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Autor: Schwab, Christian N. / Stellacci, Francesco

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Bringing new science to food

Christian N. Schwab*, Francesco Stellacci*

1. The context

The food and agriculture industry has performed extremely well over the past 50 years. The quantity of affordable food produced has increased dramatically, putting an end to the recurrent famines of past centuries. It has also contributed to a significant increase in life expectancy, to the reduction of child mortality and to the decrease of poverty. These impressive results have been achieved mostly through the intensification of agriculture and a massive increase of chemical intrants, widespread us of mechanization and irrigation, and the use of higher yield breeds of plants and animals. This dramatic turn initiated in the 1950s is referred to as the "Green Revolution", which earned its forefather, Norman Borlaug, the Nobel Peace Prize in 1970. This revolution established the paradigm of producing as much food as possible, as inexpensively as possible. This paradigm still prevails today to a large extent.

These improvements have come at a hefty cost to the environment and society. The expansion of farmland has contributed to the destruction of natural habitats and major biodiversity losses. Intensive agriculture is responsible for major greenhouse gases emissions, pollutions, fresh water eutrophication, and soil degradation. Easy access to cheap and over-processed food has also contributed to the global obesity epidemic. We also observe a significant increase of non-communicable diseases such as cancers, type-2 diabetes, and cardiovascular diseases. This latter trend may not be related to nutritional habits, but certainly can and has to be addressed through them.

Today it is widely recognized that the way we produce, transport, transform and consume food is no longer sustainable and that the food systems are one of -if not- the biggest contributor to climate change, ahead of energy, transport or housing. Some numbers illustrate the magnitude of the challenge facing mankind: the food systems are responsible for 25% of the GHG emissions, they consume 70% of the fresh water drawn, they use 37% of the emerged land and are responsible for 70% of the biodiversity losses. And they are highly inefficient too, with an estimated 32% of the food produced never cons, whilst 2.5 billion people are estimated undernourished, with 800 million starving. After decades of reduction of world hunger, the number of undernourished people has gone up again in the past three years and is accelerating. Yet, this alarming reality still fails to translate into an adequate level of initiatives at the national and the international level. The reason for this lack of resolve can undoubtedly be associated to the highly fragmented, globalized and transnational nature of the food systems, as well as to its well-known complexity. Finally, it should be almost self-evident that to improve the nutritional merit of diets around the world, in an affordable way, whilst restoring the environment is a gigantic task.

2. The approach

A systemic and courageous transformation of the food systems is urgently required. Just like the sources of the predicaments we are facing are pluricausal, the solutions that need to be mobilized are numerous: (*i*) political engagement, (*ii*) a more conducive regulatory environment and incentive systems, (*iii*) investment in infrastructure, (*iv*) more institutional and private investments towards sustainable ventures, (*v*) supportive educational systems, and (*vi*) consumers of course, with whom lie the ultimate daily decisions of food purchase and consumption. In this complex context science and technology have a critical role to play in enabling a systemic, rapid and scalable transformation of the food systems. Let us consider this specific aspect.

* EPFL, Integrative Food & Nutrition Centre, ENT-I CNU, MXD 038, Station 12, and Institute of Materials, Interfaculty Bioengineering Institute, MXG 0301015, Station 12 1015 Lausanne, Switzerland.

E-mail: *christian.schwab@epfl.ch*
https://nutritioncenter.epfl.ch

Christian N. Schwab is the executive director of the Integrative Food and Nutrition Center at EPFL.

E-mail: *francesco.stellacci@epfl.ch*
https://nutritioncenter.epfl.ch
https://sunmil.epfl.ch

Francesco Stellacci graduated in Materials Engineering at the Politecnico di Milano. After a post-doc in the University of Arizona, he became a tenure-track professor in Materials Science and Engineering at MIT in Cambridge, MA, USA. After tenure he moved to EPFL where he is a professor in the Institute of Materials and in the Institute of Bioengineering at EPFL. He is the Academic Director of the Integrative Food and Nutrition Center at EPFL.

There are many skeptics today resisting the use of science. They typically state that technology, ever since the green revolution has contributed to the problem, for example by helping with the introduction of intensive agriculture, chemical intrants and of monoculture of very few high yield crops. While the concerns are legitimate, they fail to appreciate that technology provides tools, society can use them properly or not. In the past decades, technology has been mobilized primarily for the economical objective of profit maximization, often at the expense of the nutritional quality of the products and consequently of public health, or at the expense of the environment or animal welfare. To address these challenges the approach sometimes advocated to go back to old ways is not an acceptable solution, as the old ways would bring billions of people to starve. The world has changed too dramatically both quantitatively and qualitatively and whilst protective practices associated to regenerative agriculture or more respectful consumption habits are essential and should be encouraged to their fullest, we also need more transformational and systemic measures to improve the current footprint of our food systems, and prepare to feed in a nutritious, affordable and respectful way the 9 to 10 billion people that will live on our planet by 2050. Key challenges such as a drastic reduction or food waste, soil impoverishment, fresh water consumption, availability of plant-based proteins, loss of biodiversity, to mention but a few, will undoubtedly require disruptive approaches supported by new technologies.

To prevent deleterious side-effects, the constraints are multiple and more often than not conflicting: to prevent the mistakes of the past, new technologies will need to demonstrate that they are sustainable, healthy, inclusive, effective, scalable and transparent before being adopted and widely deployed. We need solutions that cater for the "one-health": the health of environment, humans and animals alike. We need solutions for industrialized countries, as well as for emerging economies. We need solutions for large players and for smallholder farmers. They also need to be economically attractive to accommodate the prevailing economic models, at least with the support of adequate and new incentive systems. Reconciling such a diverse set of objectives is not a small endeavor and time is pressing, with an ever-mounting demography and the ongoing climate warming starting to negatively impact the productivity of major production regions. It is now urgent to mobilize our collective intelligence and increase the resources available to raise to the challenge.

3. The need/opportunity for change goes much beyond the "chemistry of food"

Where do we stand today in countries such as Switzerland? When talking about food-related technologies, many people still by default understand technologies related to the "chemistry of food": new ingredients, new formulations and recipes, new food transformation processes. Switzerland has a strong tradition in these fields, world-class talents and educational institutions, leading industrial players, and has a deeply rooted tradition for innovation. But in the face of the magnitude and urgency of the food-related challenges, we need to do more. We need to complement these established sets of capabilities with new ones. Creating new and complementary fields of research, or pivoting existing science and technologies towards food applications. Some avenues of innovation have already emerged and demonstrate an encouraging dynamism in the recent past. The following examples illustrate these trends: digitalization of the food systems and precision farming, sustainable packaging, and precision nutrition.

In the field of digitalization, despite the food industry lagging other sectors, the past years have witnessed a rapid acceleration of innovations in areas such as block-chain and traceability solutions, consumer apps as decision guide, digital twins for manufacturing optimization, social media monitoring to assess consumers acceptance for new solutions, wearable devices to monitor physiological responses. Precision agriculture is another field of innovation, making extensive use of artificial intelligence and machine learning, hyperspectral imagery and image recognition, sensors and robotics, drones and satellites, with solutions often based on clean energy. These combined technologies are unleashing the emergence of a "smarter" agriculture, less reliant on chemical entrants and fossil energy, offering the potential to be more respectful of the environment and thrifty in natural resources, protective of farmers and public health, and less detrimental to biodiversity and animal well-being.

The field of sustainable packaging is also extremely dynamic as a result of the pressure placed on single-use plastics. The images of beaches littered with empty containers and of the floating islands of plastic debris have contributed in raising public attention to the point of affecting consumption patterns, thereby forcing the industry to actively look for alternative to single-use plastics, even making bold public commitments with quantified targets to reduce their reliance on non-recyclable packaging. As a result, the past few years have seen a constant flow of innovations aimed at reducing, replacing, recycling or re-using food packaging. Those include the emergence of bio-plastics,

mostly from organic waste streams, various recycling technologies transforming plastic debris into new feed stock or energy, or intelligent packaging allowing for traceability or aiming at making the re-use of these new formats economically viable.

The area of precision nutrition is also increasingly dynamic. The recent advances made in metabolism and notably in the understanding of the microbiome, in bio-engineering and computational biology, in de novo protein design, in precision fermentation and the ability to produce complex organic compounds from modified micro-organisms is opening a wide field of applications. The industry is still struggling to deliver concrete and economically viable applications to the market, but it is only a matter of time before consumers will have access to a wide variety or more nutritious solutions, better suited to their individual needs.

4. More needs to be done

Yet, when considering the urgency of addressing the major food-related environmental and public health challenges, we cannot be satisfied with these promising advances or with the current pace of innovation. Significantly more needs to be done if we are to feed in a nutritious, sustainable and affordable way an increased world population by 2050.

There are still countless untapped opportunities of mobilizing science and technologies, in a structured and determined way, to contribute in solving these challenges. These includes creating new fields of research within the institutions or research groups already dedicated to food, or pivoting existing science from other research groups towards food-related applications.

Following are some examples to illustrate this later point. Could the experts in composite materials or other material science researchers help improve the scaffolds required for the texturing of plant-based or cultured meat analogs? Could the chemists help prevent protein unfolding (with the consequent loss of functional properties) during the high-temperature, high-pressure food extrusion process step? Could researchers in nanomaterials and polymers, together with the experts in photonics or sensors help creating smart packaging detecting the presence of contaminants for the benefit of food safety or food waste prevention? Could the experts in soil microbiomes help devise solutions for an active transport of fertilizers to the roots or the targeted plants, thereby reducing harmful agrochemical run-offs and waste? Could the experts in modelization and artificial intelligence help define more circular food systems, contributing to food waste reduction or to a more equitable distribution of food? There are most likely already several initiatives emerging in these fields, driven by individual researchers, but we need a more structured and connected approach if we are to rapidly see tangible and meaningful impact.

5. Universities are well poised

Universities and higher education institutions are uniquely poised to lead this required evolution, thanks to their academic freedom and to the broad range of science and technologies they can mobilize. But before we start to see tangible results, a few measures would need to be taken. Firstly, these institutions need to formally define food and nutrition as a strategic priority of their research programs. An approach could be to mobilize existing capabilities and apply them to the real of the food systems. Such a commitment does not require the creation of dedicated Food & Agriculture faculty or department and hence is not too demanding in terms of recourses. From the examples listed above, the digitalization research programs could be hosted in various computer science or engineering departments, sustainable packaging programs in the material science or engineering departments, and precision nutrition and healthy ageing programs in life science departments. Strong sensitization campaigns within these institutions as well as dedicated calls for interest should be organized, associated to targeted funding mechanisms, to initiate a meaningful and lasting momentum. A strong leadership in the topic would be required. These has to come from dedicated departments (e.g. Food Science) or in faculty whose primary focus is addressing the issues of Food and Nutrition for the future.

The topic of education around food and nutrition should also be represented in an appropriate way in all the committed institutions, establishing the link between the respective fields of scientific expertise of the school and their possible applications in the food systems. Encouraging students to direct their careers towards food-related applications will certainly not preterit them considering the fast-growing dynamism and diversification of this industry.

6. EPFL has started the journey

EPFL has started such a journey back in 2015 with the creation of the Integrative Food & Nutrition Centre (IFNC). From the onset, the mission of this is interdisciplinary center has been to maximize the positive impact of the school on the food systems. To this end, the center is responsible for 1) sensitizing the faculty and students to food-related challenges, 2) identifying the science, technologies and capabilities within EPFL that are of relevance to food and nutri-

tion, and 3) actively promote the capabilities of the school to external partners with the aim of establishing joint research programs. The modus operandi of the IFNC is two-fold. Firstly, the center entertains bottom-up requests coming from external partners, primarily private actors active along the food value chain. A detailed brief explaining the unmet need of the external partner is circulated to the all the faculty as a Call for Interest. The goal is to reach researcher that have expertise that are not obviously related to the problem, so to stimulate the creation of disruptive approaches. The second approach is a top-down promotion of key strategic axis where the school has clear and differentiated set of capabilities matching structural challenges of the food systems. For EPFL, the 3 strategic axis selected are sustainable packaging, precision nutrition & healthy ageing, and the digitalization of food systems, including the area of precision agriculture. These three axes are consistently and pro-actively communicated to outside partners with the aim of established a clear positioning and a solid recognition over time. After several years of activity, the IFNC has witnessed a clear acceleration of its activities in the past 24 months, notably with the membership of several new industrial members. This renewed momentum is concomitant with the raising awareness of the consumers and the public at large, the media and politicians of the pressing need to transform the food systems. We reason that the timing is also perfect for other academic institutions to raise their focus on food-related research. The recently established Swiss Food & Nutrition Valley (SFNV), gathering all leading actors in the various fields of academia, industry, and government has the clear ambition act as a key enabler for ambitious, transformative, cross-disciplinary, systemic and inclusive innovative programs, by bringing the necessary stewardship behind them. Another mission of the SFNV is to promote the Swiss food and nutrition ecosystem abroad, thereby creating a virtuous circle of attracting further talents, start-ups, investments and ambitious projects to our country, thereby further enriching this very ecosystem.

7. Call to action

To conclude, thanks to the density and quality of its research and innovation fabric, Switzerland is in a unique position to contribute in addressing some of the burning challenges related to the way we feed the planet today. But Switzerland can, and therefore must, do more. This is a moral obligation as much as it is a fantastic opportunity for its researchers, its young talents, its industry, and for the reputation and image of our country. It is everyone's responsibility to embrace this opportunity and raise to the challenge. It will be greatly rewarding for all of us, as professionals, parents, citizens or consumers, to contribute to the transformation of the food and nutrition sector, and help provide a healthy and affordable diet, from sustainable food systems, for the generations to come. ■

Literature

FAO/UN: *The State of Food Security and Nutrition in the World (SOFI): Safeguarding against economic slowdowns and downturns*; 2019 report.

Sustainable development solutions network; Fixing the business of Food: The food industry and the SDG challenge; 2019 report.

The Lancet Commission; Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems; Jan 2019.

World Economic Forum: *Innovation with a Purpose: The role of technology innovation in accelerating food systems transformation*; Jan 2018.

World Economic Forum: *Food Systems Initiative: Incentivizing Food Systems Transformation*; January 2020.