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often generates a false sense of comfort that downplays the transformational shifts that need to be confronted within both production and consumption. And technology is also the primary instrument for the concentration of economic power within global conglomerates and the dispossession of resources of local communities.

The 2030 Agenda may provid[...] connect all these dots and place sustainab[...] food systems and healthy diets at the core of the public agenda. However, this requires significant efforts to 'de-silo' the current policy approach to what are mistakenly addressed as separate challenges and break down the artificial boundaries imposed by the institutional settings that support each of the related interconnected goals.

Box 2.1

The food-health-environment nexus: addressing environmental and human health risks simultaneously

BY THE INTERNATIONAL PANEL OF EXPERTS ON SUSTAINABLE FOOD SYSTEMS (IPES-FOOD)[1]

Although they are described in different bodies of literature, discussed in different fora, and addressed (if at all) by different policies, a whole range of severe human health risks are closely connected to food system practices - and to each other. Most of these impacts fall under the following five categories:

1. **Occupational hazards:** Physical and mental health impacts suffered by farmers, agricultural labourers, and other food chain workers as a result of exposure to health risks in the field/factory/workplace (e.g., acute and chronic pesticide exposure risks, production line injuries, livelihood stresses). *People get sick because they work under unhealthy conditions.*

2. **Environmental contamination:** Health impacts arising via the exposure of whole populations to contaminated environments 'downstream' of food production, via pollution of soil, air, and water resources or exposure to livestock-based pathogens (e.g., contamination of drinking water with nitrates, agriculture-based air pollution, antimicrobial resistance). *People get sick because of contaminants in the water, soil or air.*

3. **Contaminated, unsafe, and altered foods:** Illnesses arising from the ingestion of foods containing various pathogens (i.e., foodborne disease) and risks arising from compositionally altered and novel foods (e.g., nano-particles). *People get sick because specific foods they eat are unsafe for consumption.*

4. **Unhealthy dietary patterns:** Impacts occurring through consumption of specific foods or groups of foods with problematic health profiles (e.g., resulting in obesity and non-communicable diseases including diabetes, heart disease, cancers). These impacts affect people directly through their dietary habits, which are shaped by the food environment. *People get sick because they have unhealthy diets.*

5. **Food insecurity:** Impacts occurring through insufficient or precarious access to food that is culturally acceptable and nutritious (e.g., hunger, micronutrient deficiency). *People get sick because they cannot access adequate, acceptable food at all times.*

1 This contribution is based on IPES-Food (2017).

An urgent case for reforming food and farming systems can therefore be made on the grounds of protecting human health, and the five channels listed above represent focal points for the action that is required. However, discrete actions to address a given health impact may not suffice. The various health risks reinforce one another, and arise from the underlying imperatives of the *industrial* food and farming systems that are now prevalent in many parts of the world. For example:

- The stress generated by high-pressure work environments in industrialized food processing plants is itself a key factor in increasing the risks of frequent physical injury;[2]
- Undernutrition and pre-existing disease burdens make people more sensitive to the impacts of environmental change and contamination,[3] and at further risk of food insecurity;
- Health risks are also mutually-reinforcing in livestock production; livestock disease risks in confined feedlots encourage the extensive use of antibiotics, which in turn allows antimicrobial resistance to spread;
- A pool of cheap and insecure labour, dangerous conditions and systematic stresses for farmers and foodworkers are what sustains the low-cost commodity production at the base of global food systems, and underpins the mass production of unhealthy ultra-processed foods.

Health risks in food systems are not, therefore, limited to isolated pockets of unregulated production, or to those excluded from the benefits of modern agriculture and global commodity supply chains. Many of the severest impacts result from deliberate choices and trade-offs that have been made to promote low-cost commodity production in global food systems.

Furthermore, the impacts of food systems on health are exacerbated by factors like climate change, unsanitary conditions, and poverty – which are themselves driven by food and farming activities. In particular, a whole range of health risks in food systems are deeply intertwined with ecological change and degradation - the 'food-health-environment nexus'.

First, food systems are a major driver of climate change. While estimates differ, food systems may account for as much as 30 percent of all human-caused greenhouse gas emissions.[4] Climate change, in turn, stands to aggravate a series of health impacts. The changing climate may bring novel vectors into newly temperate climates, driving alterations in the incidence and distribution of pests, parasites, and microbes, or create temperature-related changes in contamination levels.[5] For example, people may be exposed to a greater accumulation of mercury in seafood as a result of elevated sea temperatures.[6] New food safety risks could also emerge as a result of increasing floods and droughts.[7]

Meanwhile, climate change is likely to provoke crop losses due to changing frequency and severity of floods and droughts, and even to decrease the nutritional value of important food crops, such as wheat and rice, as atmospheric carbon dioxide reduces protein and essential mineral concentrations in plant species.[8] According to the US Environmental Protection Agency, "overall, climate change could make it more difficult to grow crops, raise animals, and catch fish in the same ways and same places as we have done in the past".[9] Through changes in rainfall and temperature-driven shifts in plant biomass, climate change is also expected to affect the extent, frequency, and magnitude of soil erosion,[10] with major knock-on effects for health (e.g., increased nitrogen leaching into water, threats to food production and

2 Lloyd/ James (2008).
3 Whitmee et al. (2015).
4 Niles et al. (2017).
5 Newell et al. (2010); Watts et al. (2015).
6 Ziska et al. (2016).
7 WFP (2015).
8 Niles et al. (2017); Watts et al. (2015); Ziska et al. (2016).
9 https://19january2017snapshot.epa.gov/climate-impacts/climate-impacts-agriculture-and-food-supply_.html
10 Whitmee et al. (2015).

food security). Climate change is also likely to increase the risks of natural disasters (e.g., landslides, tsunamis) with the potential to exacerbate food-related health impacts, particularly food insecurity.[11]

Food systems also contribute to broader environmental and land use changes, further exacerbating a range of health risks. As many as half of zoonotic infection events from 1940–2005 have been attributed to changes in land use, agricultural practices and food production.[12] In other words, a vicious cycle has taken root: the expansion of industrial agriculture has driven zoonotic risks directly, while driving land use changes with further risks of zoonotic disease, and contributing significantly to climate change - itself a major driver of land use change (e.g., due to loss of fertility in existing production zones).

It is also important to think beyond health impacts *per se* and to consider the broader ecological basis for health. The practices associated with industrial agriculture (e.g., chemical-intensive monocropping) are disrupting ecosystems in fundamental ways, and undermining their capacity to provide essential environmental or ecosystem services such as controlling soil erosion, storing carbon, purifying and providing water, maintaining essential biodiversity and associated services (e.g., regulating diseases), and improving air quality.[13] All of these services, provided by nature, are under severe threat, with far-reaching implications for human health. For example, with some 35 percent of global food production dependent on pollination, the loss of pollinators – closely associated with pesticide use – could fundamentally undermine future food production.[14] The general disruption of marine ecosystems is also occurring at a rapid rate, threatening fish populations and thus a key source of protein for many people.

In other words, the impacts of food systems on human health and on the environment cannot be seen in isolation. Steps to address the wide-ranging environmental impacts of industrial agriculture are also steps to address the human health impacts of agriculture – and are doubly urgent. And given the extent of the problems described above, a fundamental redesign of food and farming systems is necessary, to safeguard environmental and human health.

Five co-dependent leverage points can be identified to address the food-health-environment nexus, and to build healthier food systems:

- **Leverage point 1: Promoting food systems thinking**. The connections between different health impacts, between human health and ecosystem health, between food, health, poverty, and climate change, and between social and environmental sustainability, must systematically be brought to light. Only when health risks are viewed in their entirety, across the food system and on a global scale, can we adequately assess the priorities, risks, and trade-offs underpinning our food systems, that is, the systematic food insecurity, poverty conditions, and environmental degradation inherent in the industrial model versus the low-cost commodity production it is designed to deliver. All of this has profound implications for the way that knowledge is developed and deployed in our societies, requiring a shift toward interdisciplinarity and transdisciplinarity in a range of contexts (e.g., new ways of assessing risks; changes in the way that university and school curricula are structured). Concepts such as 'sustainable diets' and 'planetary health' help to promote holistic scientific discussions and to pave the way for integrated policy approaches.
- **Leverage Point 2: Reasserting scientific integrity and research as a public good.** Research priorities, structures, and capacities need to be fundamentally realigned with principles of public interest and public good, and

11 Watts et al. (2015).
12 Whitmee et al. (2015).
13 See, for example, Millennium Ecosystem Assessment (2005); IPES-Food (2016).
14 WHO/Secretariat of the Convention on Biological Diversity (2015); Whitmee et al. (2015).

the nature of the challenges we face (i.e., cross-cutting sustainability challenges and systemic risks). Specific measures are needed to counter the influence of vested interests in shaping scientific knowledge on the health impacts of food systems, and to reduce the reliance of researchers on private funding (e.g., new rules around conflicts of interest in scientific journals, initiatives to fund and mandate independent scientific research and independent journalism). Different forms of research involving a wider range of actors and sources of knowledge are also required to rebalance the playing field and challenge prevailing problem frames (e.g., a global North bias; approaches that exclude impacts on certain populations; siloed approaches that ignore nexus effects).

- **Leverage Point 3: Bringing the alternatives to light.** The positive health impacts and positive externalities of alternative food and farming systems must be brought to light (e.g., agroecological crop and livestock management approaches that build soil nutrients, sequester carbon in the soil, or restore ecosystem functions such as pollination and water purification). It is crucial to document and communicate the potential of alternative systems to reconcile productivity gains, environmental resilience, social equity, and health benefits; to strengthen yields on the basis of rehabilitating ecosystems (not at their expense); to build nutrition on the basis of access to diverse, healthy foods; and to redistribute power and reduce inequalities in the process. These outcomes must be seen as a package and as a new basis for delivering health – one in which healthy people and a healthy planet are co-dependent.

- **Leverage Point 4: Adopting the precautionary principle.** The negative health impacts in food systems are interconnected, self-reinforcing, and systemic in nature (i.e., bound together in nexuses). However, this complexity cannot be an excuse for inaction. Disease prevention must increasingly be understood in terms of identifying specific risk factors (not the cause) by the accumulation of evidence from many different studies, from many different disciplines, as well as in terms of the collective strength, consistency, plausibility, and coherence of the evidence base. The precautionary principle was developed to manage these complexities, requiring policy-makers to weigh the collective evidence on risk factors and act accordingly. It must therefore be repositioned at the centre of policy-making for healthy food systems.

- **Leverage Point 5: Building integrated food policies under participatory governance.** Policy processes must be up to the task of managing the complexity of food systems and the systemic health risks they generate. Integrated food policies are required to overcome the traditional biases in sectoral policies (e.g., export orientation in agricultural policy) and to align various policies with the objective of delivering environmentally, socially, and economically sustainable food systems. Integrated food policies allow trade-offs to be weighed, while providing a forum for long-term systemic objectives to be set (e.g., reducing the chemical load in food and farming systems; devising strategies for tackling emerging risks such as antimicrobial resistance). These processes must be participatory. The general public must become a partner in public risk management and priority-setting, and buy into the rationale and priorities underpinning it.

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