

# CHANGE IS ON THE MENU

FOOD SYSTEMS FOR NUTRITION AND HEALTH



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Our Nutrition site

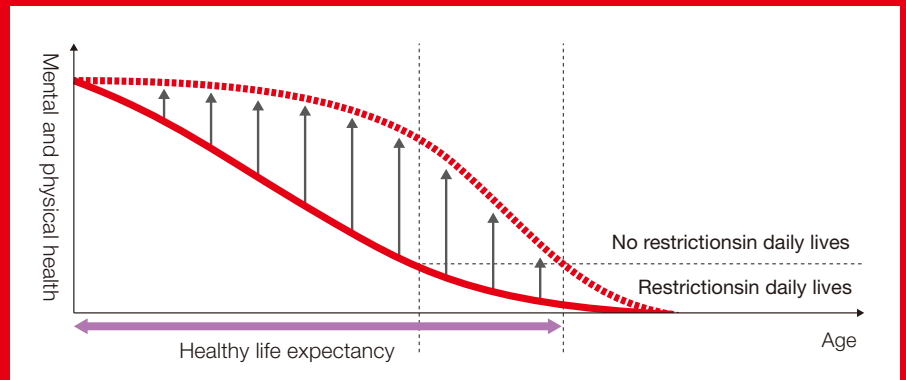


## Our Vision

Contribute to greater wellness for people worldwide, unlocking the power of amino acids to resolve the food and health issues associated with dietary habits and aging.

### By 2030

- Help extend the healthy life expectancy of 1 billion people.
- Reduce our environmental impact by 50%, while improving business performance.



# CHANGE IS ON THE MENU

## FOOD SYSTEMS FOR NUTRITION AND HEALTH

In today's world, 149 million children under five are stunted, 45 million suffer wasting and 39 million are overweight. Nutrition for these children is critically associated with their survival, future health, development and their opportunities in life. Yet, with 1.9 billion adults overweight and 462 million underweight— and hunger on the rise — it is clear that malnutrition remains an overwhelming, vicious and intergenerational challenge.

Nutrition has many niches of study and, as such, we have an incomplete understanding of the complexity of the nutrition landscape. Some view nutrition as a physiological state, some as a human right. Nutrition — and its problems — are too often viewed as a direct function of supply of nutrients and choice of dietary patterns; malnutrition as an imbalance of intake and requirements; with responsibility for nutrition falling on the individual rather than a system. Nutrition can be marginalized from high-level dialogues on sustainability and food security when the focus is placed on quantity, rather than quality, of food supply.

In this set of articles, we find that the burdens of malnutrition are, in reality, the complex fall-out from failing food, health and political systems. The extent of these failings has been drawn into sharp focus by the COVID-19 pandemic, the climate crisis, East African locust outbreaks and violent conflict the world over. The good news is that food and nutrition science is enjoying a period of remarkable innovation in technology and financing – challenged-focused and creative, science is delivering solutions, on alternative proteins, circular bio-economy, precision nutrition and more. As promising as this is, high-level dialogues on shared vision and operational trust between food systems actors — those who can make a real difference to the burdens of malnutrition — are in their infancy. Nutrition needs those dialogues.

And so, Nutrition for Growth in Tokyo offers a major opportunity for change. It falls mid-way in the Decade of Nutrition, within a global pandemic, and in quick succession from the UN Food Systems Summit and COP 26. The articles here take stock of the food, health and political systems that are driving malnutrition. With innovations in technology and finance offering creative and challenged-focused solutions, we ask if those with power in global food systems are hungry for change?

**Anne Mullen**  
Chief Editor, *Nature Food*

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FOR GROWTH**  
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# URGENT ACTION NEEDED FOR WHAT'S LEFT OF THE 'NUTRITION DECADE'

*Experts call for a concerted global push to tackle food insecurity as we reach the midway point of the UN Decade of Nutrition.*

Most gains made during the first half of the UN's Decade of Action on Nutrition have been wiped out in 2020, say nutrition experts, leaving little hope that the world can reach its nutrition targets within the 10-year programme. This has many nutrition experts worried.

The COVID-19 pandemic has interrupted global efforts to address the combined threats of undernutrition, obesity and micronutrient deficiencies. Pandemic-related disruptions to global health, food and economic systems mean the dual burdens of chronic undernutrition and unhealthy weight gain have increased dramatically. Greater investments in nutrition are needed now more than ever.

"Many effects of COVID-19 will be long term — a lot of nutrition will slide back," says Zulfiqar Bhutta, an expert in paediatrics and nutrition from the University of Toronto, Canada and Aga Khan University, Pakistan.

But, not all nutrition shortfalls can be blamed on the pandemic. "It's easy to find a scapegoat," says Bhutta, "but for years we haven't focused on reaching the poorest of the poor and that's offset much of the progress on global efforts to end hunger, achieve food security, improve nutrition and promote sustainable agriculture."

Illustration by Youssef A. Khalil



Now is the time to “build better,” says Patrizia Fracassi, a senior nutrition and food systems officer at the UN’s Food and Agriculture Organization (FAO). “From now until the end of the Decade of Action, we must make our food systems work for the most vulnerable communities.”

### Taking action, tracking progress

The ‘Nutrition Decade’ was launched in 2016 as a framework for stakeholders to implement and build upon commitments made at the Second International Conference on Nutrition (ICN2) two years earlier. An FAO/WHO-run secretariat is tracking progress toward ending all forms of malnutrition.

Top priorities include making nutrition services integral to universal health care coverage; building sustainable and resilient food systems that promote healthy diets and ensure the livelihood of food producers; and addressing malnutrition through social protection programmes and food education.

Governments, businesses, donors, multilateral organizations and other development partners were encouraged to make data-driven, time-bound commitments in targeted action areas — and a handful of countries formally stepped up to the challenge.

Brazil, for example, pledged to tackle rising rates of adult obesity, to curb the consumption of sugar-sweetened beverages and to promote more servings of fruits and vegetables. Ecuador and Italy made similar commitments around healthy eating and childhood nutrition. These and other nations also joined loose coalitions, termed ‘action networks’, to focus on issues ranging from nutrition labelling and sustainable fisheries to healthy school meals and salt intake.

### Then came the pandemic

One study from researchers at the UN World Food Programme and elsewhere concluded that the percentage of people living in low- and middle-income countries who could not afford even half the cost of a healthy diet had increased from 43% to 50% because of pandemic-related economic woes.

Another analysis from the Standing Together for Nutrition Consortium—a group that formed in 2020 to tackle the COVID-19-related nutrition crisis — anticipates a rapid escalation in numbers of children who are acutely malnourished, and thus at risk of death. By 2022, the group estimated, 13.6 million more youngsters in low- and middle-income nations will suffer from acute or chronic forms of malnutrition compared to pre-pandemic numbers.

Food insecurity due to the pandemic could also cause 283,000 additional child deaths, the study found, with millions more babies born to underweight women or mothers with anaemia — both health conditions that can negatively affect child development.

“These numbers are really staggering,” says study co-author Saskia Osendarp, executive director of the Micronutrient Forum in Washington.

Reporting in the July 2021 issue of *Nature Food*, Osendarp’s team estimated that an additional US\$1.7 billion per year is needed to mitigate the effects of COVID-19 on undernutrition and child mortality. But, she says, in many countries, “the coffers are empty”. The funding landscape is “dire,” she says, although there are glimmers of hope.

Osendarp’s immediate priorities for investment begin with COVID-19 response and recovery plans for lower- and middle-income countries that focus primarily on nutrition for women and children. Mid-term priorities should include cost-effective food supplementation and fortification. But in the longer term, she suggests, more structural investment is needed in food and health systems, which should include sector-wide commitments for direct investment in nutrition.

### Recommitting to nutrition

The World Bank singled out food security as a top priority for its International Development Association replenishment drive last year. The African Development Bank has made food systems transformation integral to its pandemic recovery efforts. And,

through the Nutrition for Growth (N4G) Year of Action launched in December 2020 by the governments of Canada and Bangladesh, several countries and aid organizations pledged nutrition-specific funding of their own.

Additional commitments are associated with two international events in 2021: the UN Food Systems Summit and the Tokyo N4G Summit. Many of those commitments might not formally fall under the banner of the Nutrition Decade but that matters little to the WHO’s Lina Mahy, a member of the Secretariat for the Nutrition Decade.

More consequential, she says, is that those commitments are made and nutrition is now on the global policy agenda. In her 30-plus-year career, “there has never been as high an alignment politically,” Mahy says. “Action is happening, impact is being realized.”

As long as commitments are made within the 10-year timeframe of the Nutrition Decade, Mahy and fellow secretariat members view those actions as contributing to a common cause. Any progress toward the effort’s objectives is included in a biannual report submitted to the UN General Assembly.

Mahy remains optimistic that the Nutrition Decade’s ambitious goals are within reach. If anything, COVID-19 has made plain the importance of healthy diets from resilient, sustainable food systems. Groups such as the Food Coalition, now led by FAO, aiming to address the pandemic’s adverse impacts on food systems and agriculture, help support these goals.

Such momentum is necessary to achieve the UN’s 17 Sustainable Development Goals (SDGs) by its deadline of 2030, notes Joel Spicer, president and chief executive of Nutrition International, a not-for-profit organization based in Canada. Whether directly or indirectly, improved nutrition underpins nearly all the SDGs and “there’s a lot to be done,” Spicer says.

“We’ve got to ring the global alarm,” he adds. The Nutrition Decade, or what’s left of it, should continue to do just that. ●

# HUNGRY FOR HEALTHIER FOOD SYSTEMS

*People need nutritious, affordable and sustainable diets. Transformed global food systems could deliver this for the people and the planet.*

As our world lurches toward a population of nearly 10 billion by 2050, the current threat to food security is not necessarily quantity but quality. Three billion people cannot afford a healthy diet.

High food prices and low incomes have resulted in 40% of the global population surviving on unhealthy diets, leaving them vulnerable not only to malnutrition but also to diabetes, anaemia and other diet-related disease, suggests a 2020 report by Tufts University. The report showed that for people on low or uncertain incomes, many healthy foods including fruits and vegetables, nuts, dairy products and fish are consistently more expensive than starchy staples, oil, and sugar: people in poverty are forced to eat less expensive items, or go hungry. Poor or unhealthy diets are deadly — even worse than smoking tobacco.

Increasing global awareness of this problem is producing a range of possible solutions under the umbrella term of ‘food systems transformation’ that proposes radically new food systems that are sustainable, resilient and inclusive.

“Transforming the food system to provide for better diets requires

actions from many actors across the food chain, including producers, transporters, processors, retailers and also consumers,” says Saskia de Pee, a scientist in the United Nations World Food Programme (WFP) Nutrition Division. “Today’s diets are not providing for good health, neither of people nor of the planet. This is related to an imbalance of production, which has placed an emphasis on providing enough food, especially in terms of caloric sufficiency, and at a low price, and not enough on dietary diversity and sustainability of production. The cost of even the lowest-cost healthy diet is unaffordable for at least three billion people.”

Health and environmental impacts of diet are often linked, but this view is “unnecessarily narrow” and requires “much deeper understanding of the drivers of food choices in all contexts around the world,” argues Eileen Kennedy in a 2021 paper in *Current Developments in Nutrition*. The United Nations is focusing on the problem through its Sustainable Development Goals, which include tackling climate change and food security alongside other economic and societal outcomes.

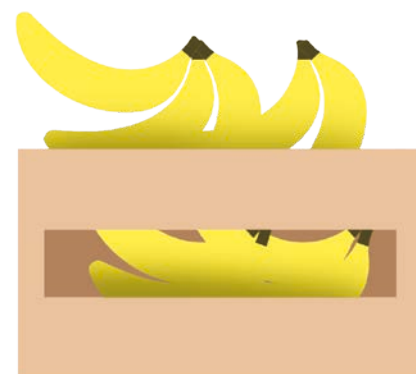
## Pre-summit calls for a revamp

In the run-up to a Food Systems Summit in New York in September 2021, more than 25,000 delegates gathered virtually and in-person in Rome in July to discuss how national food systems should change.

“Despite a 300% increase in global food production since the mid-1960s, malnutrition is a leading factor contributing to reduced life expectancy,” UN Secretary General António Guterres said ahead of the Pre-Summit gathering, noting 720–811 million people faced hunger in 2020. “Climate change is both a driver and a consequence of hunger. Our war with nature includes a food system that generates one third of all greenhouse gas emissions. The same food system is also responsible for up to 80% of biodiversity loss.”

Event participants called for producers, smallholder farmers, indigenous peoples, women and youth to be at the centre of efforts to create change. A challenge, though, is the vast diversity of food systems: there’s no one-size-fits-all solution.

One vision to achieve the goal of sustainable, healthy diets was outlined in a 2020 *Nature Food* paper by researchers from the Global Panel on Agriculture and Food Systems for Nutrition. The authors use the example of China’s Loess Plateau to show how ecosystems and food production can be transformed. After centuries of land overuse, the plateau suffered erosion and deforestation, contributing to the poverty of its inhabitants. With international partners,



the Chinese Government launched ecological rehabilitation initiatives to regenerate vegetation, build terraces and convert farms on slopes to grasslands or forest. As a result, substantial parts of the plateau were restored and millions lifted out of poverty.

Reforming agricultural subsidies and taxes, claim the authors, means governments can implement four priority policy actions: making nutritious, sustainable food available to all; improving the efficiency of food value chains; ensuring healthy food is affordable to all; and empowering consumers to make informed choices to drive demand for healthy, sustainable diets. International cooperation is key. "The inter-connectedness of food markets and trade means that no one country alone can fully change their food system," they wrote.

**Trialling transformation**

Other regions are also considering how to transform their food systems.

A Nordic collaboration of research and innovation agencies has charted eight steps required for transformation across their region.

Country-level transformation for four nations — Bangladesh, Ethiopia, Nigeria, and Vietnam — is the focus of the CGIAR's Agriculture for Nutrition and Health (A4NH), with each country at a different stage in transforming from a traditional to modern food system.

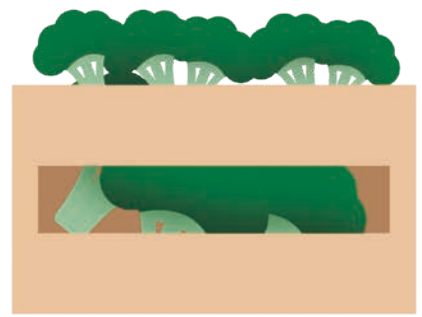
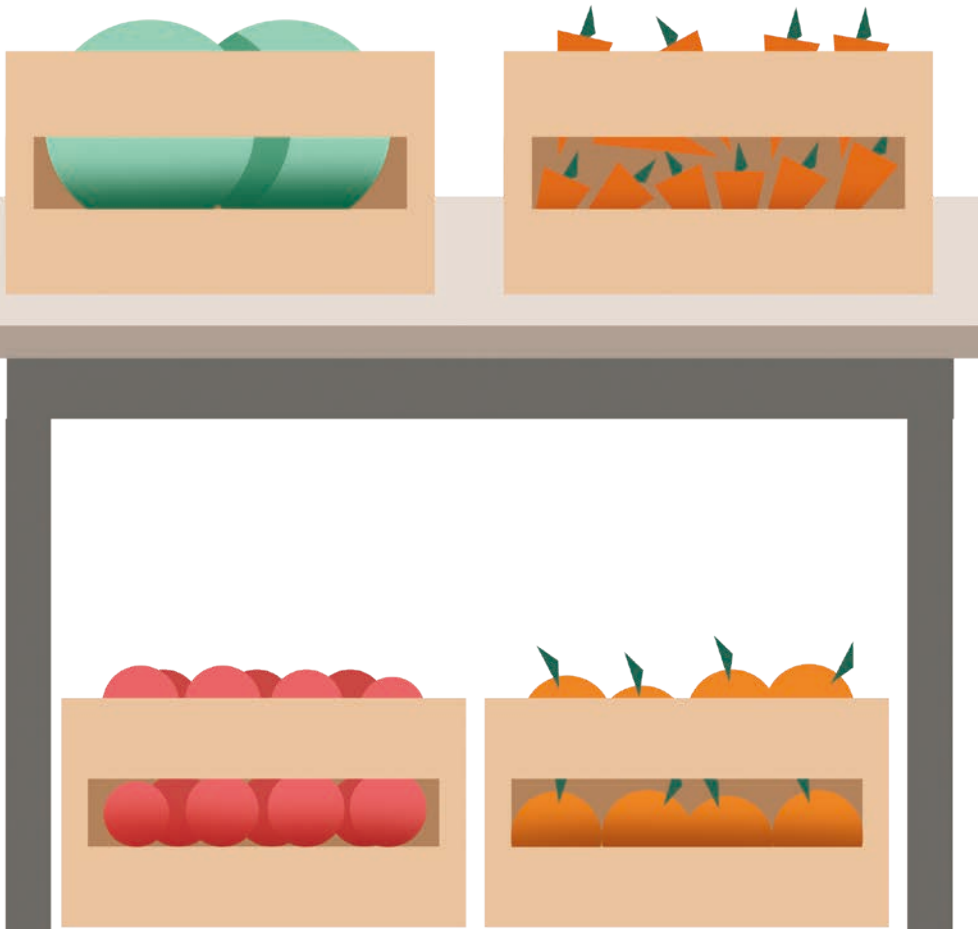
The COVID-19 crisis has further highlighted the imperative for transformation. The global pandemic and higher food prices have increased the affordability gap — the extra money needed to afford a healthy diet. The WFP Fill the Nutrient Gap (FNG) analysis outlines constraints for consumers in accessing a diet that meets their needs for good health and nutrition and charts a path to transforming food systems. It suggests interventions such as homestead food production, scaling up poultry and egg production where animal source food consumption is

too low, especially among nutritionally vulnerable groups, and providing nutrient supplements to specific groups including pregnant and breastfeeding women and children under two years old.

The larger the gap, the lower the diet quality, says de Pee, adding that the magnitude of the gap must inform the type and size of support. This is one way in which food systems can be transformed, and it's part of a larger puzzle that researchers, policymakers, UN, private sector and civil society workers are seeking to solve — and soon.

"The external drivers of the food system — including climate change and shocks, conflict and economic downturns, in addition to geography, natural resources, investment and today's status of the system — affect the extent to which food systems are amenable to transformation and how it could be approached," says de Pee. "There is no blueprint for the change: it should be designed and adapted as per a country's needs and possibilities." ●

**"There is no blueprint for the change, rather these should be designed and adapted as per a country's needs and possibilities."**



# NUTRITION IN A TIME OF COVID-19: IT'S COMPLICATED

*The impacts of the COVID-19 crisis emphasize the need for a global response that supports sustainable investment in food production and promotes healthy eating.*

The COVID-19 crisis is likely to have complex and long-lasting impacts on our already complicated relationship with food. Whereas some high-income population groups have reported less healthy eating, more snacking and weight gain, others resorted to healthier, home-cooked meals and eating more fruit and vegetables.

Yet the pandemic also triggered significant job and income losses the world over, leading to food insecurity that could exacerbate undernutrition in children and anaemia in women.

"In the early stages of the pandemic, there was much concern that we would face something akin to famines and acute food shortages," says paediatrician and nutritional scientist Zulfiqar Bhutta of Canada's University of Toronto and Aga Khan University, Pakistan. "The bottom line is that this has not happened. Outside a few extremely food-insecure regions, the supply chains had the innovation to meet expectations,

people came forward with philanthropy, and local support and social services kicked in. But there has been a huge impact on the informal sector and the poorest of the poor. This pandemic has affected inequities in ways that nobody could have imagined. It's now very clear that the rich became richer and the poor became poorer."

In a comment published in *Nature Food* earlier this year, Bhutta and international colleagues have projected that, without adequate responses, COVID-19 and the related economic recession could lead to millions more wasted and stunted children, and 168,000 additional child deaths in low- and middle-income countries. Also, tens of millions of adults could become undernourished and be plunged into extreme poverty.

This is illustrated by a recent Reuters survey, which found that for 75 rural families in India, household incomes had dropped nearly 75% since the start of

the pandemic, with almost two-thirds of the households taking on debt.

"This has a flow-on effect, with nutritional impacts in the form of wasting and chronic undernutrition," explains Bhutta. "This has been compounded by massive interruptions to education and health services."

South Asia, for example, has witnessed disruptions to family planning services, nutrition counselling and







the provision of food supplements and immunizations, including for breastfeeding women and children.

### Supply stayed steady

At the global level, food supply chains have demonstrated exceptional resilience. Total merchandise trade showed a remarkably rapid recovery. Following a sharp contraction at the start of the pandemic, it now exceeds

pre-pandemic levels and portends future growth. Trade in agricultural products was especially resilient in its response. “We never saw a trade recession in this sector,” says Josef Schmidhuber, deputy director of the trade and markets division of the UN’s Food and Agricultural Organization (FAO). “What we saw was a steady rise and even a slight acceleration of agricultural trade.”

The reasons for this are complex but have to do with our indispensable need for food and the vagaries of a competitive global import/export market.

A closer look, however, shows demand for fish and beverages declined considerably during the first six months of 2020, failing to recover to pre-crisis levels by the end of the year. These are considered luxury goods, explains Schmidhuber, that are expensive due to their high transport costs and import tariffs. Meat, fruit and vegetable trade was also affected. But cheaper goods, like cereals, rice and staples, were in higher demand.

“Where some countries had problems, other countries increased their exports, which explains why global trade remained so robust,” says Schmidhuber. For example, when European Union supply chains for citrus were disrupted at the beginning of the pandemic, Egypt stepped in to fill the gap, improving its access to the EU market.

Lessons have been learned from previous financial crises. “Governments moved away from austerity policies and understood they had an important role to play,” says Schmidhuber. “Massive stimulus packages in many G20 countries helped to reduce the period of suffering and expedite the recovery process significantly.”

But, he adds, cyclical aid tends to exacerbate price swings, contributing to the next crisis, rather than helping to avoid it. “What we need is sustainable investment and commitment to food production.”

This investment could come in the form of government support for small and medium enterprises that provide locally and regionally sourced, nutrient-

rich foods. Support is also needed for shorter and more diversified food value chains. More investments are needed in national and community agriculture, and in national micronutrient premix facilities to promote local production of fortified staples. International food markets need to become more transparent and food movement needs to be monitored in real time.

Reinvigorating post-pandemic food systems also provides an opportunity to encourage healthy eating. For example, more incentives are needed to encourage food companies to make healthier products that are more affordable. The marketing of unhealthy foods by these companies could be reduced through tougher regulations. Subsidies and food vouchers should be linked to retailers providing healthy food. And food literacy and school feeding programmes leave much room for improvement.

**“Our solutions must be global in a world that has become increasingly interconnected.”**

“At a global level, we were hopelessly unprepared for this,” says Bhutta. “We were slow and made some wrong decisions. Even now, when we have clear evidence of what needs to be done for a global pandemic at a global level, we are trying very hard to control things at local levels, by closing borders, restricting travel, getting vaccines in and caring nothing about what happens to vaccines in the rest of the world.”

“How can we protect ourselves against an enemy unless we do something at the global level?” continues Bhutta. “Like with climate change, it will just come back to us in one form or another. The lessons to be learned from this are that our solutions must be global in a world that has become increasingly interconnected.” ●

# Cutting down on sodium, not taste

As countries strive to promote healthier diets and lessen the risk of chronic illnesses, **AN UMAMI-INDUCING FLAVOUR** enhancer could hold the key to reduce salt in food without compromising on taste.

**Salt intake worldwide is currently between 9 and 12 grams a day**, much higher than the 5 grams recommended by the World Health Organization (WHO). That poses a significant health risk, particularly as too much salt can lead to high blood pressure, heart disease, and stroke, contributors to one in five global deaths in 2017, according to a 2019 Global Burden of Disease study.

## THE PARTIAL REPLACEMENT OF SALT BY MSG ENHANCES THE POSITIVE TRAITS OF LOW-SALT FOODS

To tackle the issue, the United Nations has been collaborating with member states of the WHO since 2016 to eliminate malnutrition and reduce the global population's salt intake by 30% by 2025. And as governments address the urgent need to promote balanced diets, the Japanese food technology group of companies, Ajinomoto, is

leveraging more than a century of bioscience knowledge to help drive the global nutrition agenda.

"The Ajinomoto Group prioritizes salt reduction by providing deliciousness through umami or providing products with reduced salt," says Hiroyuki Kojima, a corporate senior vice president and general manager of the R&D Planning Department at Ajinomoto Co., Inc.

"This is part of our aspiration as a group, to help people 'Eat Well, Live Well,' and extend their healthy life expectancy by providing strategies to decrease salt intake without compromising taste," Kojima adds.

Umami, which roughly translates to 'savoury' in Japanese, is known as the 'fifth taste' alongside sour, sweet, salty, and bitter. It was first discovered in 1908 when Japanese scientist Kikunae Ikeda identified glutamate as the amino acid that gives kombu — a type of kelp — its umami flavour. Glutamate is also an umami-inducing substance found in many foods such as cheese, meats, and tomatoes. Given that



glutamate is one of the building blocks of protein and peptides, it keeps bodies functioning, and aids in the digestion of protein.

In the food industry, the most frequently used flavour enhancer is derived from glutamate and called monosodium glutamate or MSG. By weight, MSG contains two thirds less sodium than salt, and as there's no chemical difference between the glutamate found in foods and commercially manufactured MSG, the body processes them in the same way. Kojima says that this makes MSG a perfect candidate for enhancing the taste of low-salt dishes.

"Umami seasoning is such a good alternative because with less sodium than salt and without adding aroma, the partial replacement of salt by MSG enhances the positive traits of low-salt foods," says Kojima.

Today, Ajinomoto sells its products across 130 countries and territories, in everything from supermarkets to street stalls. Ajinomoto has also made its thinking around healthy eating readily accessible to consumers. For instance, in 2017, Ajinomoto was able to reduce the salt intake in Iwate, a prefecture in northern Japan. To improve people's diets, the company

NaCl is essential for health, but its overuse as common table salt has been linked to a number of chronic diseases



Ajinomoto has been enhancing flavour for more than 100 years



Broth and mushrooms are natural sources of monosodium glutamate

collaborated with retailers and the Iwate prefectural government to promote low-sodium products and recipes using locally-sourced ingredients. It also raised awareness of the importance of reducing salt-intake through informative in-store displays at supermarkets. That programme has already spread to six prefectures across the Tohoku region in northern Japan, and Ajinomoto plans to expand it to a further 39 prefectures in the future.

Promoting the value of a healthy diet, reducing salt intake, and encouraging protein consumption is crucial in Japan, where more

than 28% of the population is aged 65 and older. The elderly are more vulnerable to chronic illnesses and protein is critical in maintaining muscles, mobility, and a strong immune system. Ajinomoto Co., Inc. produces amino acid supplements designed to help maintain and increase muscle mass. The company also has a database of recipes on its website that explores how MSG, itself an amino acid, can complement protein sources like beans and tofu, and other seasonal vegetables to produce delicious dishes.

On an international level, one of the most cost-effective measures countries can take

to improve people's health is reducing salt intake, according to the WHO. However, not all consumers are aware of the nutritional value of the foods they buy. Over the next few years, Ajinomoto Co., Inc. plans to roll out Japan's first nutrient profiling system (ANPS) based on the Australian government's Health Star Rating system. That initiative assigns health ratings to packaged foods and beverages. The ANPS will rate the nutritional value of 500 products from the Ajinomoto Group.

The accumulation of nutritious meals throughout the year and one's lifespan

makes up a healthy diet, according to Kojima. It's about bringing out the best in affordable, locally-sourced and sustainable ingredients, and forming bonds through sharing that knowledge. "We want consumers to enjoy flavourful low-salt products and simple but nutritious dishes that they prepare together with friends and family," says Kojima. ■

**Eat Well, Live Well.**

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# GROWING NUTRITIOUS FOOD WITH AN EYE ON CLIMATE CHANGE

*As seasons shift so must agricultural systems if we are to reduce climate shocks to food security.*

What happens when climate change throws a spanner in the palm-oiled cogs of a globalized food system? Farmers everywhere face a monumental challenge to meet the nutritional needs of Earth's expanding population in a shifting climate. Just as heatwaves destroy crops on land, disrupted ocean currents could leave fisheries floundering. Tropical zones that grow rice and corn today could dry up during longer, hotter summers as optimal growing regions slowly march poleward.

As growing seasons and territories shift, all countries need to support the global effort required to ensure food security for all. Tim Benton, Research Director in Emerging Risks at Chatham House, UK, calls for a food systems approach. "Food is not simply about

agriculture in one place," he says. "Each country is connected to the global market through its own export and import dependencies, and so the impacts of climate change are a global issue." Just as COVID-19 exposed the vulnerability of current food systems by disrupting the 'just-in-time' distribution model, climate change will do the same.

The food system also contributes to climate change, generating around a third of anthropogenic greenhouse gases. "We must make our food system more resilient without increasing emissions or pressures on the land," says Benton. Monoculture farming has already reduced natural biodiversity, while agricultural chemicals have degraded the soil and polluted water supplies. Governments must help farmers overcome these problems while also

ensuring food security, especially in times of crisis.

Climate-related disasters repeatedly highlight the need for nutritional preparedness. While high-yielding staple crops can be stockpiled for emergencies, they should be bolstered by locally grown nutrient-rich foods. However, safely storing nutrient-dense foods remains a challenge in hot countries. Crop diversity is also crucial for keeping land productive year-round and establishing a strong root system that stabilizes the soil, prevents nutrient depletion and improves water retention during droughts. Regenerative farming, which advocates no-tilling and organic compost, is gaining ground as a way to restore soil nutrients and plant biodiversity.

## Grain drain

The most food insecure regions will be hit hardest by climate change. Already, local food supplies are increasingly impacted by extreme weather events, new and shifting plant diseases and pest outbreaks such as the plague of locusts that devastated the Horn of Africa in 2020. "Climate is a major issue for African farmers: if it's not droughts, it's flash floods," says Namukolo Covic, nutritionist at the International Food Policy Research Institute. "Unpredictable rainfall makes it difficult for farmers because the expected timing for planting their crops keeps shifting."

**"Food affects climate and climate affects food, we must make our food system more resilient without increasing emissions or pressures on the land."**

Changing consumption patterns also undermine food security. Farmers have been coaxed away from growing naturally drought-resistant indigenous grains such as millets and sorghums and onto maize, a high-yielding but very thirsty crop. “Even in my lifetime I’ve seen a shift. As a child, I ate a lot of millets and sorghums as part of my staple diet,” says Namukolo. Agricultural policies in her home country of Zambia have been “maize-centric,” she says. “Most of the research is into maize; all the subsidies were for fertilizers to grow maize. Farmers will grow what they are helped to grow.”

“Yet food resilience should be addressed on multiple fronts. Much work has already gone into drought resistant maize, but there is now a greater realization of the value of other cereals,” says Namukolo. “African farmers are being advised to diversify, to add sorghum and millet to their crops in addition to maize.”

Deforestation to create vast monoculture farms has left the land at the mercy of flash floods and other weather-related events. Several African countries have now launched immense reforestation programs to reverse desertification and reduce the risk of landslides. There is even talk of planting a green belt along the southern Sahel, a “Great Green Wall” at the edge of the Sahara Desert. Ethiopia’s ambitious reforestation program has kept food security firmly in sight, with at least half of new plantings to be fruit trees.

**Production considers nutrition too**

Ethiopia has made great progress in food production since it was devastated by famine in the 1980s, but with little focus on nutrition. Now, Africa leads the world in adding much-needed nutrients to

crops. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has developed sorghums with high levels of iron and zinc. “Ethiopians are particularly deficient in these two micronutrients,” says Namukolo. “Combining biofortification with drought resistance addresses multiple challenges.” Other African countries are already growing cassava and maize with added vitamin A and iron-fortified beans, but production needs to be upscaled.

Making affordable nutrient-rich foods will require intensification, but the fragmentation of farmland into small plots makes it challenging to introduce sustainable intensification practices. Farming collectives are already helping smallholders minimize the risk of adopting new techniques.

Namukolo sees both opportunities and challenges for Africa in trying new things. “We are starting so far behind rich countries. But they have already made their mistakes and those can be lessons for us,” she says. “Developed countries want to help us do what they’ve done, but they should want to help us to do something different and do it better.” The stakes are high for Africa. “We are already facing climate issues and we have no other resources to fall back on,” says Namukolo. “For us, it is do or die.”

Paradoxically, the rest of the world could lag behind Africa’s efforts to nourish people while protecting the planet. “Over the past decade, we have moved away from globalized cooperation for the common good,” says Benton. “But if we don’t tackle the global challenges together, the perturbations will get bigger and we will be unable to cope with the increasing number of climate shocks.” Lobbyists hope to see food systems become prominent on the agenda at the next Conference of the Parties (COP26) in Glasgow in 2021.

“There’s a lot of buzz about the role of technology, but it is no silver bullet,” says Benton. “Everyone wants cheap food, and although technological efficiency gains drive down costs, we are often shifting the cost onto the environment and human health.” ●



# STEAK EXPECTATIONS FOR ALTERNATIVE PROTEIN SOURCES

*The pursuit of more sustainable food is creating an entirely new form of agriculture.*

Modern food technology is getting a shakeup. Food scientists can manipulate DNA, grow meat from scratch, and 3D print food into otherwise impossible shapes. Yet food scientists are also in a race against time. How quickly and effectively can the promise of modern food-tech translate into edible, affordable, nutritious food?

One dilemma for the food-tech industry is finding alternative sources of protein. Excessive production and over consumption of meat, particularly beef, is linked to environmental damage, climate change and, in industrialized countries, poor health through high levels of obesity.

The most widely accepted form of alternative protein is soy, used for tofu and other meat substitutes. But the solution can also become a problem: in Brazil, the largest producer of soy in the world, the crop has been linked to significant deforestation.

According to Alexander Mathys, Head of the Sustainable Food Processing Laboratory at ETH Zurich, Switzerland, successful alternative protein sources, and all food technology, will have to solve problems across three critical domains. “The three dimensions of

sustainability need to be addressed; not only environmental sustainability, but also social and economic sustainability,” says Mathys.

## **If it looks like steak and tastes like steak**

The most likely contender for alternative protein could come from cellular agriculture, in which food products are created from cell cultures. Currently, the most hyped form of cellular agriculture is lab grown meat, which has drawn the attention and the marketing energy of numerous Silicon Valley companies — despite the formidable technical challenges of creating meat without an animal. The direct costs of lab grown meat don’t yet stack up but many manufacturers claim its cost will fall.

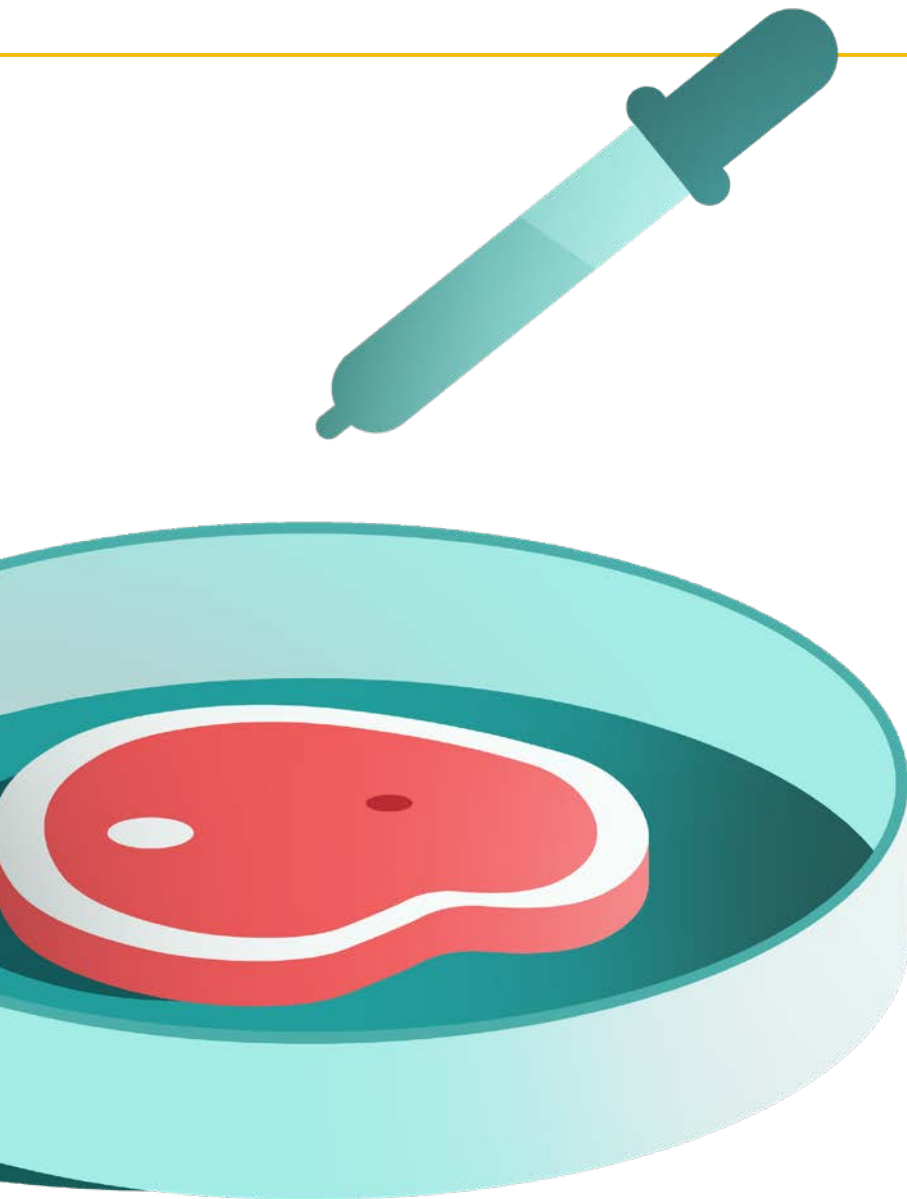
The sustainability potential of lab grown meat is less clear. Currently, it relies on animal products, like calf serum, but its greatest challenge is likely to be social. Even if it becomes technically possible to create an object that looks like a prime steak, says Michael Siegrist, Professor of Consumer Behavior at ETH Zurich, the threshold of consumer acceptance will likely be higher because manufacturers of lab grown meat are

attempting a kind of verisimilitude that other meat alternatives are not. Bean-based products might be called ‘meats’, but consumers usually assume they will taste a bit different, Siegrist explains. “For cultured meat, the benchmark will be meat.” He believes that if manufacturers produce something that looks like a prime steak but doesn’t taste quite like a prime steak, it’s unlikely to work. “Cultured meat will always be an imitation, and the imitation is always less valued than the original.”

## **Green algae and ham?**

Microalgae, a form of single cell protein, is the least developed of the alternative protein sources — in particular, it is not well-developed in terms of optimization,





worth anything from US\$1-3 billion by the end of 2025.

### **Waiter, there's a fly in my soup**

Insect farming has grown as a protein source in recent years. Many insects are naturally high in protein and the production costs of insect farming are relatively low. Some cultures in Asia, South America, and Africa already have a tradition of insect consumption. But in the West, insects often evoke a sense of disgust, a significant hurdle to overcome.

Although the insect food industry is rapidly growing in the US and Europe, insect products are still regarded as a novelty. Mathys suggests that insects might be more readily utilized in feed rather than food. Part of the world's food problem includes feeding not just 10 billion people but also the 19 billion chickens and 1 billion cows that feed us. One option, suggests Mathys is fewer animals that are fed with insects.

For Mathys, there is no single answer or alternative to the challenges of protein and food in general. Diversity is important for the health of a system, he says. Growing up in East Germany, his family used to decide what was for dinner by going to the supermarket and seeing what was available. He remembers driving to West Germany for the first time and being surprised by the amount and variety of food on display.

"There is always a huge portfolio of solutions," he says. "But we should also question the fundamental idea in wealthy, western societies that one should be able to buy any kind of food at any time." Mathys notes that lab-grown meat is a solution for people with high incomes who can afford any type of food. "Lab-grown meat is a very innovative solution, however, so far, it is only affordable for people with very high incomes. Food security and more sustainable food systems need resource efficient, affordable solutions."

This leads to the burning question — not what is the solution, but who is it for? "I don't want to create only solutions for people who can already afford any type of food they want," says Mathys. ●

says Mathys — but it has great potential. It is one of the most nutritious biomass that can be produced in a single cell system. On the environmental front, its production can bypass the need for arable land as it can be grown in buckets and on rooftops, making it a great candidate food source for cities.

Socially, microalgae may be more acceptable than lab grown meat. There is little research but, according to Siegrist, microalgae have no inherently negative associations, unlike artificial meat. But for consumer acceptance, the look, taste and feel of a food are critical. The chlorophyll in algae makes it a deep green colour that is hard to change and so limits its potential enormously. "Would you eat green meat?" asks Siegrist.

However, in a recent feasibility study, Mathys produced nutritious yellow algae with no chlorophyll. Yellow foods can be readily coloured, thus avoiding the problem of products having a green tinge. Also, without chlorophyll the new yellow algal products can be flavoured more easily.

Currently, the direct costs of microalgae compare poorly with traditional protein. Soy costs less than US\$1 per kilogram to produce and beef costs approximately US\$3 per kilogram, but microalgae is US\$10 per kilogram. Nevertheless, food giants like Nestle and Unilever have recently partnered with small startups to develop products using algae. Some marketing firms predict that the global market will be

# GUT MICROBES AND EXPLORING PROBIOTICS

Yakult's probiotics research investigates **THE DIVERSE IMPACT OF GUT MICROBES** on human health.

**On the morning of 9 June 1904**, the French press was abuzz with excitement about a scientific lecture given the day before by Russia-born microbiologist, Élie Metchnikoff. Four years later, he would be jointly awarded the Nobel Prize in Physiology or Medicine, along with Paul Ehrlich, for their pioneering research in immunology. But in 1904, the attention was all on yoghurt. Metchnikoff, who worked at the Pasteur Institute in Paris, suggested that the longevity of a rural Bulgarian community was linked to the live bacteria in a sour milk that reduced ageing-related effects caused by harmful bacteria in the gut.

"It is often said that Metchnikoff was the first advocate of probiotics in the early 20th century," says Toshihisa Ota, the science representative at Yakult Honsha's Public Relations Department. "Several decades later, Yakult's founder, Minoru Shirota, observed that lactic acid bacteria suppress harmful bacteria in the intestines. Since then, much has been published about the effects of probiotics on maintaining intestinal function, immune regulation, and on metabolic disorders and mental health."

Yakult's fermented milk product in the little bottle

requires no introduction. Each bottle contains billions of beneficial bacteria belonging to a strain called *Lactocaseibacillus paracasei* strain Shirota (previously known as *Lactobacillus casei* strain Shirota, LcS). This strain arrives in the intestine alive, due to its resistance against digestive juices.

Early research suggests the consumption of certain live microorganisms could have health benefits by replacing harmful bacteria in the gut with beneficial bacteria. The Yakult Central Institute in Japan, established at its current location in Tokyo in 1967, has

continued Shirota's research into this field of probiotics by investigating the functions and impacts of gut bacteria on human health.

## THE HUMAN GUT CONTAINS AROUND 1,000 DIFFERENT SPECIES OF BACTERIA

For example, research is uncovering links between the immune reactions that drive inflammatory bowel diseases (IBD) and gut bacteria.

Yakult Central Institute researchers collaborating with

colleagues in Japan, the US and Germany, demonstrated, in laboratory studies, how segmented filamentous bacteria, which are found in the intestines of a wide range of mammals, are involved in triggering intestinal immune cells called T helper 17 (Th17) cells.

Yakult researchers also found that a polysaccharide-peptidoglycan complex derived from the cell wall of LcS bacteria prevents the production of interleukin 6 by intestinal immune cells in the lab.

The impact of gut microbes on human health goes beyond their effects on the intestinal tract. An international research team reported in *Nature Neuroscience* that host microbiota made substantial contributions to microglia homeostasis in a germ-free mouse model. Microglia are brain macrophages responsible for gobbling up pathogens and dying cells, in addition to being important for brain functions.

And although much more research is needed, there are preliminary indications that probiotics could have impacts on mental health.

"Germ-free mice, which lack microbes in the whole body, show enhanced secretion of stress markers compared to normal mice when they are physically constrained,"

### Yakult and Shirota-ism

Infectious diseases, like cholera and typhoid, were common in Japan when Minoru Shirota began studying medicine in 1921. His desire to help prevent these diseases led to a career in the emerging field of microbiology.

By 1930, Shirota had demonstrated that lactic acid bacteria were effective in suppressing harmful bacteria in the intestine. He successfully isolated and cultured a strain of these bacteria and, in 1935, produced beverages that can safely deliver the bacteria, called *Lactocaseibacillus paracasei* strain Shirota, to the gut without being killed by digestive juices.

Shirota founded Yakult based on his philosophy, dubbed Shirota-ism, which brings together preventive medicine, the concept of maintaining a healthy gut for a long life, and the importance of affordability. Since then the company has pioneered and supported probiotics research worldwide.





Jar fermenters at microbial culture testing stations at the Yakult Central Institute.

*Lactocaseibacillus paracasei* strain Shirota.

Microorganism culture test at the Yakult Central Institute.

says Ota. "Since this finding, clinical observations have indicated that gut microbes affect brain function through a gut-brain axis in human. Dysbiosis, where there is a microbe imbalance, is observed in several disorders, like depression and autism. But the mechanisms involved are still unclear."

Yakult researchers and their collaborators are trying to understand the effects of beneficial gut bacteria. For example, they gave a small

group of healthy medical students in Japan a daily dose of 100 ml of fermented milk that contains 100 billion LcS or a placebo in the run-up to an important exam and for a short time after. The LcS group showed signs of better sleep, prompting Yakult researchers to believe the LcS-drink could help maintain sleep quality during times of stress.

In a separate double blind, placebo-controlled trial, the researchers examined the effects of regular consumption

of LcS-fermented milk on the gastrointestinal symptoms often experienced prior to important exams. The LcS group of medical exam students reported less increases in feelings of stress, a reduced total score of abdominal dysfunction, and showed more gut microbe diversity compared to the control group.

Yakult has even sent capsules of freeze-dried LcS into space. Their collaboration with the Japan Aerospace Exploration Agency aims to examine how LcS consumption affects

gut microbiota and immune function in crew members of the International Space Station.

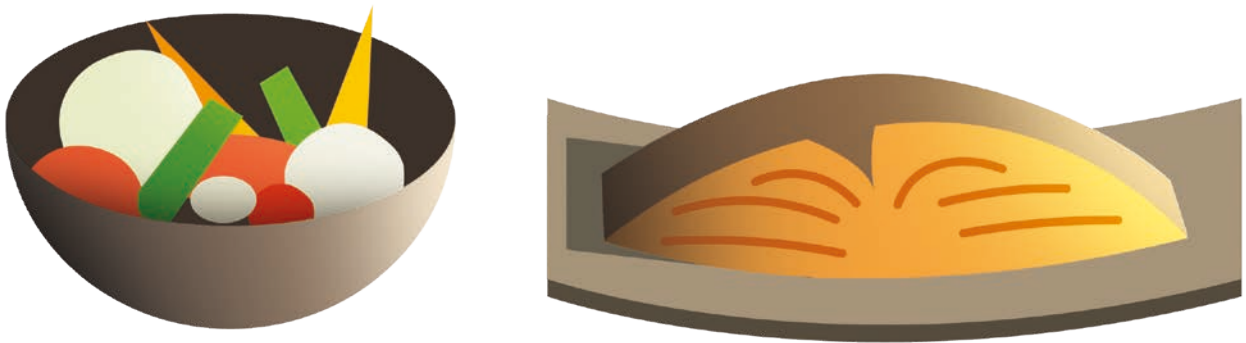
The human gut contains around 1,000 different species of bacteria. Yakult continues to use state-of-the-art technologies to uncover their roles in human health and to advance the science of probiotics. ■

**Yakult**

[www.yakult.co.jp/english](http://www.yakult.co.jp/english)



# 一汁三菜



## THE TRADITIONAL JAPANESE DIET MAY HAVE LESSONS FOR MODERN LIFE

*The traditional Japanese diet may support a long healthy life and have a low environmental footprint, but many ingredients are now sourced elsewhere, which threatens its sustainability.*

In 1945, Japan faced widespread malnutrition and its population had a life expectancy of only 45 years. In 2020, that figure hit a new record of 87.74 years for women and 81.64 years for men, the highest among G7 countries. Many researchers believe it's the result not only of general declines in heart disease, cancer and other illnesses, but also a direct result of the Japanese diet. What can Japanese food (*washoku*) teach us about leading long, healthier lives? And are there lessons in the traditional food culture of Japan that can help transform the global food system?

Food plays a central cultural role in Japan and challenges to production influence how food is prepared, consumed and appreciated. Japan is mountainous with few natural resources so it's no wonder that seafood, and rice grown in paddies on limited flat land, have been staples for millennia.

### A healthy balance

On Japanese menus, rice and fish have been traditionally complemented by *ichiju-sansai* or one soup, three dishes: miso soup and vegetables, including potatoes and pickled giant radish. The protein and carbohydrates in the staples with the minerals and fibre in the sides creates a healthy balance. In a nation famous for fermented products such as soy sauce, miso and *nattō* (fermented soybeans), the national enthusiasm for pickles is seen as beneficial, with many fermented foods acclaimed as 'superfoods' that support a healthy microbiome. Researchers are only recently exploring the potential effects of microbiome dysbiosis, with associations being made with Parkinson's disease, Alzheimer's and a range of gut conditions.

The health merits, seasonal qualities and diversity of ingredients were internationally recognized in 2013, when UNESCO decided that *washoku* is an intangible cultural heritage. "The Japanese diet is special because of the nature of the islands, the associated food culture, and the societal characteristics generated over the centuries," says

Fumiaki Imamura, scientist at the University of Cambridge's MRC Epidemiology Unit. "There is no single cause."

"Typical Japanese diets are characterized by plant-based food, such as rice, vegetables and soybeans, and seafoods," says Shoichiro Tsugane, director of the National Institute of Health and Nutrition. "Non-sugary beverages such as green tea are mainly consumed during and between meals. In my opinion, such a dietary habit makes Japanese healthy."

Elements of the *washoku* diet fit well with an idealized food system, such as the emphasis on fresh, local and seasonal ingredients, plus the importance of the community-building rituals associated with eating together. But it's not all positive.

The "traditional" Japanese diet is changing over time — before the late nineteenth century, eating beef and bread was basically unknown, but it is ubiquitous today. This mix of foreign and domestic foodstuffs has led to a hybrid cuisine: a typical Japanese office worker might have *washoku* for breakfast and dinner but curry or pasta for lunch. One reason for the shift in diet is greater international trade, which became essential to feed Japan's growing population. This has come at a cost to the nation's food self-sufficiency ratio — the proportion consumed through domestic production — which was only 38% in 2019, down from 41% in 2008.

An important reason for scrutinizing the Japanese food system is the need to reduce the environmental impact of food production and consumption, explains Steven R. McGreevy, visiting associate professor at Research Institute for Humanity and Nature (RIHN) and leader of the FEAST project, which was inaugurated as a non-profit organization in 2021.

Researchers in the FEAST project found that the Japanese traditional diet had a footprint on par with or smaller than a vegetarian diet, but it faces risk from climate change. The team also suggests that the overall diet

in Japan is increasingly dominated by imported and processed foods, with a larger environmental footprint for aged and urban populations than for rural populations. The researchers concluded that, in order to be sustainable, all aspects of food regulation, from government departments to land-use policies, must be integrated, and that domestic food production, which is in decline, must shift away from an industrial, monoculture-intensive production model to decentralized operations.

### A commons not a commodity

"Japan should focus on making regional and local food systems stronger and prioritize and support diverse ways of food production that align with diversified lifestyles to secure a base of domestic production and increase food self-sufficiency," says McGreevy. "Seeing food as 'a commons' rather than a commodity would signify the kind of shift in values we need to build a food system that feeds us instead of seeking to make a profit."

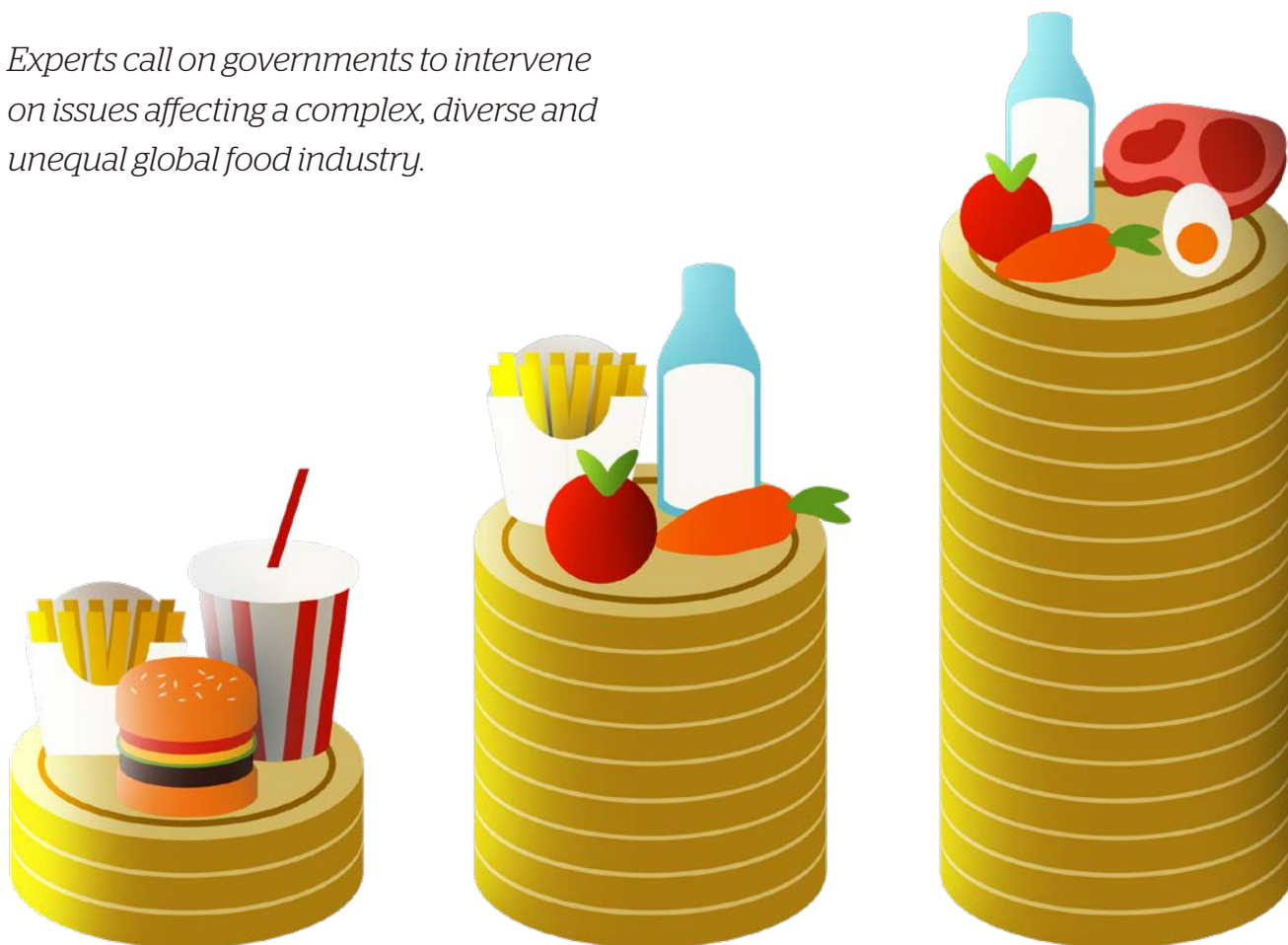
For Imamura, who has studied diabetes risk across a wide range of populations, an additional important challenge is ensuring that consumers are well informed. He notes the plethora of food and diet fads assailing consumers, some of which are based on flawed information and may be promoted by "experts" with dubious credentials.

A collaborative effort by government, industry and academia is crucial to ensure that consumers receive reliable information, says Imamura. "Some regulatory actions need to take place to control infodemics — excessive amount of incorrect or exaggerated information — and so reduce the public's exposure to harmful information.

"I understand many people are trying to improve their health behaviours, but we now need collective evidence to indicate if, and to what extent, certain types of diet-related information damage public health and what actions can prevent it," says Imamura. "Otherwise, further policy actions will be ineffective." ●

# POLITICAL AND COMMERCIAL FORCES SHAPE WHAT WE EAT

*Experts call on governments to intervene on issues affecting a complex, diverse and unequal global food industry.*



**A**t a typical supermarket in Tokyo, consumers can purchase an array of products, from colourful gummies to frozen Chinese noodles and Mexican taco mix. Corporate global sourcing arrangements mean that many populations have ready access to almost any type of food.

Meanwhile, the absolute number of hungry people has continued to

rise since 2014 and multiple forms of malnutrition remain a major challenge.

Globalization, market deregulation, technological advances, marketing sophistication and the rise of new economies have escalated the power of large corporations to change people's dietary habits. These changes have exacerbated economic and social disparity, while the COVID-19 crisis has

revealed the vulnerability of current food systems by disrupting production and distribution; triggering hikes in food prices.

## **Trends behind food systems**

The food industry has been global for centuries, but the pace of globalization has accelerated following the establishment of the World Trade

Organization in 1995. Many large companies rushed to enter new markets through huge investments and mergers and acquisitions of regional businesses.

One notable trend is the intensified specialization of ingredient supply chains, where large corporations have comparative advantages in specific products, says Jennifer Clapp, a political economist at the University of Waterloo, Canada. Concentration of corporations within these supply chains is also significant: historically, just four companies, the so-called ABCD agribusinesses — ADM, Bunge, Cargill and Louis Dreyfus — controlled 70-90% of global grain trade. In recent years, Asian companies such as Cofco, Olam and Wilmar are rapidly increasing their presence.

“In the agricultural inputs sector, concentrated industry giants have a profound impact on innovation pathways,” Clapp says. “Concentration in the inputs sector is partly a product of government policies, such as intellectual properties protection, that privilege a small number of companies in the market,” she explains. “Technological changes, such as digitalization of agriculture, gene editing and online trading, also enable large corporations to spend billions of dollars on R&D to capitalize on these opportunities.”

This industry consolidation also fosters what Melissa Mialon, a food engineer at Trinity College, Dublin, describes as the “commercial determinants of health” or activities designed to make a profit. This includes ‘Big Food’ lobbying to influence the policy environment, managing information that benefits their activities, such as funding beneficial research or undermining public health policies, or partnering with third parties to assuage their corporate social responsibility. Such activities influence the food system and often ultimately lead to the marketing and consumption of unhealthy food options.

### Ultra-processed foods

Other significant trends include a global spread of ultra-processed foods

(formulations made mostly or entirely from substances derived from foods and additives, with few containing whole foods). These include confectionary, biscuits, savoury snacks, many packaged breads, soft drinks, baby formula and meat substitutes, among others.

Consumption of ultra-processed foods is increasing globally. By 2018, young people (2-19 years) in the US consumed most (67%) of their diet as ultra-processed foods. The UK is not far behind: these foods also comprised the bulk of the diets of British children (63.5%) and adolescents (68%).

The spread of increasingly processed food affects nutrition, but not for all in the same way. Phillip Baker, a specialist in human nutrition at Deakin University, Australia, argues the rising consumption of ultra-processed foods is highly unequal. His 2020 analysis showed sales growth in ultra-processed foods is more significant in upper middle- and lower middle-income countries than high-income countries, with average annual growth rates of 2.8%, 4.4% and 0.4% respectively between 2009 and 2019. “In low-income countries, wealthy people tend to consume ultra-processed foods, but in middle-income and high-income countries, we see a social transition in consumption,” he explains, “and alongside this, we see obesity and diet-related diseases becoming a greater concern for disadvantaged and poorer population groups.”

### Consumer demand for better products

The food industry claims efforts to meet a growing consumer demand for healthier and safer products. A 2021 PricewaterhouseCoopers (PwC) report argues that governments support tighter regulations on food trade through supply chains while companies spend millions to improve safety and traceability. “Food technologies have brought benefits to industry and to people,” says Chenny Feng, senior manager for food services at PwC China. Feng says nutrition will remain a hot topic for the next decade or longer and expects the emergence of

new creative concepts of products, such as diet flavours that promote weight loss.

Shifting expectations by consumers who want more than just good nutrition are forcing companies to consider sustainability as well as public health. For example, in a 2020 stakeholder report, Nestle, the world’s largest food manufacturer, claims to have achieved its target to provide fortified foods and beverages to reduce micronutrient deficiencies in 10 countries.

The same year, both Nestle and French food giant Danone outlined plans for net zero emissions from their activities and moves to more sustainable farming practices. However, business researchers, including Lucian Bebchuck from the Harvard Law School, question the delivery on similar recent corporate pledges. Furthermore, there is a rising call for better regulatory and legislative mechanisms to hold industry to account and for new corporate governance models that go beyond serving the interests of shareholders to also serve the interests of stakeholders.

### Progressive approaches

Corporate social responsibilities alone are not a real solution to address problems of industry concentration, suggest researchers. Clapp says big corporations acknowledge the growing voices against the concentration of current food systems, but their impact is so huge they not only dominate the market but also shape public views and influence policymaking. “Governments should strengthen regulations to reduce corporate dominance, in order to make food systems more open, and also increase public investment in ecological farming to support local and regional marketing, which sell more fresh foods,” says Clapp. “Stronger rules to avoid conflict of interest and excessive lobbying power are also critical.”

Most important of all is for people to be able to have a say in creating the next generation of food systems, says Phillip Baker. “Food systems are not just for the industry and corporate lobbyists. They are for all of us.” ●

# NO MEAL IS AN ISLAND

*A myriad of factors influence what we eat, from personal preferences to the marketing campaigns of big corporates. Sometimes even a small, but well-placed, intervention can have large ripple effects.*

**“There is little in life that is as both ordinary and powerful as food.”**



In 2015, Aulo Gelli, a senior research fellow at the International Food Policy Research Institute in Washington DC, spoke to a village chief in the poverty-stricken Zomba district of Southern Malawi. To Gelli’s surprise, the man credited the local pre-school food program for helping his job as a chief. The activity around food in the pre-school had created cohesion in the community. Villagers contributed their time and money to make the program work, and their shared sense of unity and mission made it easier for the chief to lead. The programme had laid the groundwork for him to encourage his community to eat healthier food, and also highlights the nested and complex relationships that affect food choices.

Wherever people live, there is little in life that is both as ordinary and as powerful as food. Seemingly simple choices about what to eat are shaped by complicated social systems, from personal preference to family and context, to culture and institutions, to marketing and the media. These systems interconnect and, in turn, reflect and shape systems such as agriculture, policy, manufacturing and marketing. They are also overlaid by sudden shocks such as a pandemic or creeping disasters, like drought.

Understanding how such nested complexity shapes nutrition is a pressing social problem. In many Western societies, neoliberal politics and economics call for less intrusive policy approaches and health choices are considered an individual rather than collective responsibility. In a

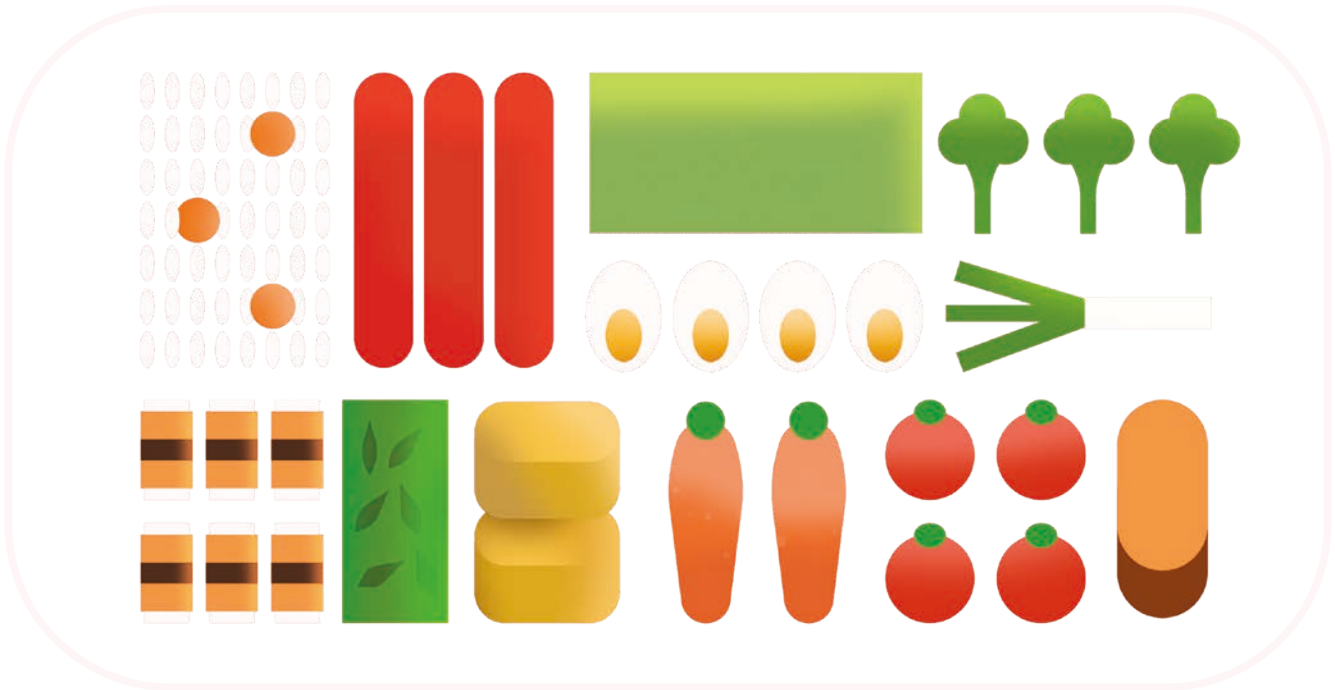
world afflicted by both ‘overnutrition’ and undernutrition, and at a time of increasingly dire environmental pressure, we need to understand which social factors have most impact on nutrition decisions.

## **Better choices come in small packages**

In the Malawi programme, Gelli provided a small piece of information, a little training and a small incentive like seeds or chicks. Many social programs in the developing world give food or cash to communities, he explains, but in his programme local mothers were taught how to tweak their pre-school children’s diets—by adding small amounts of nutrient dense foods to typical meals, like putting green leaves in the standard porridge. They also took turns preparing food for the pre-schoolers.

One year into the programme, Gelli and his colleagues found that the small amounts of information had gone a long way. The pre-schoolers who ate slightly more nutritious food were taller than a control group after one year. Remarkably, their younger siblings also grew taller because the mothers had incorporated the tweaks in their home cooking. In fact, the younger siblings grew taller, faster. The pre-schoolers eventually caught up, but it took them a bit longer. The younger siblings also performed better on standardized tests of fine motor, gross motor, language, and psycho-emotional skills than the control group.

“Key nutrients at the right time can change a child’s life beyond physical health,” says Gelli. How those key



nutrients are delivered also matters. They were not delivered from outside the community, they were incorporated as a matter of individual choice by mothers who were trained. “One of the most important factors is that people need to have a sense of ownership over their choices,” he concludes.

Creating a sense of ownership and having impact is highly context specific. Behavioural nutritionist, Anthony Worsley at Deakin University, Australia, agrees it is critical to increase people’s agency and encourage confident decision making. “Information doesn’t necessarily change behaviour,” he says. Psychology and culture must also be considered.

A 2020 review by Worsley and colleagues explored the long-term impact of a parent’s personal style when serving food. Parents who were authoritative — rather than authoritarian, permissive or disengaged — were more likely to have children with healthier diets. Outside the realm of the family, Worsley has examined the influence of more abstract values on diet, such as “caring”, either for other people or animals. In Western societies, many healthier foods are linked to that kind of caring, known as universalism, he said.

Some behaviours that are shared across cultures can be leveraged by food researchers. In Ghana and Vietnam, Gelli is piloting a programme for teenage girls that uses a phone-based app to promote healthy eating. The user takes a photo of their meal and the app’s AI program tells them how healthy it is and makes suggestions: for a photo of spaghetti and tomatoes, it may suggest adding greens.

**Better choices need top-down support**

An individual or family’s food choice decisions take place within a larger context, whether it’s the diversity of local crops, proximity to a supermarket, or how much ultra-processed food is on offer. Local food landscapes may be relatively fixed, which can be a problem, but when they are not, marketing can have a huge influence on daily choices. Worsley notes that in many countries, manufacturers of ultra-processed unhealthy food are legally allowed to market directly to children. Supporting better choices and helping prevent unhealthy ones requires legislative change. “It’s a continuum,” says Worsley. “Actions at all levels are important.”

Legislative change is just part of the public policy leadership required of

governments. Also required, suggests a 2018 article by Dariush Mozaffarian of Tufts University in Boston, US, is evidence-based policies that support integrated, multi-pronged government strategies within a learning and adaptable system. Governments also need cooperation and complementary efforts by major nutrition stakeholders, including private health and life insurance corporations, for R&D into healthier products and effective behaviour change.

For Gelli, the most effective programmes for change are those that include funding for preliminary investigations. This enables researchers to learn, in advance, about the culture and context they are trying to change. Co-design also helps. Gelli suggests that the science is more robust when it includes local experts, who can speak to subtle differences and local expectations and help shape research questions.

The key to nudging people towards healthier diets, Gelli explains, is to find the right point of entry into the complicated, interacting systems. The good news is that once you find it, one small, well-placed change can have enormous impact. ●

# FINANCING FUTURE FOOD: FILL A NEED, AND THINK LOCAL



*Investors tell what attracts them to food-tech startups.*

Chris Kerr went vegan in 2002 but, as a native of Philadelphia, he's still hoping someone can find a way to replicate his hometown's signature food. "Philly cheesesteak is still my favorite food," says Kerr, a founding partner at Unovis Asset Management, which invests in developers of alternative protein sources. "I'll retire when a really good vegan Philly cheesesteak is created."

Unovis is one of several firms supporting start-up companies that are developing new sources of nutrition, whether that's plant-based meat and dairy substitutes or replacements for fish and meat grown from cell cultures. Investment in food-tech and agriculture-tech is growing, though the sector is not as large as biopharmaceuticals or digital technology.

"If you include [food delivery services] the DoorDashes and the Instacarts of the world, it's gigantic," says Kyle Welborn, managing director at The Yield Lab, an investment firm with offices in the US, Argentina, Ireland and Singapore. Excluding those app-based

food delivery giants, the sector is a lot smaller, he says. "But in 2020, about US\$5 billion was invested in agrifood tech." These are companies that are working on either new crops or crop productivity, focused on animal health and nutrition, the supply chain, digital agriculture, the gut microbiome, and food, seed, and fuel ingredients.

## **Does your product save money, time or the planet?**

Scientists whose research is related to food production might wonder how to attract such investors. The key to translating lab work into a commercial product, investors say, is identifying a problem in the market and showing how your science can solve it. That requires having a good team, which for a startup could be just two people — a business person and a technologist — says Spencer Maughan, a co-founder of Finistere Ventures. The business person "sees a problem in a market and has a real understanding of the market dynamics as well as that gap in the market, the problem that needs to be

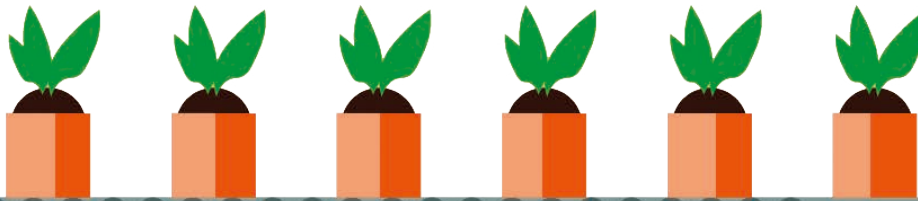
fixed," he says. "From a technology point of view, you need someone who's clearly expert, who understands how to build products based on whatever technology suite they are exploiting."

That clear definition of the need you are trying to fill can vary depending on which segment of the market you're chasing, says Jared Yarnall-Schane, entrepreneurship director at the Biomimicry Institute, a non-profit organization in Montana, that helps startups get off the ground. "If you're creating a product for farmers or others in the field, they are looking for something that will save them money, make them more money by increasing the value of their goods, or save them time," he says. That could, for example, be a way to reduce their use of synthetic pesticides so they can market their produce as organic and increase its value, or a method of tracking hydration in soil to improve yields.

Many people are interested in cutting carbon emissions, Welborn says, so they're attracted to ways to reduce food waste before food reaches the consumer.



**“It’s not just an incremental me-too evolution of a previous product. It is truly new and transformative in some way.”**



For example, by growing fewer non-saleable products. “There’s an interest in attacking this problem, both upcycling what used to be waste products into a higher value product and also just trying to reduce the waste in some way,” he says.

Venture capitalists generally invest from 10-year funds, so they are looking for companies that take only a year or two to get their products onto market, then grow for seven or eight years until they can sell their stake in a company at a profit. That means the scientific risks — questions about whether technology actually works and can be applied — need to have been addressed.

Companies can often get help reaching the stage where a venture capitalist would be interested through a university-based or government-sponsored startup accelerator. Seed funders and angel investors will make smaller investments in companies at earlier stages, and groups like the Biomimicry Institute run business competitions that offer prize money for development work.

#### **Pilot projects can show the pudding as proof**

One way to make a proposal more attractive is to run pilot projects that demonstrate the feasibility of a technology, Yarnall-Schane says. For instance, he worked with a company in Turkey that had a product to reduce fungal infections in plants. They found vineyards that would let them run small tests of the product to prove its viability.

Phospholutions, a startup based on technology developed at Pennsylvania State University, developed a product to reduce the loss of phosphorus in fertilizer, allowing growers to use less fertilizer and increase root depth. “They wanted to do this in agriculture, but they found the first market adopter in golf courses, which enabled them to scale and grow their manufacturing capabilities, sales team, product portfolio, and now they are able to move into the agricultural industry,” explains Yarnall-Schane.

The proposed product needs to be clearly different from what currently exists, says Maughan. “It’s not just

an incremental me-too evolution of a previous product. It is truly new and transformative.”

That said, familiarity also has a role to play, especially when it comes to replacements for existing food. Cheese substitutes have to melt the right way in a pizza oven, for example, says Kerr. Replacements for hamburger, which is still the lowest grade of meat, can’t fall apart on the grill. Fish, whether plant-based substitutes or versions grown from cells, have to hold their shape in a dry fish taco or a wet stew.

And food developers have to keep in mind that local tastes in cuisine vary widely, sometimes over a short distance. Kerr’s imagined vegan Philly cheesesteak might not be such a hit in San Diego, let alone Seoul. “What’s most important is if you think you’re going to conquer the world, don’t try to sell the rest of the world on what Americans eat,” advises Kerr. “Don’t sell a New England crab cake to somebody in Tokyo. Let these local cultures eat what they want to eat.” ●

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Nutrition reflects more than what we eat:  
it reflects a broad spectrum of influences that include  
individual circumstances, family relationships, information  
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