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Early Warning, Emerging Issues and Futures

Growing popularity of alternate food systems for environment and health

Background

The Foresight Briefs are published by the United Nations Environment Programme to highlight a hotspot of environmental change, feature an emerging science topic, or discuss a contemporary environmental issue. The public is provided with the opportunity to find out what is happening to their changing environment and the consequences of everyday choices, and to think about future directions for policy.

Introduction: What the issue is

Shopping and eating patterns of the global population have changed gradually but drastically since the Second World War. Food production underwent a transformative change meant to cater to very different nutritional needs. However, the change has continued over the last 30 years with globalisation giving rise to the modern food system we have today (Popkin 2017; Hawkes and Popkin 2015)..

A food system could be defined as the path that food travels - starting from conception in the field to the resulting nutritional outcomes for those consuming it. This includes the growing, harvesting, processing, packaging, transporting, marketing, consuming, and disposing of food. The inputs used and outputs obtained at each stage are also an integral part of any food system. Environmental and health advocates point to the challenges with certain foods and the current food system, that have caused a large environmental footprint on the planet (Whitmee *et al.* 2015). This foresight brief highlights some of these environmental impacts with a focus on high animal-source food and the impacts on climate change, land and water. The question around food has moved beyond a focus on food security solely, to include the context of human wellbeing and the sustainability of our planet.

Why is it important?

Food by the numbers

The food and agriculture sector is a major driver of and is extremely vulnerable to climate change. Agriculture, Forestry and Other Land Use (AFOLU) account for 23% of global GHG emissions, while broader food systems activities can represent up to 37% of global emissions (Intergovernmental Panel on Climate Change [IPCC] 2019). Over the past 50 years, food from around the world has become widely available throughout the year. To enable this, food produced on a farm may travel thousands of kilometres before it reaches the plate. To process, package, and transport this food, large amounts of non-renewable resources are employed, making food production and marketing two of the most environmentally unfriendly businesses in the world (Grauerholz and Owens 2015).

The livestock sector has seen an unprecedented growth with global annual meat consumption increasing at a rapid rate in the past 50 years. For instance, meat production increased from 70 million tonnes in the early 1960s to over 330 million tonnes in 2017. The US and Australia consume the most meat per annum, closely followed by western Europe consuming about 80-90 kilograms of meat per person annually. Rising incomes in middle-income countries like China and Brazil are positively correlated to meat consumption and one can expect to see a sharp rise in their demand for meat in the coming years (Ritchie 2019).

Our overall need for food is expected to go up by 49 per cent by 2050 and emissions from agricultural production are projected to increase driven by population and income growth and changes in consumption patterns (FAO 2017a; IPCC 2019). Therefore, a big chunk of the solutions to stay within the boundaries of the ecological limits would have to come from this sector.

Food and agriculture uses up to 50 per cent of habitable land, 70 per cent of freshwater and is responsible for 78 per cent of freshwater pollution (Figure 1). It is also responsible for the loss of global biodiversity such that 94 per cent of the total biomass is constituted by livestock, and only 6 per cent by wild animals (Ritchie and Roser 2020).

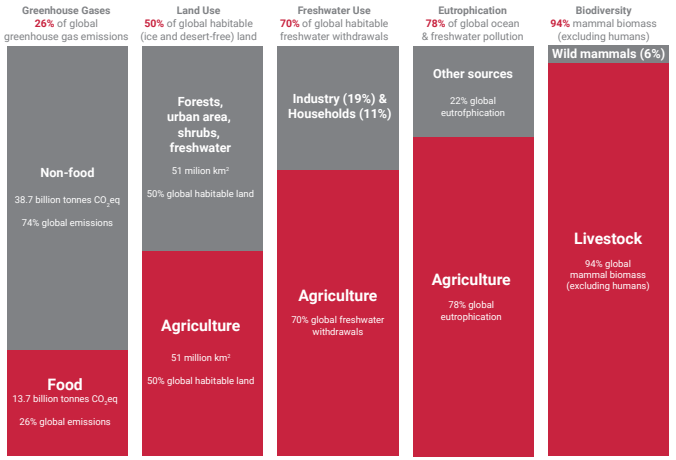

Figure 1: What are the environmental impacts of food and agriculture? Published online at OurWorldInData.org. Source: Hannah Ritchie

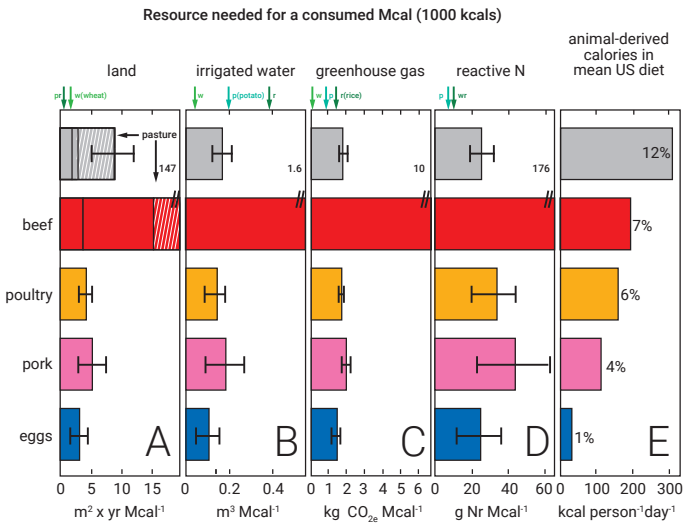

Figure 2: Environmental performance of the key livestock categories in the US diet, jointly accounting for >96 per cent of animal-based calories, in comparison with staple plant diets indicated by arrow. Source: Eshel et al. (2014)

Impact on the climate

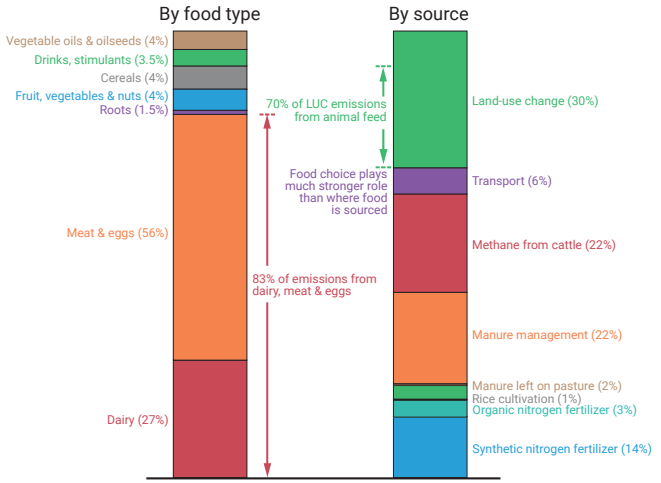

Figure 3: Carbon footprints of diets across the European Union: by food type and source. Published online at OurWorldinData.org. Source: Sandström et al. (2018)

Livestock-based food production has an important and pervasive impact on the environment. For instance, beef production in the US requires 28, 11, 5 and 6 times more land, irrigation water, GHG and reactive nitrogen than the average of other livestock categories (Eshel *et al.* 2014). Figure 2 shows the three staple plant foods in the US shows two- to six fold lower land, GHG, and Nr requirements than those of the non-beef animal-derived calories (Eshel *et al.* 2014).

Besides the ecosystem impacts, there are serious concerns about animal treatment and environmental degradation associated with current farming practices associated with the practice of concentrated animal feeding operations (CAFOs), which are distinguished by the number of animals, conditions of confinement, and waste management utilised (Grauerholz and Owens 2015).

Agriculture, Forestry and Other Land Use (AFOLU) activities accounted for around 13 per cent of CO_2, 44 per cent of methane (CH_4), and 81 per cent of nitrous oxide (N_2O) emissions from human activities globally during 2007–2016, representing 23 per cent of total net anthropogenic emissions of GHGs (IPCC 2019). However, if emissions associated with pre- and post-production activities in the global food system are included, the emissions are estimated to be 21–37 per cent of total net anthropogenic GHG emissions (IPCC 2019).

The livestock and fisheries sector contribute to over half of the total emissions from the food sector. Ruminants and the expansion of rice cultivation are important contributors to the rising concentration of methane (IPCC 2019). Figure 3 demonstrates that approximately 83 per cent of the emissions from an average European diet are constituted by dairy, meat and eggs and the majority of these come from land use change, methane emissions from cattle, management of manure or use of fertilizer (Ritchie and Roser 2020).

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Impact on human health

The global dietary transition has resulted in diets higher in refined fats and sugars, oils and meats and has led to an increase in the incidence of type II diabetes, coronary heart disease and other chronic non-communicable diseases that lower life expectancies (Tilman and Clark, 2014). In many countries, meat consumption goes far beyond basic nutritional benefits, and this too has been linked with increased risk of heart disease, stroke and certain types of cancer (Aston, Smith and Powles 2012).

Global livestock waste in 2014 amounted to 2.9 billion tonnes, far more than that produced by humans, and this is expected to increase drastically by 2050. Unlike human waste, livestock waste is not treated or well contained posing serious health hazards (Hribar and Schultz 2010; Berendes et al. 2018). Animal manure contains more than 150 pathogens including *Escherichia coli* and nitrates which can leach into the ground and surface water (Hribar and Schultz 2010). CAFOs also affect air quality, as they produce high levels of ammonia, hydrogen sulphide, methane and particulate matter, all of which have varying impacts on human health including

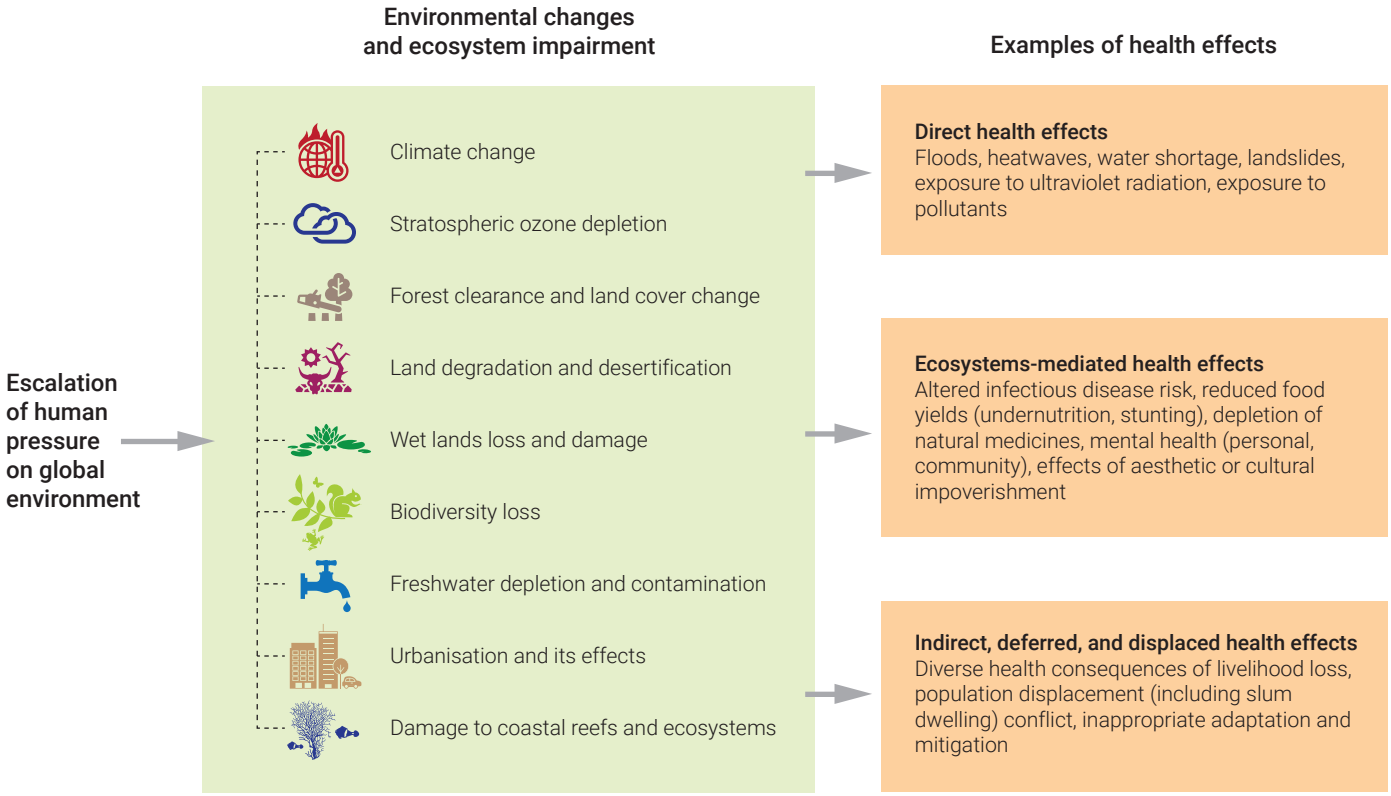

Figure 4: Mechanism by which the harmful effects of ecosystem change can affect human health. Source: Adapted by UNEP from Whitmee et al. (2015)

respiratory problems and death (Hribar and Schultz 2010 p. 5). In addition, the extensive use of antibiotics in animal feed contributes to antibiotic- resistant bacteria, and inbreeding for desirable traits reduces biological and genetic diversity that threatens food security.

Changes to the structure and function of the Earth's natural systems represent a growing threat to human health (Whitmee *et al.* 2015). The role of intact ecosystems and the suitability of climatic conditions in regulating the transmission of diseases, while not fully understood, points to an increased risk of zoonotic disease transmission in disturbed and degraded habitats emphasizing the role of biodiversity in mediating exposure to infectious diseases (Whitmee *et al.* 2015).

What alternatives exist?

Alternative food movements (AFMs)

New social movements surrounding food systems, especially the production and consumption of food products, have grown dramatically over the past several decades (Grauerholz and Owens 2015). These can be broadly categorized as alternate food movements (AFMs). Several of these are now an integral part of food habits around the world and an increasing number of people find themselves subscribing to one or several of these 'alternative' dietary regimes. This is indicative of a growing tendency to move away from food that has become increasingly industrialized, standardized, and impersonal.

Plant-based diets

There is a growing trend to move towards plant-based diets (Markets and Markets 2020). Individuals who adhere to plant-based diets may frame their choices differently. Some focus mostly on the consumption angle, focusing on their own health; others focus on the production angle, wishing to avoid practices that harm the environment and create animal suffering. They also do not necessarily share interests with those engaged in other AFMs. That is, vegetarians are not necessarily opposed to intensive farming practices of crops or GM crops. On the other hand, many industry experts note that it's not about vegetarianism or veganism as much as it is a broadening of the diet to include plant proteins as another form of meat (Petrak 2019).

Despite these differences, collectively they have succeeded in raising public awareness that reduction or elimination of meat in favour of plants is beneficial to human health, the environment, and animals. Anyone looking to adopt a vegan or vegetarian diet for environmental reasons may also want to consider whether there are some plant-based foods that also come with a heavy price (Gray 2020). Air-transported fruit and vegetables can create more greenhouse gas emissions per kilogram than poultry meat, for example.

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(Garnett 2006). The water, land and carbon footprint of growing and transporting large, perishable fruits means the environmental impact is far larger than one expects. As soy based products gather popularity in the vegetarian/vegan diet, one must also be warned of the unsustainable practices of soy production, responsible for high land use change emissions and deforestation.

The local food movement

The local food movement privileges local, seasonal foods over exotic, durable ones (Cunningham 2011). 'Local' is defined as any food produced and processed within 160 km of your residence (Rose *et al.* 2008). The movement has created new connections between producers and consumers; and between individuals and the land, reshaping the social, economic and physical landscapes of many communities. Major players in the local food movement – farmers' markets and community supported agriculture – as well as more recent trends that have taken on a do-it-yourself quality that includes urban farming and gardening (Grauerholz and Owens 2015). This movement is now a major part of the food system especially since it overlaps with the consumers' desire for healthier, plant-based, organic products (Hinrichs 2000).

Local farming is a seasonal activity, growing limited types of produce; and therein lies the challenge. Today's consumers have come to expect and appreciate the diversity and availability of non-locally grown foods, and few families today have the time or skill to preserve foods. The ability to survive on local yield alone is unlikely, implying that local foods are likely to supplement rather than replace conventional food production and consumption.

Genetically Modified Organisms (GMOs): Emergence and resistance

GMOs have been deemed the "fastest adopted crop technology in the history of modern agriculture" (James 2011). Those opposed to GMOs argue that rather than requiring fewer chemicals, insects, viruses, and bacteria become resistant, resulting in the need for new chemicals to fight new diseases and continuous genetic reengineering, often involving multiple ('stacked') trans genetic traits (Buiatti, Christou and Pastore 2013). Of major concern is gene flow between GM crops and non-GM crops, and the resulting reduction of biodiversity (Landry 2015).

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Permaculture

The concept behind permaculture – permanent agriculture or permanent culture – is developing self-sustaining systems that operate according to natural laws (Fiebrig *et al.* 2020). Despite its roots in natural systems that existed for millions of years, the practice of permaculture marks a radical shift from other AFMs and conventional farming practices. The common view in agriculture is that nature (weeds, pests) is an enemy. However, permaculture works with nature and all available features including wastes to build a sustainable ecosystem (Hemenway 2009: p. 5). An example is Cuba, which turned to permaculture when faced with a hunger crisis after the collapse of its main trading partner, the Union of Soviet Socialist Republic caused the USA to tighten embargoes on food imports to Cuba.

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Call for a planetary health diet

The Lancet Commission devised the first science-based diet that tackles both the poor diet of billions of people and averts global environmental catastrophe (Whitmee *et al*. 2015). It is largely plant-based, allowing an average of 2,500 calories a day. Globally, the diet requires red meat and sugar consumption to be cut by half, doubling the intake of vegetables, fruit, pulses and nuts (Whitmee *et al.* 2015). In specific places the changes are stark. North Americans need to eat 84 per cent less red meat but six times more beans and lentils, while Europeans need to eat 77 per cent less red meat and 15 times more nuts and seeds. This diet would save at least 11 million people a year from deaths caused by unhealthy food, while promoting a healthier environment. However, there are doubts about the acceptability of this shift among the populations (Wolfson 2019).

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Food justice movement

Many have been criticized for ignoring racial and class inequalities, and failing to recognize that disadvantaged groups and communities are the most likely to be harmed by current practices (Alkon and Agyeman 2011). The 'food justice movement' attempts to bring these inequalities to light and places emphasis on fair trade, localism, affordability, equity, and justice (Alkon and Agyeman 2011). Three strategies used by the food justice movement to address these injustices include, firstly, an emphasis on the local- and community-based initiatives, drawing on local food movement practices in order to promote food security from the ground up. Secondly, it seeks to engage in local, regional, and national policy making and planning to promote access to healthier foods for all. Thirdly, it seeks to create a 'networked food justice movement' that is fluid yet able to exist with limited funding and structure (Wekerle 2004).

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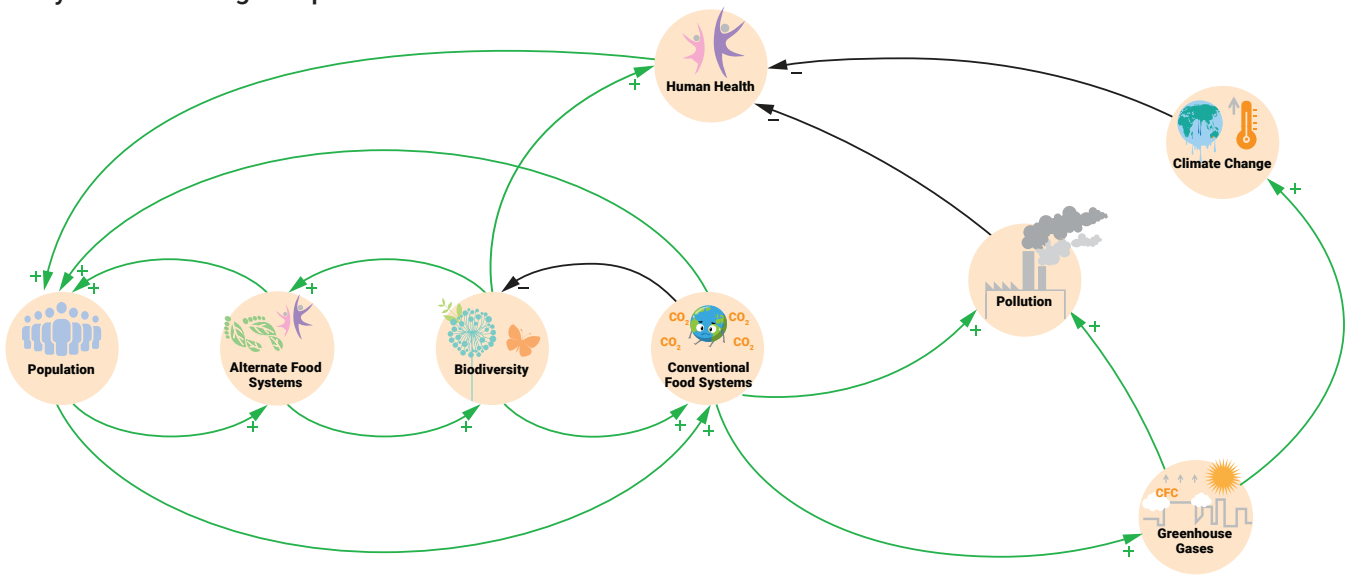
What are the challenges?

A central concern is whether the growing world's population can be fed through non-intensive farming methods and therefore, whether methods promoted by AFMs are realistic alternatives to conventional 'factory farming.' Often the more affluent societies, with greater resources and opportunities to learn about and switch to alternative food tend to dominate these movements, while those less privileged often have less information about, access to, and ability to switch to healthier and sustainable diets, resulting in an increased reliance on industrially produced food from conventional agriculture including GM foods. Thus, a larger focus on eliminating social disparities is fundamental to feeding the world through sustainable and ethical farming methods. In this sense, elimination of structural inequality rather than promotion of any specific farming method or consumption pattern must be our goal.

Recent developments such as the development of laboratory-raised meat grown from stem cells has implications for the environment, social movements, and identities. Since no animals are involved, there is potential to reduce global warming and devastation caused by concentrated animal feeding operations while reducing hunger. Questions remain for animal rights groups: Can one still be a 'vegetarian' if one eats meat raised in labs? More questions arise as we make advances in our approach to sustainable food systems. As the risks associated with contemporary food systems intensify, we may see more cooperation and communication between the Global North and Global South around shared interests in safe foods. Thus, another pertinent question is: can and will new food systems transform the relationships between wealthy and poorer countries?

A Systems Thinking Perspective



Dominant causal loops in conventional food systems and alternatives to consider. Population growth drives current food systems that also have a large environmental footprint on the planet. Alternative food systems that reinforce biodiversity and overall human health as well as have a more beneficial environmental impact are desirable. (+) Influence is in the Same direction, (-) influence is in the Opposite direction.

What are the policy implications?

A sustainable food and agriculture system is key to achieving several of the Sustainable Development Goals. This would lead to a world where food is nutritious and accessible for everyone, in which natural resources are managed in a way that maintains ecosystem functions to support current and future human needs. The Food and Agriculture Organization uses 5 principles (Figure 5) to guide global efforts. In this vision, farmers, pastoralists, fisher-folk, foresters and other rural dwellers actively participate in, and benefit from economic development, and have decent employment conditions and fair pay. Women, men and communities are food secure with control over their livelihoods and equitable access to resources which they use in an efficient way (FAO 2018). Some integrated strategies are discussed in the next section.

Five Key Principes

Figure 5: Five principles for sustainable food and agriculture systems. Source: Adapted by UNEP from FAO (2018)

Sustainable intensification

Sustainable intensification (SI) has been gaining attention in policy discussions as a means to simultaneously address food security and environmental security (Petersen and Snapp 2015). The SI approach has been proposed as the primary means to feed a growing population (Godfray *et al.* 2010). In a low-income country context, sustainable agricultural intensification might consist of three interlinked activities: ecological intensification (e.g., conservation agriculture, agroforestry, and integrated pest management to minimize pesticide use), genetic intensification (plant and animal breeding), and market intensification, which provides an enabling environment for both producers and consumers to benefit (Whitmee *et al.* 2015). Likewise, Pasture intensification through liming, fertilization and controlled grazing could increase soil organic carbon and reduce net GHG emission intensity per unit meat product, but only at increased investment cost per unit of area (de Oliveira Silva *et al.* 2017).

Efficient use of water and fertilizer

Strategies to increase crop yields while reducing water losses include water harvesting and water conservation. Although drip or trickle irrigation methods are more expensive to install than conventional irrigation methods, they can be as much as 33 per cent more efficient in water use and can carry fertilizers directly to the roots of crops (Institution of Mechanical Engineers 2013).

Reduction of food waste and spoilage

Every year the world loses, or wastes, about a third of the food it produces, generating USD 1 trillion in economic costs, around USD 700 billion in environmental costs and around USD 900 billion in social costs (FAO 2018). In low-income countries the wastage occurs mainly at the farmer–producer end of the supply chain and, as countries become more developed, the wastage moves further up the supply chain (Whitmee *et al.* 2015). Additionally, food waste contributes to biodiversity loss, consumes about 250 km^3 of surface and groundwater, and generates 4.4 billion tonnes of CO_2 equivalent greenhouse gas emissions, the third largest source after the national greenhouse gas emissions of China and the USA (FAO 2017b). To reduce food waste along the food supply chain by about 50 per cent seems feasible (United Kingdom, The Government Office for Science, 2011), and would have major benefits to the environment and the world economy.

A key challenge remains the small number of countries currently measuring food loss and waste, and the need for research into the behaviours and drivers that give rise to food waste in emerging economies, as the existing knowledge base is focused on high income countries.

Reduction of spoilage due to fungal contamination can improve health and reduce waste. Several promising aflatoxin control strategies are being developed, including the use of a natural, non-toxic technology that uses the ability of native atoxigenic strains of Aspergillus flavus (the fungus that produces aflatoxin) to naturally outcompete aflatoxin-producing strains and has been adapted for use in Africa (Atehnkeng *et al.* 2008).

Maximising awareness and capacity for sustainable food systems

School-based food and nutrition education (SFNE) could be instrumental in spreading awareness and building capacity for sustainable food systems at the local level. It consists of educational strategies and learning activities, which supported by a healthy food environment, helps schoolchildren, adolescents and their communities to improve their diets and food choices (FAO 2019).

As food is at the centre of many modern sustainable development challenges, a new vision and approach to traditional SFNE is needed, one where children and their communities develop capacities that support their health and wellbeing, and are empowered to become active agents of change in their local food systems.

To achieve this vision, new paradigms are needed that go beyond classroom-based transmission of basic and

generic nutrition information, to ones that promote hands-on learning and skill development.

Beyond providing food in schools to all children on equal terms, the promotion of equity and social justice through schools depend on employing approaches that purposely assess and address issues of inequality and inclusion throughout food procurement, preparation and consumption. These also depend on the meaningful involvement of local governments, civil society and the wider school community (FAO 2019).

Conclusion

This issue has reviewed some emerging trends in the global food and agriculture system and its critical spill over to the climate, environment and health and prosperity of the people and the planet. Several alternate social movements based on food have emerged in the recent past and continue to gain momentum as the need for substantive transformation of what we eat and how it is produced becomes increasingly pressing in order to achieve the goals set under Agenda 2030.

This transformation cannot take place without a holistic approach involving all parties including producers, consumers, and all steps in between. Overarching principles and policy best practices are only a guide to assist what will be a very complex process of change to the existing practices in different societies governed by different economic, social and cultural norms.
A simultaneous transformation of the global economy in favour of a sustainable future is imperative.

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