


Cultivating Nutritious Food Systems:

A Snapshot Report






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Global Alliance for Improved Nutrition

Foreword

By 2050, the world's population could reach 9 billion. In order to live healthy and productive lives, all will need nutritious diets. Despite the intrinsic relationship between the food we grow and the food we eat, the agriculture and nutrition sectors are only just now beginning to overcome decades of mutual isolation. The high rates of malnutrition among farming communities are a stark reminder that the link between agriculture and nutrition is broken.

The world produces enough food for everyone. And yet more than 800 million go to bed hungry, and 3 million children under the age of 5 will die this year as a result of malnutrition. At the same time, 1.4 billion of us now are classified as overweight or obese. And we throw away a staggering 1.3 billion tons of food each year.

To make the most of the opportunities we have for improving nutrition, reforming this broken food system through better and different investments in agriculture is our best bet. In its most recent report, the OECD estimated that 61 percent of official development assistance, or ODA, for Food and Nutrition Security had been allocated to agriculture, compared to a paltry 3 percent on nutrition.

In this, the first in a series of GAIN Snapshot Reports, we highlight some of the exciting innovations where nutrition is being woven into the agricultural value chain. Some of these stories illustrate bold and long-standing efforts to diversify and enrich the diet. Others are still in the exploratory stages. Some are poised to go to scale; others are just getting off the ground.

Our stories reflect the agricultural value chain itself—from seeds and soil through to harvest and post-harvest, and culminating in the moment that food reaches the consumer's mouth. We meet farmers and researchers struggling to give weight to the underinvested vegetable. We go inside the laboratories, classrooms and factories where others are directing their efforts toward stemming the overwhelming tide of fruit and vegetable waste. We learn from creative entrepreneurs who are generating markets for nutritious foods in rapidly expanding cities. And, finally, we explore some of the innovative financial mechanisms serving as workarounds to business-as-usual lending—in the form of support for the "missing middle," those nutritious-food enterprises that are too small for commercial loans yet too large for traditional microfinance schemes.

We also confront some challenges. Where are the blockages when it comes to producing better and more nutritious seed? And, crucially, why is it so hard to measure whether nutrition interventions incorporating agriculture are having the desired impacts? We journey to fields and laboratories in East Africa and South Asia, and we stroll the halls of Washington, D.C. and Ibadan, Nigeria, where policy makers are struggling to keep nutrition and food security on an agenda already overburdened with such pressing issues as climate, water, disease and national security.

We are building the evidence base on farmer nutrition to better understand what farming families are eating, how adequate that diet is and most importantly where the farmer is sourcing food. Surprisingly to some, most food is coming from the market. Even farmers are net *purchasers* of food and most importantly, when they transition from breastfeeding, nearly everything being fed to infants and young children is being purchased in local markets.

We are developing an understanding of best-practice for shaping markets for nutritious foods, including an understanding of where the obstacles are along the value chain and where we can either include nutrition or mitigate the loss of nutrients as food moves off the farm.

Our Snapshot Reports are designed to shine a light on the positive things we are seeing on the ground, and to point to the models which can have real impact if scaled up as part of the new Sustainable Development Goals. Diversifying diets and improving the health and livelihoods of some one billion poor and undernourished—many of them women farmers and their children—are achievable, but not easy tasks. All the more necessary then to applaud those who are getting it right, and to study their achievements closely in order to understand how to build better programs and policies based on this evidence.

Marc Van Ameringen
Executive Director
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In the spring of this year, Dr. Samuel Myers and colleagues at the Harvard School of Public Health published an article in *Nature* suggesting something that many of us had feared for some time.

Climate change, they wrote, will have a profound, and increasingly negative, impact on global hunger. More frequent and formidable droughts and flooding will interfere with planting and harvesting cycles and, in some cases, wipe out crops altogether. The compromised availability of foods will drive up prices, resulting in increased food insecurity. But the focus of the article also confirmed what a few of us true agriculture geeks had suspected. The steady rise in carbon dioxide in the atmosphere will wreak silent havoc on the nutritional quality of our foods. "By 2050," Myers said upon publication of the article, "a big chunk of the world's caloric intake will have lost a significant amount of nutrients like zinc and iron that are very important for human nutrition."

Malnutrition is the leading cause of the global burden of disease

Already, some 2 billion people suffer from vitamin and mineral deficiencies. The results run the gamut from shattered immune systems to physically and developmentally stunted children and higher numbers of women dying during childbirth. Malnutrition, in fact, is the lead underlying cause of the global burden of disease.

And yet, somewhere along the line, we lost the connection between our food and our health. Despite the sensibility that the agriculture and nutrition sectors must work together, the practitioners of those two camps scarcely wave at one another as they pass on opposite sides of the street. In the face of an increasingly erratic climate, linking improved agriculture to better human nutrition is a vital task. But it is not an easy one.

In September, I had a conversation with someone at the helm of a prominent international agricultural development organization. "I have at my disposal thousands of agricultural professionals," he told me, "and enough money to have an impact. Tell me what agriculturalists need to grow for an optimal diet, and we will do it."

I have worked at the nexus of agriculture and nutrition for nearly two decades, but I will confess to you that I did not have an answer. "It depends," was the best I could offer.

Most nutritionists are trained under the sort of medical model that holds randomized controlled trials like those for pharmacological products as the definitive proof of concept. But in nutrition, it's not just trial methodology that matters; the subjects do, too. Hence, it depends.

The nutritionist knows that a body requires a multitude of nutrients, some more intensively at various stages of the life cycle. Iron is important throughout life, but it is particularly critical during the first 1,000 days (the time from conception until a child turns two), as well as during pregnancy and childbirth. Vitamin A is important for immunity and eye health always. Selenium is more essential for men's health than it is for women's. Vitamin D, while always important, becomes even more so as one ages, as old skin is less efficient at processing sunlight. Further, in an optimal diet, the non-nutrient and nutrient components of food are delicately balanced and regulate themselves. Absorption of iron from cereals or vegetables, for example, likely is inhibited by the caffeine in



coffee and the phytates in pulses and whole grains. Inulin in onions promotes the same iron absorption as does the citric acid in fruit juice. In other words, it's complicated. So it all depends.

And yet, it's the rare nutritionist who has any idea what it takes to grow a successful crop, much less how agriculture affects the nutritional quality of foods. By the same token, agriculturalists mostly don't have a clue about the nutritional profile of their bounty. To complicate matters further, all nutritionists know and have been shouting for years that food availability is only one part of the equation. A healthy environment and sound caregiving play an equally essential role. If a child lives without clean water and is left alone so that her parent can go off to earn a wage, nutritious food will never be enough.

But the challenge isn't insurmountable. Initiatives across the world are bringing agriculture and nutrition together in creative and successful ways. In this document, we pay tribute to many of them.

Just as agriculture moves along a value chain—from seed to harvest and on to storage, transport, wholesale, retail and, ultimately, the plate—so have we organized our report

Just as agriculture moves along a value chain—from seed to harvest and on to storage, transport, wholesale, retail and, ultimately, the plate—so have we organized our report. We begin by looking at those working with seeds, whether they are breeding nutrients into them through a procedure known as biofortification, upping the efficiency of Africa's traditional crops using the latest in genetics, or advocating for increased investment in the important vegetable-seed industry. Seeds, however, can be only as effective as the soil they are grown in.

Worldwide, approximately

1.4

billion

tons of food is lost after leaving the farm

The Green Revolution taught us that fertilizer can play an important role in raising productivity. Now we are finding that it can also play a role in human nutrition. By adding micronutrients to the standard nitrogen-phosphorous-potassium recipe, we can deliver more nutrition to the crop, and potentially to the people that eventually eat it. It is also through interventions at the soil level that we can address the scourge of aflatoxin (a naturally occurring toxin




The agriculture supply chain

Objective: Leveraging agriculture to improve the affordability, accessibility and consumption of nutrient-dense diverse foods along the value chain

produced by a fungi, and a known carcinogen), thereby putting a dent in the stunting that has been shown to result from it.

Beyond the field, post-harvest loss is arguably the area of the value chain where nutrition-oriented agriculture should concentrate its energies. Worldwide, approximately 1.4 billion tons of food is lost after leaving the farm. Unlike in the developed world, where most of this loss occurs at the retail level or in the home, loss in the developing world happens every step of the way—a result, mainly, of the lack of infrastructure. Here we explore the latter and capture lessons from the transport and cold-storage industries working to bring perishable and nutritious foods to those living in both rural areas and the rapidly expanding cities of the developing world. We see innovations in packaging and processing that prolong shelf life, and in package sizes geared to low-income consumers who lack refrigeration.

While we work to reduce food waste at the post-harvest stage, we can also improve the nutritional value at this point. Diversity, of course, is among the key components of a healthful diet; however, it is directly linked to income. Those at the bottom of the pyramid tend not to have the means to purchase from the food groups containing essential vitamins and minerals. Upwards of 80 percent of the diet among the poor is composed of starchy staples that on their own simply don't have the complements of nutrients the body needs. Food fortification, whether of whole grains, wheat flour, vegetable oil or milk, has been shown to be among the most cost-effective nutrition interventions. We look at various established programs striving to take such initiatives to scale. In addition, we visit a formative research program in Bangladesh that is looking to fortify rice by modifications made during the milling process.

Once the food has been processed and reached the level of wholesalers and retailers, it's all about reliability—of both product and market. We consider some of the ways entrepreneurs around the world are shaping markets and, too, some of the innovations happening in the financial world to enable these business owners to get their nutritious products to a larger public.

Public institutions can play a dual role, both helping to bring better nutrition to their citizens while also helping to ensure markets for farmers and food suppliers. More than 300 million children enjoy a meal at school every day, making these educational institutions ideal delivery points for better nutrition. The ultra-poor also are served by government and public-feeding programs in hospitals and other institutions. And yet, no one knows the ins and outs of effective food delivery like the private sector. Flush with resources, private enterprise—everything from multinational

Upwards of

80%

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corporations to national companies to small businesses—has proven (for better and worse) that it can shape demand when it comes to eating habits. Why not channel that knowledge toward improving nutrition at scale? We speak with industry players about what it takes to effectively channel private-sector insights, and we consider how to encourage more in the private sector to make these changes to benefit both bottom lines as well as reputations.

The food system, it is said, is broken. But in fact the food system is performing just as we have designed it to; we simply forgot to frame it as the front line supplier of health. Happily, this is beginning to change. In June 2013, the prestigious medical journal *The Lancet* dedicated an entire issue to the topic of maternal and child nutrition. Not only did it cite the latest trends in under- and over-nutrition in middle and low-income countries, but it went out of its way to emphasize those interventions to which nutrition is particularly sensitive, including agriculture. Over the last year, that June issue has helped to galvanize the nutritional community around the importance of agriculture.

Such evidence-based research is necessary to drive momentum and policy that prioritizes nutrition. Among those making a difference at the policy level is U.S. President Barack Obama, whose Feed the Future initiative insists that agricultural development investments also have nutritional outcomes. On the other side of the globe, the Comprehensive African Agricultural Program mandates that an entire pillar of investment be dedicated to alleviating hunger and food insecurity, in part by improving nutrition. The UN's Scaling Up Nutrition (SUN) movement puts great weight on nutrition-sensitive interventions. Perhaps most inspiring are those national leaders of developing countries who put forward agricultural initiatives aimed at improving the nutrition of their citizens, as we see in Nigeria, home to one in five Africans.

In this report, we focus not on where, in summaries and framework discussions, we would like to go, but rather on what we are finding on the ground. We see agriculture paying attention to nutrition, and nutrition tackling the need to place food first. We see both sectors working out methods for measuring success. These are the people on the front lines, representing some of the most innovative approaches to reconnecting nutrition and agriculture. I hope their stories will enlighten, and inspire, and that they will enrich your understanding of the complexity of building a nutritious and sustainable food system. You will see that more solutions need to be extracted, more interventions supported. These investments will depend on the will of agriculture, health and other supporting sectors to continue the conversation and stay connected. Complex, yes—but as we see here, not at all impossible.

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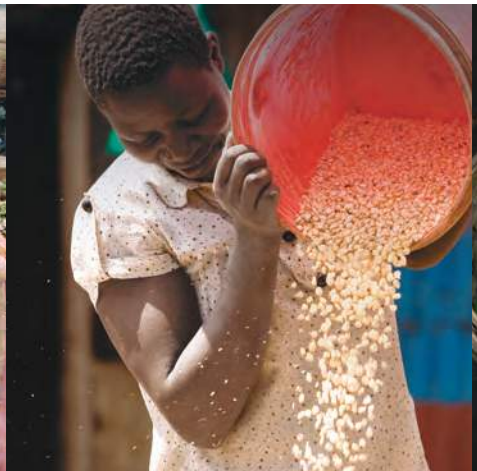


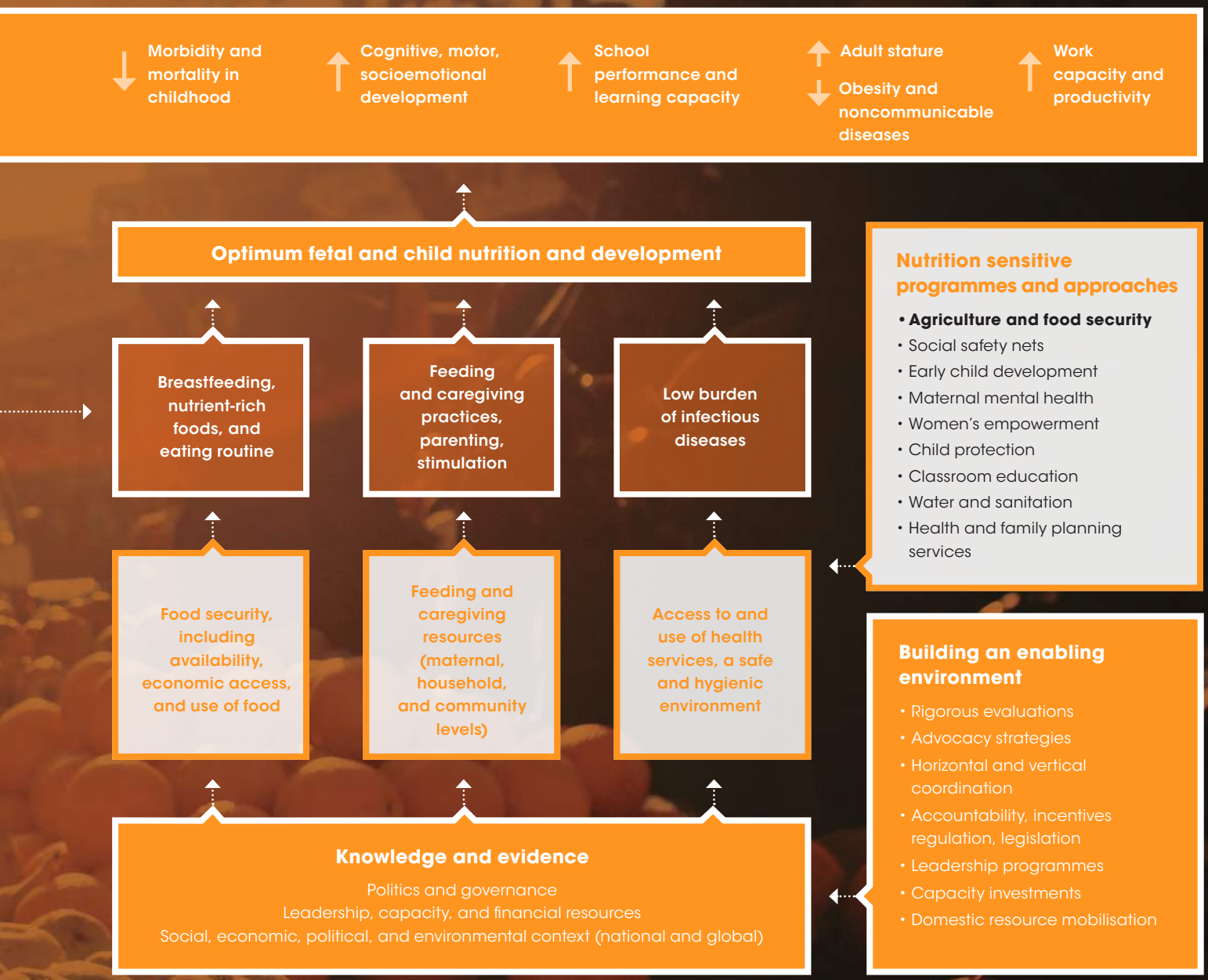

Framework for action to achieve optimum fetal and child nutrition and development

Benefits During the Life Course

Nutrition specific interventions and programmes

- Adolescent health and preconception nutrition
- Maternal dietary supplementation
- Micronutrient supplementation or fortification
- Breastfeeding and complementary feeding
- Dietary supplementation for children
- **Dietary diversification**
- Feeding behaviors and stimulation
- Treatment of severe acute malnutrition
- Disease prevention and management
- Nutrition interventions in emergencies

In June of 2013, *The Lancet* released a follow-up report to its 2008 series of papers on maternal and child undernutrition. In the report, the authors reaffirmed the fundamental role that nutrition plays in determining a person's life outcomes, including her physical growth and development, her education, her income, and her overall health. Both agriculture and dietary diversity were specifically called out as necessary to achieving optimum nutrition. The drawing of this clear line from crops to human health only underscores the continuing need to link the agriculture and nutrition sectors moving forward.



Source: *The Lancet*, Maternal and Child Nutrition, 2013.

1 Seeds

The beginning of the value chain offers three ways to improve the nutritional quality of diets: (1) breeding new nutrients directly into seeds (biofortifying); (2) preserving and amplifying the nutrients that exist when breeding new seed varieties; and (3) investing in the development and dissemination of seeds that have always possessed high nutrient content, such as small grains, pulses and horticultural crops. Too often, however, vegetable seeds get short shrift. Government policies concentrate almost exclusively on staple crops, with vegetables an ancillary concern, at best. Exacerbating the problem is that smallholder farmers are resistant to adopt improved vegetable seeds, having come to rely on their own saved seeds or on the trusted, if outdated, ones they acquire within their networks.

The World Vegetable Center

At the wholesale market in Arusha, Tanzania, it's all about tomatoes. Everywhere you look, there are stacks of wooden crates piled high with the crimson orbs, ready to be packed onto trucks and driven off to the capital, Dar es Salaam, for distribution throughout the region.

The thriving tomato trade is among the most visible success stories of AVRDC, or the World Vegetable Center, the main Africa office of which is located just a few miles away. Founded in Taiwan in 1971—as the Asian Vegetable Research and Development Center—the international nonprofit aims to increase yields of vegetables for farmers in the developing world. Rather than focus on the supreme staple, AVRDC respects the vegetable. With some 60,000 lines, its Taiwan facility is home to the largest vegetable seed bank in the world.

Tomato production in the region has increased by

40%

In the late 1990s, explained Thomas Dubois, AVRDC's Regional Director for Eastern and Southern Africa, who oversees the Arusha office, the organization released two improved tomato varieties, Tengeru 97 and Tanya. (With nearly 2,500 accessions, the Arusha center is the largest vegetable seed bank in sub-Saharan Africa.) AVRDC had bred the vegetables for improved pest and disease tolerance, a thicker skin (to reduce transport damage), and a longer shelf life. Since 1997, tomato production in the region has increased by 40 percent, and today more than 90 percent of the tomato fields in the country are planted with the two varieties. "All the tomatoes

African Orphan Crops Consortium

As the chief agricultural officer for Mars, Incorporated, Howard Yana Shapiro has traveled all over the developing world to source cacao, peanuts and other ingredients for the company's M&Ms, Snickers bars, Skittles and other products. But it wasn't until 2010, while attending a lecture at the University of California, Davis, where the 67-year-old holds a senior fellowship in plant sciences, that he learned about the condition known as stunting. Such underdevelopment of the body results from a lack of essential nutrients early on in life and impacts nearly one-third of the children in the developing world. The ramifications, which are largely irreversible, often accompany other micronutrient-malnutrition symptoms including anemia, shattered immune systems, and impaired cognitive function. In both 1990 and 2010, malnutrition and suboptimal breastfeeding were the number one risk factor for children ages 4 and below. For children between the ages of 5 and 9, iron deficiency was number one. The condition also takes a serious economic toll: A 2013 report by the African Union found that undernutrition, or "hidden hunger," can cost African nations up to 16.5 percent of their annual gross domestic product.

A plant breeder by training, Shapiro came up with the idea to combat stunting by improving the nutritional content of crops readily available to rural populations. In 2012, he and several partners, among them the African Union, established the African Orphan Crops Consortium, aimed at fine-tuning 100 indigenous plants—crops like amaranth, teff, finger millets and cocoa yam, known collectively as "orphan" crops because of the way they've been overlooked by mainstream breeding programs—to increase their vitamin and micronutrient content.

Stunting impacts nearly

1/3

of the children in the developing world

Earlier this year, the consortium cut the ribbon on a state-of-the-art plant-breeding academy in Nairobi, where 100 breeders from across the continent arrived to begin work on their chosen plants. The plan is to decode the genomes of each fruit, vegetable and nut in order to identify and locate those genes or sets of genes that correspond to the desired agronomic and nutritional traits. Molecular "markers" will be used to track the traits in successive generations of the crops, which, once optimized, will be adapted to local environments and distributed on a large scale to farmers. Shapiro envisions an anti-stunting effort that is ongoing and global—facilitated by the fact that the genetic information from the project will be made available online, at no cost, to anybody who agrees not to patent it.

you see here," said Dubois, "with a few exceptions, are Tengeru 97 and Tanya." Major companies have commercialized the varieties, and they are now popular all over East Africa. (See page 18.)

But AVRDC is also in evidence at the local market, where women sit by flat baskets of spider plant, amaranth, African nightshade and other indigenous vegetables. Long ignored by mainstream agriculture, these plants are a rich source of protein, calcium and micronutrients, and they have the advantage of being hardy and drought-tolerant. In addition, their growing cycles are shorter than those of such staple crops as maize and rice. Over the last 15 years, an increased awareness of the nutritional and other benefits of these vegetables has resulted in growing demand for high-quality varieties of them. AVRDC oversaw the selection of four improved lines of amaranth, for example, with softer, sweeter leaves. The plants, which can be harvested in as few as 21 days and which cook quickly (reducing both labor time and fuel consumption), are now grown by small-scale farmers throughout the region. African eggplant, too, once derided as "food for the poor," has become a market staple. Wandering the stalls, visitors pass mound after mound of the small, white-skinned DB3 variety released a few years ago through AVRDC by the Tanzanian Horticultural Research Institute (HORTI-Tengeru) and popularized through demonstration plots and agricultural fairs. These sweet, ovoid vegetables can be harvested every week for seven months and produced for up to 15 months, cutting across the hunger season, when nutritious crops are often not available.

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Once it has successfully bred vegetables with the desired agronomic attributes, AVRDC oversees the production of high-quality "breeder seeds," which eventually are passed on to the Agricultural Seed Agency (ASA) of Tanzania, for bulking up. National governments can access and officially release the seeds, and private companies can buy the bulked-up seed and grow it out for sale. There are whole villages around Arusha, Dubois said, where farmers grow tomatoes, amaranth and African nightshade not to eat but to sell to the region's many seed companies.

Back at the AVRDC, Dubois led some visitors down freshly painted halls to the chilly seed-preparation room, where metal shelves stand packed, floor to ceiling, with yellow and green plastic crates holding plastic bags of seeds. Laminated signs feature photos of both plant and seeds. Dubois handed us some small yellow packets labeled "Healthy Diet Gardening Kit." The organization collaborates with NGOs and other partners to disseminate its packets in disaster-relief and post-conflict situations, including in refugee camps. "That's the beautiful thing about vegetables," Dubois said. "You can grow them anywhere. You can grow them in your backyard, even on your terrace." Recipients are trained in planting, harvesting and cooking the vegetables; each packet enables a family of eight to have nutrition year-round. A new program, Vegetables Go to School, currently under implementation in six countries, employs the seed kits to promote school gardens and educate children about the importance of eating vegetables.

Next, Dubois led the way into a greenhouse—closing the first screen door before opening the second, to keep the insects out—where scores of trays of African nightshade crammed the long tables. The formerly overlooked vegetable is increasingly in demand for its high beta-carotene content. Women in tall rubber boots transferred wispy spider-plant seedlings into little plastic pots for transplanting to the center's adjacent eight-hectare farm. The center involves growers in every step of its research, Dubois said, from breeding to marketing. "The knowledge of the farmers is very rich, so we have to exploit it. Where we may see the yield alone, they see the taste."

"These are the first grafted tomatoes in Tanzania," Dubois said, pointing to a row of white plastic containers lined up on the periphery of the greenhouse. The center is working on grafting tomato plants on to eggplant rootstock, which is resistant to the pests, diseases and drought that tend to rot the tomato root at certain periods of the year. Successful grafting should allow farmers in Africa to grow them even in the off-season. (Where AVRDC introduced the same grafting in Thailand and Vietnam, the adoption rate reached 100 percent in just a few years.)

Out in the field, Dubois, a bioengineer from Belgium with a penchant for funky eyewear, pointed to the African eggplant—both the smaller orange variety used for seed production, and the white DB3s now in vogue among the region's farmers. The visitors walked past cowpeas drying on a tarp in the sun and into a cement-processing building where three women cleaned seeds for grain and leaf amaranth. Over the last decade, the high-protein grain has made huge inroads in neighboring Kenya, where women routinely mix it with maize flour for more nutritious porridges, chapattis and baked goods. (Though a facility on the campus features state-of-the-art PCR machines and other equipment for nutritional assessment, most of that work currently is done in the Taiwan office. Dubois hopes to change that in the future.)

But seed production and dispersal are just one part of the picture. AVRDC also focuses on what happens after vegetables are pulled from the field, in part through its Post-Harvest Training and Services Center (PTSC). Dubois demonstrated a few of the cooling systems on display, including a low-tech version incorporating sand and two layers of bricks, and a nylon-tent-looking model known as the Wakati 1 that was recently introduced by a young Belgian entrepreneur. Driven by solar power, the low-cost contraption

significantly extends the life of vegetables, enabling growers to maximize their profits. Every couple of weeks, the PTSC convenes farmers and others for training sessions on cooling, preserving, processing, cooking, transporting and packaging vegetables. Staff nutritionist Roseline Marealle demonstrated a range of harvesting and preserving implements and directed our attention to the range of value-added products on display, from mango chutney, hibiscus jam, and tomato paste to carrot and amaranth powders and dried African eggplant. The center also sells and rents packaging supplies, insulated cool boxes, cleaning supplies and other post-harvest tools.

The challenge now, said Dubois, is to better measure the nutritional and economic impact that AVRDC's vegetables are having on families in the region and beyond. "Getting the numbers is very difficult," he said, particularly when it comes to private seed companies. "But we are nonprofit and for the public good. So as long as we know they are out there, we are happy."

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Biofortification

Back in the early 1990s, when Howarth Bouis came up with the idea of breeding micronutrients directly into crops, people told him he was crazy. How could plant breeders possibly start worrying about micronutrients when there were still myriad issues involving yield and pest and disease resistance to address—not to mention a changing climate? Bouis, an agricultural economist, was concerned about the condition known as "hidden hunger," which results from a lack of essential vitamins and minerals in the diet and can leave children blind, permanently lower their IQs, and make them targets for long-term illnesses and early death. In particular, he was frustrated by the ongoing cost, and the access issues, involved in traditional nutrition-supplementation programs. If you could breed micronutrients directly into the staples upon which impoverished populations rely, Bouis, maintained, you'd have a permanent—and an ultimately far less expensive—solution.

1.5 million

households worldwide have received the seeds, stems or vines of biofortified crops

Fast-forward two decades, and HarvestPlus, the nonprofit that Bouis founded in 2003, has seen the release of its "biofortified" crops across the globe. Three years ago, the Nigerian government approved the dissemination of HarvestPlus's high-vitamin-A cassava, and the Democratic Republic of Congo (DRC) followed suit a year later. 2012 saw the release of high-vitamin-A maize in Zambia and of high-iron beans in Rwanda and the DRC. The beans also are being disseminated in Uganda, along with high-vitamin-A sweet potatoes. In India, farmers are cultivating high-iron pearl millet and high-zinc wheat, and Bangladeshi growers recently began planting high-zinc rice. (All of the HarvestPlus crops are bred conventionally, though the organization is looking into the potential of genetic modification.) In total, some 1.5 million households worldwide have received the seeds, stems or vines of biofortified crops.

The challenge now is how to scale up those successes. Once the enriched seeds have been approved for release, it can take several seasons of multiplication to achieve the volumes necessary to meet farmer demand. Delivery, too, can get complicated. In Zambia, for instance, where the population has long eaten white maize—"They regard yellow maize as food aid," said Bouis—there's been some resistance to the high-vitamin-A maize, whose kernels are a dramatic orange. "When we give people information," Bouis said, "and tell them that, for the same price as white maize, they can protect their families from vitamin-A deficiency," they adopt the crop readily.

The issues aren't just cultural. There is also a challenge in building demand among consumers. Because higher levels of minerals such as iron or zinc are not visually apparent, consumers have no way to identify them in the market. One way around the obstacle would be for governments to step in and prioritize biofortified crops, either by subsidizing them or by mandating that all staple crops developed in national programs be bred for nutrition in addition to yield. Officials are "well-disposed to the idea," said Bouis, but achieving the volumes required to implement such policies is several years away.

"I thought the governments would be skeptical," said Bouis. While the HarvestPlus strategy initially was to work on a single crop per country at a time, some leaders are clamoring for more. "In Rwanda, they're saying, 'Why don't you bring the maize? What about your work on the potato?'"

2 Soil

When it comes to nutrition, plants are a lot like humans: Both require good nutrition for long-term health. It turns out that adding fertilizer to farmers' fields can directly influence the nutritional density of the foods grown there. Also like humans, plants require micronutrients in smaller quantities than they do primary ones. Given the right conditions, those essential nutrients will settle in the edible portion of the crop and eventually make their way to the consumer. A team of public-sector scientists is working with private industry at the front of the value chain to improve nutrition through zinc-fortified fertilizers in Turkey. (Worldwide, zinc deficiency is responsible for the deaths of some 450,000 children every year.) At the same time, the quality of soil can have a negative impact on the crops grown in it. In Nigeria, scientists are working on minimizing the impact of soil-borne contaminants with an aim to improving human health.

Experimenting with Fortified Fertilizers

In the early 1990s, it became apparent that wheat farmers in Turkey's central Anatolia region were not only among the nation's poorest but also among its most undernourished. In particular, they suffered from severe deficiencies of zinc. When Ismail Cakmak, a plant nutritionist and physiologist at Istanbul's Sabanci University, began looking into the problem, he discovered that the soil itself was lacking in the vital micronutrient. And the compromised growing environment meant that wheat and barley yielded up to 60 percent less than wheat and barley crops in other regions.

In a series of experiments, Cakmak and some collaborators at the Ministry of Agriculture began adding zinc and other micronutrients directly to the soil. They found that, on average, the yields of those crops that had been treated with the zinc-enhanced inputs shot up by as much as 55 percent in regions where soil zinc deficiency is severe. Applying such micronutrients as iron, manganese, copper and boron, by contrast, had little effect at all.

Soon after, the Turkish fertilizer giant Toros-Agri began to add zinc to its traditional (nitrogen-potassium-phosphate) fertilizers. "We did not know anything about human zinc deficiency in Turkey or anywhere in the world," said Esim Mete, CEO of Toros-Agri, in the 20th-floor conference room of the glassy Istanbul high-rise that houses the company. (In fact, more soils worldwide lack zinc than any other micronutrient, and zinc deficiency is responsible for the deaths of some 450,000 children a year.) Toros-Agri proceeded to produce 2,300 tons of enhanced fertilizer. The company recruited farmers from across the country to test it on small patches of their land. If the new fertilizer could drive yields, Mete figured, while also improving the nutrient density of the grain, they would have a win-win situation. Farmers would be drawn to the input, and better public health could go along for the ride.

The yields of those crops that had been treated with the zinc-enhanced inputs shot up by as much as

55%

When it came time to harvest the crops, Mete and her colleagues were astonished by what they saw. "The result was like day and night," she recalled. "While one was looking like a bleak field, the other was green, and the plant had already grown 20 or 30 centimeters." The outcome was consistent across other crops. Mete recalled one farmer who told her that when he pulled up a plant that normally would hold eight potatoes, he found 15 of the tubers instead.

Cakmak and others eventually convinced the Turkish government, which at the time was providing subsidies for different grades of fertilizer, to add Toros-Agri's zinc-enhanced version to its list. Though the country's subsidy scheme has shifted, farmers continue to seek out the fertilizer due to the boost it gives to yield. Today, Mete said, some 30 percent of the company's phosphate compounds contain added zinc; other producers also have begun enhancing with the micronutrient. Mete estimated that Turkey now produces upwards of

Zinc Deficiency Among Children Under Age 5, By Region

Region	Prevalence(%)	Deaths(`000)	DALYs lost(`000)
East Asia & Pacific	7	15	1,004
East Europe & Central Asia	10	4	149
Latin America & Caribbean	33	15	587
Middle East & North Africa	46	94	3,290
South Asia	79	252	8,510
Sub-Saharan Africa	50	400	14,094
High Income Countries	5	0	2

Source: *Disease Control Priorities in Developing Countries*, 2nd edition, 2006, Tables 28.1, 28.2, and 28.3.

500,000 tons of zinc-enhanced fertilizers annually—35 percent of its total output.

The final challenge lies in convincing the consumer. "Who will pay for extra nutrient in the grain?" Mete asked. "This is the only limiting factor." Until efficacy studies have proven the health benefits of such crops—and, perhaps more importantly, the public becomes aware of them—farmers will want for a market that's guaranteed. Toros-Agri, for instance, has considered fortifying its fertilizers with other micronutrients (namely selenium and iodine, both of which are important to human health) but is concerned that farmers without a captive consumer will refrain from buying them. (Especially since, unlike zinc, they don't promise significant impacts on yield.) "This is where governments might again step in," Mete said. "Perhaps they could mandate that national grain boards pay more for cereals grown with enriched fertilizers?" She offered the example of Finland, where, unbeknownst to much of the citizenry, the government has, for the last 30 years, paid producers to add selenium to their fertilizers in the name of public health.

It may take awhile, Mete said, but fortified fertilizers will eventually become the norm. "This is still a new idea, and everybody's talking about it." Part of that has to do with Mete's own evangelizing. Long a vocal presence in the International Fertilizer Industry Association (IFIA), she was last year named its president, and she has taken advantage of that platform to advocate for the role that agriculture can play in public health. The governments of India and China are in conversations with producers in those countries about enhanced fertilizers, she said, as are some of the states located in a zinc-deficient belt that runs across Latin America. While not every nation may be in a position to subsidize enhanced inputs—those in sub-Saharan Africa, for instance, have yet to implement the large-scale use of even basic fertilizers—policy makers increasingly are aware of the potential of the intervention. "By using zinc," Mete said, "you will profit from not using so many medicines; people will not be sick and lose working time; they will not occupy hospitals." Cakmak currently is overseeing studies on the effect of zinc-containing fertilizers on wheat and rice in 15 countries, including China, India, Thailand, South Africa and Brazil. "This will certainly emanate," Mete said. In the meantime, she wonders whether major cereal-exporting countries like the United States and Canada might consider fortifying their fertilizers for the greater human good.

Fertilizers not only can help to eradicate hunger, they can combat malnutrition. We are talking about having more nutritious food, rather than having just food

In any case, said Mete, the conversation has begun to shift. Whereas the dialogue surrounding fertilizers once focused exclusively on eradicating hunger ("there is still a blind spot," she conceded), micronutrients increasingly are getting major play. "This is our main topic as IFIA. We are saying fertilizers, yes: not only to eradicate hunger, but to combat malnutrition. We are talking about having more nutritious food, rather than having just food."

The bio-control product, now trademarked as Aflasafe, generally results in an

80% to 90% reduction in aflatoxin

Aflasafe

In the 1960s and '70s, Nigeria was known throughout the world for its groundnut pyramids, massive triangular structures created from sacks of the peanuts, of which the West African country was the world's largest producer. Exports of the nuts plummeted from 502,000 metric tons in 1961 to zero in 1980. The discovery of crude oil in the populous country had something to do with the falloff, but Ranajit Bandyopadhyay, a senior plant pathologist at the International Institute of Tropical Agriculture (IITA), in Ibadan, Nigeria, points to another cause.

In the late 1960s, it was established that aflatoxins, dangerous contaminants produced by the fungus *Aspergillus flavus* and which infect peanuts, maize and other crops, are potent human carcinogens. Where aflatoxin is present in high concentrations, the link to poor nutrition is evident. Growth is impaired (a study in Benin and Togo found that blood aflatoxin levels were 30 to 40 percent higher in stunted children), and the immune system is suppressed. Children exposed to high levels of aflatoxins also experience delays in cognitive development, underachieve in school, and exhibit a higher probability of chronic diseases (cancer, heart disease) into adulthood. Once the contaminants' deleterious impacts became apparent, importing countries began imposing stricter regulations on aflatoxins, with the European Union, for example, eventually setting a standard of four parts per billion (ppb) in processed foods, a level that Nigeria and many other sub-Saharan countries were unable to meet. The export market for peanuts collapsed, and farmers turned their attention to other crops.

Aflatoxin presents an enormous food-safety and nutrition challenge, exacerbated by the fact that the contaminant tends to take hold in those foods—peanut-based nutritional supplements, for instance, and fortified corn-soy porridges—routinely promoted by the nutrition community. Bandyopadhyay has been working on the aflatoxin problem since 1983. By 2009, he and his colleagues, together with collaborators from the U.S. Department of Agriculture, had figured out that, by screening thousands of strains of *Aspergillus flavus,* they were able to locate some that did not produce the toxin. Once they had identified non-toxin-producing strains, they formulated those into a product that they put on dead sorghum grain. When farmers spread the grains on their fields a few weeks before flowering, the good fungus began to grow, its spores dispersing and occupying the soil and displacing the toxin-producing strains in the process. The bio-control product, now trademarked as Aflasafe, generally results in an 80 to 90 percent reduction in aflatoxin. So widespread has Aflasafe use become in Nigeria that Bandyopadhyay and his colleagues eventually oversaw the construction (with funding from the Bill & Melinda Gates Foundation) of an Aflasafe manufacturing facility on the campus of IITA.

Earlier this year, the African Union established an initiative called the Partnership for Aflatoxin Control in Africa, and Bandyopadhyay and his colleagues currently are working with a dozen sub-Saharan countries to scale up production of localized strains of Aflasafe. Kenya and Senegal both have plans to build manufacturing facilities in 2015. Pyramids shouldn't be far behind.

3 Post-Harvest Loss

Moving up the value chain, post-harvest loss presents a formidable challenge. A report issued earlier this year by the Food and Agriculture Organization (FAO) of the United Nations found that roughly one-third of the food produced in the world for human consumption—some 1.4 billion tons—is lost or wasted every year. Of particular concern is the loss of nutrition-dense produce—vegetables, fruits, fish, meat and dairy—some 50 percent of which goes to waste annually. Nearly half of those losses occur after the food has been harvested, resulting not just in lower incomes for small farmers but in higher prices for consumers (thereby putting those nutritious foods that much further out of their reach).

Aseptic Packaging

In the 1960s, the Swedish company Tetra Pak developed a type of aseptic packaging that made it possible to store and transport milk and other sensitive foods at room temperature without preservatives for up to 12 months. The technology opened up new possibilities, in particular for developing countries, where a lack of cooling facilities and transportation infrastructure had long limited the consumption of dairy and other nutritious but perishable foods. Since 1962, when it began supporting Mexico's school feeding programme, the company — now a part of the Tetra Laval Group — has been collaborating with governments and local dairy processors around the world to establish and administer school-meal programs featuring milk. In addition to improving nutrition for students—milk contains calcium, magnesium, selenium, riboflavin and vitamin B12—the programs serve as catalysts for developing local dairy-farm sectors.

When it goes into a new country, explained Ulla Holm, the Global Director of the Tetra Laval Food for Development Office, the company generally approaches its ministers of Agriculture, Health, and Education first. Working with the government and with local processors, it helps to set up dairy hubs, or collection stations, outfitted with cooling tanks. At the same time, it assists in putting school-feeding programs in place, so that it can guarantee the processors—who must invest their own money for equipment—a market for all of the milk they process. Tetra Pak gives discounts on packaging material to local processors, and the processors add additional discounts so that the milk is affordable for schools.

The dairy processors, with the help of Tetra Laval Food for Development, provide training to their member farmers, who may have as few as two cows. (The hubs generally consist of some 2,000 farmers overseeing some 10,000 cows.) Implementing proper feeding, watering and hygiene practices can increase milk output significantly, thereby

Implementing proper feeding, watering and hygiene practices can increase milk output significantly, thereby improving farmer incomes while also ensuring the safety of the product for consumers

improving farmer incomes while also ensuring the safety of the product for consumers. (In Bangladesh, where Tetra Pak and Tetra Laval Food for Development have been working with local food processor Pran on a dairy-hub program since 2008, collection of milk from farmers increased from 50,000 liters to 495,000 liters in just six months. Over two years, farmers involved in the program have increased their incomes 120 percent.) Without a hub system in place, farmers may be obliged to spend time travelling to and from markets to sell their milk, and they may be dependent on middlemen, who may offer unfair prices, fail to show up or adulterate the milk. Engaging in a formal arrangement with a local processor often enables milk farmers to move from a subsistence level to full-time dairy production.

The aseptic technology has been called the most important food science advancement of the 20th Century. Based on this technology Tetra Pak developed the aseptic packaging solution in the early 1960's. Today, the innovation offers hope for improving diets in the swelling urban centers of the developing world. At the same time, it broadens the possibility for smallholder dairy farmers to find a market for their delicate products.

The Global Cold Chain Alliance

Nikki Duncan, the director of International Programs for the Alexandria, Virginia–based Global Cold Chain Alliance (GCCA), spends her days figuring out how to stem food waste. A graduate of Georgetown's School of Foreign Service with a master's degree from the Johns Hopkins School of Advanced International Studies, Duncan has long moved in international circles. Which puts her in an ideal position for pairing the GCCA—a private-sector organization representing the refrigeration, transportation and storage industries—with development organizations to strengthen the cold-chain infrastructure in countries where it is wanting. The GCCA partners with the World Food Logistics Organization (WFLO) to provide advisory services to government agencies, NGOs and others, and with help from its global network of experts, it conducts cold-chain and food-systems assessments and research; produces training programs; and helps implement large-scale agricultural projects on the ground. Over the past 15 years, GCCA has worked with USAID, the USDA, the Bill & Melinda Gates Foundation, and the World Bank, among others, to fortify the cold-chain—and thereby enhance nutrition—in regions where refrigeration is a challenge.

Tomatoes in Tanzania

Over the past several years, residents of Tanzania have become well-acquainted with the REDGOLD brand: its shiny crimson and yellow label can be found on sauces and pastes, chutneys and jams. The flagship line of Darsh Industries, REDGOLD, founded 15 years ago by a gemstone dealer named Bhadresh Pandit, has had a transformative impact on the local economy. Whereas the lack of a ready market once meant that area tomato farmers lost much of their harvest to waste, Darsh today guarantees some 500 growers a buyer for all that they produce. Those nutritious tomatoes—developed with the help of the Asian Vegetable Research and Development Center (see page 9)—turn up in various forms at the region's markets. Darsh provides its partner growers with technical training and plastic crates, which cut down dramatically on spoilage during transport.

In mid-June, with tomato season just underway, the company's production facilities on the outskirts of Arusha were in full swing. Women in rubber boots and green smocks washed bottles and affixed labels to jars, while men monitored giant metal vats bubbling with red liquid. "Farmers were using a very crude method to get the seeds," explained managing director Pandit, as he led a visitor around the factory floor. "They were stomping with their feet. We said, 'Bring it to us, and we'll process it in a hygienic way.'" Today Darsh separates the seeds and skin from the pulp and returns the first two directly to growers, who have doubled their incomes by selling the cleaned seeds to the region's many seed companies. (They repurpose the skins into fertilizer.)

Last year, Darsh Industries sourced 4,500 metric tons of tomatoes from the Arusha region; its goal is to raise that figure to 10,000. This October, Darsh, which employs 300 at its Arusha facility, will open a second plant, in southern Tanzania, where it hopes to expand its network of contract farmers to 5,000—making that much more nutritious fruit available year-round while saving it from the garbage bin.

In sub-Saharan Africa,

70%

of the population lives off the grid

Most of the food loss in the developing world takes place at the front end of the value chain, a result of financial and technological constraints generally owing to the absence of functional storage and cooling facilities. Because this stage also is key to maintaining nutrients, strengthening it improves health as well as economic outcomes. The challenge is that the electricity or diesel required for cooling often is too costly or simply unavailable. In sub-Saharan Africa, 70 percent of the population lives off the grid, while in India, some 350 million people lack access to electricity. The Institution for Mechanical Engineers in the UK estimates that if those regions were to adopt the same level of refrigeration as that of developed economies, fully one quarter of the total food wasted could be eliminated.

In India, some

350

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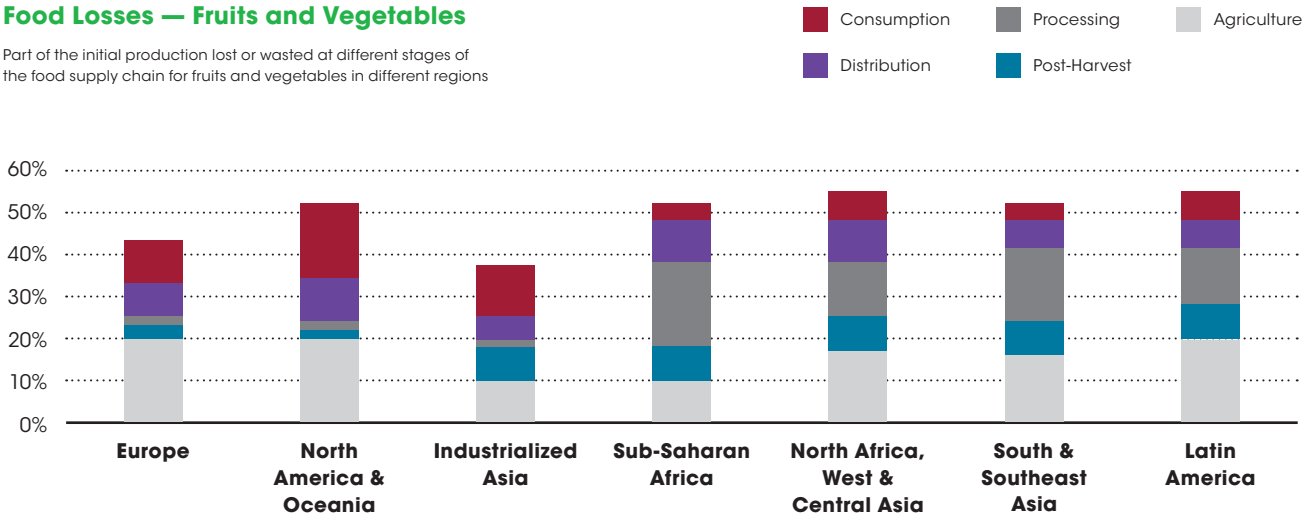
While establishing a continuous chain of temperature-controlled environments from the point of harvest to the marketplace is, for many communities, out of the question, there are numerous low-tech fixes that can fill the breach. Duncan offers the example of the Zero-Energy Cooling Chamber. Cheap and easy to build using just adobe bricks, sand and water, this sandbox-size contraption produces evaporative cooling chambers that can reduce the

Food Losses — Fruits and Vegetables

Part of the initial production lost or wasted at different stages of the food supply chain for fruits and vegetables in different regions



Article: Global Food Loss and Waste; Chapter: Extent of Food Losses and Waste; Author: Food and Agriculture Organization of the United Nations (Rome 2011); Site: http://www.fao.org/docrep/014/mb060e/mb060e02.pdf

temperature of nutrient-dense vegetables and fruits by 15 to 20 degrees, thereby extending their life by a couple of days. Cold storage enables farmers to preserve their produce and also means that nutritious foods like dairy products, meats and fish can enjoy extended lives.

Cold storage enables farmers to preserve their produce and also means that nutritious foods like dairy products, meats and fish can enjoy extended lives

The CoolBot is another innovation being adopted by farmers. A small contraption produced by a U.S.–based company, it works in tandem with a window air conditioner to transform a small shed or room into a reliable cooler. The device, which sells for about $300, can push the temperature in the room down about 32 degrees. Insulating the structure with hay bales or other materials enhances efficiency even further. A group of onion farmers in northern Tanzania tested the CoolBot and were extremely pleased with the results. Instead of selling their onions right after harvest—and when everybody else was selling them—the farmers put theirs in a CoolBot–enhanced shed and waited two months. When they finally did bring them to the market, they made a handsome premium. Their profits were so high, in fact, they were able to pay off the CoolBot in a single season.

The GCCA also provides training on best practices for avoiding post-harvest loss. In 2008, it collaborated with the WFLO under a grant from the Bill & Melinda Gates Foundation to study post-harvest losses in Africa and India. After conducting surveys in eight countries, the groups came up with a list of technologies for reducing losses and thereby enhancing nutrition. Working with the University of California, Davis, they established a Post-Harvest Training and Services Center, which they opened on the Arusha campus of the World Vegetable Center, or AVRDC, in 2012. (See page 9.) The Center offers suggestions for low-tech methods and tools that can be implemented for little or no money. It also provides training courses on harvesting, transporting, storage, marketing and preservation techniques, and provides shipping services and rents cooling spaces. Among the simple lessons taught are the importance of harvesting slightly earlier than usual, thereby gaining some time to finish ripening post-harvest; placing harvested produce in the shade to reduce spoilage, and using smooth-sided plastic bins instead of rough wooden crates to minimize damage during transport. At the Center, farmers can purchase materials for building packing tables, small-scale coolers, and insulated boxes, cartons and crates.

Duncan says that while not yet proven or brought to scale, there are a few interesting cold-chain innovations on the horizon. RefrigiWear, a company based in Georgia, produces a small, adaptable bag that would be ideal for last-mile delivery, for instance.

Solar options, too, show great promise, particularly given the climates of India and sub-Saharan Africa. Duncan offers the example of one company that has developed small rooms capable of storing one or two pallets using solar power, and of another outfit, based in London, that is looking to utilize liquid nitrogen not just as a power source but also a coolant—offering savings of both fuel consumption and emissions.

4 Post-Harvest Enrichment

Malnutrition rates in South Asia are among the highest in the world. While providing the region's population with diverse diets would be the ideal response, cost and logistics put such a fix out of reach. Augmenting the nutrition of food after it has left the farm and while it is being processed, however, offers one way to ameliorate the problem. Large-scale food fortification is a proven, cost-effective intervention that has been in place throughout the developed world for decades. Such programs could take the people of India and Bangladesh a long way toward better livelihoods and nutritional security. The Indian government does not require that milk be fortified, but a few courageous dairies have taken the initiative to do it anyway, in the hopes that fortification during processing will improve their market, increase their farmers' incomes, and reduce the country's persistent and pervasive malnutrition. In Bangladesh, the government is exploring a process for fortifying rice just after it's left the farmers' fields.

Fortifying Milk in India

On the dusty outskirts of Jaipur, a woman in a crimson sari and gold ankle bangles prodded a cow along the road with an eight-foot-long stick. A few yards away, another woman, her black umbrella held aloft against the glare, strolled with two similar-looking beasts. Here in Rajasthan, India's largest state, cows are big business. (India recently became the world's largest milk producer.) After agriculture, cattle and other livestock are the most important sources of livelihood, especially for the poor. And among the largely vegetarian population, milk and milk products may constitute the only source of animal protein. High in energy and lipids, milk contains many of the nutrients critical for growth and development, including calcium, vitamins D and A, potassium, riboflavin, and vitamin B12. The amounts of those nutrients are minimal and depends on how much one drinks, of course. Still, Indians—particularly young ones—love their milk. Since they generally consume it daily, it is an ideal medium for fortification.

High in energy and lipids, milk contains many of the nutrients critical for growth and development, including calcium, vitamins D and A, potassium, riboflavin, and vitamin B12

India is estimated to be home to 40 percent of the world's malnourished children, and though the national government provided financial support for fortification to dairy cooperatives beginning in 1989, that support was cut off a year later. Some states continued the

Fortifying Oil

In India, where micronutrient malnutrition is extremely widespread—the prevalence of underweight children in the country is among the highest in the world—edible oils are consumed by nearly 90 percent of households. Amplifying their nutritional content, then, makes perfect sense. In fact, mandatory fortification of hydrogenated vegetable oil has been in place in the country since 1953. But recent economic growth has resulted in increased consumer demand for other forms of edible oil. At the same time, the industry has consolidated, so that today there are three leading companies and only a handful of other big players. The National Edible Oil Fortification Project, announced in August 2014, aims to take advantage of these shifts in order to broaden fortification across the industry.

The agricultural giant Cargill has been fortifying its India-produced oils (soybean, rapeseed, groundnut and vegetable) with vitamins A, D and E for several years. While more educated, urban populations already will go out of their way to buy the fortified oils, awareness of nutrition in rural areas is still quite low. The partners in the new initiative, including the Confederation of Indian Industry, the National Institute of Nutrition and GAIN, think that an even larger market can be built to fuel voluntary fortification by the industry. The fortification partnership will work at the consumer level to create awareness about vitamin deficiencies with a social-marketing campaign, including radio and TV spots. They also will collaborate with local doctors, who will spread the word at the grassroots level. While mass-produced fortified oils are more likely to reach high- and middle-income consumers at the outset, the expectation is that the benefits of the oils will trickle down to low-income groups once fortification becomes the industry norm.

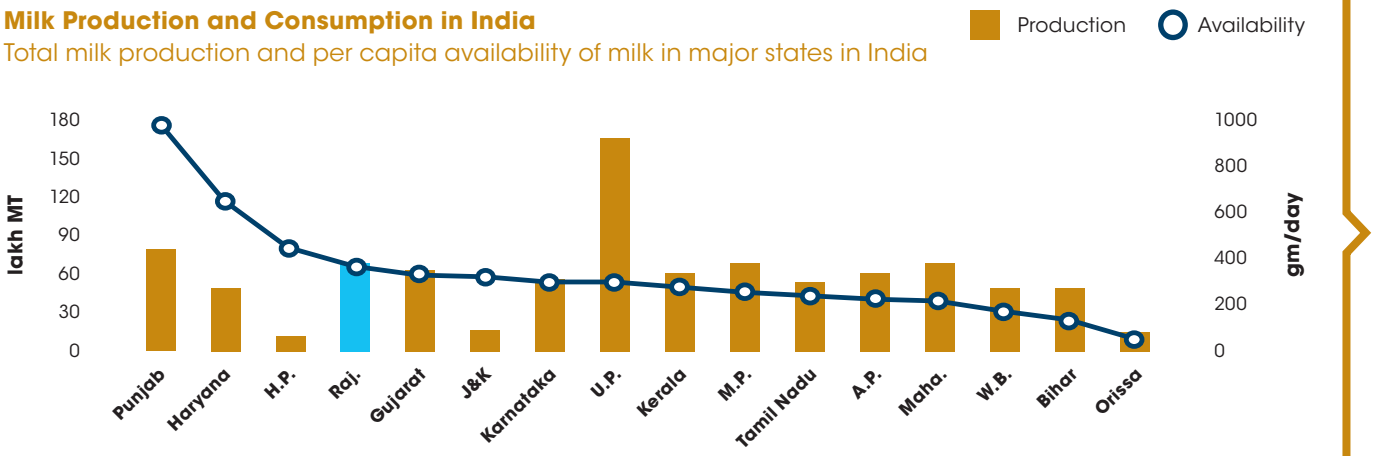
In India, where micronutrient malnutrition is extremely widespread, edible oils are consumed by nearly

90%

of households

Milk Production and Consumption in India

Total milk production and per capita availability of milk in major states in India



Report Title: Project on Livestock Industrialization, Trade and Social-Health-Environment Impacts in Developing Countries; Author: Animal Production and Health Division, Food and Agriculture Organization of the United Nations; Figure Title: Total milk production and per capita availability of milk in major states in India; Site: http://www.fao.org/wairdocs/lead/x6170e/x6170e2z.htm

Rice Fortification in Bangladesh

Bangladeshis like their rice. Even if he goes out at night for pasta, one Dhaka resident explained, he must still eat rice when he returns home afterward. Without it, his day wouldn't be complete.

Fortunately, the country has made great strides in meeting the ever-growing demand for the grain: rice production there has tripled in the last 30 years. (Bangladesh has been self-sufficient in the grain since 2010.) The problem is that, in a country where malnutrition remains a serious problem—nearly half of children suffer from some type of micronutrient malnutrition, in particular, zinc deficiencies (45 percent of preschool children suffer from a lack of zinc; in the slums, that percentage skyrockets to over 50)—most Bangladeshis prefer white polished rice, the micronutrient content of which is close to nil.

Though it's located only 52 kilometers from downtown, the Bangladesh Rice Research Institute (BRRI) generally takes some two hours to reach, on account of the infamous Dhaka traffic. BRRI's well-groomed campus houses all manner of laboratories, cold-storage seed facilities, manual and automated mills, harvesting machines and other rice-research necessities. In addition to focusing on how production will be impacted by a changing climate—already this year, the rainy season seems to be following a logic all its own—scientists at BRRI are working on an innovative approach to enriching rice with essential minerals after harvesting. Dr. Jiban Krishna Biswas, director general of the institute, explained that his staff already has had success fortifying the rice with zinc while it soaks just prior to milling. To date, the fortification trials have been limited to the laboratory and are exploratory. If the concept proves feasible on a small scale and is acceptable to millers—and if studies confirm positive health impacts—the program could be rolled out nationwide. BRRI also hopes to explore the addition of other micronutrients to rice soaking water.

The final step will be selling the product to the public, which Biswas believes will not be a problem. In the past few years, he explained, a series of television campaigns have raised public awareness about such nutritional issues as the need for diets rich in micronutrients. "The village people are concerned now about vitamin A and zinc," he said. Other TV programs urge Bangladeshis to eat native fruits. "Our generation is quite concerned about healthy food," said Biswas, who wore a mustache and the slightly distracted air of the scientist that he is. In any case, he said, this is an initiative—and, if need be, a PR campaign—that merits doing. "We are suffering from hidden hunger. We have to try every approach there is."

off a year later. Some states continued the program, but eventually it was dropped by all. In 2008, a bill advocating that government mandate milk fortification was introduced in Parliament but never passed. (This despite a 2007 study that found Indian children aged 1 to 3 who received a daily supplement of milk fortified with iron, zinc, selenium, copper, and vitamins A, C and E, for one year had a 15 percent reduction in days with severe illness; an 18 percent reduction in the incidence of diarrhea; and a 26 percent reduction in incidences of acute lower respiratory illness.) In rural Rajasthan, some 70 percent of the children suffer from a vitamin deficiency of some sort, which is one reason GAIN recently decided to step into that breach. Beginning in early 2013, the organization launched a collaboration with a handful of dairies in the state to ensure that milk be fortified with vitamins A and D2.

At the Lotus Dairy, located at the end of that dusty road, CEO Naresh Kurar Gupta walked a visitor from the reception dock, where raw milk gets hauled off of trucks in tall aluminum cans, through the various processing stages and finally to the pasteurization room, where the fortifying takes place. Dressed casually in sneakers and khakis, and with a bushy white mustache, the cheerful executive explained how the dairy manages to work with some 50,000 farmers, 99 percent of whom are women and most of whom have fewer than five animals, to source some 100,000 liters of milk every day. The dairy operates 24 hours, its 100 trucks collecting milk both morning and night from seven regional chilling centers, each serving a 50-kilometer radius. A mere seven hours from the time the milk arrives, it has been processed and packaged and is ready for distribution to the region's shops and kiosks.

The machinery clanked and whooshed as we walked through the various process rooms, where Gupta's staff of 500, dressed in pale-blue smocks, also processed and packaged buffalo milk, lassi, ghee, yogurt and milks flavored with pineapple, chocolate, strawberry and cardamom. In the pasteurization room, we ducked under a maze of metal pipes, and Gupta stopped at the six-foot-tall "balance tank." He passed around the bottled pre-blend that GAIN pays to have delivered to the dairy and which gets added at this stage of the process. GAIN works with India's Institute of Health Management Research, or IHMR, on a "proof-of-concept" project, which trains dairy personnel on the proper administration of the pre-blend to the milk. (To keep costs of the milk low, GAIN's grant to IHMR pays the full cost for the fortificant, and Lotus charges the same price that it did before the milk was fortified.) "Our job starts from the cow itself," Gupta said, explaining that healthy cows are key to nutritious milk. To that end, Lotus organizes training programs in the villages to school its farmers on best practices, and it provides ghee and cattle feed (mustard cakes and cotton seed) at subsidized rates. The company assures its farmers a market for whatever they produce, and it makes regular payments directly into their bank accounts.

Indian children aged 1 to 3 who received a daily supplement of milk fortified with iron, zinc, selenium, copper, and vitamins A, C and E for one year had a

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A few months after launching its program with Lotus, GAIN began working with two other small Rajasthan dairies, Divya Agro Food Products, Ltd, and Kota, and then with some of the milk unions that comprise the massive Rajasthan Co-Operative Dairy Federation, or RCDF. (Before opening Lotus, Gupta worked for RCDF for 24 years.) By August, all 20 of the RCDF's unions were processing fortified milk, and the total average amount of fortified milk from all the participating dairies was 42,800 metric tons. Assuming per capita, per day consumption of 200 milliliters of milk (the estimate of the National Nutrition Monitoring Bureau), more than 7 million people in Rajasthan now benefit from fortified milk every month.

Because the fortificant doesn't change the milk's appearance or smell, it has been easily adopted by consumers, and Gupta has no doubt he will continue to find a ready market. "People spend money on milk. Their first priority is milk." Proof-of-concept complete, Lotus and the other dairies have vowed to continue fortifying even after GAIN has finished funding the initiative, and the state of Madhya Pradesh has reached out to the NGO for technical support in launching its own milk-fortification program. Other states are considering similar programs. Gupta estimates that 30 percent of consumers now are aware of the benefits of the added vitamins in milk, and he believes that number will only go up, thus making the fortifying initiative a good idea for business as well as for public health.

5 Shaping Markets

Too often, the small-scale farmer scratches her living from the land, struggling to grow enough food to earn some income while feeding her family as well. Even in rural areas, though—and almost exclusively in urban ones—most of the food that is eaten derives from the marketplace. In the form of kiosks, small grocers, open-air markets, and individual vendors, a tremendous opportunity exists for not just enabling, but actually influencing the buying decisions that impact familial health. How to set these nutritious-food engines in motion, though, and ensure they have the tools needed to survive? Part of the challenge is getting these sellers the financing they need to get off the ground and grow.

Africa

The Marketplace for Nutritious Foods

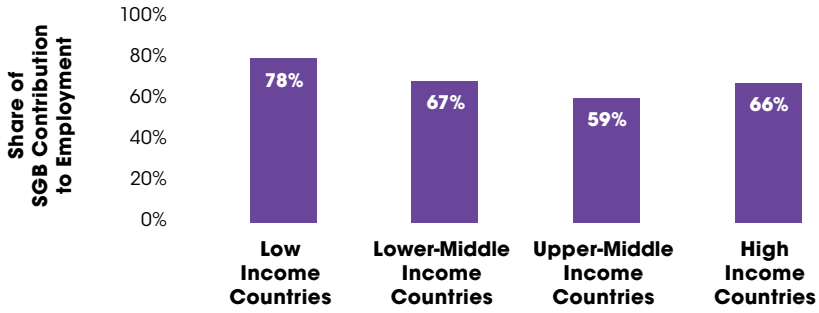
Growing up in rural Kenya, Clement Mwangi used to love delivering milk fresh from his family's cows to the teachers at his local school. He oversaw the family animals through his high school years, and while he accepted a job with the country's ministry of education after earning a degree in finance, cows were never far from his mind. Mwangi also was acutely aware of the many Kenyans unable to afford the beverage on which he'd so happily been reared. In casting about for a cost-effective way to get fresh milk to the nation's less advantaged, he came up with the idea of a coin-operated machine capable of dispensing small quantities at a time. Milk-on-demand, he thought, could meet the needs of a cash-and refrigeration-constrained population while providing access to a healthy food. Today, at the storefront Maziwa King facility he opened two years ago in Nairobi, consumers arrive on foot toting bottles or pitchers and, after depositing a few coins, walk away with nutrient-rich product less than a day from its source.

Eric Muraguri has his mother's laying hens to thank for the quality education he had the privilege of receiving. The 40-year-old studied food science before taking a job at KenChic, East Africa's largest poultry company, where he noticed that the secondary chicken parts not fit for the wealthy suburbs of Nairobi were being collected by poor women in the alley outside the slaughterhouse. Muraguri, who holds a master's degree in public health, knew the safety of the offals was questionable and needed to be better preserved for the country's poor, who had scant access to other healthy proteins. He began collecting the undervalued bird parts and selling them at low margins, and today his four Chicken Choice shops, the first of which he opened in 2007, draw consumers eager to carry home the once-neglected parts.

Mwangi and Muraguri are among the handful of African entrepreneurs currently benefiting from the Marketplace for Nutritious Foods, a program run by the Geneva-based Global Alliance for Improved Nutrition, or GAIN. The small-grants program offered to entrepreneurs is one arm of the Marketplace, a two-year-old initiative currently in operation in Kenya, Tanzania and Mozambique, that aims to increase the affordability, diversity and accessibility of nutritious foods to vulnerable populations. The Marketplace provides business-planning and technical support for the scaling-up of innovative ideas, and it brings together networks of entrepreneurs, investors, growers and institutions to address the challenges involved in the production and delivery of such foods.

In a busy area on the outskirts of Nairobi's notorious Kibera slum, a 27-year-old named Sarah Mekesa dropped a few coins into a Maziwa King machine and

Employment Contribution by Small and Growing Businesses (SGBs)



Report: Communications Toolkit, 2012 Impact Report, Small and Growing Businesses; Author: Aspen Network of Development Entrepreneurs; Site: http://c.ymcdn.com/sites/ande.site-ym.com/resource/collection/2D449B24-B86A-4B99-91D5-9ACDC9DCBD15/Communications_Toolkit-_Useful_Slides.pdf

Innovations in Finance

The past few years have seen investors around the world flocking to the agricultural sector—in particular, to the purchase or leasing of large swaths of land in sub-Saharan Africa and elsewhere. Nutrition is a different story. And with no ministry of its own, the sector tends to fall between the cracks. In 2010, the World Bank conducted a study on the money that would be required to scale up nutrition in order have real impact. It compared this figure to the funds actually available through foreign aid. The shortfall? More than $10 billion.

As the manager of innovative finance for GAIN, Chris Walker spends his days finding ways to fill that gap. Walker works with small and medium-size businesses to help them overcome the obstacles that might prevent them from scaling up the production and distribution of nutritious foods. At the same time, he cultivates relationships with investors interested in adding social impact to financial return.

GAIN is working with Root Capital, a Boston-based social lender focused on agriculture, in support of a Ghanaian entrepreneur who is producing a fortified instant porridge targeted at infants and young children. Samuel Kwame Adu Ntim resigned from his job with Unilever in 2002 in order to provide a locally sourced and affordable complementary food to rural populations with limited budgets. His company, Yedent Agro Group, works with several thousand small-scale farmers in the country's Brong-Ahafo region, guaranteeing them a market for their soy, maize and millet. (Currently, Kwame Adu Ntim is contemplating a switch to a nutritious variety of quality protein maize to give his product an extra nutritional boost.) He built his production facility nearby in order to be close to the farmers, who also can benefit from the product, which he sells in 50-gram sachets (enough for two servings) at a price that is half that of the comparable imported products on the market.

By using its grant money in such strategic ways, GAIN is able to leverage significant amounts of private investment and direct it toward improving the nutrition of low-income families, particularly among infants and young children. Based on the needs of the companies involved, Walker reaches out to different funding partners. He speaks with local banks in Africa and Asia, for instance, and works with them on ways to provide small loans to food businesses interested in producing nutritious products. For the past five years, GAIN has worked with the International Finance Corporation, the private-sector lending arm of the World Bank, to help companies reformulate and/or re-size foods. In addition to collaborating with Root Capital, GAIN teams with LGT Venture Philanthropy, a Swiss-based impact investor, with which it has invested money in nutritionally oriented enterprises. (It recently made a loan to a nonprofit that is making a ready-to-use therapeutic food.) Working with such partners, Walker pointed out, has the added advantage of exposing GAIN to a different skill set: Investors have a deep understanding of business and finance, and they bring a critical investment eye, and often technical know-how, to the table.

watched as the white liquid reached the rim of her bottle. Mekesa buys a liter of milk every day, she said, at a cost of 70 shillings ($0.79), and feeds it to her toddler daughter, often incorporated into porridge or cooked with spinach. Since she discovered Maziwa King, the young mother said, her family consumes twice the milk it once did, and she's noticed an improvement in her daughter's health. Next up to the machine was 50-year-old Simon Ngugi, who spends 60 shillings ($0.68) a day in order to enrich his tea with the creamy, full-flavored beverage. (Mwangi's milk is pasteurized but not homogenized.) Monica Mwihaki, the 24-year-old who oversees the facility, said she serves some 100 customers a day, with lines forming most afternoons and evenings.

By the end of 2014, Mwangi, whose sharp sartorial style nods to the years he spent studying in Paris, plans to have 12 of the Italian-made kiosks situated next to or inside low-income areas around the city. With the $140,000 dollars he'll receive from GAIN, he intends to increase his staff from three to eight and to purchase a refrigerated truck. He and his 37-year-old wife and business partner, Wairimu, are looking forward to guaranteeing a market to ever more farmers, whom they believe get a raw deal when selling to distributors. Ultimately, says Mwangi, he hopes to expand not just throughout Kenya but also beyond its borders. "We see ourselves going very big."

Eric Muraguri navigated a rutted dirt road outside of Nairobi before climbing down from the driver's seat of his SUV and removing a padlock from an iron gate. Dressed in Topsiders and a black cowboy hat, the spirited businessman ushered some visitors into an area alive with the sound of thousands of 3-week-old chicks. The feathered bundles skittered about, feeding intermittently from plastic bucket-like contraptions dispensing a growth-promoting mix of soy and maize. Muraguri, who buys some 2,500 chicks every two weeks from former employer KenChic, closely monitors the birds' feed intake and weight gain (he shuns antibiotics) before transferring them for slaughter at 1.5 kilos. He contracts with 17 farmers, guaranteeing them a market for all that they raise, and sells the bird parts to different markets depending on consumer price points. Arrangements with local hotels and golf clubs, for instance,

which buy the more-expensive legs and breasts, enable him to offer the less-popular cuts to others at reduced prices.

At a busy shopping plaza a few miles from Muraguri's farm, customers wandered into the neat, white-tiled Chicken Choice shop and pointed to whole birds and pieces displayed inside a glass case. Constance Zighe, a fashionable 32-year-old boutique clerk, ordered two of the popular, leek-rich chicken samosas, her standard lunch, and picked up a few raw cuts to take home for supper. "Sometimes I buy hearts, gizzards," she said, proudly admitting to an appetite for parts once considered "food for the poor." "I can get my stuff for any amount of money," she said, "and they have the best quality." Muraguri plans to use part of his Marketplace grant to open more shops in similar low-income neighborhoods. With the rest, he, like Mwangi, will purchase a refrigerated truck. He hopes eventually to buy a farm where he can consolidate all aspects of his business and raise his own growing capacity to 5,000 birds.

Meanwhile, in Mozambique, GAIN grantees are working on projects including a freshwater catfish farm; a facility for producing soy-based drinks and yogurts; a string of shops situated at depots where smallholder farmers drop off their cash crops and aimed at enabling them to access nutritious foods such as fortified oil and iodized salt; and a manufacturing plant for fortified corn-soy protein shakes intended for sale to the country's mining and other large industries for use in employee feeding programs. Increasing the availability of such previously inaccessible products shouldn't just improve nutrition, it should also grow important markets for farmers.

Promoting Traditional Vegetables

For Mary Abukutsa-Onyango, traditional vegetables are personal. As a girl growing up in western Kenya, she had rejected meat at an early age. Abukutsa-Onyango's mother, determined to provide her daughter with a varied and nutrient-dense diet, would cook the range of greens she found growing around the family's rural home. By the time Abukutsa-Onyango arrived at university, though, she was disappointed to find the same old *sukuma wiki*, or spinach, on her plate day after day. Not only had the national diet become tedious, it lacked for vitamins and minerals as well.

Abukutsa-Onyango decided to change that. Since 1991, she has devoted her professional life to the promotion of such little-known greens as African nightshade, vegetable amaranth and spider plant. It's been an uphill battle. For starters, there was a bias to overcome: Traditional vegetables had long been spurned as poor people's food, suitable only in times of starvation. When Abukutsa-Onyango applied for academic funding in the 1990s, she was told that her research into "weeds" didn't merit investment. She persevered, and today, as professor of horticulture at Nairobi's Jomo Kenyatta University of Agriculture and Technology, she oversees an entire research farm and greenhouses, working with students, the government, and thousands of Kenyan farmers to select nutritious plants that appeal to the public for things like yield, texture and taste. Abukutsa-Onyango's "indigenous-food revolution" appears to be working.

When Abukutsa-Onyango applied for academic funding in the 1990s, she was told that her research into "weeds" didn't merit investment

"Let food be your medicine," Abukutsa-Onyango told the audience of 300 at a 2012 TEDx event in Nairobi, "and medicine be your food." She clicked through slides featuring photographs of traditional foods, listing the vitamin and micronutrient content of each. "Some of you think they are weeds," Abukutsa-Onyango teased, "but they are wonder plants." Not only are they more nutritious than such staples as maize and cabbage, but they grow extremely fast and can flourish in challenging climates.

"Even the high-profile people who used to not take these vegetables seriously are now buying," Abukutsa-Onyango said, adding that you can find African nightshade, vegetable amaranth and spider leaf in most Kenyan supermarkets.

6 Innovating with the Private Sector

It's been nearly half a century since the social critic Vance Packard published his seminal *The Hidden Persuaders,* in which he explored the ways the advertising industry employs psychological techniques and subliminal messaging to influence consumer desire. In the decades since the book's publication, the industry's proficiency at separating us from our money has arguably only improved. Instead of roundly criticizing the private sector for its methods, however, public organizations might do well to steal a page from its playbook—by co-opting its powers of persuasion not just to shift consumer behavior, but also to convince industry itself to act in a manner that benefits the public good. The fact that industry must constantly answer to shareholders means NGOs and others in the agriculture and nutrition sectors need to get creative about developing initiatives that align incentives with happy end results for all.

Win-Win Opportunities

PepsiCo is among the companies that have moved into inherently risky markets with the help of the public sector, engaging with smallholder farmers in the developing world to improve livelihoods and nutrition while simultaneously serving its own interests. In Ethiopia, PepsiCo collaborated with the World Food Programme (WFP) and the United States Agency for International Development (USAID) on a program centered on chickpeas. Anticipating an upcoming famine, the country's prime minister at the time had approached the WFP about developing a local product that might save him from having to import such high-energy foods as PlumpyNut. It made no sense, he said, given that Ethiopia could grow its own high-protein chickpeas. PepsiCo, which owns the largest hummus business in

Today Ethiopia grows more chickpeas than PepsiCo can use; the excess crop is incorporated by local manufacturers into a ready-to-eat food product that gets sold to the WFP

the world, had an interest in improving and securing its supply of chickpeas (as well as of sesame, also widely grown in Ethiopia). The benefits of partnering with the WFP to invest in the country's farmers, whose yields at the time were extremely low, were obvious. In part by providing better seeds and drip-irrigation systems that enabled two crops per year, the company helped the farmers more than double their yields. Today Ethiopia grows more chickpeas than PepsiCo can use; the excess crop is incorporated by local manufacturers into a ready-to-eat food product that gets sold to the WFP. With global demand for chickpeas on the rise, the country now has the infrastructure in place—subsidized by the private sector—to play a major role in meeting it.

By providing the growers with seeds, fertilizers, equipment and technical advice, PepsiCo managed to develop a local source of high-quality, nutritious, high-oleic sunflower oil

In Mexico, PepsiCo was looking to reduce its use of palm oil, which it had been importing at a high cost from Asia and Africa for use in its Sabritas snack foods. Partnering with the Inter-American Development Bank, which helped the company lower its entry costs by funding initial infrastructure requirements, it enlisted 850 smallholder farmers. By providing the growers with seeds, fertilizers, equipment and technical advice, PepsiCo managed to develop a local source of high-quality, nutritious, high-oleic sunflower oil. Not only is the oil far better for human health than palm oil, it is far less environmentally destructive. (For the past several decades, sunflower, which is native to Mexico, had been used only for birdseed and decorative arrangements.) With the Bank's help, Pepsi was able to provide long-term advance purchase agreements to its network of farmers. The company continues to guarantee them a buyer for all they grow, an amount it hopes will eventually reach 40,000 tons. The new oil has improved the nutritional quality of the Sabritas snacks, many of which are consumed locally, while at the same time significantly lowering the company's transportation costs. Farmer incomes have risen, a situation that could also positively affect their nutritional status.

Hershey's also is working with the public sector in a way that benefits both the public good and the bottom line. The company was interested in manufacturing a lipid-based nutrition supplement and a line of peanut-based snack foods in West Africa. Because of the prevalence of aflatoxin in the region, however (see page 15), Hershey's was unable to locally source the quantity of high-quality safe nuts that it required. The company helped underwrite a research initiative overseen by USAID and other partners aimed at identifying and implementing best practices for lowering the incidence of the mycotoxin. Hershey's has strengthened its supply chain, while the broader agricultural community—and the West African public—benefit from healthier peanuts and practical information available to all through the public domain.

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Initiatives involving the corporate world and a double focus on agriculture and nutrition are increasingly common, said Derek Yach, who, as the former senior vice president for global health and agricultural policy at PepsiCo, oversaw the chickpea and sunflower initiatives. For starters, there is the rising pressure on the agricultural supply chain in an era of climate change. Companies are realizing that they need to be more proactive when it comes to securing the long-term

supply of those commodities central to their businesses. Environmental pressures also mean that NGOs and social impact investors are looking that much more carefully at corporate track records, just as they are focusing more on human rights and labor issues. "I think it's all part of the same movement," said Yach, who has served at the executive level with the World Health Organization. "Long-term, the investor community and the NGO community are expecting high standards to be applied right across the supply chain."

A stronger focus on the nutrition of the farmer, he says, can't be far behind. "People are starting to look at the nutritional and health status of people working in the farming communities." Reputation plays a part in this. "There's certainly the negative risk. But I think many are seeing the positive impact of improving the quality of health and nutritional status of workers. It benefits the bottom line."

Long-term, the investor community and the NGO community are expecting high standards to be applied right across the supply chain

There's a growing awareness, in other words, that a healthy workforce is a more productive one. Better nutrition, said Yach, translates directly into "more innovation, more morale, more retention, more profitability. As that applies to a blue-collar industrial worker, it applies as much to a farmer."

India's Britannia Foods

In 2008, when Vinita Bali served as chief executive officer of Britannia, a maker of biscuits in India since 1892, she oversaw a program to fortify its biscuits (a.k.a. cookies) with iron. The decision to do so, she said, "was actually quite simple." The company, which represents one-third of the country's $3 billion biscuit market, had been making fortified biscuits for the United Nations World Food Programme since the early 2000s, so the procedures were in place. Add to that the statistics on malnutrition in the country: 47 percent of children under 5 are malnourished, 70 percent of schoolchildren suffer from iron deficiency. "If you take both of these things," said Bali, "and the fact that biscuit is a universally accepted product—whether you're a kid or an adult or a geriatric, everyone loves the taste of a biscuit"—the move was virtually a no-brainer. Instead of trying to focus on multiple deficiencies, she said, the company opted to concentrate on the one that was most pervasive: iron.

Britannia began producing biscuits for the commercial market based on World Health Organization standards (India doesn't have fortification standards for biscuits), but it recognized that the need among children was significantly higher than that among the general population. Teaming up with a few large NGOs and private companies, it came up with a plan to supply biscuits fortified with even higher amounts of iron through the country's midday school plan, which reaches some 120 million children. Piggybacking on an established program and delivery mechanism, said Bali, made implementation that much easier.

Bali, under whose direction the company's revenue tripled, added that she made the decision to fortify in part based on a sense of purpose. "I think people believed that we could use our business to be part of the solution and not stand and talk about the problem." But it also has been good for business, as Britannia has established a reputation over the years for selling healthy products. (It also removed all trans fats from its biscuits.) Today, fully 50 percent of the products Britannia sells by volume in India—it makes bread and yogurt in addition to biscuits—are fortified. A win for nutrition and for business.

Bali stepped down from her position in March 2014 (she continues to sit on the board of the Britannia Nutrition Foundation, which she founded in 2009), but she still believes that corporations have a responsibility to do good. Still, she concedes, however that it may be a while before India's corporations take up the mantle of good nutrition on a widespread basis. (Aside from Cargill and a few other oil companies (see page 21), very few currently add fortificants to their products.) For starters, there is still a lack of awareness among consumers. "For most people, filling their stomach is the big event," she said, "not looking at what affords good nutritional status." This is particularly true among India's rural populations, where some 75 percent of farmers live below or just above the national poverty line. In addition, most of the population simply does not buy a lot of packaged food: branded packaged food represents just 9 percent of total food sold in India. For now, given the country's size and widespread poverty, interventions at a different stage of the supply chain—at the seed or soil level, for instance—or through government mandates might prove the more effective way to go.

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7 Working through Public Institutions

The World Food Programme estimates that schools feed over 300 million children around the world each day. For many of these kids, such meals may be the only nourishment they get. The programs are administered through a variety of mechanisms: some are supported externally, while others are funded entirely by governments. The poorest nations, perhaps not surprisingly, fall within the former camp. But even wealthy nations struggle with the operational costs of providing healthful school meals; budget shortfalls tend to manifest themselves in the form of plates piled high with inexpensive and nutritionally wanting starches—rice, tortillas, ugali. Incorporating diverse foods into school feeding programs takes commitment at the funding level and from local institutions, including farmers. In Ethiopia, Alive & Thrive is working with agricultural extension agents affiliated with the national goverment to bring better nutrition to the public. Through its Purchase for Progress initiative, the World Food Programme zooms out even farther, pairing the UN agency's global capacity with the efforts of national and local institutions.

School Meals in India

At 7 o'clock on a Tuesday morning, the Akshaya Patra centralized kitchen on the outskirts of Jaipur, in the Indian state of Rajasthan, was abuzz with activity. Workers in royal blue smocks paddled steaming mounds of rice out of giant cauldrons, while others loaded dough into a room-size contraption that rolled out, cut and baked some 40,000 chapattis an hour. Still others added cumin and turmeric to massive pots of dal. Eventually, the hot food would be transferred, at breakneck pace, to stainless-steel containers and spirited to a line of 65 trucks waiting just outside. The interior of each vehicle has been custom-built to hold the containers and transport them without spillage over the rutted roads to the designated schools in the kitchen's network.

In June 2000, the Akshaya Patra Foundation (the name means "the pot should never be empty") was established with an aim not just of feeding the students of India's schools, but of feeding them well. (India is home to more malnourished children than all of sub-Saharan Africa.) The federal government kicks in about half the funding; Akshaya Patra works with state governments and private donors to make up the difference. The kitchens have been designed to optimize quality and minimize cost, their innovative technology and strict quality-control measures ensuring that meals are as nutritious as possible. Just $15 feeds a child for an entire school year. Today, as the provider of lunch to 1.4 million children every day, Akshaya Patra is the largest midday-meal program in the world.

As the provider of lunch to 1.4 million children every day, Akshaya Patra is the largest midday-meal program in the world

"Akshaya Patra kids come from a deprived sector of society," explained Madhu Sridhar, the president of the center, seated in its storeroom amid white sacks of rice and flour and the intermingling scents of cumin and cinnamon. "Food provides an added incentive for them to come to school." Fresh vegetables are sourced daily, cleaned with potable water, and kept in cold storage until ready for cooking. Gravity-flow mechanisms minimize human handling of food, and steam cooking maintains nutrients and hastens preparation time. All cauldrons, trolleys, rice chutes, sambar and dal tanks, cutting boards and knives are steam-sterilized daily, and standardized recipes ensure quality and uniform nutrition. As of 2012, the midday meals have become even more nutritient-dense: GAIN began working with Akshaya Patra that year to help it source flour fortified with iron, folic acid and vitamin B12. (The center already had been working with the government to incorporate fortified rice and oil into its meals.)

Perhaps as important as the benefits to the students are those to the wider community. The Akshaya Patra center provides contracts to local farmers, ensuring them

66 million school-age children across the developing world attend classes hungry, with 23 million in Africa alone.

WFP estimates that $3.2 billion per year is needed to reach all 66 million children.

Author: World Food Programme
Site: http://www.wfp.org/hunger/stats

a market for all that they produce. Working with area suppliers cuts down on costs affiliated with transportation, ensures fresh ingredients, and insulates the program from fluctuations in global food prices. In addition, the center hires local men and women to prepare the food, drive the vehicles and serve the meals, thereby increasing income and potentially enhancing nutrition in that many more households. In the very rural areas, "decentralized" kitchens, run with the oversight of Akshaya Patra, are managed by women's groups, who produce similarly nutritious meals and earn an income that enables them to do so in the home. (The Jaipur kitchen, which was established in 2004, feeds some 30,000 preschool children in addition to its larger middle-school program. It also produces affordable food for 5,000 rickshaw drivers and other casual laborers, extending its nutritious reach even further.)

At 11:30 the same morning, some 395 children sat in two lines outside of a brightly painted school 10 miles away. Their legs crossed, their dark heads down, they devoured the school meal on their segmented silver plates. Afterward, they crowded around in their blue and khaki uniforms—the girls' hair done up with decorative white ribbons—to lavish praise on the meal to a few visitors. "Tasty!" exclaimed a little girl named Diksha Senani. "No one leaves anything on her plate." (Based on the appearance and aroma of the lunches, this was not difficult to believe.)

Teacher Inder Kumar Upadyaha affirmed that much had improved since the Akshaya Patra program was introduced to the school 10 years ago. "Earlier, there was no money for cooks, so the teachers had to cook," he said. From 1994 to 2004,

the school had been receiving some government funding for its midday-meal program, but it was not enough to pay an outside cooking staff. In addition, he said, "there were no economies of scale," so both the quantity and quality of the food suffered. The school's principal, 39-year-old Vishrukant Sharma, said he had observed a visible improvement in his students' health and concentration over the years. "We can see the difference from when they arrive and when they leave," he said. "They are much healthier."

The World Food Programme

Global

As the world's largest humanitarian agency fighting hunger, the World Food Programme (WFP) is a major buyer of staple foods, spending more than $1 billion on them annually. For the last five years, the organization has been piloting a program called Purchase for Progress, or P4P, through which it locally procures commodities from smallholder farmers in Africa, Asia and Latin America. With technical and other assistance from WFP, the smallholders are able to improve their agricultural production while at the same time being ensured a market for their crops. Many of the programs incorporate a nutritional component at some point along the value chain.

When women participate in decision-making, they are likely to invest in the nutritional needs of children and the rest of the household

From the outset, explained Ken Davies, global coordinator for P4P, the initiative deliberately set out to work with female farmers, as studies have found that when women participate in decision-making, they are likely to invest in the nutritional needs of children and the rest of the household. In West Africa, for example, WFP increasingly purchases commodities, such as pulses, that are nutritious and traditionally grown and marketed by women. Female farmers in Mali have been educated on the benefits of consuming the nutrient- and protein-rich local bean *niébé*; and more and more are incorporating the legume into home meals.

The Guatemala P4P program, said Davies, also has an explicit nutrition linkage, with farmers growing crops specifically for use in a fortified maize porridge that is distributed to mothers and young children through a government program. P4P also assists rural women in the planting of home gardens and in the creation of support groups where mothers discuss feeding and good-nutrition practices.

Surplus crops produced by smallholders working with P4P also have been used to make fortified foods in Afghanistan, Ethiopia, Kenya and Malawi. In Afghanistan, P4P provides support along the entire value chain in order to facilitate local production of fortified wheat flour, high-energy biscuits, and lipid-based nutritional supplements. In Rwanda, P4P-supported farmers sell their surplus grain to processors that

produce a fortified flour made from sorghum, soy and maize. They have also begun to incorporate beans specifically developed to be more nutritious, such as HarvestPlus' biofortified high-iron beans.

School feeding programs also play a large role in P4P pilot programs around the world, stimulating local economies and promoting attendance and better nutrition among students. In Ethiopia, for instance, P4P-supported smallholders supply nutrient-dense beans and legumes for use in school meals. In some cases, the meals are coupled with nutrition education. In Malawi, a P4P partner organization supports a school feeding program in which local farmers supply staple crops to 10 primary schools. The schools purchase fruits and vegetables, as well as fish, groundnuts and bananas, from smallholders, thereby diversifying student diets and ensuring students have adequate nutritional intake.

The P4P program is moving beyond the piloting stage; there is an opportunity to build more conscious links to nutrition into its design as it is mainstreamed

"The nutritional aspect has been in the whole value chain," said Davies. "And now that the P4P program is moving beyond the piloting stage, it gives us the opportunity to build more conscious links to nutrition into its design as it is mainstreamed and moved forward."

8 Consumer Behavior Change

At the end of the food value chain, we find the consumer. And when it comes to nutrition, not just any consumer matters. Infants, young children and their mothers are key to stopping the intergenerational scourge that is malnutrition. Not only are mothers the universal providers of food, but they also are imprinting, as early as in utero, the taste preferences and eating patterns of their children. During the first year of life, eating patterns undergo profound changes. Ideally, infants start out by obtaining all of their nutrition from breast milk. Somewhere between 6 months and 1 year, however, they generally transition to meals and snacks. These are determined to a large extent by a mother's diet and by her ability to access foods. Her choices are cultural, economic and psychological—and they are profoundly important, given that it is during the transitional period from breast milk to solid food that nutritional status tends to fall off and that mortality rates increase. Changing the habits of mothers is not an easy task.

It's All About the Moms

As any psychologist will tell you, human behavior often is not rational. Our actions may be based on subconscious needs or wants, or on conditioning of which we are unaware. Such instincts come prominently into play in the feeding of infants and young children. Marti van Liere, who studied behaviors around food in her capacity as senior nutrition advisor at the Royal Tropical Institute, in Amsterdam, found that mothers' choices often are driven by cultural beliefs, social conditioning and questions of status, and that, even among the very poor, consumer marketing and the aspirations that it instills have an impact.

In Indonesia, van Liere discovered that, despite widespread campaigns encouraging women to breastfeed exclusively, many still purchase formula. "Everybody there knows the message 'breast is best,'" said van Liere, but often a new mother lacks the confidence that she will be able to breastfeed. Midwives or health professionals convey a message that anybody can do it, so when a new mother has trouble, she may become convinced that she is incapable or her milk is insufficient. If she hasn't had the dietary diversity she's been advised to follow during pregnancy, she might believe her milk is of subpar quality. There are also social pressures, and in particular a widespread perception that mothers who do not give their babies at least some formula are poor. "They feel embarrassed if they can't give infant formula because their peers will think they can't afford it," explained van Liere. Of course, there is also the marketing of the formula companies, which advance the message that their product is clean, nutritious and comparable to mother's milk.

Similar pressures play into the trend among Indonesians to feed young children unhealthy snacks. A child that is crying or unhappy, van Liere said, reflects badly on the mother, who might therefore placate her with a biscuit. "A happy child is almost more important than a well-fed child." Mothers are also consumers, and tend to be pressed for time. Van Liere mentioned a recent study in Ghana that revealed the extent to which even very low-income consumers look for convenience when shopping for food. Even those in rural areas buy some processed foods, and they are exposed to marketing through cell phones, radio, and other media.

Mothers' choices often are driven by cultural beliefs, social conditioning and questions of status

Parallel constraints come into play among the pastoralists of northern Kenya, where increasingly erratic weather patterns are testing the resilience of families already challenged by a harsh, arid climate. As rainfall becomes harder to predict, these normally nomadic peoples are beginning to settle down, with an impact on what family members are eating. The African development organization Adeso is running a USAID Feed the Future project aimed at understanding the challenges these families are facing and at reducing the rates of hunger and poverty among them. The partners, who have enlisted Kenyan experts in agriculture, nutrition, planning, and communication, are utilizing what are known as Focused Ethnographic Studies to look at infant and young child feeding patterns among three communities in the region. "In our in-depth interviews," said Enock Musinguzi, a project manager for GAIN and the person overseeing the nutritional component of the program, "we found that multiple aspects of household function and conditions affect what ultimately gets into the mouths of infants and young children."

Among the most interesting findings, said Alison Tumilowicz, a GAIN researcher, was the role that natural resources—or the lack thereof—play in determining what children eat. The mothers in the three regions studied, all of which are dry and characterized by extreme poverty, spend so much time sourcing water and firewood that they are able to cook only once a day, usually in the morning. That means the food sits around for several hours, and very possibly longer than is safe. While the mothers and caregivers in the study were universally concerned about food hygiene and aware that foods can be contaminated, they didn't have the option of cooking multiple times given the need to conserve firewood. They also were aware of the importance of hand washing, but, in the absence of adequate water or

They also were aware of the importance of hand washing, but, in the absence of adequate water or soap, often were unable to do it routinely

soap, often were unable to do it routinely. "You think it's education," said Tumilowicz, "that people just need to know what they should do and eat and they will be fine." With food hygiene and sanitation, she said, the message is getting through just fine, but the resources simply are not in place for them to be put into action.

The researchers were surprised to learn the extent to which the three nomadic populations were sourcing foods for infants and young children from the market. With the exception of milk, all of the products—mainly maize flour, oil and fruits—are purchased outside the home. Households therefore require cash, which means that mothers often must engage in activities outside of the home, leaving young ones in the care of siblings or other caregivers.

Cultural perceptions also come into play. If there is a stigma associated with standing in line to receive a fortified product, a mother might opt to use a non-fortified one instead. At the same time, she may be receiving contrary advice from various segments of public and private health delivery. In the face of too many messages, she may opt to shut out all of them.

All of which makes changing behavior around feeding practices exceedingly difficult. The means to do so, in fact, often have nothing to do with food. Ensuring better nutrition for the infants and young children in those Kenyan communities might involve sinking boreholes in order to free up mothers' time. Supplying the households with more efficient stoves could reduce the dependence on firewood. Providing closed thermos storage containers could improve food safety. Since mothers are sourcing cereals from outside the home anyway, those products could be fortified at the commercial level. Nutrition education could be more forcibly targeted at grandmothers and fathers so that the burden of overcoming constraints doesn't rest solely on the mothers. Expanded market opportunities for women-produced crafts such as woven baskets and beaded jewelry could help boost women's incomes, and stronger marketing systems for the livestock that form the basis of the families' wealth could help balance seasonal income disparities. In the dust of northern Kenya, nutritionists are turning to cookstoves and the thermos in addition to their traditional fortificants and improved diets as public health interventions.

Because human behavior plays into all of these situations, development experts stress the importance of integrating behavior change communication (BCC) into every aspect of intervention planning and implementation. Whether through text messages, posters, radio spots or talks at mosques, churches and health centers, all messaging, they say, must take into consideration the much broader landscape at play in the decisions that get made around feeding.

Van Liere, who currently serves as director of Maternal, Infant and Young Child Nutrition at GAIN, previously worked for Unilever, and she believes that when it comes to behavior change, everyone could learn from the private sector. In Indonesia, van Liere has collaborated with behavior-change and marketing professionals on a series of television commercials and posters aimed at improving the diets of infants and young children. A spot about breastfeeding features a grandmother dispensing advice, as elders are looked upon as figures of authority in the culture. Another ad and accompanying poster, aimed at promoting dietary diversity, prominently feature a street cart overflowing with nutritious—and eye-catching—fruits and vegetables. As any adman will tell you, "Visuals work better than just words," van Liere said. "It's about establishing social norms, and about copying what you see."

Development experts stress the importance of integrating behavior change communication (BCC) into every aspect of intervention planning and implementation

In the dust of northern Kenya, nutritionists are turning to cook stoves and the thermos in addition to their traditional fortificants and improved diets as public health interventions

Alive & Thrive

Over the course of five years working in Ethiopia, Alive & Thrive, an initiative aimed at improving infant and young nutrition, found that engaging fathers was key to achieving its goals. "The men are decision makers here," said Manisha Tharaney, senior technical advisor, Nutrition, for the organization, "so to really change the social norms at the community level, we need to work with them as well as the women." The gendered aspect of food production and consumption determines a large part of what is available on the plate.

For instance, Tharaney said, while her organization promotes the feeding of an egg a day to young children, men often are getting contradictory advice from agricultural agents, who counsel them to sell the household eggs. "We realized that we need to tackle men's perceptions about complementary foods," Tharaney said, while at the same time "enhancing their role as economic providers and decision makers." One of the best ways to reach them, they realized, was through such agricultural agents, who tend to interact frequently with men. "If we can target them with simple, doable actions, we might be able to effect behavioral change."

Alive & Thrive, which also works in Vietnam, Bangladesh, and other countries, has collaborated on posters promoting "seven excellent actions," two of which are directed toward men. "Fathers," reads one, "for your child to be healthy, smart, and strong, it's your job to make sure that baby has special foods added to his porridge." The accompanying photo features a man handing his wife a few eggs and an armful of leafy greens. The posters, which were distributed to each household, feature small boxes next to each action. When the families succeed in carrying out an action consistently, the health worker or community volunteer checks off the box. Those families with seven checked boxes are deemed "model families" and celebrated in community ceremonies. "When they are congratulated in front of their peers," said Tharaney, "it motivates other families to follow suit."

9 Policy

In its 2012 study "Aid for Food and Nutrition Security," the Organisation for Economic Co-operation and Development (OECD) reported that most official development assistance, or ODA, for food and nutrition security is allocated to agriculture. In the years from 2008 to 2010, for instance, that figure was 61 percent. The second largest category, development food aid, received 22 percent. ODA for nutrition, however, stood at just 3 percent. There is no doubt, given the persistence and severity of malnutrition, that the scope and definition of what is "agriculture" deserves to be expanded beyond the farm. At the country level, such a shift will require the kind of bold and creative leadership already in evidence in Tanzania and Rwanda. Nigeria, too—home to one in five Africans, and where agriculture is responsible for some 40 percent of gross domestic product—is leading the way when it comes to a more nutrition-centered vision for agriculture. The United States also has made great strides in putting nutrition at the forefront of its vision for responsible food systems, both at home and abroad.

Michelle Obama's Let's Move! Campaign

Today nearly one in three children in America is overweight or obese

While children in the developing world suffer from high rates of stunting and malnutrition, the food-related health problems of youth in the United States tend to be found at the other end of the spectrum. In the three decades prior to 2010, childhood obesity rates in the country tripled; today nearly one in three children in America is overweight or obese. (Health experts blame obesity for a variety of medical conditions, including heart disease, high blood pressure, diabetes, cancer and asthma.) Once it takes hold in a society, obesity is a particularly intractable problem, in part because eating habits and preferences get passed down from one generation to the next.

In February 2010, First Lady Michelle Obama announced the Let's Move! campaign, with the goal of rolling back the childhood obesity rate in this country to 5 percent, the level it was in 1976, before the epidemic began. The initiative, which involves partnerships with the medical, scientific, business, education and athletic communities, has five main thrusts, including creating a healthy start for children; empowering parents and caregivers; providing healthy food in schools; improving access to healthy, affordable foods in communities; and increasing physical activity. At the launch of Let's Move!, Barack Obama signed a presidential memorandum creating the first-ever Task Force on Childhood Obesity. The mission was to conduct a review of every program and policy related to child nutrition and physical activity and develop a national action plan to maximize federal resources and set concrete benchmarks toward the First Lady's goal.

But some things are easier said than done. While Michelle Obama has played an instrumental role in raising the profile of the importance of healthy eating, many say that her initiative has not yet met its ambitions. Aside from the increase in healthy food at childcare centers and the reforms in school lunches—the Healthy, Hunger-Free Kids Act, signed into law in December 2010, gave the Department of Agriculture, for the first time, the power to regulate foods sold in à la carte lines, vending machines and school stores—not much has changed in this country. Part of the problem, observers say, is that not even Mrs. Obama has the power to make the regulatory changes (a soda tax, for example) necessary for a true transformation. Others blame politics and the difficulty of taking on the multibillion-dollar food industry, with its lobbying infrastructure and influence on Capitol Hill.

Let's Move! may be somewhat hobbled by entrenched interests, but imagine what the First Lady's model could achieve for nutrition and overall health if the presidents and prime ministers of the world could get to our children before the lobbyists do.

Nigeria's Minister of Agriculture

When it comes to improving nutrition on a wide scale, innovations at the level of seeds and soil can go a long way. Without a government that is committed to supporting agriculture in a manner that prioritizes nutrition, however, broad change can be difficult to effect. Among those who have embraced the cause wholeheartedly is Akinwumi Adesina, Nigeria's minister of agriculture since 2011. The dapper Adesina, who received a PhD in agricultural economics from Purdue University, came up through the ranks at the International Institute of Tropical Agriculture (IITA), the Rockefeller Foundation and the Alliance for a Green Revolution in Africa. He understands well the role that agriculture policy can play in improving human health.

Adesina has proved deft in bringing new technologies to agriculture and adopting successful innovations from other countries. He also has broadened the typical mandate of the agricultural sector from producing simply more food to producing better food.

For four decades prior to the minister's arrival in the Nigerian capital of Abuja, for example, the national government had been buying and selling fertilizers itself, in a system notorious for its corruption. "No more than 11 percent of fertilizers ever got to the farmers," Adesina said. He put an end to that through the help of the cell phone. Adesina's ministry launched Nigeria's first Know Your Farmer network, which entailed the compilation of a database of the nation's farmers. Today, some 14.5 million of them are registered. Each of the farmers—25 to 30 percent of whom are women—receives subsidized seeds, fertilizers and other inputs via electronic coupons sent through their mobile phones. With the new system, the government has been able to reach 95 percent, in some cases 98 percent, of farmers, depending on the state, with

inputs by phone. "It's been a revolution for us," said the minister, who added that the program has enabled national food production to grow by 21 million metric tons in just three years.

The Know Your Farmer network has enabled national food production to grow by

21

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While the e-wallet system has allowed those 14 million farmers to improve the food security for the 50 million people in their households, Adesina conceded that malnutrition is still a problem in the country. In some areas, the rates of stunting are as high as 30 percent. His ministry hopes to contribute to a solution via three routes. First, he says, it is reaching out to women farmers. This year the government began a program similar to that in place for seeds and fertilizers. In this instance, it distributes multinutrient powders via coupons sent to mobile phones. He hopes to reach 2.5 million women directly with the powders, which also are subsidized at 50 percent of cost. In addition, the government is targeting women farmers with highly subsidized vegetable seeds and encouraging more diversified farming systems at the household level. Better nourished farmers, of course, are more productive and therefore also better for business.

Today Adesina hopes to reach

1.5

million

households with the sweet potatoes and with a cassava developed by IITA and bred to be high in pro-vitamin A

Nigeria also is investing money and energy in biofortification. Two years ago, an orange-fleshed (high-vitamin-A) sweet potato developed by the International Potato Center (CIP) and other partners was distributed to 300,000 households in the country. Today Adesina hopes to reach 1.5 million households with the sweet potatoes and with a cassava developed by IITA and bred to be high in pro-vitamin A. Both of the new cultivars have been readily adopted by Nigerians, who bake them into breads, chips and other products. In addition, Adesina is working with the private sector to improve the fortification of such products as oil, flour, salt and seasonings.

Adesina sees all of these initiatives as key to furthering the one goal he considers primary: investing in the long-term future of the nation. "If you look at Africa," he

Certifying for Food Security

Over the past decade or so, businesses involved in the production of such cash crops as tea, coffee and cocoa have sought to achieve certification through organizations like Fair Trade, the Rainforest Alliance and UTZ Certified. The labels focus on issues related to labor conditions, environmental impacts and human rights, with the broader aim of ensuring a more sustainable future for the tens of millions of smallholder farmers involved in their supply chains. Of course, certifications have the added benefit of boosting a company's profile in the eyes of the socially minded—and often wealthy—consumers who might purchase its products. Despite the fact that research has shown severe levels of undernutrition among the main tea, coffee and cocoa producing areas of Africa and Asia, however, a nutrition component has been notably lacking from the schemes.

The broader aim is to ensure a more sustainable future for the tens of millions of smallholder farmers involved in their supply chains

This may soon change. A movement is afoot to work within the existing labeling systems to also certify that the producers of the products are food-secure. Though cash crops themselves typically have no nutritional value, the businesses involved in the supply chains surrounding the crops—along with such organizations as the Global Alliance for Improved Nutrition—are exploring other avenues for getting good nutrition to their growers. UTZ Certified already has adopted a nutritional angle in its implementation guidelines, including recommendations for integrating nutritional trees into shade-cropping systems and incorporating hygiene and nutrition training into farmer-education programs. Given the difficulty of linking the nutritional status of farming families directly to a product, however, the UTZ guidelines currently are voluntary rather than mandatory.

Some multinational companies are also dipping their toes into the waters of better farm-worker nutrition. They are launching pilot projects that aim to improve nutrition on any number of fronts, including by increasing the dietary diversity of farming families through intercropping with nutritious fruits, nuts and other crops, and integrating nutrition education and awareness into farmer training programs. Some are even looking into the possibility of providing nutritious meals, along with farm-site childcare, and they are promoting breastfeeding-friendly practices. Once the companies have identified successful nutrition interventions, they will be in a position to expand them to their other commodity-based product lines. Given the high cost of ignoring nutrition—studies have connected lower on-farm productivity to malnutrition among grower families—companies are recognizing that improving nutrition among their farming communities makes good business sense.

USAID's Feed the Future

At the 2009 G8 Summit in L'Aquila, Italy, President Obama announced a $10.15 billion commitment over three years to an initiative focused on reducing hunger and poverty in the developing world. Feed the Future, officially launched in 2010 and coordinated by the United States Agency for International Development (USAID), focuses on the advancement of global agricultural development, increased food production and food security, and improved nutrition, particularly among women and children. The program currently works in 19 countries in Africa, Asia, Latin America and the Caribbean, partnering with host-country governments, the U.S. government's Global Health Initiative and other partners to create nutrition strategies specific to each location.

"It was intentional from the beginning that the bureau blend nutrition and agriculture," said Rob Bertram, director of the Office of Agricultural Research and Policy at the Bureau for Food Security, set up to coincide with the launch of Feed the Future. The highest-level objectives of the program, he added, are reducing poverty and reducing stunting. "That alone reflected a much more integrated vision of how agriculture, food and other issues have to come together to get outcomes."

Sally Abbott, the nutrition and food security advisor for the bureau, cited a series on malnutrition that appeared in *The Lancet* in 2008 as among the main drivers behind the program. "It showed that preventing malnutrition was far more effective than treating it once it's happened," she said. "That allowed us to be working from an evidence-based perspective on why integrating nutrition with agriculture is so important."

Among the specific programs in the Feed the Future portfolio is one focused on legumes. The last 40 years have seen a productivity lag in legumes as relative to cereals, explained Bertram. "If rice and wheat are much cheaper than lentils and chickpeas, you're going to eat more of them." Unfortunately, such cereals are far less nutritious than legumes. Feed the Future is looking at various ways to integrate more legumes into diets. In Malawi and Zambia, for example, it is taking a "doubled-up legumes approach," wherein farmers rotate two legumes, such as pigeon peas and groundnuts, with maize. The maize yields increase, and the availability of nutritious food in the household goes up, as do incomes.

From the beginning of Feed the Future, said Bertram, "our missions have adopted a value-chain approach." In addition to working at the farm level to increase production, it also looks at post-harvest handling, processing and linking to markets. In Ethiopia, for instance, it worked with the World Food Programme and PepsiCo on a program aimed at increasing chickpea production (see page 29). In Kenya, Tanzania and Mozambique, Feed the Future teamed up with GAIN to support entrepreneurs and something called the Marketplace for Nutritious Foods (see page 25).

Already, says Bertram, Feed the Future has made great strides in bringing the nutrition and agriculture communities together. At the same time, he said, other components are critical when it comes to reducing stunting. Moving forward, he hopes to see "even stronger connections between food-security investments and water, sanitation and hygiene."

said, "you find six of the 10 fastest-growing economies in the world. You find skyscrapers all over the place. You have infrastructure. But we're not investing in what I think is the most important infrastructure, which is gray-matter infrastructure. Gray-matter infrastructure is what determines how economies grow." Stunting and malnutrition permanently impair mental development, with long-term negative consequences for a nation's economic prospects.

Nearly

90%

of the high-energy foods (such as PlumpyNut) eaten in Africa are imported from outside the continent

Among other works in progress is a nationwide school feeding program, for which Adesina is taking cues from Brazil's successful Bolsa Familia initiative. The idea is for schools to contract with local farmers to be ensured a steady supply of nutritious ingredients. He also is championing the Partnership for High-Energy Foods in Africa. Today, nearly 90 percent of the high-energy foods (such as PlumpyNut) eaten in Africa are imported from outside the continent. To make them, says Adesina, requires basically three ingredients: sorghum, maize and soy beans (and perhaps peanuts), all of which Nigeria produces in abundance. A company called Dansa Foods has put in $45 million to set up a high-energy-food manufacturing plant in northern Nigeria, and Adesina is in talks with the World Food Programme to provide product for its use. He hopes to service not just his own country, but also neighbors like Niger, Mali and Burkina Faso, which tend to have large populations of nutrition-vulnerable people. "I really feel that this is the time for African businesses to recognize the importance of nutrition," said Adesina, who also has placed the issue of aflatoxin contamination (see page 15) at the center of his agenda. His ministry oversaw the construction of a manufacturing facility for Aflasafe at the Ibadan facility of the IITA, and it now is looking to build four more facilities that will produce locally appropriate strains of the remedy.

"My view of agriculture is that it's not a development program," Adesina says. "It's a business. For way too long people have looked at agriculture in Africa as just a development activity, and we should just throw more money at the problem. Even doctors will tell you, 'Take three tablets a day, *after food*.' Food is first. And so unlocking that potential of agriculture is the key." The way to do that, he says, is by enabling the private sector, including the farmer, to reach its full potential. And unless the farmer is well-nourished, doing so will prove impossible.

10 Measuring Impact

In the late 1990s, when the British statistician Adrian Smith was running for president of the country's prestigious Royal Statistical Society, he stumped on a platform of "evidence-based" policy. Smith, who had served as head of the mathematics department at Imperial College, London, questioned the then-popular strain of policy-making that relied on ideology over proven fact. (Smith eventually served under Prime Minister Tony Blair, whose administration would come to be known for its evidence-based decision-making.) In fact, Smith had borrowed a page from the field known as"evidence-based medicine," in which research findings provide the support for clinical decisions, and evidence—gathered through randomized controlled trials that compare treatment groups with placebo groups—is used to measure results. Generating evidence in real life, whether for medical or policy-making purposes, is rarely linear or straightforward. At the same time, it is necessary for making decisions about future courses of action. For agriculture policy to pay attention to nutrition, we need evidence. In turn, for public health decision-makers to bring agriculture to the table, we need evidence—even if it isn't very easy to get.

Easier Said than Done

Over the course of 2013, a handful of partners, including the Washington, D.C.–based International Food Policy Research Institute (IFPRI), conducted a study focused on a remote population of pastoralists living in northern Senegal. Among the challenges for these nomads is that during the dry season, in particular, the output of their animals is extremely low, thus further constraining the nomads' already limited diets. (Though dairy is central to the lives of most Senegalese, two-thirds of the country's milk demand currently is met by imported powder.) Rates of malnutrition among the population are extremely high: Up to 80 percent of children, and 60 percent of women, suffer from anemia.

The researchers teamed up with a local dairy, the Laiterie du Berger, which collects milk from the pastoralists and processes it into an iron-fortified yogurt, to understand how a value chain might be made nutrition-sensitive, as well as how putting in place incentives might have the effect of strengthening that chain. The plan was to leverage the logistics already in place for milk collection to deliver the nutritious yogurt to young children within the dairy's supplier households. The product would be offered only to those households that increased their milk output, thereby rewarding the farmers, most of whom are women, for additional effort. At the same time, the implementers instituted a behavior-change campaign intended to increase knowledge about best practices when it comes to feeding children.

The incentive worked, said Marie Ruel, Director of IFPRI's Poverty, Health, and Nutrition Division. The farmers produced more milk, and the rates of anemia among the children decreased, if modestly. And yet, she said, "I can't say it was a grand success." The reasons for that point to just how difficult it is to measure the impact of an intervention, particularly one that involves agriculture and nutrition.

For starters, said Ruel, a sound study needs control groups. Simple "before" and "after" measurements don't provide a rigorous assessment because there are too many outside factors—weather, conflict—that might impact any change over time. But even establishing control groups presents a challenge. While a rigorous evaluation mechanism had been put in place in Senegal, with one group receiving the incentive and another not receiving it, there is almost always "leakage," Ruel said. Families receiving the yogurt likely shared some of it with their neighbors. And though the product was designed specifically for children aged 2 to 5, the mothers likely fed some of it to younger and older siblings. Such "contamination" reduces the impact, thereby rendering the final results that much less valid.

Ruel said that while researchers can potentially prevent such leakages by locating control groups farther from those receiving an intervention, they then run the risk of introducing other factors into the equation. Perhaps that other community lives closer to a stream, for instance, so that its cows already produce more milk. Or maybe there's a mango tree nearby that provides one set of children with an additional source of nutrients.

There also tends to be leakage in the educational components. "You cannot withhold behavior-change communication sessions from people who are not in the program," said Ruel. "If women come by and want to listen in, you cannot keep them out." Nor should you, of course.

Just as the humans involved in a study introduce more complexity than do specimens in a petri dish, so does a real-world environment present challenges not present in a lab. Any program involving agriculture, for instance, is at the mercy of the weather. The early or late arrival of a rainy season, for instance, might delay implementation and eventually affect findings.

There are also time and financial constraints. Programs that run several years become extremely costly to monitor. Professionals with a deep understanding of how to put rigorous evaluations into place can be difficult to find, and they don't come cheaply when you do find them. Unfortunately, the NGOs, private companies and governments that design and implement the programs generally haven't had training in evaluation. And trying to assess a program that has not been rigorously designed—one that doesn't have valid comparison groups, for example—will yield compromised results. Exacerbating the situation is that faulty studies are never published—the scientific journals won't accept them—so that their lessons don't get passed on.

And while donors generally work in increments of two and three years, human behavior tends to change much more slowly than that. "You may have improved women's empowerment," said Ruel, "but it will take awhile for those women to be able to act in a way that changes what they are buying and feeding their families."

In the end, said Ruel, it's the complexity of the programs that makes rigorous evaluations so hard to carry out. "We're trying to improve nutrition, and nutrition is a complex construct. If you only give food to people, they will not necessarily improve their nutrition. You need to also make sure that you prevent infections, that they have access to water and sanitation, that women are able to make decisions about how to allocate resources…." Attempting to change so many factors at the same time only renders it that much more difficult to attach any specific intervention to one particular outcome.

Proving agriculture can have an impact on nutrition, in other words, isn't the no-brainer that many of us might have assumed it to be. Continuing to engage the communities involved in the sector—and to amass evidence of the impacts that various programs are having—should go a long way toward shaping nutrition-focused food systems moving forward.

In Conclusion

Given the growing demand for these foods, we need to redouble our efforts to strengthen the supply chains that support them, most importantly in refrigeration and other aspects of the cold chain, in the absence of which too many nutritious perishables go to waste.

A colleague from Helen Keller International likes to begin her presentations with an anecdote meant to knock her audience off its guard. "In 1935," she begins, "Stanley Bruce, addressing the General Assembly of the League of Nations [Bruce was Australia's High Commissioner to the United Kingdom at the time] brought the issue of agriculture and nutrition to the attention of its members, with the aim of inducing them to increase the consumption of agricultural products, thereby improving world nutrition standards. At the conclusion of Bruce's speech, his advisor, Frank McDougall, sent a triumphant telegram to a colleague, John Boyd Orr. "Brother Orr," he wrote, "we have this day lighted such a candle, by God's Grace, as we trust shall never be put out."

The point being, of course, that this is not the first time we have vowed to marry the agriculture and nutrition sectors. But now there are a few differences. For starters, the food system has gone global. It is being shaped at both the most macro and the most micro levels. In addition, the private sector, both big and small, has become our willing partner. Both public institutions and multinational corporations are working with local farmers, and

as farmers are increasingly being seen as growers in a complex value chain, their health and well-being have become a part of the business model. Small businesses are being heralded as marketplace champions, bringing affordable nutritious options to their communities, and national and local processors are adding nutrients to their everyday processing. Today, just as nutritionists are learning about diets and foods in their labs at agricultural universities, so are agriculturalists placing nutrition at the center of their breeding programs—kudos to the 16 international research institutes of the CGIAR for recently announcing that they will make nutrition a non-negotiable plant-breeding aim in all their programs. And policy makers are paying close attention to what development practitioners have been saying for some time—that women matter, land rights matter, and multi-sectoral approaches are key to achieving impact.

Moving forward, we can expect to see even greater change. While we were writing this Snapshot Report, the United Nations University World Institute for Development Economics Research (UNU/WIDER) published a notable working paper addressing the transformations in the food system that we are likely to see over the coming 30 years, driven in large part by a growing middle class. The study, which concentrates on eastern and southern Africa, makes three main points.

The first is that highly processed foods will penetrate far deeper into rural and urban areas than previously believed, eventually comprising up to one-third of all purchased foods. As we learned from Vinita Bali on page 31, this shift is already underway in India, where between 2007 and 2013 the packaged-food market grew at a remarkable 16 percent. It suggests that farming populations will soon be eating as much purchased processed foods as their urban brethren. While the processed-food revolution has spurred positive innovations in convenience, food safety and storage, its ultimate impact will depend on the degree to which processing avoids doing harm. These new foods must be low in fat (and the remaining fats must be good fats), low in sugar and salt (preferably iodized), and fortified with the essential vitamins and minerals often lost during mass production.

The second point is that more nutritious, but perishable foods such as vegetables, dairy and other animal-sourced goods will fortunately comprise a large portion of the diet, even in urban settings. Given the growing demand for these foods, we need to redouble our efforts to strengthen the supply chains that support them, most importantly in refrigeration and other aspects of the cold chain, in the absence of which too many nutritious perishables go to waste. As Nikki Duncan illustrates on page 71, we need to look toward non-traditional partners to improve nutrition, including the cooling, transport and storage authorities. The third point of the WIDER report is that rising incomes will, contrary to popular wisdom, be spent largely on local, rather than imported, foods. This is good news not only from a "climate-smart" perspective, but also for smallholder farmers and local markets. The nutritional content of those foods will depend on whether farmers and traders have the inputs (improved seeds, enriched fertilizers, and modern post-harvest technologies, like Coolbots and drying sacks) necessary to prevent rot and minimize such health threats as aflatoxins.

What priorities for action, therefore, does this Snapshot Report point to?

At a recent meeting with the UN agencies in Rome, GAIN brought stakeholders together to ask where the best opportunities lie for linking agriculture and nutrition. A recurring theme was the need to "bridge the gaps"—to make markets work by bringing food producers and consumers closer together; to guide agricultural investments so that they produce healthier food and benefit rural communities; and to build an integrated research agenda that is supported by both the nutrition and the agriculture sectors. There is no reason why complementary approaches that integrate what works for both agriculture *and* nutrition can't be developed. But, as with all nutrition interventions, there is no single sector that can deliver the solution. The private sector—including smallholder farmers, local millers, and small- and medium-sized businesses—civil society, the UN system, and local and national governments of both developed and developing-world countries, must come out of their silos and work together if we are to integrate agriculture and nutrition for positive outcomes.

We need a clear plan of action to ensure that the money spent on agriculture results in better nutrition and that the health sector continues to pay close attention to food. This means optimizing basic food systems so that we are sustainably producing the greatest amount of nutrients per square foot. We must support national governments and policy makers to incentivize greater collaboration between the agriculture and nutrition sectors. It is only by consolidating efforts, setting common goals, pooling resources and sharing experiences that we can make these two camps work better together. In the face of population growth, urbanization and climate change, this task becomes ever more urgent.

We need the evidence. Full stop. If we don't build a body of evidence that verifies that agriculture can have, and is having, an impact on human nutrition, the two sectors will continue along their separate ways. Investments will diminish, and attention will move on to such competing "musts" as climate change, poverty reduction, trade and education—all of which are essential yet also dependent on better-fed populations, but none of which recognizes nutrition as a vital input or outcome. It seems hare-brained, and for agriculture particularly so, what with food being the most ubiquitous source of nutrients.

So while the colleagues highlighted in this report continue to generate that evidence and build on what is working, it is up to the rest of us to keep linking agriculture with nutrition and continue the dialogue. It appears, at a minimum, that agriculture and nutrition have finally gone beyond merely waving from opposite sides of the street to actually holding hands. It is our job to continue to support their stronger union.

More to Explore

Introduction

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About GAIN

The Global Alliance for Improved Nutrition (GAIN) is an international organization launched at the UN in 2002 to tackle the human suffering caused by malnutrition. Today nearly 3.5 billion people worldwide are malnourished in some way. Close to 2 billion people survive on diets that lack necessary vitamins and nutrients, while about 1.4 billion people struggle with overweight and obesity. We know that sustainable, nutritious diets are crucial to ending the cycle of malnutrition and poverty. By building alliances that deliver impact at scale, we believe malnutrition can be eliminated within our lifetimes. Today our programs are on track to reach over a billion people with improved nutrition by 2015.

About the Authors

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Acknowledgment of Contributors

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