused by the same poor dietary habits. The incidence of type 2 diabetes and cardiovascular disease is rapidly increasing as a consequence.

In the case of hidden hunger caused by micronutrient deficiency, the engagement of stakeholders such as governments and industry is critical to establish a sustainable supply of high-quality food and a clean environment that can improve the average nutritional status of the individual. Individuals in this environment lack the power to significantly improve their personal situation, and are thus highly vulnerable.

In the case of obesity, the individual inhabits an environment that provides sufficient food and generally also food of sufficient quality, but which also contains foods that can have an adverse impact on health. The individual is challenged to make the right choices and must resist the temptation to make bad ones. Personal habits, traditions, behaviors adopted from parents, levels of knowledge about food and food preparation, and awareness of the impact of food on health strongly influence individual choices here.

There are, of course, zones also in HICs where fresh fruits and vegetables are poorly distributed and only available far away from where people live.

When accessibility and security of food supply are the dominating factors for raising the average nutritional status to an acceptable level, investments in general measures such as food fortification and improving the general food supply are more effective. But these measures appear not to be effective in counteracting the bad habits that put people at risk of obesity. Changing personal dietary habits is a big topic in personalized nutrition, and it is one of the key factors in successful interventions. The relevant literature is full of the struggle to overcome

TABLE 1: Nine models of personalized nutrition seen in middle- and high-income countries⁴

1. Employee lifestyle guidance	Employers offering lifestyle advice program to employees. The key value proposition focuses on a shared responsibility between the employee and the employer for a healthy lifestyle relevant to employee wellbeing and productivity. Key activity is feedback of lifestyle plan based on individual information and diagnostic data to employees. Customer relationships are established by a one-to-one partnership with the client to build employee satisfaction and performance.
2. Standing strong together	The key value proposition of this model is to enhance healthy lifestyle improvement through social support rather than individual struggle. Social support and even a certain level of peer pressure are adopted to increase self-control and compliance with health advice. Key activities are the organization of social reinforcement networks for improving health (most often weight loss) and the production and distribution of health foods (most often slimming products).
3. Health club	The key value proposition in this model is like that of 'standing strong together', but with a more balanced focus between individual responsibility and institutional support, with a lower level of peer pressure and social support. It is typically based on a broader range of lifestyle changes required for weight management, appearance, or fitness. Key activities are the maintenance of training facilities, coaching in physical training programs, including dietary intake advice, and product sales (e.g., supplements, training gear).
4. Do-it-yourself-healthy-diets	The value proposition in this model is of a more distant nature, often Internet-based. The model provides a diagnostic tool based on individual dietary intake data coupled with tailored dietary advice. However, the initiative and follow-up are left entirely to the consumer. The channel used is the Internet, there are few follow-up options, and the target group comprises individuals who occasionally want to improve their food choices.
5. Step in, step out	This model takes the 'do-it-yourself-healthy-diets' model one step further to include non-invasive phenotypic information in addition to dietary intake data. Key activities are gathering information on dietary intake from the individual, as well as self-reported phenotypic parameters, providing dietary advice and optional feedback based on monitored progress. The mostly used channel is the Internet, but face-to-face contact or telephone sessions are also possible.
6. Test and run to the finish	This model takes the 'step in, step out' model one stage further by providing the consumer with relevant feedback on progress towards health improvement on relevant biomarkers, both non-invasive and invasive phenotypic measures. The key feature is an iterative feedback loop that assures follow-up of the consumer's progress and the possibility to adjust the dietary advice accordingly.
7. All-in lifestyle guidance	This business model extends the 'test and run to the finish' in two directions. It includes genotypic information next to dietary intake data and phenotypic information both as a source of personalized advice and as a monitoring for goal approach. The personalized advice is also broader in scope: it includes other lifestyle changes besides dietary improvement such as activity level or stress/time management. The key feature is the inclusion of genetic information as well.
8. Face-to-face	This business model is close to that of traditional dietician's advisory services. The value proposition is that of personal contact and guidance in face-to-face personalized advice based on dietary intake data. The key feature is the type of customer relationship-building, which is an individual real-life situation. The target group comprises individuals who are diagnosed as requiring some form of dietary guidance (e.g. diabetics, food-allergic patients).
9. We told you so	This business model represents the traditional information-based approach to improving lifestyle following the 'explain and prescribe' dogma. Many governmental organizations follow this approach as a part of nutrition education programs on lifestyle changes with a view to improving public health. It is predicated on mass-media communication channels and, increasingly, Internet-based communication. There is some (target population) advice, but only limited personalization involved, based on dietary intake data alone and with no personal contact. A key distinguishing feature is that the source of the (personalized) nutrition advice is a non-profit organization, which may increase its trustworthiness.

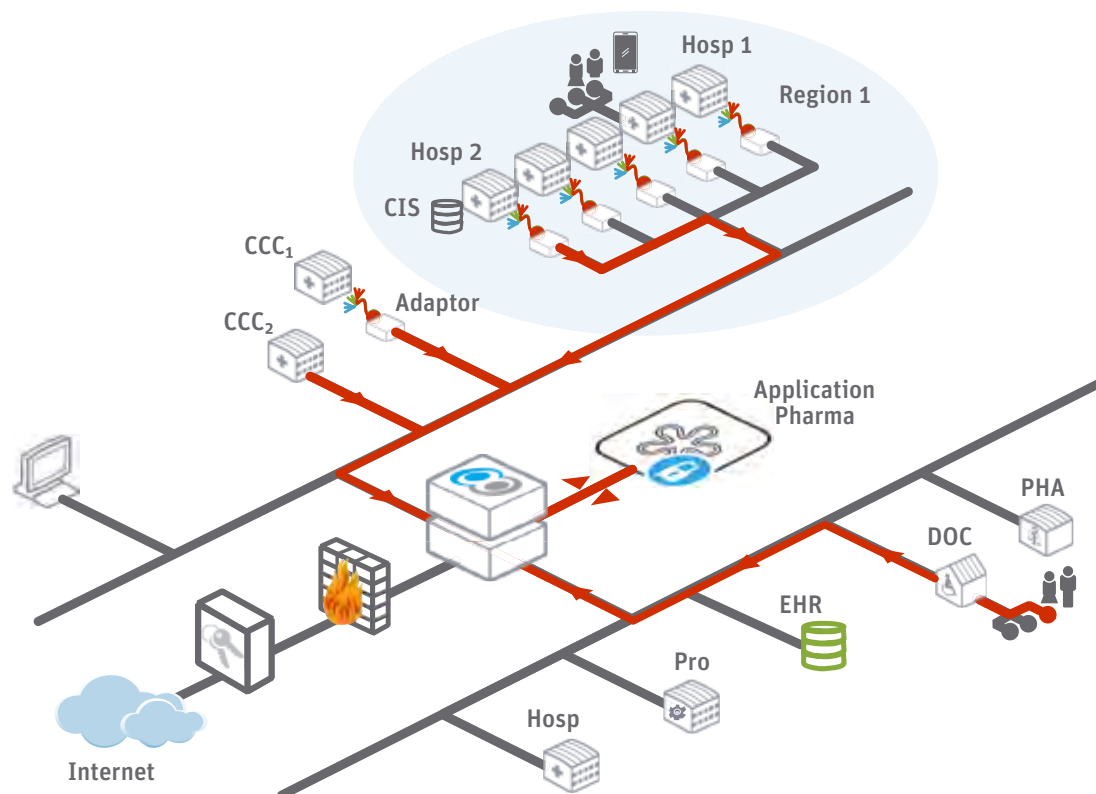
consumers' resistance to change. Investing in personalized nutrition concepts may be an option to improve the health status of this consumer segment in low- and middle-income countries (LMICs).

Different consumer segments have different dynamics. The segment of healthy-agers in Western countries is growing. This segment is willing to invest significant discretionary spending in their personal health and is therefore an attractive target group for all kinds of companies offering services in the personalized nutrition space. In addition, other payers such as health insurance companies are starting to invest in prevention.

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“Mobile-based technologies offer plenty of options for designers of services”

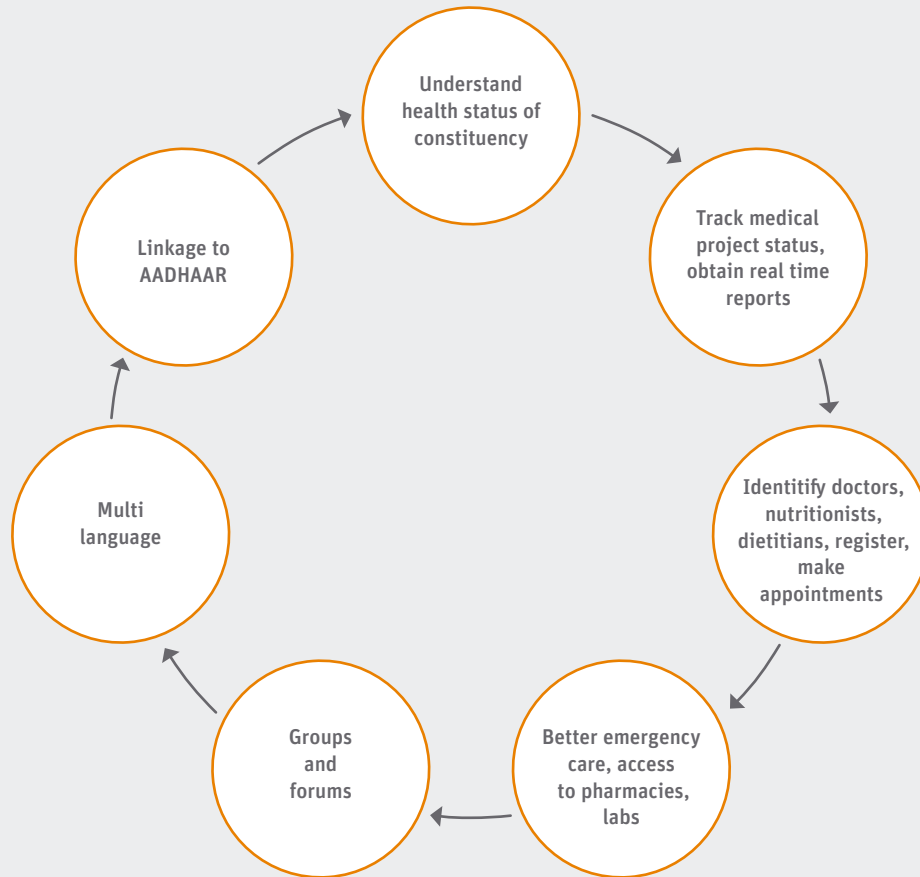
The capabilities of mobile-based technology offer plenty of options for designers of services to choose appropriate business models and vehicles to reach and retain targeted consumer segments, although the characterization of the various consumer segments is still incomplete. Service providers are very much in trial-and-error mode in this emerging area of personalized nutrition. We therefore find many applications and business models that personalize counseling and behavior change using age, gender, BMI (body mass index), dietary intake data, and phenotypic information such as blood pressure, body fat, waist-to-hip ratio, cholesterol, and so forth. Such personalized offers include personal diet plans, shopping lists, lifestyle advice and personal coaching. A recent study⁴ sets out to review and categorize existing business model proposals. This study summarizes nine different models in the marketplace covering middle- and high-income countries such as India, USA, UK, Netherlands, New Zealand and Belgium, where consumers either want to lose weight or want a healthier lifestyle (Table 1).

FIGURE 1: The Care Integrator platform connects multiple service providers, including nutritionists, around the needs of the consumer.



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Legend: HOSP: Hospital that connects to patients; ADAPTOR: Interface between clinic information system and Careintegrator; PHA: Pharmacy; EHR: Electronic health record; PRO: Health insurers, service providers, pharma companies; DOC: Doctor's office that connects to patients; CIS: Clinic information system; APPLICATION PHARMA: Tailor-made applications for the pharma industry compliant with data protection legislation using anonymized data sets.

FIGURE 2: Paripal’s virtuous cycle of personalized advisory platform for low income groups in India



Note: AADHAAR is a unique identity number given to all Indian residents. Paripal is an integrated platform designed to provide affordable services for low income groups and can be used by hospitals, clinics or NGOs.

Platforms connecting multiple stakeholders such as HCPs (health care providers), nutritionists, hospitals, insurers, operators of electronic health records and other service providers around consumers and/or patients offer possibilities to deploy suitable business models via these platforms. Some of these platforms also address needs of consumers at the base of the income pyramid. Careintegrator⁵ (Figure 1) and Paripal⁶ (Figure 2) are just two of many such examples.

In LMICs, the ratio of out-of-pocket spending to spending by insurers or public programs is relatively high, but this money is spent on basic health services, as these are not sufficiently covered by insurers. Additional discretionary funds are simply not available, and therefore no spending on personalized nutrition is expected. Consumers will probably not themselves create demand for personalized nutrition services. Some of the business models or their variations mentioned in the study may also be suitable for LMICs. It remains to be seen, however, whether other business models will emerge.

Preparing the ground

Other new trends in LMICs, however, may prepare the ground for personalized nutrition and diagnostics concepts.

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“Rwanda is firmly dedicated to seize the chances of the digital revolution”

One trend is the strong intention of some LMICs to jump into the digital future by investing in connectivity and digitalization. Examples are Rwanda and India. President Kagame of Rwanda has started a program to establish a broadband network infrastructure and an industry based around digital services. He sees a great opportunity for Rwanda and for the rest of Africa here, observing: “In Africa we have missed the agricultural and the industrial revolution. Rwanda is firmly dedicated to seize the

chances of the digital revolution.” India likewise is strategically investing in a powerful broadband infrastructure. An Indian IT industry is already established and growing. In the health care sector, too, India is pushing for smart hospitals that embrace the digital future.

These investments in connectivity will trigger many new trends in LMICs. Connectivity is the vehicle that delivers services to areas with a low density of health care infrastructure and health care professionals. It will encourage local entrepreneurs to develop digital services tailored to the needs of the local population. Local companies will develop products and services around prevention and nutrition. This is an opportunity for these countries to create their own industries around digital services.

The quality of these new services will empower informal health care givers (IHCGs) such as non-professionals, family members and volunteers to provide many services that were previously reserved for professional health care givers and were only available at a point-of-care location. People will receive support in their village without needing to travel long distances and will be able to organize health care locally, empowered and supported by remotely accessible services.

Diagnostic technologies are evolving at a tremendous speed. The cost of sensors and of analytical devices that deliver accurate data is shrinking by significant orders of magnitude. Their use will become easy and convenient in the course of time. Diagnostic data can be generated locally and uploaded.

Science around nutrition will become cheaper, and it will become affordable for countries to invest in it locally. It will be easier to establish centers of excellence in LMICs. Scientific work carried out locally will consider local environmental and genetic aspects more effectively. With increased connectivity, just a few centers will be needed to provide services of sufficient scale and quality for any individual country.

Ownership of the point-of-care location will also change. The classical general health care practitioner (GHCP) who takes care of families, knowing their medical history and social environment over many decades, will partly vanish in HICs. For instance, in Europe, GHCPs generally prefer to work in the city nowadays and no longer in the countryside, although the average patient-to-doctor ratio of 200–400:1 is still high. In LMICs, the density of GHCPs is in general lower, particularly in remote areas. In Africa especially, the density is very low, with a patient-to-doctor ratio of 30,000–50,000:1. The trend is that more and more pharmacy chains, retailers and other business-to-consumer players are taking over point-of-care coverage. Informal health care practitioners will also play a bigger role, however. In the Netherlands, the contribution of informal health care providers is recognized, and they are reimbursed for their contribution to the health care system. If they are given access

to sophisticated services, their potential to make a contribution will greatly increase.

Probably the concepts of personalized nutrition will evolve in emerging countries, although consumers there are currently not demanding personalized nutrition. These services will find their place because they are powerful, practical and accessible, and they can be delivered via family members, volunteers and friends in a much more effective way. Being close to the patient or consumer, these people can provide personalized services to them. Personalized nutrition concepts to prevent chronic diseases may well fit into this group.

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New Horizons for the Forgotten Generation

Improving adolescent nutrition in Indonesia

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Key messages

- > Indonesian adolescents have been increasingly confronted with the double burden of malnutrition.
- > This paper examines the nutritional status of adolescent girls and boys in Indonesia, and reviews policy and programmatic actions to address current nutritional challenges facing teenagers.
- > Evidence indicates that adolescent undernutrition is ubiquitous in Indonesia, and there are rising epidemics of overweight and obesity in Indonesian adolescents.
- > Programs and policies targeting adolescent nutrition in Indonesia are at a nascent stage and mostly limited in geographical coverage.
- > It is time to position adolescent nutrition in Indonesia as central to development, and mainstream it into health sector plans, strategies, and policies.
- > Comprehensive evidence-based program guidance on adolescent nutrition is urgently needed to support national and sub-national program scale up processes.

> Both nutrition-specific and nutrition-sensitive interventions need to be combined into integrated, multi-sectoral responses to achieve optimal nutritional status of adolescents by mobilizing the support of various line ministries including education, religious affairs, and social affairs.

> A well-functioning adolescent nutrition program should be inclusive and accommodating, targeting both girls and boys and reaching the most vulnerable groups, and should take into account cultural and gender-specific barriers.

Adolescence has recently attracted increasing attention as a critical life course stage. Worldwide, there are an estimated 1.2 billion adolescents aged 10–19 years, comprising about one-fifth of the total global population, and the majority of adolescents live in low- and middle-income countries.¹ Indonesia alone is home to approximately 45 million adolescents.²

Adolescence is a period of rapid growth and development. About half of adult body weight and 15% of adult height is attained during adolescence, along with changes in body shape and composition.³ Prominent psychosocial and emotional changes occur, and enhanced cognitive and intellectual capacities are achieved during this life stage due to important neuronal development.^{4,5} Various health-related behaviors are developed during adolescence, which affect the present and future health and wellbeing of individuals.⁶

Nevertheless, adolescents have so far been one of the most neglected age groups. The majority of adolescents are living in countries with multiple socioeconomic challenges, exposing this unique age group to various health and social issues such as infectious diseases, poor sexual and reproductive health, injury, violence, and noncommunicable diseases.^{7,8} A large proportion



Adolescent girls in Indonesia

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of teenagers living in low- and middle-income countries are also suffering from poor nutritional status.

“Adolescents have so far been one of the most neglected age groups”

Suboptimal quantity, quality and diversity of diets, inadequate care especially for girls, as well as high rates of infectious diseases due predominantly to an unhealthy environment and poor access to health services, lead to poor nutritional status of adolescents. Compared to other age groups, adolescents have increased requirements for energy and nutrients to support rapid growth and development, which makes them more vulnerable to nutritional deficiencies.⁹ Iron-deficiency anemia affects an estimated 619 million children and adolescents, leading to increased number of years lived with disability among teenagers.¹⁰ Overweight and obesity is on the rise among adolescents, which is associated with multiple immediate and long-term risks, including elevated blood cholesterol, triglyceride, and glucose levels, type 2 diabetes, and high blood pressure.¹¹

Indonesian adolescents have been increasingly confronted with the double burden of malnutrition, characteristically defined by the coexistence of under- and overnutrition, whereas few programmatic and policy actions have been taken to address these challenges.¹² This is worrisome, because adolescent nutrition has important implications for the country's ability to achieve the Sustainable Development Goals and national economic growth and development.¹³ Adolescent girls are the mothers of the future, and their nutritional status has a direct impact on the health and wellbeing of future generations.

In this paper, we aim to examine the nutritional status of adolescent girls and boys in Indonesia, and review policy and programmatic actions to address current nutritional challenges facing teenagers. We propose a set of recommendations for future programming to improve adolescent nutrition in the country.

Nutritional status of adolescents in Indonesia

Evidence indicates that adolescent undernutrition is ubiquitous in Indonesia. The 2013 National Basic Health Research Survey (RISKESDAS) showed that approximately 35% of adolescents aged 13–15 years, and one-third of adolescents aged 16–18 years were stunted (height-for-age z-score <-2) (Table 1), with

TABLE 1: Nutritional status of adolescents in 2013¹⁴

Age Sex	Thinness Prevalence (%)	Stunted	Overweight	Anemia
13–15 years				
Boys	13	38	12	-
Girls	9	32	10	-
16–18 years				
Boys	13	38	7	-
Girls	6	25	8	-
13–15 years				
Boys	-	-	-	12
Girls	-	-	-	23

Thinness is defined as having z-scores less than -2 for Body Mass Index for Age using WHO growth standards.

Stunting is defined as having z-scores less than -2 for height-for-age using WHO growth standards.

Overweight or obese is defined as defined as having z-scores higher than one or two for Body Mass Index for Age using WHO growth standards respectively.

Anemia is defined as having hemoglobin concentration below 130 g/L for boys aged ≥ 15 years and 120 g/L for boys < 15 years and all girls.

the prevalence varying widely by province.¹⁴ Thinness (body-mass index z-score <-2) affected about 11% of adolescents aged 13–15 years, and 9% of adolescents aged 16–18 years.¹⁴ Importantly, more boys than girls were classified as stunted and thin in both age groups.



Limited space for physical activities

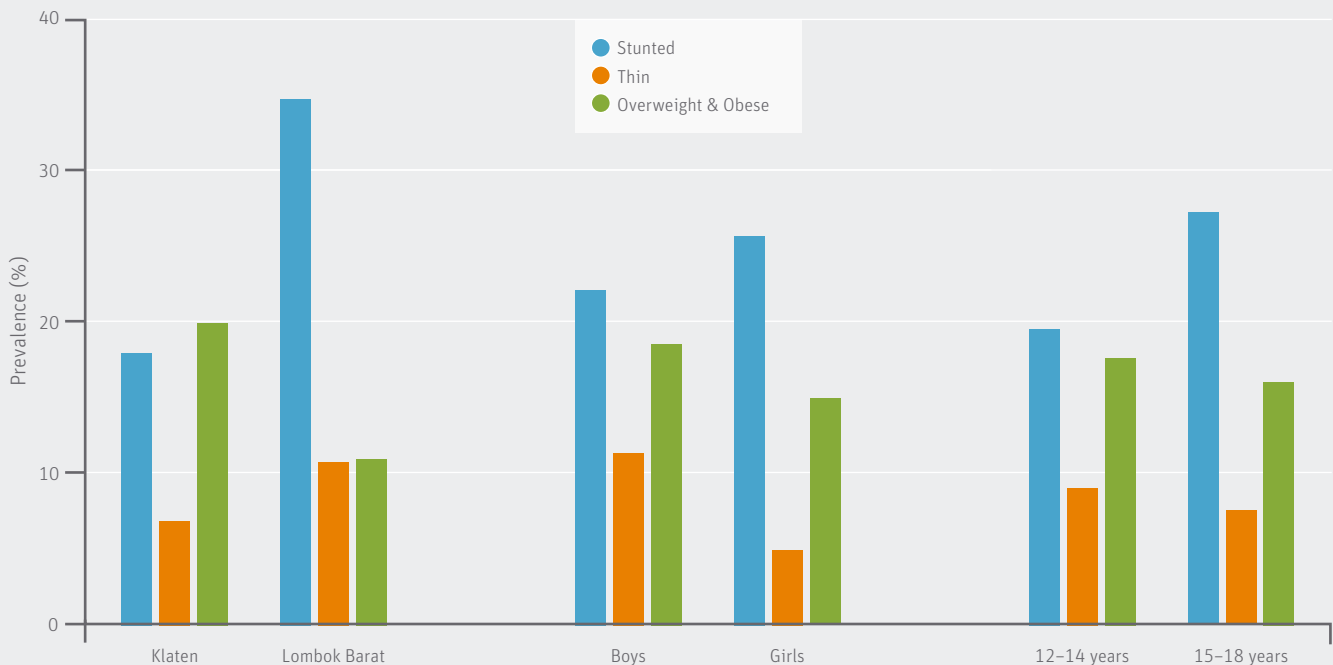
“Evidence indicates that adolescent undernutrition is ubiquitous in Indonesia”

Anemia is highly prevalent among Indonesian adolescents, affecting 23% cent and 12% cent of adolescent girls and boys aged 13–18 years, respectively.¹⁴ Several studies have shown that anemia prevalence among Indonesian teenagers ranged between 22 and 24%, which exceeds the World Health Organization cut-off for a moderate public health problem, defined as anemia prevalence of 20–39.9%.¹⁵

Moreover, the double burden of malnutrition continues to affect a significant proportion of adolescents in the country. Indonesia is rapidly undergoing its nutrition transition, often defined by characteristic changes in diet and physical activity patterns that occur as a result of macro-level changes in economic development, globalization, and urbanization.¹² According to the Global Burden of Disease study, overweight had increased by about 4 percentage points between 1990 and 2013 among Indonesian adolescents.¹⁶ In 2013, about 11% and 7% of adolescents aged 13–15 years and 16–18 years, respectively, were reported to be overweight or obese.¹⁴

The rising epidemics of overweight and obesity in Indonesian adolescents is not surprising considering the rapid changes in dietary and physical activity patterns. National data suggests that the intake of processed and energy-dense foods is rapidly increasing, while only 3% of adolescents aged 15–19 years

FIGURE 1: Prevalence of stunting, thinness (low BMI), and overweight among adolescents in the districts of Klaten and Lombok Barat in 2017



Thinness is defined as having z-scores less than -2 for body-mass index for age using WHO growth standards.

Stunting is defined as having z-scores less than -2 for height using WHO growth standards.

Overweight or obese is defined as defined as having z-scores higher than one or two for body-mass index for age using WHO growth standards respectively.

consume at least five servings of fruits and vegetables a day.¹⁷ Studies have shown that half the adolescents aged 10–14 years and 35% of adolescents aged 15–19 years in Indonesia are determined as sedentary.¹⁸

The recent qualitative inquiry conducted by the Reality Check Approach Plus (RCA+) and UNICEF, in collaboration with the Ministry of Health, reported that Indonesian adolescents often miss meals (i.e. breakfast), and tend to snack and consume take-away and energy-dense foods more frequently than younger-aged children.¹⁹ The rapidly changing contextual environment which influences the eating behaviors and physical activity patterns of adolescents was also highlighted. For instance, nowadays adolescents often make their own decisions regarding food choice and consumption, and as adults work additional hours and jobs due to increased need for cash and household income, teenagers increasingly rely on pre-prepared, energy-dense foods.¹⁹ In addition, improved access to electrical goods gives adolescents increased exposure to western food marketing, and rapid changes in the built environment and motorized transport contribute to reduced physical activity of adolescents.¹⁹

These are of great concern, as the eating and physical activity behaviors acquired during adolescence can track throughout

the life course, and may contribute to nutrition-related chronic diseases in adulthood. Yet adolescent nutrition has received little attention in Indonesia, and the prevalence of adolescent malnutrition has remained stagnant. A recent survey carried out by UNICEF in collaboration with the Ministry of Health in two selected districts in Indonesia, namely Lombok Barat in the Province of Nusa Tenggara Barat and Klaten in the Province of Central Java, found that approximately 24% of adolescents aged 12–18 years were stunted, 8% thin, and 17% overweight or obese (unpublished data) (Figure 1).

This may not be surprising, as the programs and policies targeting adolescent nutrition are at a nascent stage and mostly limited in geographical coverage. Further, more in-depth information on adolescent nutrition is warranted, including data on the national prevalence of biomarkers of important micronutrient deficiencies, subclinical inflammation and worm infestation, and body composition.

Current gaps in policies and programs on adolescent nutrition

Optimizing the nutritional status of Indonesian adolescents will require quality implementation of evidence-based, high-impact nutrition-specific interventions, coupled with large-



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Adolescent Scouts at the national Scouts health camp

scale nutrition-sensitive programs which address the key underlying determinants of poor nutrition, such as poverty, low education attainment and child marriage. However, in Indonesia few nutrition-specific interventions are targeting adolescents at scale, and nutrition is yet to be mainstreamed in most nutrition-sensitive sectors and interventions.

The Ministry of Health has been implementing flagship programs to improve adolescent health, which include the School Health Unit called *Usaha Kesehatan Sekolah [UKS]*, an activity undertaken to improve the health status of school-aged children and adolescents in all types and levels of education.²⁰ The UKS program provides health education and immunization services to schoolchildren and adolescents and has recently started to provide iron-folic acid supplements to adolescent girls. The *Pelayanan Kesehatan Peduli Remaja (PKPR)* program provides reproductive health education to teenagers through community health centers. However, nutrition improvement is still not considered a priority in these programs.²⁰

The majority of adolescent nutrition programs are still being implemented in a pilot mode with limited geographical coverage. The distribution of iron-folic acid supplementation has become a national program, and relevant national program guidelines for adolescents has recently been released.

However, program implementation is mostly at a preliminary stage, being implemented in some districts targeting primarily school-going adolescents, and supplements are not available for all schools.

The Global Alliance for Improved Nutrition (GAIN) recently pilot-tested social media interventions promoting healthy diet among adolescent girls in urban areas, given that young people are the largest population group using mobile phones and their software applications in Indonesia.²¹ More than 80,000 adolescent girls were reached with nutrition content during the three-month pilot phase in 2017, and the messages on sugar and salt consumption were particularly well accepted (personal communication). Based on the successful engagement of adolescents during the pilot phase of the intervention, the use of social media is considered an effective platform to provide nutrition education and has potential for further trial to motivate adolescents to improve their dietary behaviors in Indonesia.

Overall, few policies are targeting adolescent nutrition. A recent landscape review of legislations, policies and programs has identified only one specific policy aiming to improve adolescent nutrition, focusing on the prevention of overweight and obesity in school-aged children (unpublished data). All other policies have limited focus on adolescent nutrition.

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“Social media is an effective platform to provide nutrition education and has potential to motivate adolescents to improve their dietary behaviors”

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Roadmap and recommendations

Evidently it is time to position adolescent nutrition as central to development, and mainstream it into health sector plans, strategies, and policies. Comprehensive evidence-based program guidance on adolescent nutrition is urgently needed to support national and sub-national program scale up processes. Both nutrition-specific and nutrition-sensitive interventions need to be combined into integrated, multi-sectoral responses to achieve optimal nutritional status of adolescents by mobilizing the support of various line ministries including education, religious affairs, and social affairs.

The essential components of successful adolescent nutrition programming are well defined. A well-functioning program should be inclusive and accommodating, targeting both girls and boys and reaching the most vulnerable groups such as adolescents that are out of school, married, pregnant, or already in the workforce. The programs should also offer adolescent-friendly services for free, take into account cultural and gender-specific barriers, and be sustainable. On the other hand, programs that are not institutionalized (i.e., not incorporated into the government fiscal plans or policies, or integrated into other programs) will face serious limitations in their sustainability of implementation at scale and over time.

We also know what works to improve adolescent nutrition. Based on available evidence, the minimum package of interventions for adolescents should include nutrition-specific interventions such as iron-folic acid supplementation coupled with deworming for both school- and non-school-going adolescents, as well as nutrition education. Specifically, the iron-folic acid supplementation should be delivered through school-based platforms and health centers in order to reach both school-going and non-school-going girls and boys. Nutrition education also needs to be provided through diverse delivery mechanisms including school-based platforms, adolescent youth centers, peer education, and technology-based platforms. Importantly, for pregnant and lactating adolescents, continued efforts should be made to improve the coverage and quality of essential nutrition specific interventions such as iron-folic acid supplementation and anti-helminths, as well as monitoring of pregnancy weight gain.

As part of the ongoing efforts to prevent double burden of malnutrition, evidence-based advocacy should continue to target school officials and teachers to promote integration of nutrition and physical education messages into the existing school curriculum and structure. Whenever school meals are provided either in the school canteen or as supplemental meals, specific food and nutrition standards should be applied to all food outlets and meals to improve the availability of healthy foods. Legislation should be strengthened to support improved nutritional quality of available foods and ensure adequate food labeling, as well as to control inappropriate advertising of food aimed at adolescents. In addition, nutrition education needs to be provided to canteen staff, and social and behavior change communication on healthy eating and physical activity be carried out in schools, mass media, and social media.

The minimum package of interventions should also include various nutrition-sensitive interventions such as improving access to reproductive health services aimed at delaying first pregnancy and improving knowledge related to reproductive health. Interventions that are designed to improve school attendance including the initiatives addressing menstruation hygiene management and programs empowering adolescent girls with information, skills and support networks should be included in the minimum intervention package.

Lastly, it is crucial to invest in efforts to improve data on monitoring and evaluation to ensure effective program approaches to improve adolescent nutrition. There is a paucity of rigorous monitoring and evaluation data, particularly for programs that are operating at scale. Having relevant quality data and information on this age group is essential both for tracking progress, and to stimulate investments in Indonesian adolescents in coming decades. In addition, the existing coordination platform on adolescent nutrition should be strengthened to share information on adolescent nutrition activities on a regular basis and ensure harmonized efforts made by various stakeholders.

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“It is crucial to invest in efforts to improve data on monitoring and evaluation to ensure effective program approaches to improve adolescent nutrition”

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Beginning in 2018, the Ministry of Health in collaboration with UNICEF and other partners will develop adequate nutrition-specific and nutrition-sensitive intervention packages and identify the most suitable platforms to reach adolescent girls and boys in Indonesia. Training packages and job aids will be

developed to support program implementation. The designed intervention package will then be tested in selected districts by the local government authorities and other partners. These interventions will also be aligned, integrated, and combined with other interventions and services aimed at improving adolescent health and wellbeing and addressing deleterious cultural norms such as child marriage. Efforts will be made to conduct solid monitoring and evaluation, which will help generate evidence to scale up adolescent nutrition programs nationwide in the coming years.

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Multisectoral Tools to Guide National and District Anemia Programming

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Phil Harvey

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Key messages

- > Anemia is a major global health concern, with negative consequences ranging from poor cognitive development to infant and maternal mortality.
- > Traditionally, iron deficiency has been focused upon as the cause of anemia; however, emerging research suggests that a host of causes exist.
- > USAID's global nutrition project, SPRING, has developed two complementary tools to help countries assess and address their national and local-level anemia situations.
- > These tools have been developed with input from both experts and users to ensure they are accessible, usable, and adaptable for the purposes required.
- > The success of these tools is highly dependent upon their adoption by relevant national bodies and is likely to be most effective when introduced at opportune times.

Facilitating country-led anemia efforts by filling the guidance gap

Anemia is a highly prevalent public health problem that results in a range of negative consequences, from poor cognitive and

motor development to maternal and newborn mortality.¹ It is characterized by low levels of hemoglobin in the blood and is caused by multiple factors including micronutrient deficiencies, infections, inflammation, and genetic disorders.¹ Globally, progress to reduce anemia has been slow.²

Recently, efforts to improve nutrition have moved from a focus on individual micronutrient deficiencies to being a part of a larger multisectoral framework.^{3,4} In the case of anemia, this change has been especially important. Anemia programming has predominately centered on interventions to reduce iron deficiency, but evidence now suggests that iron deficiency contributes less to anemia than previously estimated.⁵ Although iron deficiency remains an important cause, strategies need to be broadened to address all causes of anemia (e.g., malaria, hookworm, thalassemia, etc.) and better coordinated across sectors.

Country-led anemia efforts are essential to effect change, as underlined in the Paris Declaration (2005) and the Accra Agenda for Action (2008). Strategy formulation at the national level is often the first step to anemia reduction. District implementers then need to translate policy into action, especially



A Uganda Ministry of Health representative speaks at a National Anemia Working Group meeting



Workshop participants in Ghana work together on DATA

as governments move toward decentralized systems. However, this process is often less effective when using a top-down approach: thus a strong feedback loop between national and district level planning is encouraged. Given the complexity of anemia, tools to help make use of data to plan, design and implement anemia reduction efforts at all levels of decision-making are needed.

The United States Agency for International Development's (USAID) global multisectoral nutrition project, Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING), has developed two separate but complementary tools designed to facilitate a data-driven and multisectoral approach

to reduce anemia. The *Guidance for Conducting a Landscape Analysis for Anemia* ("Anemia Guidance") provides a how-to guide for understanding the national anemia situation,⁶ and the *District Assessment Tool for Anemia (DATA)* helps district officials prioritize actions to reduce anemia.⁷ This article covers the objective, design, and application of these two tools.

“The level of understanding of what causes anemia and how multifactorial it is has improved enormously”

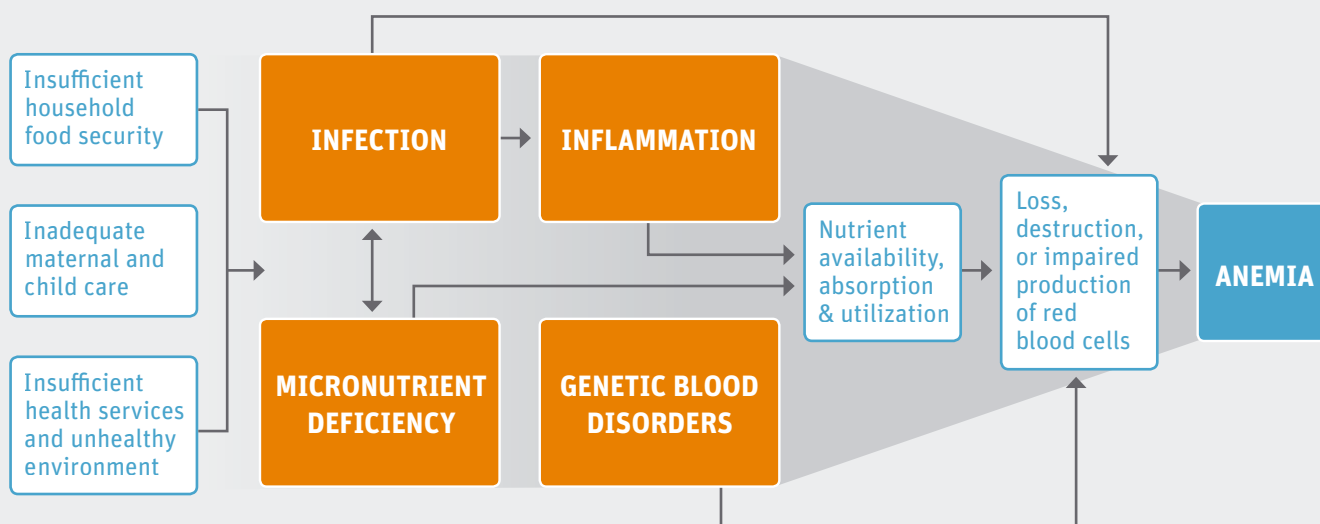
National Anemia Working Group Member

Guidance for conducting a landscape analysis for anemia

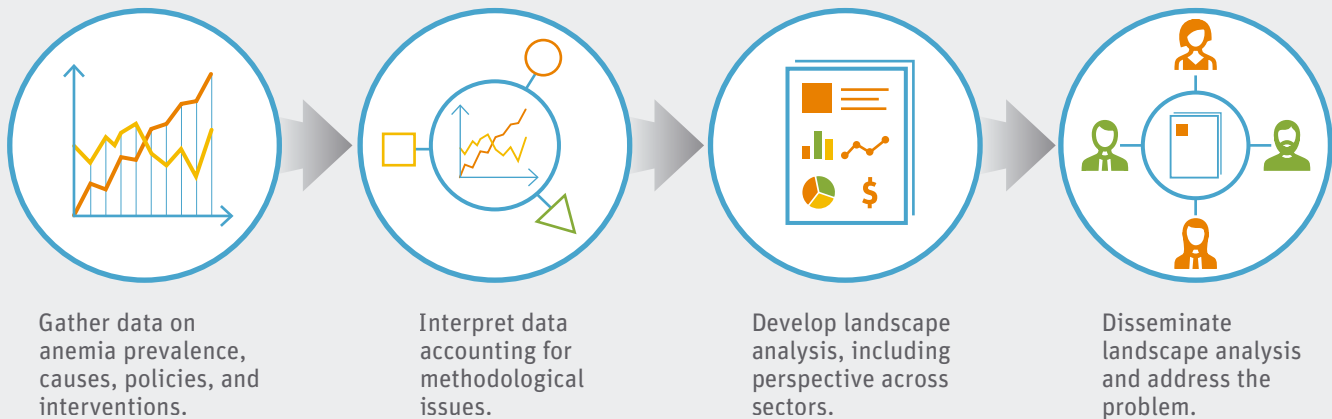
Objective and design

The *Anemia Guidance* was developed to help countries assess the national anemia situation and inform strategy development. The guidance is directed at technical experts within the government or supporting implementing agencies that are planning to conduct a landscape analysis. The guidance is based on an anemia causal pathway (Figure 1), and uses a structured process (Figure 2) to help users capture information on the underlying and direct causes of anemia, and prioritize policies and interventions accordingly. The guide is accompanied by an Excel-based tool and user's guide to synthesize data and automate analyses. In addition, the guide links to examples of landscape analyses

FIGURE 1: Anemia causal pathway



Adapted from the Biomarkers Reflecting Inflammation and Nutritional Deficiencies (BRINDA) Project.

FIGURE 2: The landscape analysis process

conducted in several countries. The *Anemia Guidance* has incorporated input from 38 subject-matter experts to ensure its relevance and accuracy.

Application and lessons learned

The *Anemia Guidance* is based on SPRING's experience supporting the generation of anemia landscape analyses in Uganda, Ghana, and Sierra Leone (Table 1). Although the tool has yet to be applied, Sierra Leone provides an illustrative case study. At the request of the Government of Sierra Leone, SPRING gathered data from two Demographic Health Surveys, a National Micronutrient Survey, and published and grey literature obtained from a systematic review. On-the-ground partners also provided national policies and guidelines. Interpretation of the data showed that, despite a high prevalence of anemia, iron deficiency did not account for much of the anemia burden, even after accounting for methodological issues with measuring iron status. Rather, infections were identified as a main driver of anemia. A Landscape Analysis summarized these findings, which included substantial input and review from in-country partners across sectors. The Landscape Analysis was disseminated in conjunction with the release of the National Micronutrient Survey, which led to the formation of a National Anemia Working Group. Guided by an understanding of the context-specific causes of anemia, policies, and interventions, the National Anemia Working Group developed a strategy that tailors interventions to the causes of anemia.

District Assessment Tool for Anemia (DATA)

Objective and design

The District Assessment Tool for Anemia (DATA) was developed to allow multisectoral actors at the district level to use local data to assess the anemia problem, coverage of relevant inter-

ventions, and barriers to implementation (Figure 3). The DATA package, which includes an Excel-based tool, users', facilitators', and training-of-trainers' guides, is designed for use during a two-day workshop with district-level programmers. Workshop participants enter information on local anemia risk factors and interventions, generating a dashboard to guide programming.

DATA uses standardized and broadly applicable indicators, with an option to customize indicators or use qualitative responses in the absence of quantitative data. DATA was developed with input from an advisory board of experts who emphasized making the tool accessible, usable, and adaptable.

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“Many people think that anemia is basically a health care problem, but through DATA we realize that very many sectors must be involved”

District Health Officer

Application and lessons learned

DATA was initially tested in Ghana and documented through observations and participant evaluations. This led to further modifications to the tool (Table 2). Subsequently, DATA was implemented in Ghana, Nepal, and Uganda during two-day workshops in each country. These experiences were documented using similar techniques to the testing phase, except in Uganda, which added one-on-one interviews with workshop participants.

SPRING found that early and high-level government endorsement of DATA was essential for its uptake, as was the tool's alignment with country priorities. Ghana's interest to im-

TABLE 1: Guiding principles identified from conducting anemia landscape analyses in several countries

Lesson	Resulting feature
Anemia is caused by many factors that require expertise across fields, but there is limited guidance on how to synthesize and interpret the causes of anemia, and on appropriate interventions to address these causes.	The guidance provides information on how risk factors and associated interventions are linked to anemia, how to find relevant data, and the issues one should understand in order to use the data properly.
Demographic Health Surveys often have the most information available on the anemia situation but do not include information on the prevalence of many of the risk factors for anemia. In addition, assessment of institutional capacity and barriers to program implementation are often overlooked.	The guidance highlights the importance of using a range of data sources. Instructions are provided on reviewing and interpreting available survey data and conducting systematic literature searches and key informant interviews.
The process of conducting a landscape analysis was as important as the outcome. It provided an opportunity to engage multisectoral stakeholders, raise awareness, and catalyze the establishment of coordination bodies to develop anemia strategies.	The guidance highlights the role that anemia landscape analysis plays in building an enabling environment. The guidance highlights participation by multiple stakeholders to ensure inclusion of relevant data and to generate consensus.

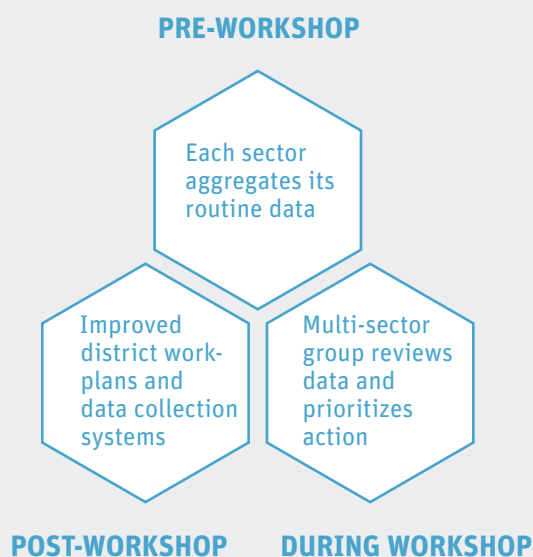
prove anemia training for health workers at the local level gave impetus to test and roll out DATA in districts; in Uganda, National Anemia Working Group members highlighted the need for district engagement; and in Nepal, the tool was adopted within the context of the country’s Multi-Sectoral Nutrition Plan, which emphasized decentralization to the district level and a cross-sector approach.

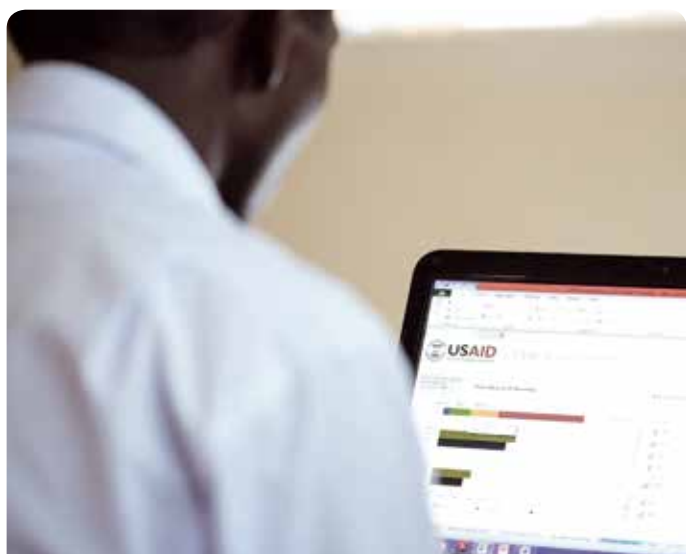
Multisector participation in the workshop was crucial. In Ghana, for instance, agriculture sector representatives developed a plan to remove non-essential standing water from farming sites, thereby reducing breeding grounds for mosquitos.

Another example is in Uganda, where the health and education sectors worked together to improve the delivery of deworming interventions in schools. Equally valuable was the participation by national policy-makers, local planners, frontline workers, and implementing partners. In Uganda, for example, National Anemia Working Group members helped facilitate workshops, which revealed and resolved gaps in communication (e.g., on supply chain management) between the national and district levels. Furthermore, at least based on current experiences, the role of implementing partners such as non-governmental organizations was a valuable addition to the implementation of DATA, providing much-needed time and resources to support government officials in conducting workshops and follow-up visits.

In workshop evaluations and interviews, participants noted a number of benefits, as well as challenges, of using DATA. The availability and reliability of quantitative data was raised as an obstacle. DATA allows participants to apply their local knowledge to answer questions qualitatively, but participants expressed reluctance to use this method, especially for monitoring the progress of anemia-related program coverage. As the workshop and tool emphasize the importance of using routine data in decision-making, participants were more motivated to improve monitoring systems, and agreed to use qualitative information to make decisions in the interim. Funding was mentioned as an ever-present barrier, which sparked interesting discussions on ways to involve donors and advocate for cross-sector resources. Both intra- and inter-sector collaboration were found to be crucial to the process. In all three countries, individual sectors prioritized sector-specific actions, because resource allocation and implementation were conducted within – not across – sectors. At the same time, cross-sector exchanges provided opportunities for integration.

FIGURE 2: The DATA process





Workshop participant in Soroti, Uganda, reviews DATA dashboard

“The tools presented here can be used to identify the causes of anemia, build and strengthen partnerships across sectors, and improve program design”

Conclusions

The tools presented in this article can be used by governments to identify the causes of anemia, build and strengthen partnerships across sectors, and set priorities to improve program design at the national and district levels. The tools are designed to complement each other – *Anemia Guidance* directing national decisions would be reflected in local-level planning with DATA.

Use of these tools will likely be most effective when introduced at opportune times in the planning process, such as conducting a national landscape analysis following the release of survey data, or holding a DATA workshop as part of a district’s annual work planning. It is critical that these tools be used within, not parallel to, established planning processes.

The tools allow users to make data-driven decisions by emphasizing the use of available data, however scarce, while advocating for improving information systems. The resources required to collect comprehensive data, which ultimately result in higher-quality outputs from these tools, are expensive. Nonetheless, these costs need to be weighed against the cost of developing ineffective policies or poorly designed programs.

As new tools, ongoing review of their value for informing anemia programming and potential for scale-up and sustainability continue to be important. SPRING encourages countries to use a participatory approach, with representatives from, and outside, the health sector and stakeholders including funders, implementing partners, research universities, and the private sector, to adopt these tools.

Join the Accelerated Reduction Efforts of Anemia community of practice, a group of stakeholders from more than 65 countries who exchange ideas on ways to improve and scale up anemia-reduction efforts:
knowledge-gateway.org/area/join

Acknowledgements

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TABLE 2: Observations during testing that informed DATA modifications

Observation	Modification
Completion of the questionnaire as a multisectoral group was time-intensive.	Questionnaire reduced by 62% and relevant sections now completed separately by sectoral groups.
Indicators included in the tool did not always align with district indicators.	An Indicators tab was added to allow users to customize indicator definitions.
Brainstorming of barriers resulted in duplicative categories that required consolidation.	A built-in barriers section on commodities, funding, capacity, and demand was added to streamline the discussion.
Breakout groups with representatives from each sector were asked to develop an action plan for one sector. This resulted in often unrealistic and vastly different plans across groups.	Established parameters to guide the prioritization exercise. Individual sectors developed action plans and shared with multisectoral group for input and revisions.



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Asha Basnyat, Deputy Country Director of HKI, speaks at a training session

Davis, Mary Hodges, Rolf Klemm, Madhukar Shrestha (Helen Keller International); and Toby Stillman (Save the Children).

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The Belly of Paris: Hunger in the face of plenty

Jonathan Steffen

Jonathan Steffen Limited, Cambridge, UK

This issue of *Sight and Life* carries on page 159 a review of the report on Nutrition and Food Systems published in September 2017 by the High Level Panel of Experts (HLPE) on Food Security and Nutrition of the Committee on World Food Security (CFS) of the United Nations Food and Agriculture Organization (FAO).

The Foreword, written by Patrick Caron, Chairperson of the Steering Committee of the HLPE, observes that: “malnutrition in all its forms ... now affects all countries, whether low-, middle- or high-income. Those different forms of malnutrition can co-exist within the same country or community, and sometimes within the same household or individual, and can even paradoxically be linked: they thus must be fought altogether. As a consequence, hunger and malnutrition will not be “self-corrected” only by economic growth, as many people thought in the past: nor will these concerns be spontaneously addressed. On the contrary, nutrition must be integrated as an explicit objective in national policies, programmes and budgets, not only in low-income but also in high-income countries. Cross-sectoral nutrition strategies should be designed and implemented at different levels, from global to local.”

The phenomenon whereby hunger and malnutrition fail to “self-correct” despite dramatic economic growth and the abundant presence of food is meticulously dissected by the 19th-century French novelist Émile Zola in his 1873 novel *Le Ventre de Paris* (The Belly of Paris), which revolves around Les Halles, Paris’s central market.

“The belly of humanity”

Dating from at least the Middle Ages, Les Halles was dramatically modernised in the 1850s. Redesigned by the architect Victor Baltard as a series of massive buildings made of glass and iron, it became a symbol of modernity and of the Second Empire of Napoleon III, which ran from 1852 to 1870. It was literally known as “the belly of Paris.” As Zola wrote in his preliminary notes for the novel, “The general idea is: the belly, the belly of Paris, Les Halles, where food floods in and piles up before flowing out to the various neighbourhoods; – the belly of humanity, and by extension the belly of the bourgeoisie ... People gorging themselves and growing fat is the philosophical and historical side of my novel. The artistic side is the modernity of Les Halles, the gigantic still lifes of the eight pavilions, the avalanches of food to be seen every morning in the center of Paris.”¹

The main protagonist of *The Belly of Paris* is the young Parisian Florent Quenu, an intellectual who has been mistakenly arrested during a failed coup in 1851 and sentenced to five years’ hard labor on Devil’s Island (*Île du Diable*), the notorious French penal colony of Cayenne in French Guiana, which opened in 1852. Escaping Devil’s Island after a long spell in prison there, he makes his way back to Paris by a lengthy and circuitous route but collapses from hunger and exhaustion just a few miles from the city’s outskirts.

It is at this moment that the novel starts. The front driver of a train of horse-drawn carts carrying vegetables into Les Halles from the market gardens around Paris almost runs over the body of the unconscious Florent by mistake in the dark. She takes pity on him and gives him a lift back to the center of his native town. Ironically, the famished Florent completes the final stage of his journey home on a heap of food that he cannot consume:

“Now here he was, lying at ease on a bed of greenery which felt as soft as a feather bed. He raised his head a little to see the luminous haze rising above the dark roofs that could



Émile Zola (1840–1902) early in his career



A photograph of Les Halles in its heyday

© T. Drouot

just be made out on the horizon. He was nearing his goal, he was being carried along towards it, and had nothing to do but abandon himself to the movement of the cart; and this effortless advance left him with only his gnawing hunger to contend with. It gripped him once more, causing him terrible, almost unbearable pain. Now that his limbs had fallen asleep, he could feel only his stomach, racked and twisted as by a red-hot poker. The fresh smells of the vegetables around him, especially the carrots, affected him so much that he almost fainted. He pressed as hard as he could against this deep bed of food in order to tighten his stomach and silence its groans. The nine carts behind him, with their mountains of cabbages and peas, their piles of artichokes, lettuces, celery and leeks, seemed to be rolling over him as if to bury him beneath an avalanche of food. There was a halt, the sound of loud voices. They had reached the barrier and the customs officials were looking into the carts. Then Florent entered Paris on a heap of carrots, his teeth clenched and in a dead faint.”²

.....
“Florent entered Paris on a heap of carrots, his teeth clenched and in a dead faint”

A hallucinatory cornucopia

Florent is taken straight to Les Halles by the carter, who needs to sell her produce there. His return to his home town – transformed unrecognisably by the ambitious building projects of the

Second Empire – is a nightmare experience. The food itself – so varied, so vivid, and arrayed in such prodigious quantities – is beautiful, but overwhelming for a man who is almost starving to death:

“By degrees, as the fires of dawn rose higher and higher at the far end of the Rue Rambuteau, the mass of vegetables grew brighter and brighter, emerging more and more clearly from the bluish shadows on the ground. Lettuces, endives, chicory, open and rich soil still clinging to their roots, exposed their swelling hearts; bunches of spinach, sorrel, and artichokes, piles of peas and beans, mounds of cos lettuces, tied up with straw, sounded every note in the scale of greens, from the lacquered green of the pods to the coarse green of the leaves; a continuous scale of rising and falling notes that died away in the mixed tones of the tufts of celery and the bundles of leeks. But the highest notes, at the very top of the scale, came from the bright carrots and snowy turnips, scattered in tremendous quantities throughout the markets, which they lit up with their medley of colours.”³

With immense difficulty, Florent – who has no money for food – steals a carrot that has fallen to the ground, only to find that his stomach can barely digest it. Eventually he has to flee this hallucinatory cornucopia, still famished:

“He had but one thought and desire, which was to get away from Les Halles. He would wait, and later, when the footprints were clear he would look again. The three streets that converged here – the Rue Montmartre, the Rue Montorgueil

and the Rue Turbigo – filled him with uneasiness. They were cluttered with traffic of every kind, and vegetables littered the footpaths. Florent walked straight ahead as far as the Rue Pierre-Lescot, but the cress and potato markets seemed impassable. So he turned into the Rue Rambuteau. But in the Boulevard de Sébastopol he was confronted with such a bottleneck of furniture wagons, handcarts, and traps that he turned back and proceeded along the Rue Saint-Denis. He found himself once more among the vegetables. On either side the stallholders had just set themselves up, their wooden planks placed across tall baskets; and the deluge of cabbages, carrots and turnips began all over again. The markets were overflowing. He tried to fight his way out of the current that had swept him from the line of his escape; he tried the Rue de la Cossonnerie, the Rue Berger, the Square des Innocents, the Rue de la Ferronnerie, and the Rue des Halles. Then he stopped, discouraged, frightened, unable to escape from the infernal merry-go-round of vegetables that seemed to be swirling round him, slowly entwining his legs with their greenery. The endless stream of horses and carts stretched as far as the Rue de Rivoli and the Place de l'Hôtel de Ville; huge wagons were carrying away supplies for all the greengrocers of an entire district; traps, their sides creaking, were setting off for the suburbs. In the Rue du Pont-Neuf he got completely lost. He stumbled upon a mass of handcarts, in which greengrocers were arranging their mobile displays of purchases. Among them he recognized Lacaille, who took off along the Rue Saint-Honoré, pushing a barrow of carrots and cauliflowers. Florent followed him, in the hope that he would guide him out of the mob. The footpath was now quite slippery, although the weather was fine; the litter of artichoke stalks, turnip tops, and leaves of all kinds made walking dangerous. He stumbled at every step. In the Rue Vauvilliers he lost sight of Lacaille. Near the corn market he again found the streets blocked with carts and wagons. This time he made no attempt to struggle; he was once more engulfed by Les Halles, the tide swept him back.”

What Zola does here with vegetables, he does elsewhere in the novel with fruit, meat, charcuterie, fish, and cheese; there is in fact a very famous passage which has come to be known as ‘the Cheese Symphony’ for its exuberant evocation of the pungent splendours of French cheese.

The battle between the Fat and the Thin

The starving Florent Quenu eventually reconnects with his half-brother and sister-in-law, who run a very successful butcher’s shop in Paris. Through their agency, he recovers his health, puts on a little weight, and eventually – going by an assumed name, for he is an escaped convict who has returned illegally to his

native country – obtains a job as the fish inspector of the market. The irony is supreme: The socialist-leaning Florent becomes an agent of the establishment, keeping order among the stall-owners who despise him for everything he represents – his sincerity, his work ethic, and, not least, his thinness. For – and this is a major difference between Zola’s day and ours – *The Belly of Paris* chronicles the battle between the ‘Fat’, successful, well-fed bourgeoisie who support Napoleon III and the ‘Thin’, discontented outsiders who cannot belong to this new world of industrially organized plenty. “‘Cain,’ remarks one of the novel’s characters, ‘was a Fat man and Abel a Thin one. Ever since that first murder, the big eaters have sucked the lifeblood out of the small eaters. The strong constantly prey on the weak; each one swallows up his neighbour and gets swallowed up in turn.’”⁴ Zola was writing long before the dietary transition of our times, which has triggered an epidemic of obesity among sections of society who subsist on a high-energy, low-cost western diet packed with fat, sugar and highly processed carbohydrates.

.....
 “The giant markets, overflowing with food, had brought things to a head. They seemed like some satiated beast, grown enormously fat, embodying Paris itself”



The market of Les Halles was demolished in 1971 and replaced by a modern shopping mall called the Forum des Halles. This picture shows a section of the Forum des Halles in recent times, with the Church of Saint Eustache in the background. The shopping mall underwent major reconstruction recently and was reopened in 2016.

Approach and conceptual framework from the CFS 2017 report on Nutrition and Food Systems

1. A **food system** gathers all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the outputs of these activities, including socioeconomic and environmental outcomes. This report pays specific attention to nutrition and health outcomes of food systems. It identifies three constituent elements of food systems, as entry and exit points for nutrition: food supply chains; food environments; and consumer behavior.
2. The **food supply chain** encompasses all activities that move food from production to consumption, including production, storage, distribution, processing, packaging, retailing and marketing. The decisions made by the many actors at any stage of this chain have implications for other stages. They influence the types of food available and accessible, as well as the way they are produced and consumed.
3. The **food environment** refers to the physical, economic, political and socio-cultural context in which consumers engage with the food system to acquire, prepare and consume food. The food environment consists of: “food entry points”, i.e. the physical spaces where food is obtained; the built environment that allows consumers to access these spaces; personal determinants of food choices (including income, education, values, skills, etc.); and the political, social and cultural norms that underlie these interactions. The key elements of the food environment that influence food choices, food acceptability and diets are: physical and economic access to food (proximity and affordability); food promotion, advertising and information; and food quality and safety.
4. **Consumer behavior** reflects the choices made by consumers, at household or individual levels, on what food to acquire, store, prepare and eat, and on the allocation of food within the household (including gender repartition, feeding of children). Consumer behavior is influenced by personal preferences determined by taste, convenience, culture and other factors. However, consumer behavior is also shaped by the existing food environment. Collective changes in consumer behavior can open pathways to more sustainable food systems that enhance food security and nutrition (FSN) and health.

Florent eventually gives up his loathed job as a fish inspector and falls in with a set of revolutionaries who are plotting a socialist coup: “The giant markets, overflowing with food, had brought things to a head. They seemed like some satiated beast, embodying Paris itself, grown enormously fat, and silently supporting the Empire ... Les Halles were the shopkeepers’ belly, the belly of respectable petit bourgeois people, bursting with contentment and wellbeing, shining in the sun, and declaring that everything was for the best, since respectable people had never before grown so wonderfully fat.”

From hunger to insurrection

Florent is by now a very different man from the innocent schoolmaster who got caught up in the protests of 1851 and was unjustly arrested and deported for suspected complicity. He is now a political visionary, a man who wants to assuage his hunger for justice through violent action. Florent and his fantasists fail in their attempt to overturn the Second Empire, and Florent is arrested and deported once more: his life comes full circle again as he is condemned to return to Devil’s Island, having achieved nothing during his brief and unhappy return to Paris.

Reverting to the CFS’s report on Nutrition and Food Systems, we can see that Zola describes in *The Belly of Paris* the core elements outlined in the FAO’s conceptual framework: the food system, the food supply chain, the food environment and consumer behavior (see **Box**). Our current concerns with obesity are not reflected in Zola’s world, which still viewed fat as a sign of wealth and concomitant health; nor is the global world view of the CFS reflected in *The Belly of Paris*, which focuses squarely on the contemporary French society of Zola’s age and, like most of his novels, the society of Paris. But despite the differences between these two pieces of writing, appearing almost 150 years apart from one another, they agree – the first implicitly, the second explicitly – on the right to food:

“Every human being has the right to adequate food. However, the progressive realization of this right will not be achieved without more sustainable food systems that facilitate healthy and sustainable food choices and ensure FSN (food security and nutrition) for all, including vulnerable people with specific nutrient requirements (such as young children, adolescent girls, pregnant and lactating women, the elderly and ill people), or marginalized people with less control over their diets (such as the poor, as well as some indigenous peoples).”⁶

The Belly of Paris demonstrates poignantly how a highly organized society can create sophisticated food systems that fail to meet the needs of society as a whole and consequently breed suffering and alienation. Florent and his little group of dreamers fail in their fictional coup attempt in 1873; but Lenin and his Bolsheviks were to succeed spectacularly in Imperial



A fruit stand in Paris, 2015

Russia just half a century later, in 1917. In a world shaped by ever-sharpening conflicts over the world's natural resources, Zola's vision of hunger in the face of plenty still has much to teach us.

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02. *Ibid.* pp 6–7.
03. *Ibid.* p. 25.
04. *Ibid.* p. 191. The speaker is the painter Claude Lantier, who was modeled on Zola's friend Paul Cézanne and also features as the main protagonist in Zola's 1886 novel *L'Oeuvre* (The Masterpiece).
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06. FAO, *Nutrition and Food Systems: A report by the High Level Panel of Experts on Food Security and Nutrition*, Rome, September 2017, p. 9.

A Day in the Life of Rajan Sankar

Program Director for Nutrition, Tata Trusts



Dr R Sankar, Nutrition Symposium, Delhi

Sight and Life (SAL): Dr Sankar, you are Program Director for Nutrition, Tata Trusts. What are your key responsibilities in this role?

Rajan Sankar (RS): My role involves providing technical and operational guidance to the Trusts within the framework of the organization's nutrition portfolio. I direct a small team that is responsible for converting nutrition strategy into action, making use of the learnings provided by other, larger programs.

Spread over 17 states and 172 districts in India, Tata Trusts are focused on seven strategic work areas: health; water; education; urban poverty alleviation; rural upliftment; energy; and arts, crafts & culture. Programs supported by the Trusts reach out to millions of households through an efficient network of more than 450 partner organizations.

Mr Ratan N Tata, Chairman of the Tata Trusts, has made nutrition a priority for our organization. India has enjoyed strong economic growth in recent times, and has produced many great intellectual, scientific and technical achievements. This progress has not been reflected in the nutritional status of the population as a whole, however. Malnourishment still exists on a wide scale, affecting woman and children in particular. It is too early to report concrete results, but we are forging important partnerships in the fight against malnutrition, especially with governmental agencies, and the early signs of progress are promising.

“We are forging important partnerships in the fight against malnutrition, and the early signs of progress are promising”

SAL: Could you tell us something about the history of Tata Trusts, and about the organization's current focus?

RS: Tata Trusts is one of India's oldest philanthropic organizations, with a history of over 125 years of service to humanity.

Its origins date back to the illustrious Jamsetji Nusserwanji Tata, an Indian industrialist and philanthropist who made his fortune in cotton and in 1879 set up Empress Mills in what was then called Bombay (Mumbai today). Empress Mills set very high standards in worker benefits and welfare at a time when humanitarian concern for workers was unheard of, even in the west.

In 1912, Tata Steel became the first company to introduce pioneering labor welfare policies such as free medical aid; the formation of a Works Committee for handling complaints concerning service conditions and grievances; paid leave; a



During a field survey in Sikkim

worker's provident fund scheme; and a workmen's accident compensation scheme. In 1919 – the year after the death of Sir Ratan Tata – the Sir Ratan Tata Trust was set up, in accordance with his will.

Jamsetji Tata founded the Tata group, which comprises marquee global enterprises such as Tata Steel, Tata Motors (including Jaguar Land Rover), and Tata Consultancy Services. Tata Trusts holds 66% of the equity of Tata Sons, the principal investment holding company of the group. Tata Trusts' returns from this holding are entirely devoted to philanthropy. As the fourth Chairman of the Tata group, JRD Tata, memorably said, "What came from the people has gone back to the people many times over."

Our Chairman, Mr Ratan N Tata, who led the Tata group from 1991 to 2012, believes that to augment the impact of our work, we must pursue important causes that are good for India as a whole.

.....

“A large share of the profits made by Tata is ploughed back into society via philanthropic initiatives”

.....

SAL: *Prior to joining Tata Trusts, you worked for GAIN, UNICEF, the Micronutrient Initiative (MI), and the Indian Army Medical Corps. Could you tell us how your career evolved?*

.....

RS: I am a medical doctor by training. I joined the Indian Army Medical Corps in 1976, working initially in a big tertiary hospital in Mumbai. After some time in this position, I was posted to Sikkim, a state in north-east India, as a medical expert. I found myself working in a tiny hospital in an impoverished region, with little but a stethoscope by way of medical equipment.



Dr Sankar (dark suit, center) with Board Members of GAIN in Andhra Pradesh, India



Launch of a fortified wheat flour program in Rajasthan, India. Marc Van Ameringen (right), formerly Executive Director of GAIN, and Dr Gupta, Director of the Institute of Health Management Research, Rajasthan (left).

I noticed signs of iodine deficiency in the local population, whose local diet was lacking in naturally occurring sources of iodine (Sikkim is landlocked, and the nearest source of salt is 2,000 km away). This lack of iodine in the diet manifested itself in terms of goiter and neurological deficiencies. Having taken specialist advice in the matter, I conducted a 9-month epidemiological survey of the local population, which ascertained that 56% had goiter, with a cretinism rate of 5%, as well as other physical symptoms, such as deafness and muteness. The link between iodine deficiency and the health status of the population had not been understood before, but this research made it clear.

When the results were published, the authorities were very supportive. The army extended my tenure by two years, and the

government established a thyroid research center for Sikkim, along with a salt iodization program. In the ensuing decade, this deficiency was eliminated in the local population.

I then moved on to different fields – first radiation biology, and then clinical thyroidology – and eventually left the army, initially to do a six-month course in nutrition policy at Tufts University in Medford, MA, USA and then to a role with Canada's Micronutrient Initiative, where I held the position of Senior Technical Adviser South Asia. This involved further work in the field of micronutrition, with a focus especially on anemia and vitamin A deficiency, and I became responsible for a number of food fortification programs in Nepal and India.

I moved on to UNICEF for a year, and was then offered a position with GAIN (the Global Alliance for Improved Nutrition), which was under the directorship of Marc Van Ameringen at the time. As the Regional Representative for South Asia, I established offices in India and Bangladesh, but I also worked in Pakistan, Afghanistan and China, focusing on the fortification of staple foods including edible oil, milk and wheat flour – 40 products across 22 countries, in fact. This was a very rich and rewarding experience for me. On reaching retirement age, I wanted to return to clinical practice. An opportunity presented itself at Tata Trusts, which before too long developed into my current full-time role. I feel very privileged to have this position – and I still do some clinical work in the field of thyroidology.

The fight against iodine deficiency has always been important to me, and I am now focusing on children who are born without a thyroid gland (congenital hypothyroidism). Less than



In an Anganwadi Center (community center) in Rajasthan

10% of babies with this condition are detected in the first month after birth, and less than 35% in the first three months. Every day counts, however! And so I'm now involved setting up a network to encourage screening for signs of iodine deficiency by hospitals and mothers across India.

SAL: *As an Indian concerned with the wellbeing of some of the less advantaged sections of society, what is your view of the concept of the “Base of the Pyramid” as formulated by C K Prahalad in 2004?*

RS: Big business today is very successful at reaching the higher echelons of society, but is still failing to meet the needs of the people who live at the base of the economic pyramid. Although they are individually poor, however, these sections of society have considerable collective purchasing power. I think that businesses should pay more attention to the Base of the Pyramid, and look on opportunities to meet these people's needs as a win/win situation.

Companies can only be really successful if society as a whole is healthy, and much more could and should be done in this area. We've come a long way in the past ten years, with growing urbanization and more and more women in the workforce, and the private sector plays an increasingly important part in our lives. It is markets that must help to solve the problem of malnutrition – markets that deliver affordable food with improved nutritional content for the poorest and more vulnerable sections of society.

“It is markets that must help to solve the problem of malnutrition”

SAL: *Could you tell us something about your working day? Do you have such a thing as a “normal” working day? And what are the things that you most enjoy about your work today?*

RS: I usually have an idea of how my day should go, but it rarely works out according to plan! There is so much to do on so many fronts. I'm fortunate in being able to work with many well informed young people who are passionate about what they do, and I also very much enjoy the travel that my work entails, which always offers new ideas and insights. My shift from pure clinical practice into public health gives me the chance to touch the lives of millions. I sometimes feel that I should be volunteering for the work I do, rather than getting paid for it!

SAL: *Many thanks, Dr Sankar, and good luck with all your new ventures.*

RS: Thank you.

Dr Rajan Sankar was interviewed by Jonathan Steffen



At the Micronutrient Forum 2016 – Elevator Pitch Contest Participants and Jury

The 18th International Symposium on Carotenoids

Lucerne, Switzerland, July 9–14, 2017

George Britton

Formerly of The University of Liverpool, School of Biological Sciences, United Kingdom

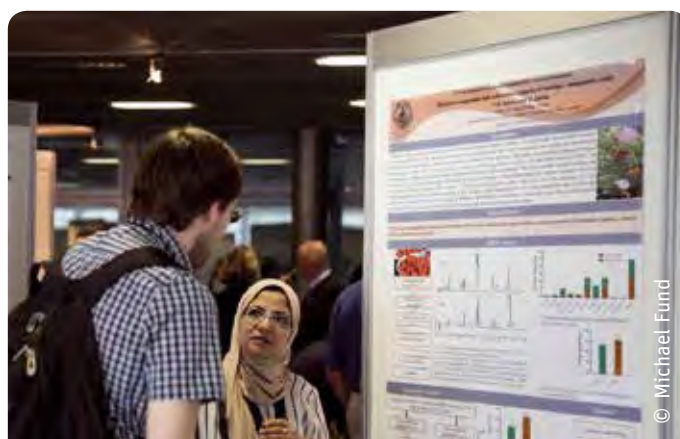


Lucerne was a fitting and popular location for the 18th International Symposium on Carotenoids, held in the impressive Lucerne Convention Center (KKL), adjacent to the main railway and local bus stations, and just a short walk away from the hotels, restaurants and other attractions offered by this historic city. The Center is ideally situated on the shore of Lake Lucerne, with attractive views across the lake to the backdrop of mountains which, sadly, during the week were frequently illuminated by rainbows and flashes of lightning.

This was the second time the Symposium had been held in Switzerland; the 4th Symposium in 1975 was held in the country's capital, Bern. Hanspeter Pfander, who served as secretary for that earlier meeting, was Chairman of the Scientific Committee for Lucerne, overseeing the massive efforts of the Symposium Chairman and Organizer Manfred Eggersdorfer, aided by Adrian Wyss and Wolfgang Schalch and an energetic and efficient secretarial team led by Céline Zuber.

“More than 30 countries were represented among the 250 or so active scientific participants”

More than 30 countries were represented among the 250 or so active scientific participants. Traditionally, the International Carotenoid Symposia cover all aspects of the broad carotenoid field, but reflect the interests and expertise of the organizers, in this case human nutrition, with, as the main theme, the health roles of the xanthophylls lutein and zeaxanthin in the eye and brain. The program was diverse, with the usual mixture of plenary/keynote lectures, together with about 70 shorter invited or selected contributions and more than 100 poster presentations. The texts of the main lectures will not be published as a conventional Proceedings volume, but presenters have been invited to submit manuscripts for a special issue of *Archives of Biochemistry and Biophysics*, scheduled to appear in 2018.



Ahlam Al-Yafeai explaining details of her poster presentation



A lively poster session

The practice of Lunchtime Seminars given or supported by the main (Gold) Symposium sponsors (BASF Newtrition, Lycored, Kemim, DSM, Astareal, Omniaactive and Abbott) was maintained on Monday to Thursday, and featured, among others, John Nolan, Billy R Hammond, and Lisa Renzi-Hammond.

Papers and posters

A few papers addressed directly provitamin A carotenoids and their role in providing and maintaining vitamin A levels in poorer populations. Green leafy vegetables are seen as sources of the provitamin A carotene, but they also provide lutein, which is not only important for vision in the macula but also implicated in optimizing brain development in infants and maintaining cognitive function. South American native fruits were evaluated as potential sources of provitamin A and other carotenoids. Several presentations, oral and poster, addressed aspects of bioavailability and bioaccessibility of carotenoids, and methods for determining the efficiency of uptake, and conversion factors. Many concentrated on xanthophylls, especially lutein, but the principles are applicable to the provitamin A carotenoids β -carotene and β -cryptoxanthin. In a study of associations between relevant plasma proteins and vitamin A status and food carotenoid intake in a group of undernourished Nepalese children of school age, the results emphasized the importance of β -cryptoxanthin as a provitamin A carotenoid. The bioavailability of β -cryptoxanthin was addressed in a study with biofortified orange maize. Other work explored the relationship between dietary diversity and serum concentrations of retinol and β -carotene in 4–8-year-old children in Zambia.

Registration for the Symposium was open throughout the day on Sunday, and most participants had arrived to enjoy the

reunion of the carotenoid “family” in the traditional Welcome Reception with drinks and light refreshments, and music played on the alpenhorn and even on a metal watering can. Everyone left with eager anticipation of the week ahead.

The main business of the Symposium began on Monday morning, with the Opening and Welcome Ceremony, and the first scientific sessions on the topics **Nutrition and Health**, and **Chemistry: Analytics and Synthesis**, with plenary lectures by Manfred Eggersdorfer on “*The role of carotenoids in human health*” and Frederick Khachik on “*Transformation of naturally occurring (3R,3'R,6'R)-lutein and its fatty acid esters into (3R,6'R)-a-cryptoxanthin, (3R)- β -cryptoxanthin and carotenoid metabolites.*” Two afternoon sessions were held, in parallel, on the topics **Industrial Production I** and **New Research Methods**. The group photograph was then taken on the terrace outside KKL before the first scheduled Poster Session.



Manfred Eggersdorfer (Organizer) and John Landrum (President of the International Carotenoid Society) unfurl the Symposium banner at the Opening Ceremony



© Michael Fund

Delegates group waiting to enter the Restaurant Seeburg for the Symposium dinner

Tuesday began with plenary lectures on “*Current understandings of the photochemistry and photophysics of carotenoids in photosynthesis*” by Hideki Hashimoto and on “*The biochemical mechanism of production of meso-zeaxanthin from lutein in the eye: teaching an old enzyme new tricks*” by Paul Bernstein. Parallel sessions on **Photochemistry/Photophysics** and **Carotenoids in the Eye** in the morning and on **Emerging Carotenoid Science** and **Apocarotenoid and Retinoid Metabolism and Function** in the afternoon, preceded a second Poster Session.

The scientific program for Wednesday was shorter, with only two sessions, in the morning, on **Risk Reduction of Chronic Diseases** and **Plant Genetics**, consisting of Keynote lectures by Xiang-Dong Wang (“*Unique biological function of intact β -cryptoxanthin: implications for chronic disease prevention*”) and Eleanor Wurtzel (“*A novel gate-keeper of carotenoid biosynthesis in plants*”), as well as shorter talks by five speakers in each of two parallel sessions. The afternoon and evening were devoted to the main Social event: a two-hour cruise on Lake Lucerne on the historic paddle steamer Stadt Luzern, which took us to the Hotel-Restaurant Seeburg for a reception and the Symposium Dinner. The weather was kind; the sun shone brightly and the water was calm. The scenic cruise, the friendly informal atmosphere and the drinks and refreshments were much appreciated.

The Symposium dinner was a memorable event, and was graced by the presence of Dr Ruedi Isler, son of the late Dr Otto Isler, one of the true giants of the carotenoid field. During the proceedings, the ICS Otto Isler Award for a lifetime of achievement in research on carotenoid chemistry and of dedicated service to the carotenoid field was presented to Hanspeter Pfander, and the George Britton Young Investigator Award for an early ca-

reer researcher was presented to Ralf Welch. Stephen Schwartz and Richard Cogdell could not be present to receive, respectively, the Norman Krinsky Award for research excellence in nutrition and disease prevention, and the Trevor Goodwin Award for achievement in research on carotenoid biochemistry. Frederick Khachik and Adrian Wyss were presented with ICS President’s Awards, 2017, in recognition of outstanding service to the International Carotenoid Society.

.....
“Outstanding and consistent contributions in the carotenoid field were recognized by bestowing on selected members the honorary title Fellow of the International Carotenoid Society”

Finally, outstanding and consistent contributions in the carotenoid field were recognized by bestowing on selected members the honorary title Fellow of the International Carotenoid Society. Recipients were presented with specially commissioned medallions by the President, John Landrum.

Thursday saw the final full day of scientific presentations, beginning with Keynote lectures by Loredana Quadro (“*Carotenoid metabolism*”) and Liz Johnson (“*A decade of research on lutein and cognition*”) and followed by sessions on **Carotenoid Metabolism; Industrial Production and Commercial Applica-**

tion; Brain and Cognition; and Food Science and Technology, either side of a lunchtime Gold Sponsor's seminar. To close the day's proceedings, the members' business meeting of the ICS was held, followed by the third and final poster session.

The shorter program for Friday began with a plenary lecture by George Britton about the pioneers who laid the foundations on which current carotenoid research is built. The coverage then moved forward as John Erdman and Liz Johnson spoke about setting DRIs for carotenoids. Antonio Melendez looked to the future with a visionary outlook on carotenoid research, and then chaired a round-table discussion, featuring the chairs of the sessions throughout the week. The final scientific activity was a series of short talks given by young investigators Vaclav Sebelik, Jacinta Watkins and Emily Webb, who received prizes for their posters which were selected by the judging panel to be the best of those displayed.

The Symposium closed at lunchtime, when the incoming President of the ICS, Bruno Robert, handed the Symposium banner on to Yoshifumi Tomita, who invited members to attend the 19th International Symposium on Carotenoids in Toyama, Japan, in 2020, provisional dates July 11–17.

“An innovation in Lucerne was a Young Investigators Forum”

An innovation in Lucerne was a Young Investigators Forum, held on the Sunday afternoon. Graduate students and post-doctoral researchers were able to present their research



Two new Fellows of the International Carotenoid Society, Tomas Polivka and Harry Frank, proudly showing their medallions

among their contemporaries. Led by Johannes von Lintig and featuring established carotenoid scientists Loredana Quadro and Giovanni Giuliano, the two sessions were chaired by the young investigator organizers Rachel Kopec and Emily Mohn. Eight contributions were selected as talks, the others presented as posters. A Forum such as this gives the young investigators confidence to know that they are accepted into the carotenoid community and helps them to obtain the greatest benefit from the subsequent main symposium. It is to be hoped that a pre-Symposium event for young investigators will be a feature of subsequent meetings.

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Adrian Wyss receiving the President's Award from John Landrum

Unlocking the Potential of Rice Fortification in West Africa

Kesso Gabrielle van Zutphen

Knowledge and Research Specialist, *Sight and Life*

Outside of Asia, the highest per capita consumption of rice is in Africa. Of the 40.4 million metric tons (MMT) of rice globally traded in 2015/16, 11.7 MMT was exported to Africa.¹ Rice is a growing key staple food in 19 African countries. The prevalence and impact of micronutrient deficiencies in West Africa are significant, and anemia rates, vitamin A deficiency and iodine deficiency remain a concern. Against this background, fortified rice has the potential to reach 130 million people in 12 African countries – none of which are in West Africa.²

In the light of this untapped potential, a two-day workshop on **'Rice Fortification – An Opportunity to Improve Nutrition in West Africa'** took place in Dakar, Senegal, on November 27–28, 2017. Convened by the *World Food Programme (WFP)* in partnership with the *Food Fortification Initiative (FFI)*, the *Global Alliance for Improved Nutrition (GAIN)*, *Nutrition International (NI)*, the *Food and Agriculture Organization (FAO)*, the *United Nations Children's Fund (UNICEF)*, *Hellen Keller International (HKI)* and *Sight and Life*

(*SAL*), the meeting brought together country delegates, and global and regional technical partners to raise awareness and discuss opportunities and challenges around rice fortification and its potential for improving dietary quality and reducing micronutrient deficiencies in the region. Representatives from the following countries were invited: Benin, Cabo Verde, Côte d'Ivoire, Gambia, Ghana, Guinea Bissau, Liberia, Mali, Nigeria, and Senegal.

Country experiences in the spotlight

Country experiences from Costa Rica, Bangladesh and Mali enriched the debate and provided key insights into implementation enablers and challenges while also giving an overview of the various types of delivery that exist. Participants exchanged thoughts on a variety of topics including the feasibility of rice fortification in the region, the integration of rice fortification into supply chains for cost efficiency, the existing technologies and their respective characteristics, and how to balance a fortified food basket. Country delegates had the opportunity to apply what they had heard to their country's context and to brainstorm strategies to make rice fortification a reality. The enabling environment of The West African Health Organization (WAHO) and Economic Community of West African States (ECOWAS) shone throughout the workshop, revealing a strong base of technical partners who can provide guidance, share country expertise and become leaders in the field. In a region which already sets great store by fortification and accepts the fortification of other commodities, and in which eleven countries import 5 to 6 million metric tons of rice per year, rice fortification represents a quick and significant opportunity to address micronutrient deficiencies.² There is undoubtedly sufficient evidence to move ahead with scaling up fortified rice in West Africa as part of an integrated approach to reduce micronutrient deficiencies.



Participants guessing which rice samples are fortified with extruded kernels

“There is no bigger opportunity to scale up rice fortification than in West Africa”



© Fadoi Chaouki & Priscila Porto

Participants at the rice fortification workshop in Dakar, Senegal

Today, there is no bigger opportunity to scale up rice fortification than in West Africa. The current collaborations among regional bodies are encouraging. It is now up to the region to build on its strengths, generate political will, and make rice fortification a priority. This workshop marks a milestone in West Africa's journey towards scaling up rice fortification and impacting the wider continent. It is hoped that it will plant productive seeds and be the first of many future gatherings at national, regional and global level.

As we have done in the past for Asia and the Latin American and Caribbean region, *Sight and Life* aims to publish a special supplement on rice fortification in West Africa in June 2018. This will be a compilation of original articles from leading regional and international public health professionals.

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The Power of Portable Micronutrient Testing

Strengthening food fortification programs through improved monitoring tools

**Holly McKee and
Dr Anna Zhenchuk**

BioAnalyt GmbH, Berlin, Germany

Key messages

- > To understand if a nutrition intervention has achieved its intended impact, the nutrients must be tracked at every point of the food value chain.
- > In response to the challenges of transporting blood samples from remote field locations to the laboratory, BioAnalyt developed the field testing solution iCheck.
- > *Sight and Life* has been a key partner of BioAnalyt, supporting the introduction of innovative testing in the field and acting as a catalyst for measuring impact.
- > This article provides an overview of field methods for micronutrient testing.
- > The biggest application area for this type of field test to date has been quality control of food fortification.
- > BioAnalyt helps execute nutritional status surveys, delivering evidence on the nutritional status in populations. Its products enable the sharing of data with the population in real time.

There are numerous approaches to combat malnutrition, from the fortification of staple foods through diet diversification and vitamin supplementation to reducing infection.¹

To understand if a nutrition intervention has achieved its intended impact, the nutrients must be tracked at every point of the food value chain from farm to fork – i.e., from production to human intake. Only thus can it be demonstrated that a nutrition program delivers its intended expected health benefit in a population. This is the challenge that BioAnalyt has taken on.

Bringing the lab to the sample

The company BioAnalyt was founded by Prof. Dr FJ Schweigert as a spin-off of the University of Potsdam, and initially provided analytical food testing services for researchers and NGOs. For a population study in Laos, for which hundreds of blood samples were to be tested for vitamin A,² it became clear that although complex, the most difficult part was not the sample analysis. Getting the samples safely from a remote village in Laos to the lab in Germany proved the biggest challenge. This sparked the idea of bringing the laboratory to the sample instead of transporting the sample to the laboratory, and the development of a mobile lab to simplify micronutrient analysis began.

“Our solution was to create a miniature lab”

The solution was to miniaturize a lab, resulting in a small portable photometer using the latest LED technology and pre-filled reagent vials, customized for the detection of specific micronutrients.

FIGURE 1: iCheck device and reagent vial

Sight and Life has partnered with BioAnalyt since the beginning, supporting the introduction of innovative testing in the field.

“iCheck can be used by almost anyone, anywhere”

What is innovative about iCheck is that the measurement process was standardized and reduced to three steps, simplifying the logistics of ordering extra chemicals and meaning that this tool can be used by almost anyone, anywhere.

Field methods for micronutrient testing

Making analytical equipment locally available is a critical step in the fight against micronutrient deficiencies in developing countries.

Iodine in salt

Numerous field tests exist for determining the content of iodine in (iodized) salt. Qualitative or semiquantitative tests include spot tests, whereby a color reaction indicates the presence or absence of iodine.³

Quantitative test kits, on the other hand, can precisely determine the concentration of iodine in salt. A study performed in 2015 by Rohner et al assessed the performance of five available field kits, including iCheck Iodine.⁴ The parameters of cost, ac-

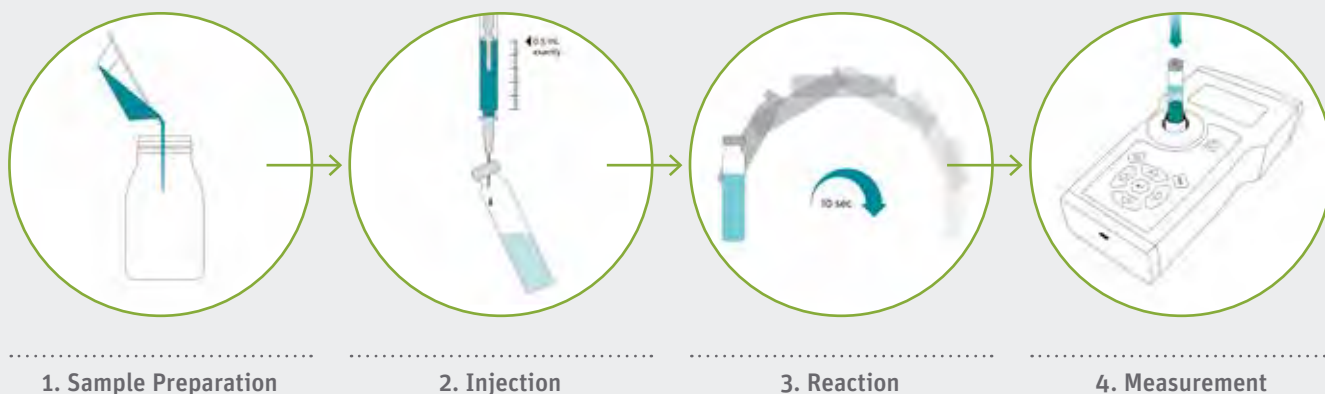
FIGURE 2: iCheck 3-step measurement process

TABLE 1: Comparison of the performance of five available field kits

You want to measure:	Vitamin A	Vitamin A in oil	Carotenoids	Iron	Iodine	Vitamin E (from Jan 2018)
In this sample:	Premix, milk, flour, sugar, milk powder, bouillon powder. Biological fluid: Breast milk, blood	Refined edible oils and fats of plant origin	Premix, roots (i.e. cassava), beverages, eggs, salmon flesh. Biological fluid: Cattle blood and milk	Premix, flour, soy and fish sauces, beverages, Corn-Soya-Blend (CSB), Lipid-based Nutrient Supplement (LNS)	Salt	Biological fluid: Cattle blood
Use this product if:	iCheck Fluoro	iCheck Chroma or Chroma 3	iCheck Carotene	iCheck Iron	iCheck Iodine	iCheck Vitamin E
Vitamin or mineral form is:	Retinyl palmitate, retinyl acetate, retinol	Retinyl palmitate	Total carotenoids	Ferrous sulfate, ferrous fumarate, NaFeEDTA, intrinsic iron	Potassium iodate	Contact us for the information
Measurement range is*:	50–3000 µg RE/L	3.0–30.0 mg RE/kg	0.15–25.0 mg/L	1.5–12.0 mg/L	1.0–13.0 mg/L	–

*The upper limit of the measurement range can be increased by diluting the sample

curacy, and field usability were compared (Table 1), and iCheck Iodine was determined to be the most precise field method, followed closely by the IReader. The reference method for the study was iodometric titration.

Vitamin A in foods and humans

Vitamin A is critical for health, but complex to analyze. It is fat-soluble and difficult to extract from the matrix, as well as being light- and heat-sensitive. The standard method for measuring vitamin A is high-performance liquid chromatography. Though precise, it requires a fully equipped lab, extensive sample extraction and highly trained operators, making it unsuitable for use in the field or low-resource settings.

Colorimetric methods exist, but these require solvent handling and produce only qualitative results.⁵

To overcome these challenges, BioAnalyt developed two test kits using different approaches for measuring vitamin A: iCheck Fluoro, based on fluorescence, for foods and biological fluids, and iCheck Chroma, based on the vitamin A specific Carr-Price reaction, for edible oils. Both test kits have been compared to the standard reference methods, showing a good linearity between the results and comparable or slightly better intra-assay precision.^{6,7}

Areas of application

The biggest application area to date has been food fortification – painting a clearer picture of where the nutrients really are. For years, the addition of micronutrients to staple foods and condiments – known as food fortification – has helped to deliver essential vitamins to the malnourished. While food fortification is cost-effective, scalable and can be effective in both industrialized and developing nations, measuring its impact has remained difficult. Part of the problem is that as food moves along the value chain, for example during transportation or in-home preparation, it can lose some or even all of its added nutritional value. Knowing where nutritional loss occurs, or whether food has been properly fortified in the first place, is therefore essential.

“Knowing where nutritional loss occurs is essential”

Biofortification – Rapid screening of β-carotene in cassava

Biofortification is the process of enriching plants with vitamins and minerals through selection and breeding. In the case of

COMING SOON

TABLE 2: Comparison of quantitative test kits for measuring iodine in salt (modified from Rohner et al)

Device name	Method principle	Description of test kit contents	Analytical performance	Overall rating
iCheck Iodine	Reduction of iodate to iodine by potassium iodide, followed by the formation of pentaiodide anions that inside the helical β -amylose chain of starch form a blue color that is linear with the iodine concentration. Colorimetric quantification of the concentration using photospectrometry.	Device, scale and power plug come with the device kit; activation solution, reagent vials, syringes and needles come with the reagent kits. Only purified water and plastic flasks required.	4.5	4.1
ID-ERTK	NA	Device comes with power plug, scale, quartz cuvette, and some other lab hardware. Reagent solutions need to be prepared by the user.		3.4
IReader	NA	Device comes with pyrex tubes and tubeholder, disposable pipettes and small dosage spoons (to measure the salt volumetrically rather than by weight), and a basic reagent stock (two bottles, sufficient for approx. 330 analyses). Scale not included.	4.3	4.3
saltPAD	Iodate is reduced to triiodide using potassium iodide. Thiosulfate is used to titrate a predetermined amount of triiodide. Excess triiodide reacts with starch to form a blue color that can be calibrated for visual or computerized image analysis.	This device is not yet commercially available; beta-testing version was used for this evaluation. Besides the testing cards that were delivered by the developer, a light box had to be constructed to take pictures for automated analysis. A standard calibration series also had to be prepared for calibration of the software to the specific light conditions.	3.5	3.6
WYD iodine checker	NA	Same as iCheck, ID-ERTK and IReader. Test kit comes with device and power plug, some lab hardware and a manual. Scale not included. Reagent solutions need to be prepared by the user.	3.8	3.6

Table adapted from Rohner et al⁴

cassava, the challenge in breeding biofortified roots is the large numbers of genotypes that need to be evaluated for their total carotene content (TCC) to then select the promising genotypes for advancement to the next breeding cycle.⁸ Our technology makes it possible to test pro-vitamin A profiles of crops to accelerate the selection and breeding process.

Food fortification monitoring

Food fortification can only be successful if industry and government are fully equipped and committed. Working closely with

local food producers and governments in the context of testing fortified foods, it became apparent that the capacity gap was much bigger than merely the need for a portable lab/test kit. A system surrounding the monitoring of fortified foods was missing. In collaboration with other organizations, we help build up the support system for food testing. Since 2013, BioAnalyt has trained over 650 stakeholders in over 30 countries on Quality Control and Assurance. In collaboration with food producers and vitamin premix suppliers, who use iCheck together with their systems, we work out the optimal processes to ensure correct dosing.

TABLE 3: Comparison of iCheck to standard lab method for testing vitamin A

Resource	Standard Laboratory Method (HPLC)	iCheck
Equipment	Fully equipped laboratory Analytical instruments Stable power supply Refrigerator	iCheck device
Chemicals	Chemicals and standards	iCheck reagent vial
Personnel	Highly educated lab technician	1-day trained operator
Cost per sample	50–200 US\$	5–15 US\$
Time per sample	1 day–2 weeks	5–10 minutes

In the market and in the household – Coverage and market surveys

An essential part of every nutrition intervention is the process of monitoring and evaluation. In order to assess the success of large-scale food fortification programs, food samples from markets and households must be tested for fortification levels. Test kits such as iCheck make the analysis of large sample sizes of up to 10,000 affordable, and what’s more important, possible in a specific country, cutting out the need for extensive logistics. The Global Alliance for Improved Nutrition (GAIN) partnered with BioAnalyt to assess the coverage of fortified foods (FACT) in ten countries, testing thousands of samples for micronutrient levels.⁹

In humans – nutritional status surveys

We help execute nutritional status surveys, delivering evidence on the nutritional status in populations. Our products enable the sharing of data with the population in real time.

We would love to hear from you: What field methods are needed in your work?

About BioAnalyt

BioAnalyt is a product innovation company based in Berlin, Germany, with a global reach and drive to improve nutrition through transparency. Tracking nutrients at every point along the food value chain enables better management of nutrition programs. Our products and services help organizations to measure impact and, therefore, to spend their funds effectively. In doing so, we help improve the nutritional status of millions of people around the world.

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FIGURE 3: Application areas along the food value chain



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Knowledge Can Empower

Delivering health information via the 3-2-1 Service

Leah Newman

3-2-1 Product Director

Key messages

- > Although health awareness is improving globally, there are still challenges in spreading accurate health information to those who need it most.
- > For those living in emerging markets, adults can have low levels of literacy – particularly women – and can lack the resources they need to help them access valuable health information.
- > Human Network International (HNI) has created a mobile phone information system – the 3-2-1 Service – with the aim of improving access to resources and information.
- > The 3-2-1 Service has repurposed existing technology, using Interactive Voice Response (IVR).
- > Independent research studies have demonstrated the efficacy and impact of the 3-2-1 Service, most recently in Malawi.
- > The 3-2-1 Service is currently live in 12 countries and growing.

Nelson Mandela once stated, “Education is the most powerful weapon we can use to change the world.”¹ But for many living in emerging markets, education is unavailable, inadequate, or too costly. Adults, particularly women, may have low levels of literacy and may lack resources to access essential information to improve their lives.

So how, at a moment of need, will Georgette,² an illiterate woman living in rural Africa, get reliable health information?

Public service campaigns in developing countries are often disseminated through mass media channels, such as radio mes-

sages, billboards and posters. These channels have proven to be effective at reaching large numbers of people and even increasing people’s knowledge, but have had mixed results when it comes to changing behaviors. A weakness of these communication channels is not the quality of the information, but the fact that people cannot access the information when they need it most.

The 3-2-1 Service innovation

Eight years ago, Human Network International (HNI) created an innovative mobile phone information service – the 3-2-1 Service – to improve access to important public service information. The Service works as a search engine where there is no Internet, and allows people to use any mobile phone to proactively select and listen to actionable information to increase their knowledge and improve their wellbeing across a range of topics. Callers dial the toll-free number “321” anytime, anywhere and retrieve the information they need in their chosen local language. The Service offers a range of topics such as Agriculture, Financial Literacy, Gender, Health, Nutrition, and Weather. Each topic can contain many sub-topic messages:

“What would you like to know about Public Health? Press 1 for Nutrition. Press 2 for Family Planning. Press 3 for Water and Sanitation. Press 4 for Gender Equality. Press 5 for Emergency Preparedness and First Aid.”

The service uses Interactive Voice Response (IVR), a technology you have probably encountered when calling your bank or making a reservation using a 1-800 toll-free number (“Press 1 for reservations, Press 2 for ticketing ...”).

Getting information where and when it is needed

The 3-2-1 Service has repurposed this existing technology so that Georgette can get the life-enhancing information she needs,



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The 3-2-1 Service was first developed and launched in Madagascar

when she needs it, in the language she understands, using the basic cell phone she already possesses.

Our messages are developed from formative research among the population, compiled and approved by national, international and government experts during a well-defined “content committee” process. The messages are field-tested and updated according to feedback from end-users.

The 3-2-1 Service is innovative because **1)** individuals can access the information that addresses their immediate needs at a time and place of their choosing, both independently and confi-

dentially; **2)** it takes advantage of high levels of cell phone penetration in developing countries to reach millions of the most vulnerable; and **3)** it is an effective, sustainable and cost-effective intervention provided at national scale by telecommunication companies, without donor dependency.

“The 3-2-1 Service is an effective, sustainable and cost-effective intervention provided at national scale”

When resource-poor people have access to locally relevant, reliable information on the 3-2-1 Service, we see that they proactively search for the information they need. Then, armed with this information, they act to improve their health and wellbeing. Independent research studies have demonstrated the efficacy and impact of the 3-2-1 Service, most recently by GSMA in Malawi.

Case Study: Malawi

“As a newly married young man I want to know what kind of diet my wife will need when she becomes pregnant.”

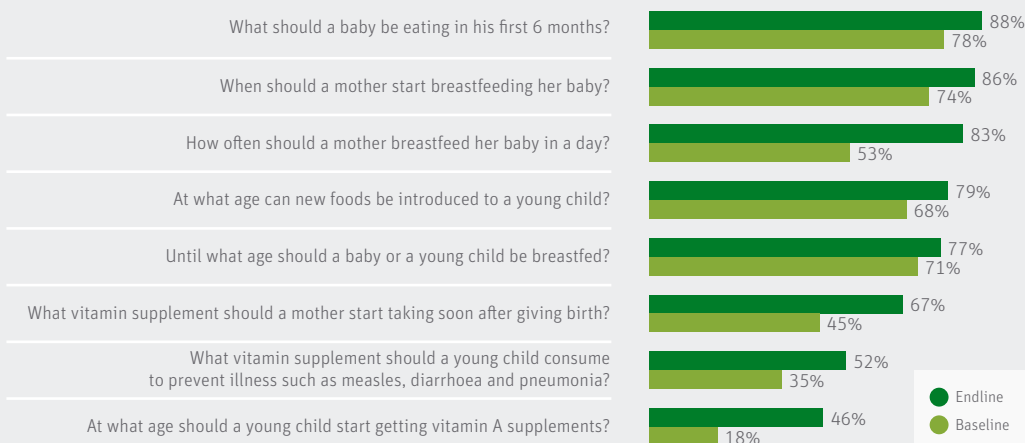
Benson, Urban, Self-employed, 25

Eighty-four percent of the 18 million people in Malawi live in rural areas where the GDP per capita is a meager US\$300.³ The 3-2-1 Service launched in Malawi in 2014, and currently 150,000

FIGURE 1: Significant nutritional knowledge results, endline vs. baseline

Could you please answer the following questions for me?

N=Endline: 381, Baseline: 422 – trial & repeat users only – % of right answer



> Knowledge improved by 6% to 28% for all questions in the endline vs. the baseline

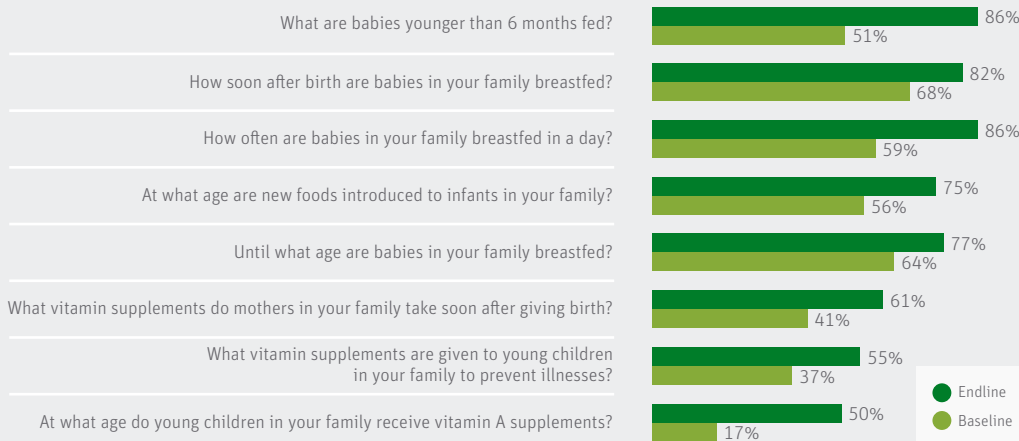
> Knowledge on vitamin A improved the most

Source: GSMA blog post

FIGURE 2: Significant nutritional practice results, baseline vs. endline

Can you tell me about nutritional practices in your house?

N=Endline: 381, Baseline: 422 – trial & repeat users only – % apply the right practices



> Nutritional practices have **improved by 11% to 35% for all questions** between the baseline and the endline

> **Both breastfeeding and vitamin A improved significantly**

Source: GSMA blog post

unique users access the Service each month. In total, 1.8 million users, more than half of Airtel’s market share, have relied on the 3-2-1 Service for beneficial information.

Key information is accessible nationwide in Chichewa, Malawi’s national language, from any type of mobile phone via IVR, SMS or USSD (an alternative text-based system).

GSMA’s analysis focused on the nutrition section of the 3-2-1 Service, which provides nutritional information for food recipes, vitamins and healthy living, pregnant women, food for babies, and the six food groups.

Users like Benson can call the Service for free eight times per month.

The GSMA-funded evaluation in Malawi assessed the use of the nutrition information available on the 3-2-1 Service and its impact on nutritional knowledge and practices of the more than 285,000 individuals who accessed the information.

Methodology

Baseline: In February 2016, researchers conducted a quantitative baseline study of 800 phone interviews three months after the launch of nutrition information on the 3-2-1 Service. The baseline was used to establish users’ demographics, knowledge, behavior, attitudes, and existing nutritional practices.

Endline: In February 2017, researchers followed with a second wave of 800 quantitative phone interviews to compare results to the baseline and assess the impact on users’ nutritional knowledge and practices.

Focus Group Discussions were conducted to supplement both baseline and endline surveys.



In Malawi 150,000 individuals access the 3-2-1 Service each month

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“Information on the 3-2-1 Service is crafted to be relevant, engaging, and useful for the user”

Results and findings

Information on the 3-2-1 Service is crafted to be relevant, engaging, and useful for the user. In the GSMA study, users rated the usefulness of the information at 6.9 out of 10. Eighty-nine percent said they would “absolutely” recommend it. Furthermore, 92% of people using the Service said that they learned something new.

New or novel information can help messages stick and can lead to longer-term attitude and behavior change. Nutritional practices have improved by 11% to 35% for all questions between the baseline and the endline.

Moreover, the findings from this evaluation show not only that the 3-2-1 Service can improve knowledge but that it can also drive behavior change. Of those surveyed, 98% declared they had changed (at least some of) their practices due to the information they accessed via the Service.

For the nutritional practices presented in the 3-2-1 Service, the adoption of the practices increased by an average of 22%. The greatest increase in behavioral practice was in breastfeeding, with a 35% increase from baseline.

Key findings

- > A majority of users (71%) are male, live in rural areas (78%) and are on average 31 years old. Most (94%) have a basic education (primary or secondary school level) and are poor (52% earn less than 25,000 MW or US\$34 per month).
- > The main reasons for accessing the Service are curiosity (86%) and interest in nutrition (64%).
- > Users rated the usefulness at 6.9 out of 10, and 89% would “absolutely” recommend it.
- > Of those who listened to a “healthy recipe” message, a majority (68%) tried it out. All users who made the recipe were satisfied and would make it again.
- > Information was (at least partly) new for 92% of users, and 98% declare having changed (at least some of) their practices.
- > Nutritional knowledge, attitudes and practices improved significantly (by a range of 11–35 percentage points) between the baseline and endline surveys.
- > Both breastfeeding and vitamin A indicators improved significantly.

FIGURE 3: Geographical scope



Map showing countries where 3-2-1 Service Agreements have been signed, plus logos of telecommunications partners

Scale

The Pew Research Center estimates that in emerging and developing nations, a median of 84% of people own some type of cell phone.⁴ The 3-2-1 Service ensures that anyone with access to a cell phone can use it as a tool to retrieve vital information when they need it most, irrespective of their level of literacy.

The 3-2-1 Service is currently live in 12 countries and growing. Globally, more than 8.8 million people have contacted the 3-2-1 Service more than 80 million times. Georgette, Benson and millions of resource-poor individuals around the world deserve information they can use to improve their lives. Now, with the 3-2-1 Service, such information is only a call, or an SMS, away.

.....
**“The 3-2-1 Service is currently
 live in 12 countries and growing”**

.....
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Leveraging Women's Empowerment and Entrepreneurship for Targeting Malnutrition

Experiences and lessons from India

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Key messages

- > Malnutrition is a serious public health problem, with approximately 2 billion people suffering from micronutrient malnutrition and another 800 million facing calorie deficiency.
- > Stunting and anemia numbers for the state of Gujarat, India, stand at 38.5% and 54.9% respectively, while the same for Tapi district stand at 35.9% and 54.4% respectively.
- > It was against this backdrop that a consortium of partner organizations led by the Tata-Cornell Institute for Agriculture and Nutrition (TCI) took up this project to address iron-deficiency anemia and related micronutrient deficiencies in 15 villages in Songadh block of Tapi district.
- > The project was designed to leverage women's empowerment and entrepreneurship for creating a sustainable business model for the supply and consumption of essential micronutrients through village-level flour fortification strategies.
- > At the end of the first phase of the project, about 69% of all households had consumed the product at least once.

Introduction

Malnutrition is a serious public health problem, with approximately 2 billion people suffering from micronutrient malnutrition and another 800 million facing calorie deficiency.¹ Almost 38.4% of India's children under five are stunted² and about 58.4% children in the age group of 6–59 months and 53% women in the age group of 15–49 are anemic.³ Reasons for high prevalence of anemia in India include poor dietary intake of iron, its poor bioavailability, infections such as malaria and hookworm infestation, and poor sanitation practices.

Food fortification is a common practice of adding essential vitamins and minerals to staple foods to improve their nutritional content. It is considered a safe and effective way to improve public health and has been used with reasonable success globally since the 1920s.⁴ Commonly fortified foods include staple products such as salt, maize/wheat flour, sugar, vegetable oil and rice. Flour fortification, a form of food fortification carried out in many developing countries, involves adding vitamins and minerals to wheat or rice or millet flour to make it more nutritious. It has been implemented with reasonable success in many countries.

“Flour fortification has been implemented with reasonable success in many countries”

Though the state of Gujarat has done reasonably well in economic terms, it has struggled in several key development indices. Stunting and anemia numbers for the state stand at 38.5% and 54.9% respectively, while the same for Tapi district (where the



The SFurtI team at Songadh, Gujarat, India

project villages are situated) stand at 35.9% and 54.4% respectively. It was against this backdrop that a consortium of partner organizations led by the Tata-Cornell Institute for Agriculture and Nutrition (TCI) took up this project to address iron-deficiency anemia and related micronutrient deficiencies in 15 villages in the Songadh block of Tapi district. The consortium partners included BAIF Development Research Foundation (BAIF), *Sight and Life*, Tata Institute of Social Sciences (TISS), Maharaja Sayajirao University (MSU), and Sri Surabhi Swasahay Federation. BAIF has been working in several villages in the project location and had facilitated setting up of the Sri Surabhi Swasahay Federation, an apex-level body of almost 70 self-help groups (SHGs)⁵ covering approximately 800 households from these villages.

The project was christened as SFurtI,⁶ abbreviated from 'Sustainable Flour Fortification Initiative, India'. The program strategy of SFurtI was designed to leverage women's empowerment and entrepreneurship for creating a sustainable business model for the supply and consumption of essential micronutrients through village-level flour fortification strategies that would eventually address micronutrient malnutrition. The communities in the program villages were mostly tribal, poverty levels among which were high, even by Gujarat standards. Preliminary visits, discussions and a rapid situational assessment study revealed that rice, wheat and *ragi*⁷ were common staples. Rice was mostly consumed for lunch, while *rotis*⁸ made out of wheat/rice/*ragi* flour was consumed for dinner. Pulses were a regular in the food plate. Consumption of vegetables and fruits depended on availability and/or market prices. Preliminary data for anemia were not available, though discussions with communities and a subsequent clinical baseline study carried out by MS University suggested that anemia lev-

els among women and children were high. Incidence of sickle cell anemia was also reported by the villagers.

Program design and delivery:

Weaving an entrepreneurial strategy

The SFurtI program was designed and delivered by the women, with the consortium partners playing a facilitative and supportive role. The project was implemented in three broad stages.

1. Program design and approval stage

The first phase of the program was the design and approval phase, during which the program details were discussed and finalized. Several rounds of design workshops and meetings were held among the partners, as well as with the Federation and community members. Efforts were made to explain every element of the program to the communities, and their approval won. During this phase, institutional ethical approvals were also obtained.

A team of 27 village-level service providers called SFurtI Bens (meaning SFurtI sisters) was identified from the 15 project villages to anchor the program. These were women from the Federation, and had considerable knowledge and understanding of the project villages. They were assisted by a small team of professionals based at the project office.

It was decided that sachets containing four micronutrients – iron (20 ppm),⁹ folic acid (1.5 ppm),¹⁰ vitamin A (300 ppb) and vitamin B₁₂ (0.01 ppm), adequate for mixing in 5 kg of wheat/ rice flour – would be made available to the communities through the women's federation at INR3.0 (US\$0.05) per sachet¹¹ per month. The product was sponsored by *Sight and Life*.

An ecosystem-level stakeholder mapping was done to map out all key players in the program location. Departments of



A SFurtI sachet



© Ms. Karuna Salve

SFurtI meeting in Kharsi village

Health, Education and Women and Child were identified as key government stakeholders in the program. Panchayat,¹² Church¹³ and the Dairy Cooperative¹⁴ were identified as key village-level institutional partners critical for the program outreach. Several meetings were organized with District and Block level officials for approval and involvement of village-level government staff¹⁵ to assist the project team in awareness-generation in the villages.

2. Awareness material design and capacity-building stage

The second phase of the program involved awareness material design and capacity-building. Since awareness creation was an important element of the program, and one on which its success depended, significant efforts went into content creation and subsequent capacity building of federation members in using it.

Paperboat, a well-known consulting firm that develops campaign strategies for development programs, was engaged for designing the awareness strategy and material. The developed drafts were pre-tested in the program villages by the SFurtI Ben to ensure context specificity, relevance and recall value of the campaign. A total of 12 different awareness-generation materials, targeting mostly women, were designed in the local language and used during the awareness campaign.

The SFurtI Ben went through an intensive training program with theoretical and practical inputs on awareness generation, effective communication, sales pitch, record-keeping, etc. They were also trained to handle difficult conversations in villages, which came in extremely handy in some villages. The SFurtI Ben were also trained in managing data pertaining to outreach efforts, sales numbers and cash flow etc., which was compiled in the project-level MIS once a month.

The SFurtI Ben reached out to the village-level stakeholders such as Panchayat, the milk federation, pastors, local shopkeepers and millers to create a supportive ecosystem at the village level. Similarly, the ASHA and Anganwadi workers were put through two rounds of training to help facilitate awareness-building in the villages.

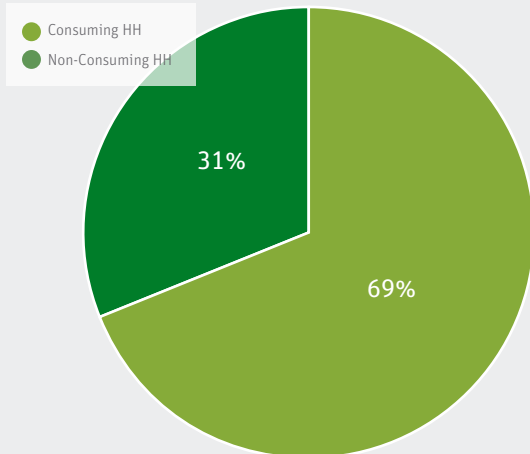
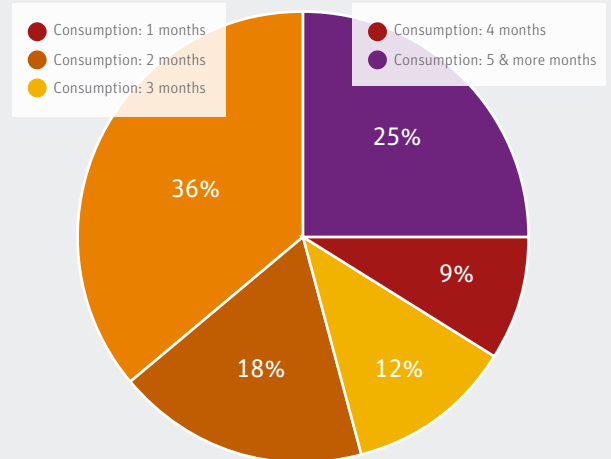
3. Awareness-generation and implementation stage

The product and the awareness campaign were launched on June 15, 2016. A total of three rounds of mass awareness campaigns were carried out. During each round of awareness campaigns, the SFurtI Ben traveled to various hamlets in the project villages to conduct meetings about the project, the product and its benefits, points of sale in the village, cost, etc. Apart from conducting door-to-door awareness-raising activities, the SFurtI Ben also carried out mixing demonstrations at the hamlet level. The outreach program was designed in such a way that it did not burden the SFurtI Ben, but left her with adequate free time.

The SFurtI Ben were reimbursed through a fixed-plus-variable pay structure. They received a small fixed payment which was equal for everyone, and thereafter received a percentage of the total sales value for the month. The honorarium was deposited directly in their respective bank accounts.

Outcomes and lessons learnt

The first phase of the project was completed on March 31, 2017, with an implementation phase of about nine months. Response to SFurtI varied across the 15 villages, with about 69% of all households having consumed the product at least once. There were households who consumed the product only once (possibly to see how it looks, tastes etc.), while others consumed it

FIGURE 1: SFurtI HH coverage (Jun 16 to Mar 17)**FIGURE 2:** SFurtI consumption regularity (Jun 16 to Mar 17)

for variable periods. **Figures 1** and **2** capture the consumption picture at an aggregate level.

From the MIS, the project team could track the households based on their consumption patterns. A subsequent household visit by the SFurtI Ben revealed the following reasons for irregularity in consumption:

- > **Complex mixing process.** Some women complained that the recommended mixing process was cumbersome.
- > **Objection by family members.** There were some households in which, even though the women wanted to use it, other members in the family objected to using SFurtI for various reasons.
- > **Demonetization.** Around early November 2016, the government of India initiated the process of demonetization. This resulted in a drop in sales during November and December.

It was also observed that the motivation levels of the Ben were reflected in their sales numbers. It was seen that failure to close sales early on during the program demotivated some of the women, while others were demotivated by adverse comments from members of the community. Regular motivational programs helped improve the performance of the SFurtI Ben.

“The SFurtI Ben displayed exemplary entrepreneurial and managerial skills”

The way ahead

Though coming from fairly disadvantaged backgrounds, the SFurtI Ben displayed exemplary entrepreneurial and managerial skills to take on a challenging program of this nature. Most of these women were participating in such a program for the first time in their lives. They picked up essential skills such as clear and concise articulation, managing conversation, tracking consumers and tracking revenues. Their financial discipline was evident from the fact that the money from sales was kept meticulously and deposited in the Federation's bank account at the end of every month. Their initiative and persistence was on display during times when sales were low due to factors beyond their control. The SFurtI Ben are confident, motivated and excited about expanding the program, and believe that women can and should come forward to take charge of their own health. The new-found confidence can be seen in their own words: **“Women's federations like ours, throughout the country, can take up similar programs for a healthy future for their families.”**

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02. Height below -2 standard deviations, based on the WHO standard.
03. International Institute for Population Sciences (IIPS) and Macro International. National Family Health Survey (NFHS-4), 2015–16: India: Mumbai: IIPS.
04. It has proven incredibly successful in countries like United States and Canada to Guatemala, Chile, South Africa, and China, due to its proven cost effectiveness and health impact.
05. The SHG movement in India has been a unique bottom-up experiment in women's empowerment and livelihood enhancement through formation of village level groups comprising of up to 20 women in each group. Each village could have several groups. These SHGs are then federated into a Cluster Organization and finally into a Federation, the final apex institution. Women's Federations in India today are a major grassroots movement whereby women have come forward to take charge of their present and future.
06. Meaning enthusiasm
07. Finger millet
08. Flattened bread made out of wheat or rice or millet flour
09. It has been proposed that the iron salt will be Sodium-Iron EDTA (also known as NaFeEDTA), which has been found to be most easily absorbed by the human body. The Joint FAO/WHO Expert Committee on Food Additives has approved the use of NaFeEDTA at 0.2 mg Fe/kg body weight per day.
10. Folic acid and vitamin B₁₂ facilitate the absorption of iron, while recent studies have shown that a large population in India does not get an adequate quantity of vitamin A through food sources.
11. The production cost came to approximately INR1.4 (\$0.02) per sachet.
12. The lowest institution of self-governance at the village level in India
13. A large number of tribes in the region follow Christianity and the Church holds considerable sway in their affairs.
14. The Milk Federation in Gujarat is one of most successful cases of Cooperative functioning anywhere in the world, and has contributed immensely to India's white revolution.
15. ASHA, Anganwadi worker and Teacher are the key-village level staff of the health department, women and child and education departments.

Eggciting Innovations

A cost:benefit model for engaging smallholder poultry farmers in India

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Key messages

- > More than 70% of egg production in India is by smallholders.
- > Eggs have an important role to play in the fight against malnutrition among children under the age of five.
- > Optimized feed for backyard poultry could improve egg production for farmers and deliver added nutritional value for consumers.
- > Investments in the egg value chain are very effective: The cost to save one disability-adjusted life year ranges from US\$30 to \$76, and an investment of \$1 has the potential to generate \$7.85 of sustainable income in the hands of rural women.

Eggs have an important role to play in the fight against malnutrition among children under the age of five. Naturally packaged, amenable to different cuisines, and rich in protein and micronutrients, the egg holds great potential. A review article¹ explores this in detail and makes a case that “eggs may be an uncracked part of the solution.” A recent study² on the impact of consuming an egg a day suggested a 47% reduction in the prevalence of stunting and a 74% reduction in the prevalence of underweight, confirming the long-held views of advocates for eggs in the global fight against child malnutrition. More than 70% of egg production in India is by smallholders. Poultry farming has many advantages: The birds are inexpensive to house, breed, and process, making their meat an economically viable protein source. Moreover, hens also produce eggs each day that can be eaten or

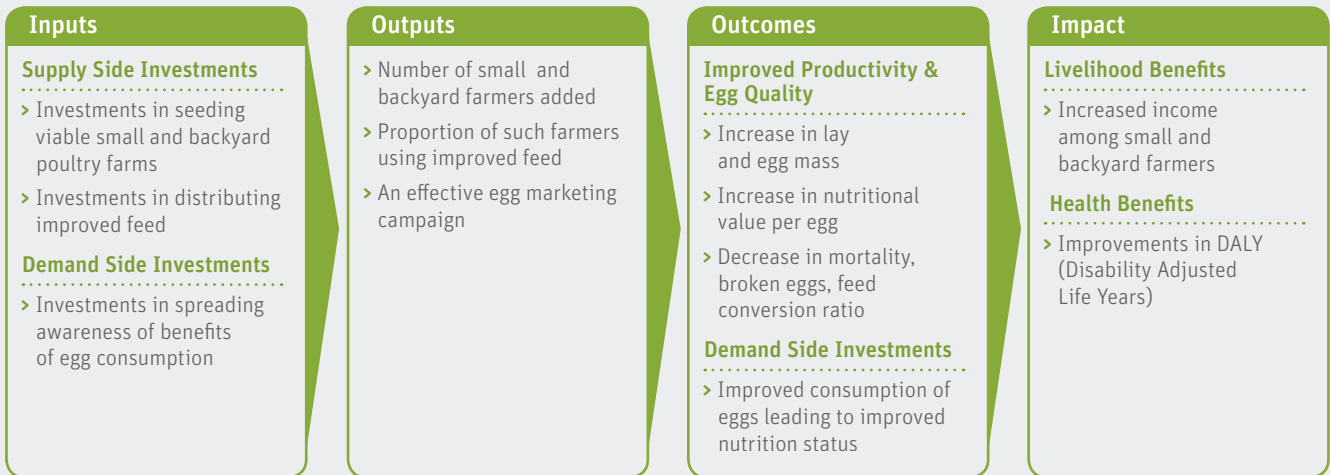
sold. Because of urbanization, economic growth and a change in consumption patterns in developing countries, the demand for eggs in these countries is projected to increase by 70%, and for poultry meat by 170%, between 2010 and 2050.³

“The demand for eggs in developing countries is projected to increase by 70% between 2010 and 2050”

The Forum of the Future⁴ identified feed innovation as an area for immediate action to meet the demand for animal protein. This makes the idea of tapping into the potential of eggs extremely “eggciting.” Optimized feed for chickens could support farmers through improved egg production and benefit consumers by providing added nutritional value. The nutritional content of eggs is to a certain extent a function of the hen’s dietary intake, and optimal diets improve all phases of egg production: increased egg numbers, egg weights, percentage lay and increased feed efficiency.^{5,6,7} In the case of many micronutrients, egg content responds to dietary changes within just a few weeks, providing an excellent opportunity to improve the nutritional value of eggs with only limited input in the feed. The transfer efficiency from feed to egg depends on the nutrient and can be high (vitamin A, selenium, iodine, and docosahexaenoic acid [DHA]), medium (vitamins D₃ and E), or low (folic acid, niacin, and iron).^{8,9}

We present our findings here from a recent study in India on how to crack this potential, possible approaches, and likely costs and benefits of such an approach. Through literature review and interviews with eleven experts in backyard poultry farming models, we reviewed business models that engage backyard farmers through micro-leasing, community farming, micro-credit, and micro-distribution of inputs. We also reviewed rural marketing campaigns in India and nutrition education interventions. We found that these models could overcome several challenges that traditional backyard poultry farmers face: high mortality of chicks; low productivity due to high input costs; and limited access to resilient breeds, vaccines, feed, and extension services.

FIGURE 1: Theory of Change: Introducing improved feed for backyard poultry farming and a social marketing campaign to improve awareness of benefits of egg consumption.



The theory of change

Findings from our primary research show that three areas require the most attention:

1. Empower small and backyard poultry farms that can address the issue of unmet demand for eggs among rural populations.
2. Extend the benefit of improved poultry feed to small and backyard poultry farmers.
3. Design compelling marketing campaigns to reinforce the benefits of eggs

For any approach to succeed, a coordinated effort is necessary to improve both the supply of eggs (by making them easily available and affordable to rural women with young children) and the demand for eggs (by increasing egg consumption among children under the age of five). In **Figure 1**, we describe the theory of change of intervening in the egg value chain.

Supply-side investments in backyard poultry

In many parts of rural India, especially those with a high prevalence of child malnutrition, the supply of eggs is far below the market demand. Large commercial poultry farms with flock sizes in the thousands often neglect this customer segment and prefer to focus on meeting urban demand. Backyard poultry farming

FIGURE 2: Keeping and feeding backyard poultry



Backyard chickens in a coop



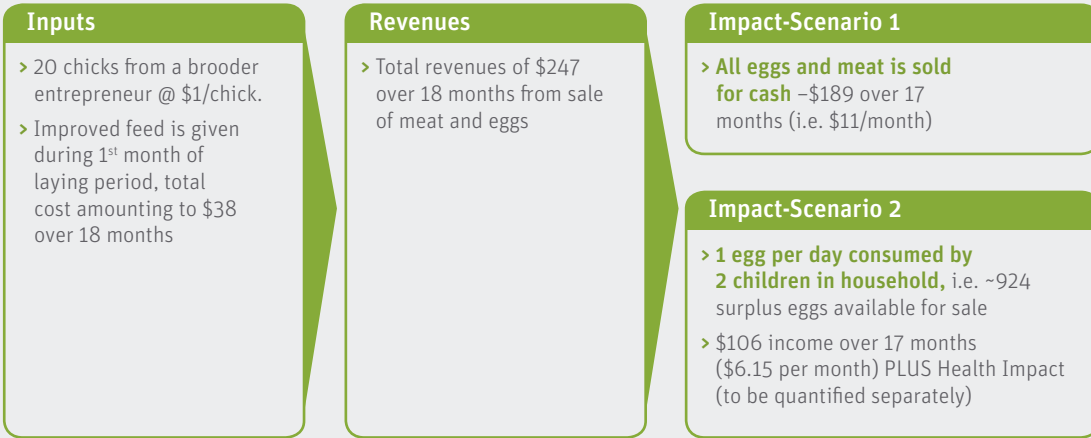
Mixing the feed for the chickens



Feeding the chickens

Photo credits: Anne Milan

FIGURE 3: Economics of an Indian backyard farmer using improved feed



with small flocks of 5 to 20 birds often serve as a good alternative to meet this demand. The birds primarily scavenge on kitchen waste, agricultural waste, and insects. However, in some of the models we reviewed, purchased feed is given as a supplement during brooding and laying stages (Figure 2).

A well-managed flock of 20 birds can provide an egg a day for up to five children, serving the family as well as providing surplus for their neighbors. Our analysis shows that a woman farmer taking up backyard poultry can earn a monthly supplemental income of approximately US\$6 while also ensuring the nutritional needs of two children in the family (Figure 3).

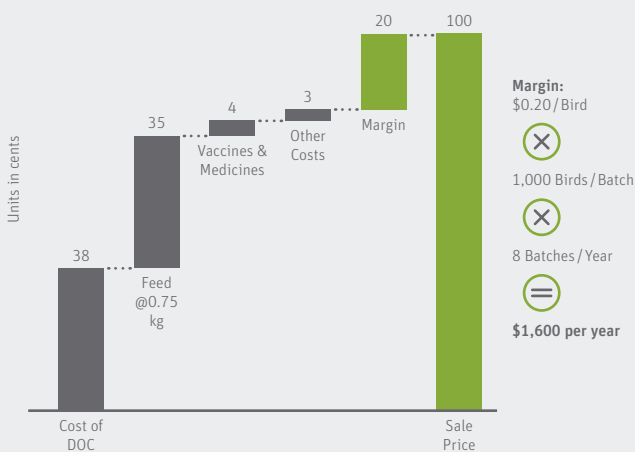
A critical element in the development of backyard poultry supply chain is the role of aggregators – local entrepreneurs who

provide chicks of improved variety, administer vaccines, and in some cases, brood the chicks to 30 to 45 days age, by which point they are hardier when introduced into a farmer’s backyard. These aggregators are local micro-entrepreneurs who, with an initial investment of around \$2,500, can earn \$1,600 in annual income (Figure 4). In addition to developing aggregators, offering small subsidies to women with children under five can also ensure better targeting.

“A critical element in the development of backyard poultry supply chain is the role of aggregators”

FIGURE 4: Economics of brooding aggregator

Costs per Bird over a 30-day Brooding Cycle



DOC: day-old chicken

Demand-side investments to stimulate increased egg consumption

One of the most common communication models used in rural markets is AICDA – Awareness, Interest, Conviction, Desire and Action. Any static or dynamic promotional elements should get the prospect’s attention, foster the consumer’s interest in the offer, build a desire (and conviction) for the product or service and generate a favorable action by the customer¹⁰ (Table 1).

An effective rural marketing campaign to spread the message of the benefits of egg consumption should be built on the following pillars:

1. Focus on three to four below-the-line marketing tactics: A message that is primarily addressed to mothers with young children is best delivered through the help of local influencers and participatory events, as well as broadcast vans.

TABLE 1: Rural communication model – AICDA

Promotional Element	Communication Objective or AICDA Level				
	Awareness	Interest	Conviction	Desire	Action
Dynamic					
Haat (rural open-air market) demonstrations	✓	✓			
Short campaigns	✓	✓			
Video shows	✓	✓			
Farmers’ meetings and village demonstrations	✓	✓	✓	✓	
Opinion leaders	✓	✓	✓	✓	
Personal selling			✓	✓	✓
Static					
Handbills	✓	✓			
Wall paintings	✓	✓			
Dealer signboards	✓	✓			
Audio jingles	✓	✓			
Caps, T-shirts, bags, calendars	✓	✓			

AICDA: Awareness, Interest, Conviction, Desire and Action

➤ Below-the-line marketing activities are broadly defined as those that offer direct, often personal communication to the target audience. These include advocacy channels such as salesforce; expert channels where independent experts engage with target buyers; and social channels consisting of neighbors, friends, family members and associates.¹⁰ These channels are less expensive to use than mass media, easier for tracking return on investment, and more effective – especially in rural areas, where they provide a platform for experience (trial and use) and feedback on the part of the end-consumer.

- Some above-the-line marketing spend may be required: Using radio and regional language television channels can help to reinforce the messages.
- Above-the-line is an advertising term used to describe advertising spend via mass media as a medium to promote and reach target consumers. This kind of advertising is usually aimed at reaching a larger number of consumers and is effective when the target group is very diverse and difficult to define. Commonly used mass media include broadcast media (television, radio); print media (newspapers, magazines, direct mail); and display media (billboards, signs, posters).
- Continued engagement through technology can help message retention: the use of text messages or robocalls to reinforce messages can make them “stickier.” Investments in continued engagement can also be used to tap into referrals and improve coverage through word of mouth.

- Use supply-side investments to reinforce messages: Point-of purchase displays on the supply side (i.e. aggregator’s shopfront, packaging material for improved feed) can also serve as secondary modes to reinforce messages.

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“The cost to save 1 DALY ranges from \$30 to \$76”

Our analysis shows that investments in the egg value chain are very effective, the cost to save 1 DALY (disability adjusted life year) ranges from \$30 to \$76, and an investment of \$1 has the potential to generate \$7.85 of sustainable income in the hands of rural women.

In conclusion, innovation in feed delivery models is needed to enable smallholders to improve their poultry-farming activities by using locally available resources combined with lower production costs, leading to improved yields as well as increases in the nutritional value of eggs. Social marketing campaigns focused on women and children will stimulate the consumption of eggs and hence improve the nutritional status of local populations, especially the most vulnerable.

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Six Important Characteristics of a Successful Microfranchisee

Towards a blueprint for nutrition enterprises

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Key messages

- > Social entrepreneurs drive social innovation and transformation in various fields including education, health, environment and enterprise development.
- > Microfranchising is a business model that applies elements and concepts of traditional franchising to small businesses or individual entrepreneurs in resource-poor contexts.
- > This field report attempts to bring various social entrepreneurial activities across Asia and Africa into the spotlight to uncover which factors make for a successful nutrition microfranchisee.
- > Our research has uncovered six key attributes that contribute to a microfranchisee's success in serving base-of-the-pyramid (BoP) customers:
 - > Women microfranchisees are preferred.
 - > A strong supportive network is beneficial.
 - > They work for their goal like their lives depend on it.
 - > They have a sufficient level of education.
 - > They speak the local language.
 - > They are well trained.

- > It is hoped that this case study will be the source of many other investigations, and that its lessons learned will serve as a reference point for many other nutrition start-ups in Africa.

According to the latest Global Entrepreneurship Monitor's (GEM) Social Entrepreneurship Report, published at the end of May 2016, social entrepreneurship and entrepreneurs are on the rise in both high- and low-income countries. *"Social entrepreneurs drive social innovation and transformation in various fields including education, health, environment and enterprise development. They pursue poverty alleviation goals with entrepreneurial zeal, business methods and the courage to innovate and overcome traditional practices. A social entrepreneur, similarly to a business entrepreneur, builds strong and sustainable organizations, which are either set up as not-for-profits or companies."*¹ Although they have sparked interest among academics, policy-makers and practitioners, investigations in the field remain limited when it comes to cross-national investigations. Cross-national analyses are valuable as they enable comparison and replication, and reduce the risk of disseminating non-generalizable results.²

Microfranchising is one of the most common tools social enterprises use to expand, while the microfranchisee is simply the individual recruited to run a unit of the microfranchise business. This field report is an initial attempt to bring various social entrepreneurial activities across Asia and Africa into the spotlight to uncover which factors make for a successful nutrition microfranchisee and can be attributed to the specific personal traits of the entrepreneur him- or herself and his or her environment. This report is the first of a series through which we hope our findings will serve as a primary step towards the

development of a blueprint for nutrition enterprises. Whether you are a franchisor, an entrepreneur, academic, government representative or researcher, these discoveries may help you fine-tune your franchising strategy, your entrepreneurial profile or your recruitment tactic.

.....
“Finding the same empirical patterns in different countries provides evidence that the same explanations of entrepreneurial phenomena have broad empirical support and, hence, deserve greater confidence for applications in any one situation”²

A successful microfranchisee can be hard to find

But before delving into this subject, let us take a step back and further frame this topic by defining the term “microfranchising.” In fact with its increasing popularity has come less certainty about what exactly microfranchising means, which has led to all sorts of initiatives now being called microfranchises.³ At *Sight and Life*, we like to refer to the following definition of the word: “Microfranchising is defined as a business model that applies elements and concepts of traditional franchising to small businesses or individual entrepreneurs in resource-poor contexts. It refers to the systemization and replication of microenterprises and to the provision of goods and services in low-income areas where access is poor, prices are inflated and counterfeiting is rampant.”⁴

Microentrepreneurs can now become part of a well-established franchise network with very small upfront investments. Needless to say, not everyone is an entrepreneur. While it has long been assumed that people living in poverty were natural entrepreneurs because so many of them own small enterprises, this hypothesis has widely been rejected in that most of them are entrepreneurs by necessity, not by choice.⁴ Indeed, our research has uncovered six key attributes which contribute to a microfranchisee’s success in serving base-of-the-pyramid (BoP) customers. The terms “franchisee” and “entrepreneur” are used interchangeably throughout this article.

Methodology

Seven case studies were chosen (Table 1). Each of them met the following inclusion criteria:

- > Microfranchises serving BoP customers
- > Microfranchises achieving a certain level of success

- > Microfranchises selling health-related products
- > Microfranchises located in Asia, Africa or Latin America

We compared elements at work across all case studies and teased out which key factors were most likely to contribute to a microfranchisee’s success. Four categories helped us classify the information we came across, and these are: gender, support network, socioeconomic status (SES) and skills/character traits. We then looked for characteristics related to the person him- or herself and his or her environment and excluded elements related to the way the enterprise was set up, its strategy, structure and implementation (Table 2). Since 2013, *Nutri’Zaza’s* entrepreneurs, the so-called *animatrices*, have been employed by *Nutri’Zaza*, and are thus officially no longer considered as entrepreneurs on the ground. Nevertheless, although their official status has changed, much can be learned from this social business’s recruitment strategy, and hence it is included and explored in this review. *Sizanani Mzanzi*, the South African microfranchising business founded by *Sight and Life* and DSM South Africa in 2014, also appears in this article. Its lessons learned were cross-checked against the results of the literature search and provide additional evidence to support our preliminary findings or shed light on outliers that require more attention. Microfranchises with differing missions (e.g., eyeglasses, nutrition, clean energy, hygiene) were deliberately included with the aim of increasing the generalizability of the outcomes and their applicability in any one situation.

Analysis

✓ Women microfranchisees are preferred

Although harder to recruit due to family and cultural influences on the role of women in low- and middle-income countries, female microfranchisees tend to perform best. Not only are they the main consumers, but there is enough evidence to support the view that they are much more focused on the greater good. In fact, research suggests that as women earn higher wages, there is a cascade of potential benefits to their social and economic wellbeing, translating into better educational, nutritional, health and productive outcomes for their families and communities.

.....
“As women earn higher wages, this translates into better educational, nutritional, health and productive outcomes for their families and communities”

TABLE 1: Description of case studies

Name	Type	Product	Scale	Geography
Shakti	Microfranchise	Hindustan Unilever Limited (HUL) products that promote better health and hygiene	Project Shakti has over 72,000 micro-entrepreneurs supported by 48,000 Shaktimaans ⁵	India, Bangladesh, Sri Lanka
Global corporation Unilever established its Shakti microfranchise model in the year 2000 to reach millions of potential customers in remote parts of rural India. Project Shakti is an initiative to financially empower rural women and create livelihood opportunities for them. It provides a regular income stream for the Shakti entrepreneurs and their families.				
VisionSpring	Microfranchise	Eyeglasses	More than 360,000 eyeglasses sold across four continents and 11 countries since 2001 ⁶	40 developing countries in Latin America, Africa and Asia
"Each Vision Entrepreneur receives his or her own Business in a Bag, a microfranchise sales kit containing all the products and materials needed to market and sell eyeglasses. Vision Entrepreneurs undergo a three-day training in basic eye care and business management and receive close, ongoing support from staff. Equipped with their Business in a Bag, Vision Entrepreneurs conduct educational outreach on vision care and offer screenings in their communities." ⁷				
wPOWER India	Microfranchise	Clean Energy	1,010,000 people reached through clean energy awareness and 200,000 households reached ⁸	India
"The Partnership on Women's Entrepreneurship in Clean Energy program (wPOWER India) has built and empowered a network of over 1,000 women clean energy entrepreneurs, who work in rural underserved areas. They enable market-based solutions to work for rural communities that have a concrete need for modern energy solutions." ⁸				
Solar Sister	Microfranchise	Clean energy technology	Since 2010, more than 700,000 people have gained access to light and energy through Solar Sister ⁹	Africa
Solar Sister eradicates energy poverty by empowering women with economic opportunity by combining the breakthrough potential of clean energy technology with a deliberately woman-centered direct sales network to bring light, hope and opportunity to even the most remote communities in rural Africa. ⁹				
Living Goods	Living Goods	Goods and lifesaving medical supplies	At the end of 2014, Living Goods and partners were supporting roughly 1,300 health promoters serving a population of roughly one million ¹⁰	Uganda, Kenya, Zambia and Myanmar
Living Goods employs and trains local people – the majority of whom are women who sell goods and lifesaving medical supplies at competitive prices. Living Goods provides businesswomen and saleswomen with employment and entrepreneurial skills while improving health outcomes in their communities. ¹¹				
Nutri'Zaza	Microfranchise	Koba Aina: fortified porridge flour mix and ready-to-eat porridge	About 100 jobs created; 34 Hotelin-Jazakely ('restaurants for babies') and more than 9 million units of Koba Aina distributed in 2015 ¹²	Madagascar
A social business, the goal of which is to sustainably combat chronic child malnutrition in Madagascar. It was formerly a project called <i>Nutrimad</i> , supported by GRET, a French NGO. ¹³ <i>Nutri'Zaza</i> distributes a food supplement called Koba Aina to disadvantaged populations through a network of restaurants for babies (<i>Hotelin-Jazakely</i>) and a home sale network, using <i>Nutri'Zaza</i> field employees, so-called <i>Animatrices Nutri'Zaza</i> . Since 2013, <i>Koba Aina</i> has also been selling single-serving sachets through retail.				
Sizanani Mzansi	Microfranchise	A fortified flavored instant porridge and fortified flavored powdered beverage	Too early to tabulate	South Africa
This social business's objectives range from bringing affordable, nutritious foods to vulnerable South African households to creating income-generating opportunities and building local capacity by involving low-income community members as microfranchisees. In addition to empowering gender equality, the project contributes towards improved nutrition, health, environmental resilience and sustainability. ⁴				

TABLE 2: Six characteristics of a successful microfranchisee

Name	Gender	Support Network
Shakti	HUL taps into the growing number of women's self-help groups (SHGs) and identifies and invites women to become <i>Shakti</i> entrepreneurs. ¹⁴ The women who are trained can then choose to set up their own business or to become Project <i>Shakti</i> distributors – or <i>Shakti Ammas</i> ('mothers'). ¹⁴	Furthermore, the <i>Shakti</i> program was extended to include <i>Shaktimaans</i> , who are typically the husbands or other male family members of the <i>Shakti Ammas</i> . ¹⁵
VisionSpring	Although the model does not purposely target female candidates, about 90% of current entrepreneurs are women. ¹⁷	VisionSpring looks for entrepreneurs with a good reputation and connections within the community to provide them with a solid customer base. ¹⁸
wPOWER India	wPOWER India solely recruits women entrepreneurs, and has built and empowered a network of over 1,000 female clean energy entrepreneurs. ⁸	The network of wPOWER India entrepreneurs, known as <i>Sakhis</i> , forms the core of wPOWER India, aided by multisector partnerships that enhance access to technology, finance and markets. ¹⁸ Evidence has shown that a <i>Sakhi's</i> success potential increases significantly if her business activities are approved and supported by her husband and family. ⁸
Solar Sister	Solar Sister recruits women only. ⁹ Management staff train and recruit Business Development Associates (BDAs), who are locally hired field staff and Solar Sister's direct link to entrepreneurs. In turn, each BDA recruits, trains and supports a group of 1–25 self-employed women entrepreneurs (Solar Sister entrepreneurs or SSEs). ¹⁹	Men are also encouraged to join and engage in their wife's work, to avoid family conflict when she earns money. ²⁰ The business model is based on the Avon model (which benefits from the powerful connections of women's social networks and highly personalized sales).
Living Goods	Living Goods rigorously trains Community Health Promoters (CHPs). Although Living Goods does not specifically target women, the typical CHP is a mother. ²²	Living Goods looks for a savvy and connected entrepreneur with rich social networks that he or she leverages to spread health education and build his or her business. ²² These businesses are based on the Avon model. ²²
Nutri'Zaza	<i>Nutri'Zaza's</i> recruits are mostly women entrepreneurs, known as <i>animatrices</i> . Each <i>Hotelin-Jazakely</i> (baby restaurant) is entirely managed by one or two <i>animatrices</i> , who prepare the ready-to-eat porridge and sell it. Most of them are mothers.	Women are part of <i>Sozazas</i> – associations that regroup <i>animatrices</i> and serve as an internal network whereby the interests of the <i>animatrices</i> are put forward and/or defended. ²⁵
Sizanani Mzanzi	<i>Sizanani Mzanzi</i> targets women specifically. ²⁶	A nonrestrictive invitation is sent to all potentially interested women. However, for the future franchisors, it was decided it would be preferable for the women to belong to an existing network (church, <i>stokvel</i> , community, school, political). ²⁶

A qualitative assessment conducted by Solar Sister reports that women's contribution to the household income has led them to play a larger role in deciding what proportion of the household budget is spent on themselves and their children. This trend is more noticeable for women than if men were the recipient. *Sizanani Mzanzi's* initial recruitment mandate in 2014 was women only; however, this was later revised to include male entrepre-

neurs. Nearly all case studies specifically target women, except for VisionSpring and *Nutri'Zaza*. Despite this difference, 90% of VisionSpring's current entrepreneurs are women and *Nutri'Zaza* has rarely had to recruit men, as very few of them apply for this type of work. In fact, most of *Nutri'Zaza's* entrepreneurs are mothers. Likewise, the typical Living Goods entrepreneur, called a Community Health Promoter, is also a mother. For some so-

SES*	Skills character traits
Disadvantaged women living below the poverty line are identified and invited to become <i>Shakti</i> entrepreneurs. ¹⁶ For Unilever, these had to be individuals for whom earning US\$16 a month fundamentally changed their life, rather than just making life a little easier. ¹⁶	“Soft” skills, like confidence-building, as well as “hard” skills, such as selling and bookkeeping, are looked for. Confident and independent distributors who are motivated and committed to the cause are recruited. ¹⁶ Unilever considerably invests in trainings to develop such skills among the entrepreneurs. Language plays a key role, and <i>i-shaktis</i> ** content is available in the local language. ¹⁴ Moreover, HUL has a team of rural sales promoters (RSPs) who coach and help <i>Shakti Ammas</i> in managing their business. ¹⁵
Most candidates are unemployed prior to joining VisionSpring. ¹⁶ Additionally, VisionSpring looks for an adequate education level that will allow the candidate to run a business as well as someone who seeks a higher income to promote entrepreneurialism. ¹⁸	VisionSpring looks for entrepreneurs with potential leadership ability, ¹⁸ self-motivation and the ability to work under pressure to meet sales targets. ¹⁷
wPOWER India looks for an entrepreneur with enough education to influence business understanding and to communicate with and convince consumers. ⁸ The entrepreneur must be willing to invest, which in turn ensures that a <i>Sakhi</i> has a stake and interest in her clean energy business. In fact, wPOWER strongly believes that profits should not be the sole motivator and that a <i>Sakhi</i> must be committed to wPOWER India’s social objectives. ⁸	<i>Sakhis</i> need to be comfortable interacting with people and must be committed to the social objectives of wPOWER India. ⁸ These skills are partly passed on by means of trainings on clean energy technology, products, technical aspects of doing business, and knowing their customers. ⁸
Most families are subsistence farmers, with income of less than US\$2 per day. Most of the women are eager for the opportunity to earn income to help support their families. ²¹	Solar Sister gives attention to training women, supporting them and giving recognition. It acknowledges that women entrepreneurs gain important skills from trainings and ongoing mentorship support, and that they consequently become increasingly confident. ¹⁹
Living Goods looks for entrepreneurs with between six and 10 years of schooling. They should be able to pass a basic math/reading test in English. Unlike many microfinance organizations, Living Goods does not aim to help the neediest people start businesses. ²³	Microentrepreneurs must be literate in both the local language and English, and previous work experience or training in health or business skills is desired (but not mandatory). ²⁴
The <i>animatrices</i> originate from the poorest areas and have very little income or no income at all prior to joining the business. In terms of their level of education, they should be able to read and write. ²⁵	<i>Animatrices</i> must be able to speak Malagasy (the local language), whereas neither French nor English is required. Women with a flair for business and who have some experience in social work are preferred. Experienced and no longer active <i>animatrices</i> will coach four to five <i>animatrices</i> and play the role of quality assurer. ²⁵
Among the recruits, some are unemployed, others are employed part-time and/or are pensioners. None of them completed secondary school. <i>Sizanani Mzansi</i> recruits community-based entrepreneurs from low-income areas. ²⁶	<i>Sizanani Mzansi</i> focuses more on recruiting savvy entrepreneurs that require less support to launch and operate a business and who have more experience. Furthermore, it is mandatory for entrepreneurs to know the local language. English is not required. ²⁶

*Socioeconomic status (SES): education, income; ** *i-shaktis*: these are information “kiosks” that are operated and hosted by the *Shakti* Entrepreneur. *I-shaktis* give access to information on education, employment, agriculture, health, personal care, legal procedures, e-governance and entertainment.

cial businesses in India such as *Shakti* and wPOWER India, self-help groups (SHGs) have proven to be an ideal instrument to recruit women entrepreneurs by providing them with a safe and supportive environment (financial and social support) through which they are encouraged to take on entrepreneurial initiatives. Interestingly, the entire family is often involved when the woman is the primary entrepreneur, while men are much more likely

to do it alone. This additional support may be one of the factors that positively influence women’s entrepreneurial success.

✓ A strong supportive network is beneficial

Why are women the best microfranchisees? Much of their success is attributed to their powerful social network. “We look for women who are uber-connected in their communities. That’s the



An Indian woman in her VisionSpring glasses

currency,” says Chuck Slaughter, the founder of Living Goods.²⁷ By tapping into their relationships, social networks and social influence, women lay the foundation for a solid and personalized customer base, making it easier to build and extend a supply chain. Solar Sister, Living Goods and *Nutri’Zaza* resort to the Avon distribution channel, where social networks are crucial as sales depend on direct distribution such as door-to-door sales, bypassing wholesalers and retailers. Three of the case studies highlight the importance of families’ involvement, particularly the husbands. It seems that women whose husbands and/or other male family members are included and involved in their wife’s/female family member’s work are more successful in their business activities.

Shakti has gone as far as extending the program to women’s spouses and naming them *Shaktimaans*, who are none other than the male versions of their female counterparts, *Shakti Ammas*. Likewise, Solar Sister encourages men to join and engage in their wife’s work to avoid family conflict as soon as they start earning money. The network of wPOWER India entrepreneurs known as *Sakhis* forms the core of the microfranchise and goes beyond social networks: *Sakhis* closely engage with an enabling partnership ecosystem comprised of financing institutions, private sector, government and other stakeholders providing them with access to technology, finance and markets. *Nutri’Zaza’s* *Soazazas* are associations that regroup *animatrices* and serve as an internal network whereby the interests of the *animatrices* are put forward and/or defended, while *Sizanani Mzanzi* decided it would be preferable for the women to belong to an existing network(s) (church, *stokvel*, community, school, political) for future franchisors to improve the selection of more successful entrepreneurs. In South Africa, mothers are the pillar of the house, as they take

care of the family needs (while the man is at work) including diet and within available household funds. Consequently, they may be more inclined to know about the value of vitamins and minerals and influence the state of nutrition in the community.

✓ *They work for their goal like their lives depend on it*

According to John Alexis Guerra Gomez, “*The true social entrepreneurs are ghosts that never claim the glory for themselves, that work for their goal like their lives depend on it, because actually their lives do depend on it.*”²⁸ A good predictor for successful entrepreneurship is one’s socioeconomic status prior to becoming an entrepreneur. Evidence points to a positive correlation between low income and successful business. Nearly all case studies targeted unemployed women living below the poverty line and/or living in low-income areas. Part-time workers and even pensioners were targeted in some cases (e.g., *Sizanani Mzanzi*). Among the candidates recruited by *Sizanani Mzanzi*, a few suffered from life-changing events with drastic consequences for their quality of life (see **Box 1**). It seems that those who are already financially successful are some of the least motivated. Hindustan Unilever explains that they would look for someone for whom higher income would fundamentally impact their daily life rather than slightly improve it. *Sizanani Mzanzi* seconds this approach and indicates that this method encourages prospective candidates to value the opportunity once given and further promotes entrepreneurialism. Nonetheless, for others, low income is not enough and needs to be complemented with a will-



A Vision Entrepreneur ready to conduct vision screenings and sell reading glasses to customers. In Bangladesh, VisionSpring partners with BRAC.



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Solar Sister Fatma uses her networks (here a village savings and loan group) to sell products in Tanzania.

ingness to invest to ensure that profits are not the sole motivator to engage in entrepreneurial activities. *Nutri'Zaza* reflects this, too, and demonstrates a preference for women with a flair for business and with some experience in social work. Interestingly, Living Goods does not aim to help the neediest people to start a business: similarly to Hindustan Unilever and *Sizanani Mzanzi*, it seeks someone who is willing to invest, reflecting their stake and interest in engaging with the social business.

.....

“The best entrepreneur displays the right mix between not being needy and yet being someone for whom entrepreneurial activities would significantly and positively change their quality of life”

.....

Sizanani Mzanzi requires future entrepreneurs to pay a sign-up fee of R100.00 (US\$7.30) for the training, which would determine acceptance on the premise that only a committed prospect would pay the price to take advantage of the opportunity. *Sizanani Mzanzi*'s experience has revealed that entrepreneurs with less cash are unable to recover from shocks (death of a family member, credit sales, etc.). Moreover, the needy have developed a short-term view to most things. They want to gauge quickly what is in it for them, how quick the gain might be and how much effort might be required. Consequently, commitment levels are very low or else quickly evaporate. Regarding the *Shakti* project, each *Shakti* en-

trepreneur invests US\$220 in stock at the outset – usually borrowing from SHGs or microfinance banks. All in all, it seems that the best entrepreneur displays the right mix between not being needy and yet being someone for whom entrepreneurial activities would significantly and positively change their quality of life.

✓ *They have a sufficient level of education*

Our case studies seem to reflect a preference for recruiting women with a level of education that will allow them to run a business, influence it and enable them to communicate with and convince consumers. *Nutri'Zaza* recruits literate women; Living Goods recruits entrepreneurs with between six and 10 years of schooling, as they tend not to stick around if they have more, and the candidates should be able to pass a basic math and reading test in English. According to *Sizanani Mzanzi*, women who start off with low levels of education require upskilling that starts with very basic concepts, with slow increments of complexity in training, resulting in high costs. Equally, they must be assisted for a long time until they have mastered new skills.

This labor-intensive approach requires a significant amount of human capital to work. In this light, *Sizanani Mzanzi* decided to focus more on recruiting savvy entrepreneurs who require less support to launch and operate. However, it recruited women who had not completed secondary school yet had many years of working experience – hence their comprehension and spoken English was good. This is important to be aware of, especially in countries in which education was not available to everyone (e.g., in South Africa, due to *apartheid*). In such cases, adapting to the context is necessary. *Sizanani Mzanzi* therefore adjusted the criteria of education level to grade 10 (two levels lower than secondary completion).

Box 1: Perseverance – When business seems to be in your DNA

As an experienced seller with over 15 years of informal and formal sales expertise, you would expect Adelaide to be flamboyant, expressive and a convincing negotiator. That is not the case – her calm and quiet (introverted) nature may be part of her learned strategy that has made her a successful microfranchisee.

Her narrative of her youthful days reveals a driven individual who traveled and sold various personal care and household products in several southern African countries including Botswana, South Africa, Swaziland and Lesotho. A tragic car accident while en route to sell brought this adventurous entrepreneur's activity to a halt, leaving her with a back injury that causes discomfort every now and then.

With a reduced appetite for travel but an increased need to care for her family, she was forced to be flexible and to work with the constraints and opportunities within her immediate residential area. One such opportunity was Sizanani Mzansi. Adelaide was one of the 20 participants of the successful 2014 micro-franchising pilot in Ivory Park, which led to the establishment of Sizanani Mzansi Non-Profit Company (NPC).

Adelaide's sales results since the pilot show consistency and demonstrate that she has mastered her model and way of interacting with consumers. Listening to her talk about strategy reveals a plotter who has become proficient at her trade. From lowering her own margins to push volumes through other sellers when she doesn't have time or capital, to identifying underserved markets and roping in friends and family to be the feet on the ground, she is a tactician. The wealth of experience that she has gained over time has given her both the insight and the maturity to make trade-offs when constraints exist, but also to remain nimble in her approach and reactions.

Every entrepreneur has his or her fair share of challenges to overcome, and certainly Adelaide is no exception. For example, some of her most reliable clients and even close family members have become bad debtors, resulting in losses or the injury that limited her mobility; the list is endless. Despite these hardships, Adelaide doesn't give up and remains focused on her goals, and she has the results to show that. As the most consistent and highest seller of all current microfranchises, one could say it's in Adelaide's DNA to pursue entrepreneurial activities and persevere in this sector.

Taurai Nyakunu



A Sizanani Mzansi entrepreneur hard at work selling nutritious products

✓ They speak the local language

Often, the ability to speak the local language reduces the suspicion and increases the trust between the microentrepreneurs and the end users. This higher level of trust allows the consumers to simply evaluate the products and services that are offered rather than be preoccupied with the ulterior motives of an outsider. For *Sizanani Mzansi*, women are not required to speak English. Instead, women who spoke Zulu and/or several other languages were preferred for appropriately reaching out to the local community. The same applies to *Nutri'Zaza*, where women are only required to speak Malagasy. With regard to Living Goods, microentrepreneurs must be literate in both the local language and English. An IT component of the *Shakti* project, *i-shaktis*, are IT-enabled community portals run by the *Shakti* entrepreneurs and designed to give rural people access to information on a wide range of topics, including Unilever products, employment, education, personal care, agriculture, health, legal procedures, entertainment and e-governance. Users can post queries on these subjects to local experts in their local language and access free content developed in their local language as well.

✓ They are well trained

The best entrepreneurs are not necessarily the ones with the highest risk tolerance and ability to develop new business ideas.⁷ Of course, entrepreneurs need to have hard skills, be able to sell and be able to keep the books, but soft skills – the ability and willingness to follow processes and procedures and a desire to learn – are often more important than having a high-risk tolerance or the ability to generate a new business idea. Trainings therefore make up an important part of the process, as they foster these much-needed soft skills among women.

Following the training, many women will feel more confident and independent as distributors. Additionally, other skills that relate more to one’s personality traits are extremely beneficial, such as the ability to work under pressure to meet sales targets, being committed to the social objectives of the business, having the ability to lead, self-motivation and feeling comfortable interacting with people. Recruiting women from below the poverty line in India brings its own challenges: It is difficult for them to visit the homes of those who are better off, while the caste system adds an extra layer of complexity. For the *Shakti* project, this meant teaching a lot of confidence-building, but also investing considerably in training and coaching women to become highly competent and confident business operators. Additionally, the daily reality of *Shakti* staff often requires arduous work in remote areas of the country. To do this, motivation and commitment to the cause are required.

Hindustan Unilever has a team of rural sales promoters (RSPs) who coach and help *Shakti Ammas* in managing their businesses. At wPOWER, *Sakhis* are provided training on clean energy technology, products, technical aspects of doing business, and knowing their customers on a regular basis. Clémence Boulle Martinaud, Nutrition Project Manager and social marketing expert at GRET, tells us that the most successful *Nutri’Zaza* entrepreneurs are the flexible ones who are keen to adapt to the demand (e.g., ensuring that the porridge is delivered at the same time on a daily basis for the baby in the baby restaurants). They also need to be motivated – carrying heavy thermos flasks containing ten liters of porridge requires some level of motivation! The *animatrices* benefit from continuous coaching: Experienced and no longer active *animatrices* will coach four to five

animatrices and play the role of quality assurer. Lastly, a flair for business and good relationships with the health authorities and agents are beneficial, as these give them increasing credibility and legitimacy among their networks.

To retain motivation, *Sizanani Mzanzi* scheduled bi-weekly meetings that served for both discussion and product stocking. Pre-set themed discussions ranging from successful sales tactics to bad experiences, challenges, prospecting plans, etc., were organized. Worth mentioning is the key role that social recognition seems to play: “*When my husband left, I had nothing. Today everyone knows me. I am someone,*” says Rojamma, a *Shakti* entrepreneur.²⁹ *Nutri’Zaza* explains that this increase in social recognition stems from the social nature of the business and its charitable objective for the most vulnerable – namely, the children. The women are proud and feel privileged to play such an important and valued role in society.

.....
“The women are proud and feel privileged to play such an important and valued role in society”

Conclusion and recommendations

Recruiting the right entrepreneurs is critical, and a tough call. The sustainability and overall success of an entrepreneurial activity depends a lot on finding the right person. Not just anyone can and will become a successful entrepreneur. While several organizations have tried to identify the exact combination of variables that would make a successful one, cross-national investigations in this area are rare, and this report is a modest attempt to put a spotlight on the key characteristics related to the person him- or herself and his or her environment and which make for a successful nutrition entrepreneur. Our investigation has revealed six common characteristics observed across different contexts (geographical setting, mission of the business), namely the following:

1. Women microfranchisees are preferred
.....
2. A strong supportive network is beneficial
.....
3. They work for their goal like their lives depend on it
.....
4. They have a sufficient level of education
.....
5. They speak the local language
.....
6. They are well trained
.....



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An “*animatrice*” (*Nutri’Zaza* entrepreneur) serving fortified porridge, *Koba Aina*, to a family



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Solar Sister Julieth Mollé serves dinner to her four grandchildren who live with her in her home near Arusha, Tanzania. Julieth has had a lot of success selling Solar Sister products to her community. She is now able to have a little savings put aside from her Solar Sister sales and to care for her family.

Our analysis has also revealed other elements which may have been overlooked and are worth considering, such as whether mothers are even more successful than women in general and whether age plays a role at all, and if so, in which direction (older, younger or mid-generation) and why? Some businesses (e.g., *NutriZaza*) go as far as requiring the candidates to have some health/nutrition knowledge prior to recruitment. It would be interesting to know to what extent this adds value to the business and leads to more success. Furthermore, although some level of education is beneficial, too much education may lead to high turnover rates – the right balance must be struck, but what is that balance? Some case studies highlight the fundamental role that context plays – overcoming the caste system in India, and historical aftermaths and their implications in South Africa.

Sizanani Mzanzi, the South African microfranchising business founded by *Sight and Life* and DSM South Africa, is a fascinating example in which many (if not all) of these elements are encountered. It is hoped that this case study will be the source of many other investigations, and that as it matures and improves, its lessons learned will serve as a reference point for many other nutrition start-ups in Africa.

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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**.

Appointment of Saul Morris as new Director of Programme Services at GAIN



On September 4, 2017, the lead author of the Lancet 2008 paper “Effective international action against undernutrition: why has it proven so difficult and what can be done to accelerate progress?” joined GAIN as the new Director of Pro-

gramme Services. Prior to this position, Dr Morris was Director of Nutrition at the Children’s Investment Fund Foundation (CIFF), and before CIFF, he was a Senior Program Officer at the Gates Foundation and a Senior Adviser at DFID. For the past 10 years, Dr Morris has been working to provide services to support teams in country to deliver innovative and impactful food and nutrition programs which combine public and private actors. Dr Morris will be based in London.

“I am incredibly excited to join GAIN as Director, Programme Services. Building strong alliances in nutrition is more important than ever, and I look forward to helping build on the impressive base that GAIN’s country offices have constructed over recent years [...] I have no doubt that the next few years will allow GAIN and its partners to show dramatic impacts from a portfolio of robust program implementation and bold innovation.”

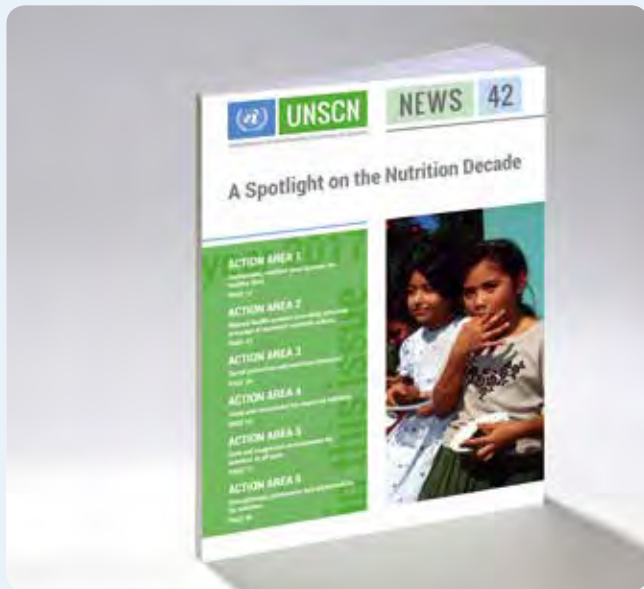
Dr Saul Morris

Sight and Life sends its best wishes and warm congratulations to Dr Saul Morris.

Did You Know?

- › Dr Morris was Senior Lecturer at the London School of Hygiene and Tropical Medicine in 1998–99.
- › CIFF commissioned the ethnographic research for the *Sight and Life* “Eat more, eat better” project, which targets pregnant and lactating women. The project examines how to improve eating habits through a behavior change intervention.

A Spotlight on the Nutrition Decade



This important document, published at the beginning of the Nutrition Decade by UNSCN, serves as a platform for various stakeholders to share tangible examples of how to eliminate malnutrition in all its forms. The publication features papers related to the Decade's six action areas identified in the ICN2 Framework for Action, namely:

1. Sustainable, resilient food systems for healthy diets;
2. Aligned health systems providing universal coverage of essential nutrition actions;
3. Social protection and nutrition education;
4. Trade and investment for improved nutrition;
5. Safe and supportive environments for nutrition at all ages; and
6. Strengthened governance and accountability for nutrition.

Setting out the Nutrition Decade is a continuous, collaborative and inclusive undertaking, whose success depends on connecting the varied and independent initiatives of governments and their many partners. The papers in this publication reflect medium- and long-term views and provide an interesting assortment of recommendations for action. This collective thinking and joint action towards one common goal is necessary to reach the tipping point that leads to transformative and systemic change. Moving forward, UNSCN looks to the examples provided in these papers to inspire and encourage nutrition stakeholders to act in line with the 2030 Agenda

for Sustainable Development, and the different national and regional strategic frameworks.

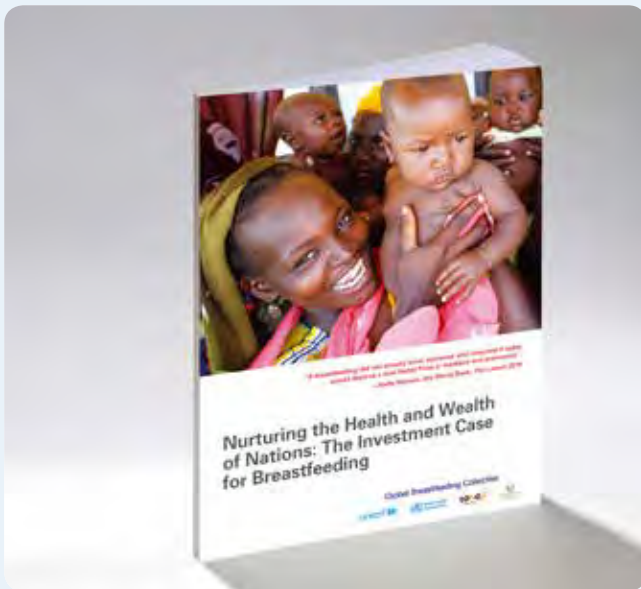
“Setting out the Nutrition Decade’s Work Programme is an inclusive, continuous and collaborative process, building upon and connecting the independent initiatives of governments and their many partners. The UNSCN is supporting these efforts by collecting the ideas and contributions of all relevant actors through online discussions and by exploring the issues raised through this edition of UNSCN News” *Michel Mordasini, UNSCN Chair*

You can read the report here: www.unscn.org/uploads/web/news/UNSCN-News42-2017.pdf

Did You Know?

- > More than 45,000 of you have already downloaded the publication!
- > How did this document come about? Through its Resolution 70/259, the UN General Assembly called on UNSCN to support the Nutrition Decade. UNSCN therefore launched the Call for Contributions to which many responded.
- > UNSCN distributes a quarterly e-newsletter which you can sign up to here: www.unscn.org/en/newsletters

Nurturing the Health and Wealth of Nations: The Investment Case for Breastfeeding



The case to invest in breastfeeding has never been stronger – yet, investments in breastfeeding remain far too low. In fact, it is estimated that annually only US\$85 million is spent by donors, and about US\$250 million by governments, on breastfeeding programs in low- and middle-income countries. This key report published by UNICEF & WHO in collaboration with the Global Breastfeeding Collective, provides a financing analysis justifying increased investment in breastfeeding. It demonstrates that an annual investment of only US\$4.70 per newborn is required to increase the global rate of exclusive breastfeeding among children under six months to 50% by 2025. The report further suggests that meeting this target could save the lives of 520,000 children under the age of five and potentially generate US\$300 billion in economic gains over 10 years, due to reduced health care costs and illness and increased productivity. Likewise, the analysis shows that in five of the world's largest emerging economies, namely China, India, Indonesia, Nigeria and Mexico, the lack of investment in breastfeeding has led to an estimated 236,000 child deaths per year and US\$119 billion in economic losses.

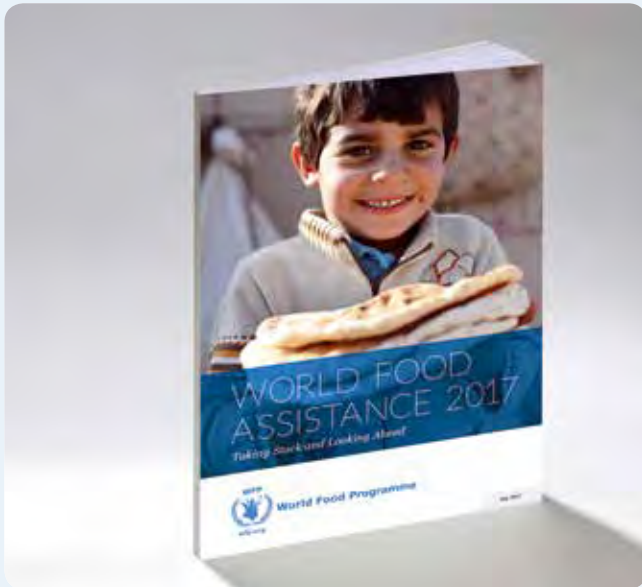
“If breastfeeding did not already exist, someone who invented it today would deserve a dual Nobel Prize in medicine and economics”

*Keith Hansen, the World Bank,
The Lancet 2016 Dr Saul Morris*

Did You Know?

- Breastfeeding is one of the best investments in global health: every US\$1 invested in breastfeeding generates US\$35 in economic returns.
- The Global Breastfeeding Scorecard documents key indicators on the programs and policies that affect breastfeeding rates and gives current information on global breastfeeding rates. The Scorecard evaluated 194 nations, and found that only 40% of children younger than six months are exclusively breastfed and only 23 countries have exclusive breastfeeding rates above 60%. Have a look at the rates by clicking on this link: www.who.int/nutrition/publications/infantfeeding/global-bf-scorecard-2017.pdf?ua=1
- During the World Breastfeeding Week in August 2017, the new Global Breastfeeding Collective was established to highlight the importance of breastfeeding and to accelerate progress towards international breastfeeding targets. The Collective is a partnership of NGOs, academic institutions and donors led by UNICEF and the WHO.

04 Compendium of Indicators for Nutrition-Sensitive Agriculture



More than 100 million people currently face severe food insecurity and almost 800 million suffer under chronic hunger. World Food Assistance 2017 is a new global report which shows how food assistance saves lives in humanitarian crises while addressing the root causes of hunger. The report also highlights the huge costs that are linked to poor humanitarian access, inefficient food systems and instability. It further aims to build understanding about the scale, reach and composition of these “food assistance” measures over time and space; current and emerging challenges and opportunities facing food assistance providers and participants; and options for policy-making and investment to boost the relevance and impact of food assistance under the 2030 Agenda for Sustainable Development.

Three questions are addressed throughout the report:

1. What are the levels, trends and patterns of food assistance at global, regional and national levels?
2. What are the primary challenges facing design and delivery of food assistance in different contexts of food system functioning?
3. How are these challenges being met? That is, what kinds of innovations in food assistance are being developed to address the challenges?

To download the report, click here:

docs.wfp.org/api/documents/WFP-0000019564/download/?_ga=2.182390564.2048301678.1504178353-770383812.1501691633

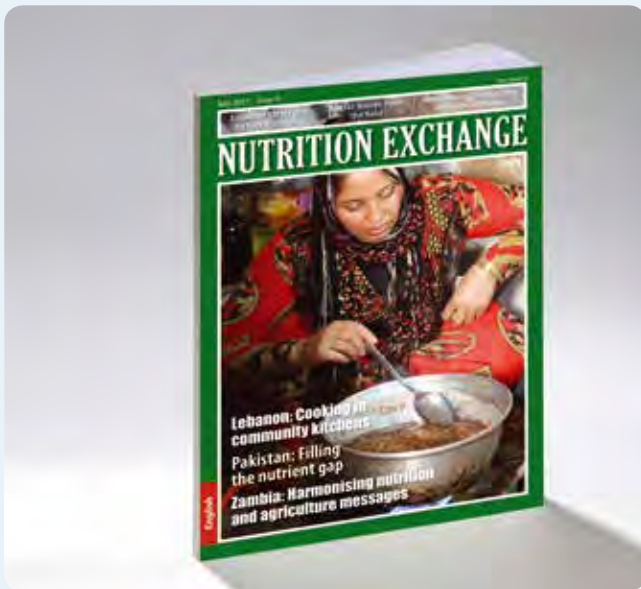
“By ‘food assistance’ we do not mean old-style ‘food aid’ handouts, but rather the full range of instruments, activities, and platforms that empower vulnerable and food-insecure people and communities so they can regularly have access to nutritious food”

David Beasley, Executive Director, WFP

Did You Know?

- > In 2017 alone, food crises have made 108 million people worldwide severely food-insecure.
- > Find out more about the link between urbanization, food security and nutrition in this excellent chapter of the new edition of Nutrition and Health in a Developing World. You can download your own copy of the book here: link.springer.com/chapter/10.1007%2F978-3-319-43739-2_32

ENN's 8th issue of Nutrition Exchange (NEX)



The 8th issue of Nutrition Exchange (NEX) is out! NEX is ENN's publication that captures short, non-technical and easy-to-read articles on nutrition program experiences and learning, from countries with a high burden of under-nutrition and those that are prone to crisis. The report also summarizes research and provides information on guidance, tools and upcoming trainings in nutrition and related sectors.

In this issue, NEX focuses on longer-term development actions such as community kitchens and school feeding programs in Lebanon, Ecuador's policies to tackle overweight and obesity, efforts in Pakistan to "fill the nutrient gap", and initiatives to make agriculture nutrition-sensitive in Ethiopia and Zambia.

Nutrition Exchange targets all those working to combat under-nutrition at the community, district and national level such as government, civil society and all sectors concerned with nutrition including health, social protection, education, agriculture, water and sanitation.

The publication can be downloaded at:

files.enonline.net/attachments/2646/NEX-8_English.pdf

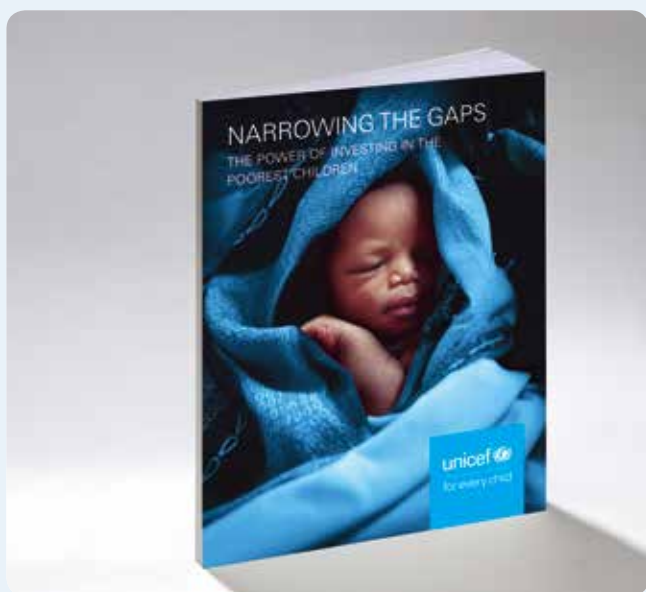
To subscribe to NEX, click here:

www.enonline.net/subscribe/nex

Did You Know?

- › Nutrition Exchange is available in English, French, Spanish and Arabic.
- › Another of ENN's flagship publications is Field Exchange (FEX), a technical publication on nutrition and food security in emergencies and high burden contexts. The latest and 55th edition can be downloaded here: files.enonline.net/attachments/2660/FEX-55-Web_share.pdf
- › ENN runs en-net, a free and open resource to help field practitioners have access to prompt technical advice for operational challenges for which answers are not readily accessible. Have a look at their forum here: www.en-net.org/

Narrowing the Gaps: The power of investing in the poorest children



This groundbreaking report presents compelling new evidence that on average, every US\$1 million invested in the health of the poorest children prevents nearly twice as many deaths as an equivalent amount spent on providing the same interventions for non-poor children. Consequently, investing in the health and survival of the most deprived children is not only right in principle, it is also the smart thing to do.

The study draws from new data from 51 countries where around 80% of all newborn and under-five deaths occur. Results reveal that improvements in coverage of life-saving interventions among poor groups helped reduce child mortality nearly three times faster than among non-poor groups.

These conclusions come at a critical time, as governments continue their efforts towards achieving the SDGs, which set a target of ending all preventable deaths among newborns and children under the age of five by 2030.

You can download the publication here:

www.unicef.org/publications/files/UNICEF_The_power_of_investing_in_the_poorest_children.pdf

“Children growing up in poverty are nearly twice as likely to die before reaching their fifth birthday as children living in better circumstances” UNICEF

Did You Know?

- > This report follows up on the “Narrowing the Gaps to Meet the Goals” report published by UNICEF in 2010. At the time, the publication justified the need for an equity-focused approach to child survival and development as the most cost-effective and practical way of meeting the health Millennium Development Goals for children.
- > The SDGs have set a target of ending all preventable deaths among newborns and children under the age of five by 2030. Unless greater progress in reducing child mortality is achieved, by 2030 almost 70 million children will have died before reaching their fifth birthday.

Evaluation Toolkits for Social Enterprises in Health

These recently published evaluation toolkits developed by Evidence Lab of the Social Entrepreneurship Accelerator at Duke (SEAD) and funded by USAID's Higher Education Solutions Network (HESN) are great resources for social enterprises that work in contexts where they lack the requirements for rigorous, gold-standard evaluations. In fact, this series of tools can help social enterprises in healthcare to evaluate their products, services and/or technologies. Donors and funders may use them to better understand what types of information are reasonable to request from social enterprises in health, or from their grantees.

Have a look at the different evaluation toolkits available:



Monitoring Organizational Reach and Influence:

globalhealth.duke.edu/sites/default/files/files/e_l_monitoring_org_inf_feb21.pdf



Monitoring Household Out-of-Pocket Health Expenditure:

globalhealth.duke.edu/sites/default/files/files/e_l_measuring_household_outofpocket_feb15.pdf



Economic Impact: Finding the right analysis for your evaluation needs:

globalhealth.duke.edu/sites/default/files/files/e_l_econtool.pdf



Strengthening Access and Quality of Care Patient Data:

globalhealth.duke.edu/sites/default/files/files/e_l_patienttool.pdf



Considerations in Leveraging Data for Expansion:

globalhealth.duke.edu/sites/default/files/files/e_l_expansiontool.pdf

Did You Know?

- > The SEAD is a five-year accelerator program of Duke University that brought together interdisciplinary partners through a coordinated effort across the university and leveraged institutional relationships and networks to create an integrated global health social entrepreneurship hub.
- > SEAD, in partnership with the US Agency for International Development (USAID) and the USAID Higher Education Solutions Network (HESN), mobilized a community of practitioners, investors, policy-makers, faculty, staff, and students to identify, assess, help develop, build capacity of, and scale solutions, technologies, and business models for healthcare delivery and preventive services in developing countries around the world.

Progress on Drinking Water, Sanitation and Hygiene: 2017 Update and SDG Baselines



This Joint Monitoring Programme report presents the first ever global estimates of water, sanitation and hygiene for the Sustainable Development Goals. It provides estimates of the population using “safely managed” drinking water and sanitation services – meaning drinking water free from contamination that is available at home when needed, and toilets whereby excreta are treated and disposed of safely. It also documents progress towards ending open defecation and achieving universal access to basic services. The report identifies several critical data gaps that will need to be addressed to enable systematic monitoring of SDG targets and to realize the commitment to “leave no one behind.”

Key findings of the report include:

- > Many countries lack data on the quality of water and sanitation services. The report includes estimates for 96 countries on safely managed drinking water and 84 countries on safely managed sanitation.
- > In countries experiencing conflict or unrest, children are four times less likely to use basic water services, and two times less likely to use basic sanitation services than children in other countries.

- > There are big gaps in service between urban and rural areas. Two out of three people with safely managed drinking water and three out of five people with safely managed sanitation services live in urban areas. Of the 161 million people using untreated surface water (from lakes, rivers or irrigation channels), 150 million live in rural areas

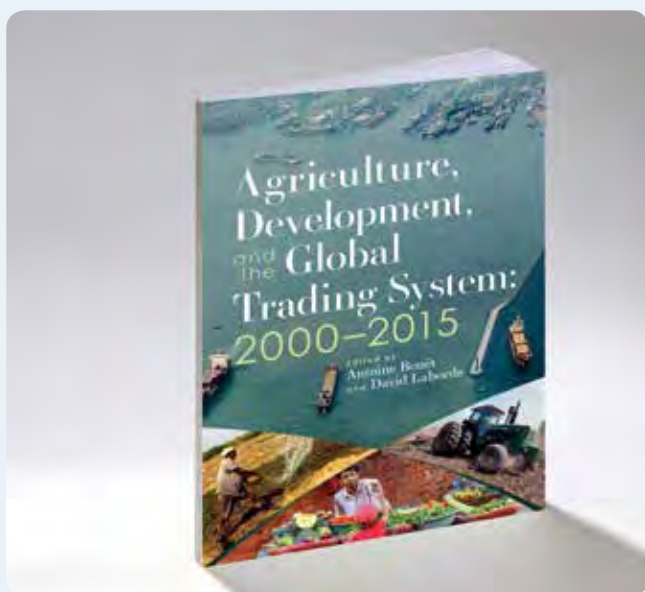
“Safe water, effective sanitation and hygiene are critical to the health of every child and every community – and thus are essential to building stronger, healthier, and more equitable societies”

Anthony Lake – UNICEF

Did You Know?

- > Some three in 10 people worldwide, or 2.1 billion, lack access to safe, readily available water at home, and six in 10, or 4.5 billion, lack safely managed sanitation
- > Dr Klaus Kraemer, *Sight and Life's* Managing Director, wrote a fascinating piece in the previous edition of the magazine, entitled “To WASH or Not to WASH”. The article provides an insightful perspective on the complexity of stunting and its relation to WASH. Read it here: sightandlife.org/wp-content/uploads/2017/07/Sight-Life-Magazine-To-WASH-or-not-to_WASH-1.pdf

Agriculture, development, and the global trading system: 2000–2015



Does global trade foster food security? IFPRI attempts to answer this crucial question in this thought-provoking book by unpacking the complex relationship between food security and global trade. This is a timely publication at a period where the global trading system is under intense criticism.

The book focuses on key elements, namely the Doha Development Agenda (DDA) and trade's influence on price volatility, and is constructed as follows:

- > **Part 1** is based on the premise that more trade integration can lead to poverty and hunger alleviation.
- > **Part 2** examines whether price volatility can be managed through more or less trade integration, and looks at policy instruments available for policy-makers to deal with price volatility such as export restrictions, crop insurance and food stocks.

- > The book concludes that a strong and efficient World Trade Organization (WTO) capable of leading ambitious trade negotiations is key to hitting the food security target.

You can download the book here:

www.ifpri.org/publication/agriculture-development-and-global-trading-system-2000%E2%80%932015

and order your own free hard copy of the book here:

www.ifpri.org/publication-request-form?nid=17970&title=Agriculture%2C%20development%2C%20and%20the%20global%20trading%20system%3A%202000%E2%80%932015

Did You Know?

- > Short on time? Have a read of the book's synopsis: www.ifpri.org/publication/agriculture-development-and-global-trading-system-2000-2015-synopsis
- > Read Joseph Glauber's insightful and related blog on "How trade barriers aren't the way to fix nutrition": www.ifpri.org/blog/trade-barriers-arent-way-fix-nutrition

The Global Fortification Data Exchange (GDFx)



Check out the website here:

www.fortificationdata.org

“The purpose of the GFDx is to empower governments, donors, implementing agencies and other members of the global health and development community to make data-driven decisions in the planning, resourcing and tracking of food fortification policies and programs.”

Designed by the fortification community, this fantastic new tool is intended to improve food fortification data availability for the development and global health sectors, and will continue to be updated and expanded with the most recent datasets, additional indicators and analyses.

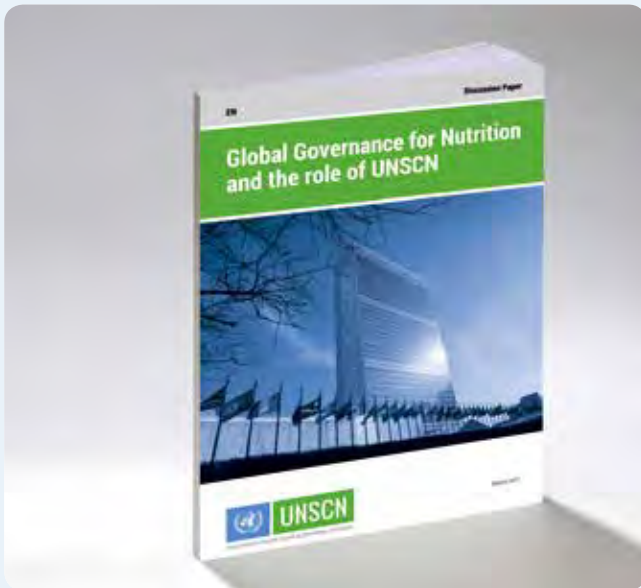
What can the GDFx do for you? The GDFx is an analysis and visualization tool that provides you with free access to data on food fortification. In its first release, the GDFx includes indicators on food fortification legislation from 1942 to the present as well as available standards, food availability, and intake for over 230 countries. In the future, it plans to include coverage data, quality data, and more as it is available. The tool enables you to generate custom maps, charts and tables, or download data for offline analysis.

Did You Know?

- > Your government, agency, company or institution can contribute by completing the following form: fortificationdata.org/#contact
- > The GDFx was developed by a cross-agency team in response to the 2015 Arusha Statement on Food Fortification.
- > *Sight and Life* published the proceedings of the #FutureFortified Global Summit on Food Fortification. Read it here: sightandlife.org/wp-content/uploads/2017/05/Sight_and_Life_FutureFortified.pdf
- > *Sight and Life's* 1/2017 magazine supplement (available in English & Spanish), written in collaboration with the WFP, is full of information regarding rice fortification in Latin America. Download the English version here: sightandlife.org/wp-content/uploads/2017/04/Scaling-Up-Rice-Fortification-WFP-Rice-Fortification-ENG.pdf

Key 2017 UNSCN Publications

There is so much happening in the nutrition community that one can get a bit lost! If that's you, then these two key publications of UNSCN might help you find your way ...



UNSCN Discussion Paper – Global Governance for Nutrition and the role of UNSCN

This excellent report aims describes the current nutrition architecture by proving a detailed overview of the main nutrition actors and their mandate. It highlights the role of UNSCN in the architecture focusing on the UN. Given the evolving nutrition landscape and the many direct and indirect nutrition-related agendas that are being pursued by a variety of state and non-state actors at the international, national and subnational levels, it is timely that, as the "strategic nerve center of the UN" and the UN committee tasked with setting the direction, scale, coherence and impact of the UN system response to nutrition problems globally, the UNSCN assesses the state of play in the global nutrition landscape and the governance arrangements therein.

You can download the report here:

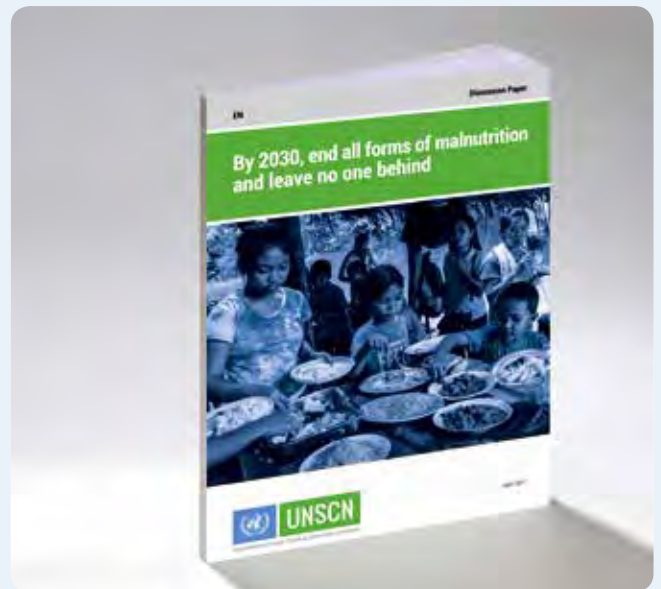
www.unscn.org/uploads/web/news/document/GovernPaper-EN-may17-WEB.pdf

UNSCN Discussion Paper – By 2030, end all forms of malnutrition and leave no one behind

Another excellent overview of the numerous and interrelated nutrition targets that have been agreed upon by intergovernmental bodies, placing these targets in the context of the SDGs and the UN Decade of Action on Nutrition. This paper nicely connects the dots between the various identified areas for policies and action. It aims to inform nutrition actors, including non-traditional ones, regarding opportunities to be engaged and connected in a meaningful way.

You can download the report here:

www.unscn.org/uploads/web/news/document/NutritionPaper-EN-may2017-WEB.pdf



India's First "Nutrition Atlas" Comes Online



Have a look at the Nutrition Atlas here:
218.248.6.39/nutritionatlas/home.php

“The prevalence and incidence of various nutrition and health parameters have been given for all 679 districts, wherever such information is available in the public domain”

The National Institute of Nutrition (NIN) based in Hyderabad has developed India's very first Nutrition Atlas. The atlas was developed to bring together in one place all the available data and information regarding the country's nutritional status and will be very useful tool for program managers, policy-makers, students, research, the media and other stakeholders. The data provided presents the nutritional status of various population groups at national and state levels, and accompanies this information with an overview of the prevalence of nutrition-related disorders and deficiencies throughout the country. Its interactive statistics and graphics make anemia, obesity, wasting, stunting and tuberculosis numbers come to life and give you a better understanding of India's double burden of malnutrition.

The atlas differs from other databases in that it includes both nutrition and health parameters. Moreover, the incidence and prevalence of a range of health and nutrition indicators is available for all 679 districts. The Nutrition Atlas will be regularly updated with the most recent data from the public domain, notably from sources including the World Health Organization, the National Health Family Survey, and the National Nutrition Monitoring Bureau, among other public databases.

Did You Know?

- > The National Institute of Nutrition (NIN) is a leading laboratory in the field of nutrition research under the Indian Council of Medical Research.
- > Read about *Sight and Life* and partners' recent nutrition & WASH project in Karnataka, India, in our previous magazine edition: sightandlife.org/wp-content/uploads/2017/07/Sight-Life-Magazine-School-Based-Strategy-1.pdf

Artificial Intelligence and Big Data to fast-track the fight against malnutrition in Africa



How can cutting-edge technology be used to tackle malnutrition in Africa? On September 9, 2017, the International Center for Tropical Agriculture (CIAT) convened about 150 delegates at the African Green Revolution Forum 2017 in Abidjan, Côte d'Ivoire, to discuss this essential question and the potential role that artificial intelligence can play in designing an effective nutrition early warning system (NEWS) for Africa.

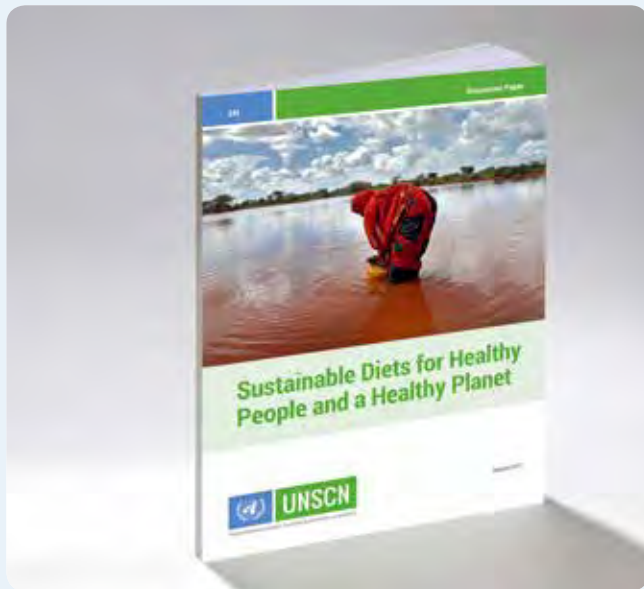
The “*Enhancing Africa’s Nutrition Resilience through Artificial Intelligence*,” high-level breakfast gathered experts from tech companies such as Facebook, Apple, and Microsoft with top agricultural specialists from the Africa Development Bank, the Alliance for a Green Revolution in Africa (AGRA), and many other international organizations including but not limited to UN organizations, the Graduate Institute Geneva, Johns Hopkins, Sheffield University, Cornell University, and the World Economic Forum. The meeting paved the way for further collaboration and development in the field and emphasized the need for a paradigm shift in this field.

“Things have to change: we have to use a different approach. Previous responses to malnutrition have relied on crisis data – from areas already in crisis mode. Today, we’re discussing how to analyze data from a range of sources, diagnosing crises well before they happen, allowing decision-makers to respond and tackle malnutrition threats well before they show up on any map.”

Did You Know?

- The Nutrition Early Warning System (NEWS) leverages big data and machine learning to track, monitor and prevent crises before they strike.
- The CGIAR Platform for Big Data in Agriculture works to harness the capabilities of big data to accelerate and enhance the impact of international agricultural research. Learn more about it here: blog.ciat.cgiar.org/cgiar-platform-for-big-data-in-agriculture
- Modelling Early Risk Indicators to Anticipate Malnutrition (MERIAM) is a four-year project whose primary aim is to develop, test and scale up models to improve the prediction and monitoring of undernutrition in countries that experience frequent climate- and conflict-related shocks. Find out more here: www.actionagainsthunger.org/meriam

14 Sustainable Diets for Healthy People and a Healthy Planet

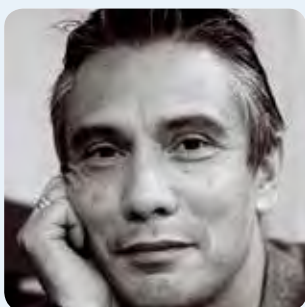


This highly relevant publication from UNSCN on the link between climate change and nutrition comes at a crucial time, as this topic has not been given the attention it deserves within the international community. The report looks at how to address climate change while promoting healthy diets and explains the need for trade-offs and how innovative approaches should effectively promote environmental sustainability considering the 2030 Agenda for Sustainable Development. The sustainability of food systems and of healthy diets is a key element in this process.

The full report can be found at:

www.unscn.org/uploads/web/news/document/Climate-Nutrition-Paper-EN-WEB.pdf

15 Martin Bloem Appointed Director of the Johns Hopkins Center for a Livable Future (CLF)



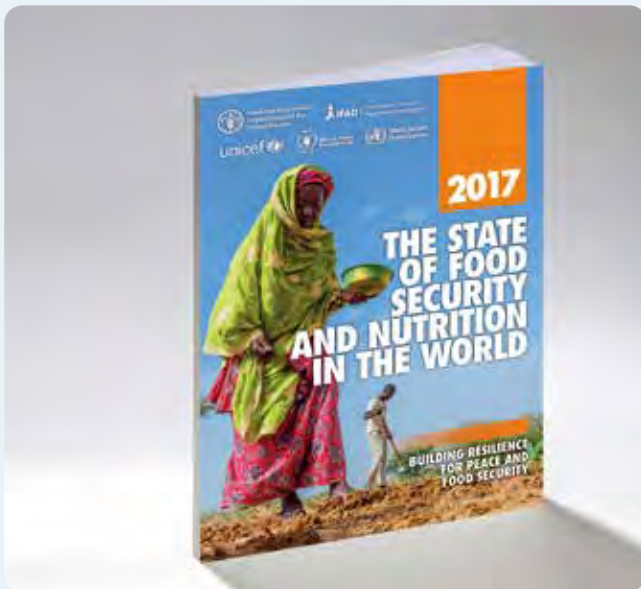
On November 15, 2017, Dr Martin Bloem – a leading expert in global food and nutrition research and policy – started his new role as Director of the Johns Hopkins CLF. Prior to this position, Martin was Senior Advisor to the United Nations World

Food Programme's (WFP) Deputy Executive Director and WFP's UNAIDS Global Coordinator. He also holds adjunct faculty appointments with Tufts University and the Bloomberg School's Department of International Health. Dr Bloem has devoted his career to improving the effectiveness of public health and nutrition programs through applied research and is a distinguished professional in nutrition, food systems and international health.

Did You Know?

- > Dr Martin Bloem holds a medical degree from the University of Utrecht and a doctorate from the University of Maastricht. He has co-authored and co-edited seven books and 105 peer-reviewed articles.
- > Read Dr Bloem's illuminating guest editorial entitled "The Right to Nutrients Should Be a Human Right" in *Sight and Life* 28 (1)/2014.

16 The State of Food Security and Nutrition in the World – Building Resilience for Peace and Food Security



For the very first time, the annual State of Food Security and Nutrition in the World (SOFI) report has been published by an expanded partnership, with UNICEF and WHO now joining FAO, IFAD and WFP. This year's SOFI report reveals that the long-term declining trend in undernutrition seems to have come to a halt and may in fact be starting to climb once more. Achieving the target of a world without malnutrition and hunger by 2030 will be a challenge and will require renewed efforts through new ways of working.

“World hunger is on the rise: the estimated number of undernourished people increased from 777 million in 2015 to 815 million in 2016”

Other key messages from the report:

- › The food security situation has worsened in parts of sub-Saharan Africa, South-Eastern Asia and Western Asia, and deteriorations have been observed particularly in areas of conflict and in areas of conflict combined with floods or droughts.

- › Childhood overweight and obesity are increasing in most regions, and in all regions for adults. Multiple forms of malnutrition coexist, with countries experiencing simultaneously high rates of child undernutrition, anemia among women, and adult obesity.
- › Conflict is a key driver of situations of severe food crisis and the recent return of famines, while hunger and undernutrition are considerably worse where conflicts are prolonged and institutional capacities weak.
- › A conflict-sensitive approach should be adopted to address food insecurity and malnutrition in areas affected by conflict. This approach should align actions for long-term development and peace, along with immediate humanitarian assistance.

You can download the report here:

docs.wfp.org/api/documents/WFP-0000022419/download/?_ga=2.211557013.1075716980.1509447426-770383812.1501691633

Did You Know?

- › Click here to read the executive summary of the report: data.unicef.org/wp-content/uploads/2017/09/SOFI2017_InBrief_EN_dtp5.Sep-08.pdf
- › You can view IFPRI's special event “Discussion on the Key Findings of FAO's 2017 State of Food Security and Nutrition in the World Report” on YouTube: www.youtube.com/watch?list=PLeqdWbb3Knj_k8m2vz10eE8NaF77dy7jV&v=yJIPzwrLqSY

1 Nutrition & Food Systems – A Report by the High Level Panel of Experts (HLPE) on Food Security & Nutrition



This brilliant report was launched at the CFS44 in October 2017, following a request from the Committee on World Food Security (CFS) in 2015. The purpose of the report is twofold:

1. To analyze how food systems influence people's dietary patterns and nutritional outcomes; and
2. To highlight effective policies and programs that have the potential to shape food systems, contribute to improved nutrition and ensure that food is produced, distributed and consumed in a sustainable manner that protects the right to adequate food for all.

The report is very action-oriented and provides a set of recommendations addressed to states and other stakeholders to inform CFS engagement in advancing nutrition and its contribution to the UN Decade of Action. While highlighting the need for context-specific solutions, the report also underlines the need for consistent and coherent action at all levels, and it calls for the establishment of individual, institutional and system-level collaborative engagement and coordination; for strengthening the integration of nutrition within budgets and national policies; and for addressing the impacts of trade agreements on food environments, among other things.

“This report demonstrates that human decisions and choices regarding production and consumption can influence food systems and improve their ability to deliver healthy and sustainable diets”

You can download the report here:

www.fao.org/fileadmin/user_upload/hlpe/hlpe_documents/HLPE_Reports/HLPE-Report-12_EN.pdf

Did You Know?

- > The HLPE is composed of a Steering Committee of 15 internationally recognized experts in a variety of food-security- and nutrition-related fields.
- > The HLPE was established in 2010 as the science-policy interface of the UN Committee on World Food Security (CFS) and aims to improve policy-making by providing independent, evidence-based analysis and advice at the request of the CFS.
- > Missed *Sight and Life's* 1/2016 edition on food systems? Read it here: sightandlife.org/wp-content/uploads/2017/02/SALF_Magazine_01_16.pdf

Goalkeepers Report – The Stories Behind the Data



On September 20, 2017, the first ever Goalkeepers event took place in New York and was streamed live across the world. The event, hosted by the Bill & Melinda Gates Foundation, brought together a generation of determined thinkers, doers and givers committed to sharing their ideas and work to help reach the Global Goal targets by 2030. The Stories Behind the Data is the Foundation's first annual progress report on the SDGs, and was developed in partnership with the Institute for Health Metrics and Evaluation (IHME).

The Gates Foundation's Goalkeepers report highlights past progress on some of the most challenging and pressing issues poor countries face and uses IHME's projections to show how the future might look under different scenarios. It tracks 18 data points included in the SDGs that are crucial to people's health and wellbeing. The first Goalkeepers report presents stories and numbers on child mortality; maternal mortality in Ethiopia; family planning in Senegal; HIV; financial services for the poor in India; and stunting in Peru.

“We are launching this report this year and will publish it every year until 2030 because we want to accelerate progress in the fight against poverty by helping to diagnose urgent problems, identify promising solutions, measure and interpret key results, and spread best practices”

The full report can be downloaded here:

www.globalgoals.org/goalkeepers/datareport/assets/downloads/Stories_behind_the_data_2017.pdf

Did You Know?

- > The Gates Foundation plans to release a new Goalkeepers report every year until 2030.
- > You can follow the hashtag #Goalkeepers17 for Twitter updates on the subject.
- > You can catch up on the event by watching the full streamed event right here: www.youtube.com/channel/UCRi8JQTnKQilJW15uzo7bRQ.
- > At the Goalkeepers event hosted in New York, The Power of Nutrition was chosen as one of the inaugural “accelerators”, recognized for driving progress towards achieving the SDGs.

Nourishing India – National Nutrition Strategy



With the aim of spreading awareness and formulating policies on the state of nutrition in India, the National Institution for Transforming India (NITI Aayog) released the National Nutrition Strategy in September 2017, which aims to ensure that every child, adolescent girl and woman attains optimal nutritional status by 2022. The strategy was developed through an extensive consultative process and lays down a roadmap for effective action in achieving nutrition objectives. The nutrition strategy envisions a framework wherein four determinants of nutrition – uptake of health services; food; drinking water & sanitation; and income & livelihoods – work together to accelerate the reduction of undernutrition in India.

Key messages of the report:

- > The National Nutrition Strategy outlines a framework that will focus on improvements in health, food, drinking water, sanitation, income and livelihoods.
- > The Integrated Child Development Services Mission will be expanded to form a National Nutrition Mission along the lines of the National Health Mission under the Ministry of Women and Child Development (WCD).

- > A decentralized approach will be promoted, with greater flexibility and decision-making at the state, district and local levels. The states will be asked to create customized, district-specific action plans with a greater role for rural and urban local bodies.
- > Nutrition outcomes will be monitored by NITI Aayog.
- > The strategy proposes targeting and tracking children from birth until they are three years old.

“The strategy enables states to make strategic choices, through decentralized planning and local innovation, with accountability for nutrition outcomes”

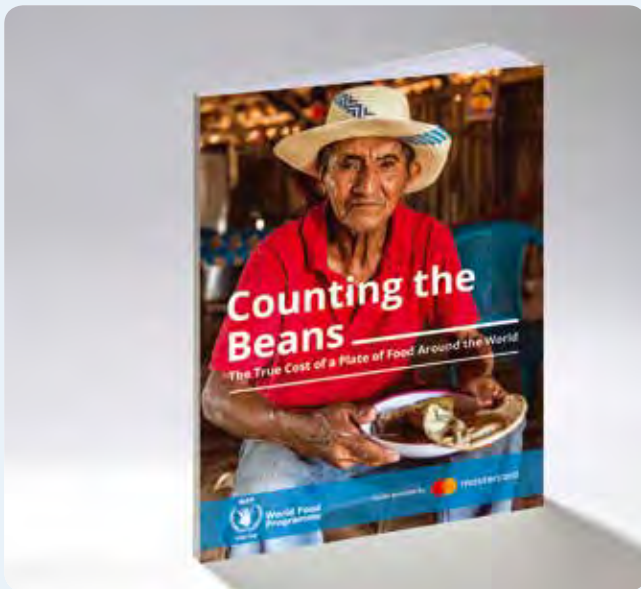
The full report can be downloaded here:

niti.gov.in/writereaddata/files/document_publication/Nutrition_Strategy_Booklet.pdf

Did You Know?

- > As a premier think tank of the Government of India, NITI Aayog provides innovation, entrepreneurial support and critical knowledge to the country.
- > You can read about *Sight and Life's* work in nutrition and WASH education at schools in Karnataka, India, in the *Sight and Life* 1/2017 magazine edition on Food Culture: sightandlife.org/wp-content/uploads/2017/07/Sight-Life-Magazine-School-Based-Strategy-1.pdf

2017 Counting the Beans – The True Cost of a Plate of Food around the World



A must-read work, this fantastic publication outlines the true cost of a plate of food around the world. The report is aimed as much at food and nutrition professionals as at humanitarians, development practitioners, policy-makers and the general public.

Much hunger and food insecurity is due to food being simply unaffordable. Counting the Beans is an attempt to establish the cost of a basic plate of food in selected countries and to report it back in Western terms. It is hard to imagine having to hand over half of our daily wage for a can of baked beans, yet this is the stark reality for people in many parts of the world where food as a share of personal income is incredibly expensive due to conflict, disasters (human-induced or otherwise), bad roads, wrecked ports, waste and ruined markets, to name but a few factors. This publication is both an illustration of wild disparities in the affordability of food and an attempt to disentangle the causes behind them.

Here is how WFP calculated the cost of food:

1. A standard meal was put together – in this case, a stew of beans with a carbohydrate component.
2. The quantity of each ingredient was then worked out.
3. The cost of the ingredients for a serving was calculated in the national currency of each country covered, and an average daily budget per person was estimated in local currency. This was derived from national GDP per capita figures.

4. The meal-to-income ratio was calculated.
5. A theoretical price was then calculated by retrospectively applying it to persons in a developed country vs. a developing country.

“While someone living in New York might spend just 0.6% of their daily income on the ingredients for making a simple bean stew, someone in South Sudan would need to spend 155% of their daily income”

The full report can be downloaded here:

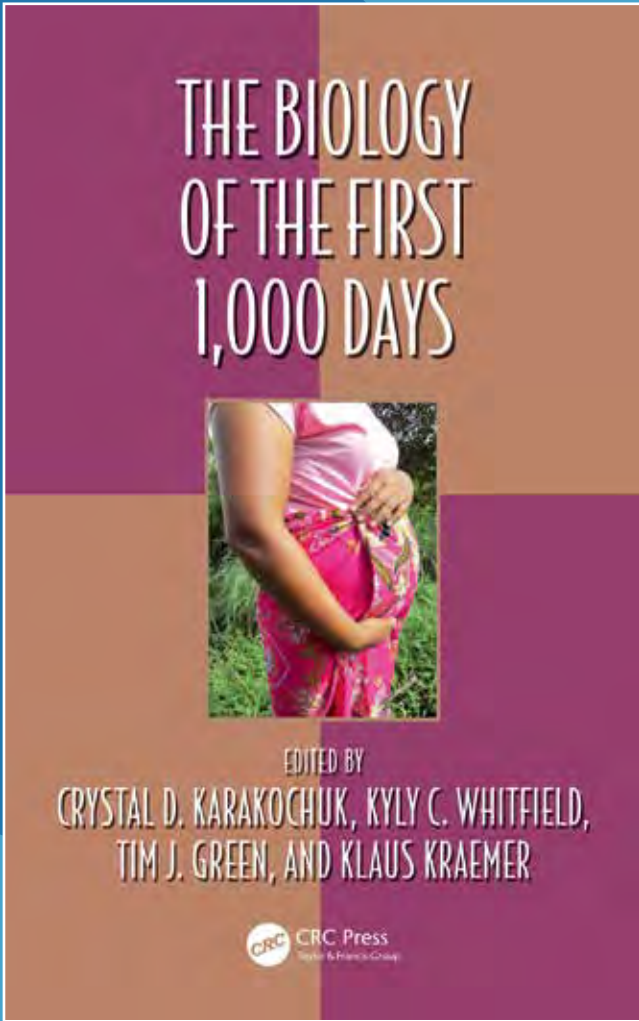
docs.wfp.org/api/documents/WFP-0000023327/download/?_ga=2.144299317.1075716980.1509447426-770383812.1501691633

Did You Know?

- › Counting the Beans’s online platform lets you interact with the data: choose where you live, then see what the relative cost of a simple plate of food is in another country. Try it out at wfp.org/plateoffood.

ADVERT

The Biology of the First 1,000 Days



This book addresses the importance of the **first 1,000 days**, from conception to two years of age, by **linking concepts** across all biological fields to outcomes such as **fetal growth** and **pregnancy results** or gut microbiome and cardiovascular disease happening later in life. The strength of this book lies in its cross-disciplinary nature.

FREE standard shipping when you order online at **crcpress.com!**

ISBN: 978-1-4987-5679-2



Editor's note: This section contains reviews of books, whether brand new or classic, that we hope will be of interest to our readers.

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Book Review

Nutrition and Health in a Developing World (Third Edition)

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Nutrition and Health in a Developing World (Third Edition)

ed. Saskia de Pee, Douglas Taren and Martin W Bloem

Publisher: Humana Press 2017

Series Editors: Adrienne Bendich and Connie W Bales

ISBN: 978-3-319-43737-8 ISBN 978-3-319-43739-2 (eBook)

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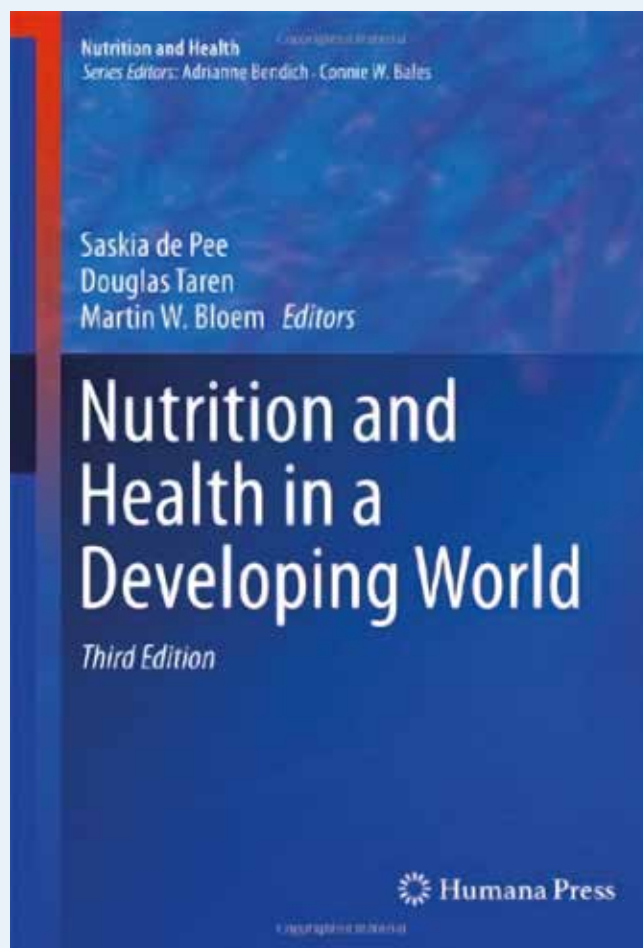
Library of Congress Control Number: 12016956634

This third edition of *Nutrition and Health*, which was last updated in 2008, shows how far the nutrition community has come in a few short years.

As Etharin Cousin, Executive Director of the UN World Food Programme from 2012 to 2017, explains in her Foreword to the 800-page volume: “Our collective efforts to achieve the Agenda 2030 goals – including number two, achieving Zero Hunger – require responses that take account of the trends currently reshaping society and shrinking the world, such as climate change, migration, urbanization and rising economic inequality. Globalization has dispelled the illusion that these challenges are separate and geographically confined. Instead, we have come to learn that they are interconnected and common to us all. These interdependent relationships have profound implications: never before have health and nutrition professionals been called upon to respond to issues of such complexity and find new solutions to them.”

The first two editions of this textbook, published in 2001 and 2008 respectively, were produced against the background of the Millennium Development Goals (MDGs), and this context was reflected in the title: *Nutrition and Health in Developing Countries*. For the third edition, the book has been retitled *Nutrition and Health in a Developing World*, and 20 new chapters have been included.

In their Preface, the editors – Saskia de Pee, Douglas Taren and Martin W Bloem – reinforce the rationale for this broadening of focus: “Climate change, pollution, hunger, food systems, Ebola and Zika viruses, etc., have taught us that the world is interconnected and interdependent ... Students in the field



of public health, nutrition, development practice, and related fields can no longer be trained and educated only in domestic or local problems ... The evolving complexity and interconnectedness of our world requires a different approach [on the part] of public health.”

This edition therefore covers a variety of topics which are related to public health but were not considered in previous volumes, such as urbanization, supermarkets and food value-chains.

The editors see the major drivers of public health and nutrition problems in the next 15 years as (1) the implications of climate change, (2) the increase of inequity in the world, (3) political instability between and within states, (4) migration, (5) urbanization, and (6) challenges to achieving sustainable food systems. They predict an increase in the incidence of non-communicable diseases and infectious diseases as well as in the double burden of malnutrition in many low- and middle-income countries. This is viewed from today’s baseline, with no fewer than 3 million children under the age of five still dying each year from causes attributable to malnutrition. “We have never seen such a complexity of health and nutritional problems in the world,” the editors write, “and we have to propose, pilot, and find new solutions.”

.....
“We have never seen such a complexity of health and nutritional problems in the world, and we have to find new solutions”
.....

The book is divided into eight parts: I History of Nutrition; II Contextualizing International Nutrition – Considering Benefit-Cost, Evidence-Base and Capacity; III Malnutrition, Nutrients and (Breast)Milk Explained; IV Tuberculosis, HIV and the Role of Nutrition; V Nutrition and Health in Different Phases of the Lifecycle; VI Tackling Health and Nutrition Issues in an Integrated Way in the Era of the Sustainable Development Goals; VII Trends in Urbanization and Development, Impacts on Food Value Chains and Consumers, and Private Sector Roles; and VIII Ethics – Critical to Making Progress in Public Health.

The new edition’s 36 chapters, penned by 59 eminent authors, contain a total of 200 detailed tables, boxed explanations and informative figures, and are complemented by a

detailed index and more than 3,300 up-to-date references. *Sight and Life* makes a valuable contribution, with Kalpana Beesabathuni, Kesso Gabrielle van Zutphen and Klaus Kraemer co-authoring chapter 35, “Role of Foundations and Initiatives by the Private Sector for Improving Health and Nutrition.” Meanwhile Jee Hyun Rah (formerly of *Sight and Life* and now Chief Nutrition, UNICEF Indonesia) co-authors chapter 25, “Adolescent Health and Nutrition,” together with Satvika Chalasani, Vanessa M Oddo (a *Sight and Life* intern) and Vani Sethi.

Praise as well as sincere thanks are due to the Editors, who themselves contribute to several chapters, as well as to the Series Editors Adrienne Bendich and Connie W Bales: this is a broad-ranging, thoroughgoing and thought-provoking reference work that will assist the work of public health professionals and nutritionists for many years to come.

First things last: *Nutrition and Health in a Developing World* contains a moving joint dedication to the Editors’ parents, “who pursued a better life for the next generation.” Their inspiration has clearly informed the creation of this milestone publication.

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Review by: Jonathan Steffen, Suite C, 153 St Neots Road, Cambridge CB23 7QJ, United Kingdom
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Imprint

Sight and Life Magazine

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Editorial team: Kalpana Beesabathuni, Eva Monterrosa, Kesso Gabrielle van Zutphen

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Erratum: *Sight and Life* apologizes for the error printed in VOL. 31 (1)|2017 on page 74, table 1. The No./% covered by Vitamin Angels (2016) of Vitamin A to children 6–59 months was 256,250, and not 7,454,758 as originally reported. This has been corrected in the e-version of this issue.

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Sight and Life is a humanitarian nutrition think tank delivering innovative solutions to eliminate all forms of malnutrition in children and women of childbearing age and improve the lives of the world's most vulnerable population.