Fixing our food system: an imperative for achieving sustainable development

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Introduction

In 2015 the United Nations adopted a set of goals to be achieved by 2030 with the aim of ending poverty, protecting the planet, and ensuring prosperity for all as part of a new sustainable development agenda (UN 2015). While considerable progress has been made over the past decade across all areas of development, the pace of progress observed in recent years is insufficient to fully meet the Sustainable Development Goals (SDGs) and targets by 2030 (UN 2017). Faster and more inclusive progress is needed to accomplish the bold vision articulated in the 2030 Agenda.

One of the seventeen SDGs is directly related to food and nutrition, namely SDG 2 which is to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture. While some progress has been made to reduce hunger and malnutrition, it is not enough to meet the goal. Despite significant population growth, the share of undernourished people in the world decreased from 14.7 percent in 2000 to 11 percent in 2016, although with evidence of a slowdown in the last year attributed to the rising numbers of conflicts and natural disasters (FAO, IFAD, UNICEF, WFP, WHO. 2017). While the rates of stunting in under-five year old children fell from 29.5% to 22.9% between 2005 and 2016, rates of young child overweight increased from 5% to 6%.

Failure to achieve SDG2 will also make other SDGs difficult to achieve, since the pervasive negative influence of our current food system endangers many others. The purpose of this article is to lay out the evidence for the damage our food system does to global health and the environment, and describe why changing our food system must become the backbone of efforts to achieve sustainable development by 2030. The food system is first described and then the evidence for its negative influence on six other SDGs are explored.

How our food system has evolved in the last few decades

Feeding the global population has certainly become a challenge. Not only has the world population tripled since the second world war, but it has become predominantly urban. From around 2 billion in 1950 the global population rose to just over 7 billion in 2009, and will grow to around 9 billion in 2050 (Bremner et al, 2009). The proportion living in urban areas surpassed those living in rural areas in 2009, and projections are that about two thirds of the global population will be urban by 2050, and over a half will be living in the urban areas of the current low and middle-income countries (LMICs). The evidence indicates that the steadily widening economic gaps between rich and poor are

due more to consumption growth among the rich than to population growth among the poor (Kent 2015).

With growing urbanization, the distance from the place of food production to the place of consumption inevitably gets longer. To grasp the issues involved in the globalization of the food system in the last few decades it helps to envisage the sequence of steps from the place of production to the place of consumption, passing through the space of flows (Oosterveer & Sonnenfeld, 2012), as is shown in Figure 1. An analysis of the global food system needs to consider the actors, institutions and technologies involved in each of these places and spaces, going from production to trade, to processing, to retail and finally to consumption.

Figure 1. Steps in the food chain through the spaces of place and flows

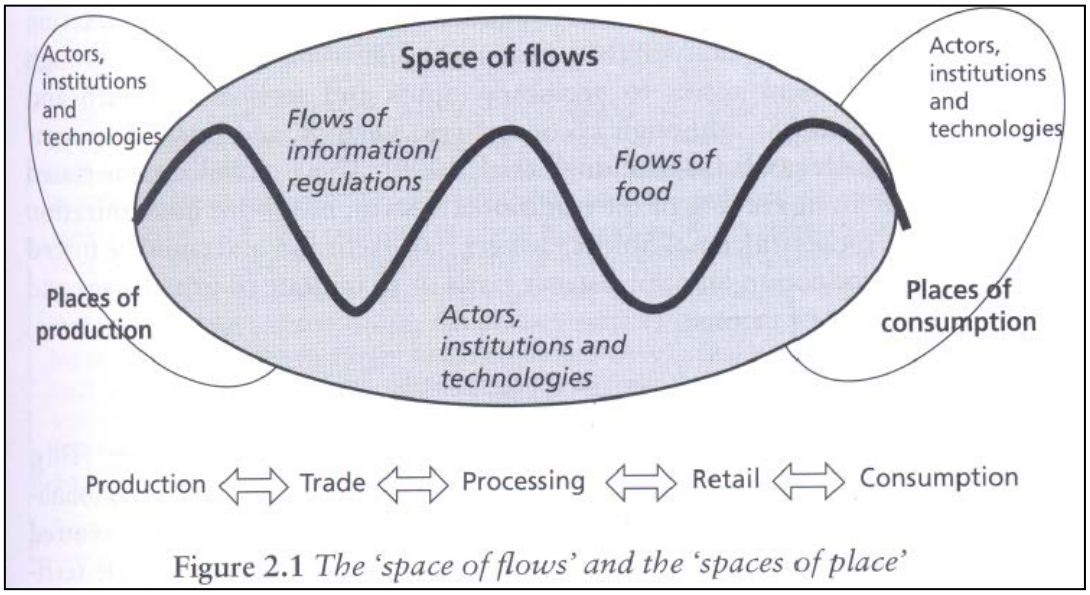


Figure 2.1 *The 'space of flows' and the 'spaces of place'*

Source: Oosterveer P, Sonnenfeld DA. 2012. Food, Globalization and Sustainability. London: Earthscan.

Food production

Global food production has outpaced rising demand based on population growth rates during the last four decades (FAO 2002). Despite the population almost doubling, the per capita supply of energy from food for human consumption rose by just over 20% between the early 1960s and the late 1990s. The greatest growth came from increases in the production of wheat, vegetable oils, sugar, and meat. Presumably most of the increase in per capita supply of energy has gone to people with money, not to the needy, and there is evidence for this in the data on overweight and obesity further described below.

The number of farms globally is around 570 million, and of these 83% are small farms of less than two hectares (Lowder et al 2016), which operate about 12% of the world´s land. Of the 446 million small farms, the majority (87%) are in Asia, and only 8% are in Africa and 1% in the Americas. About a half of small farms are pre-commercial, i.e. not benefitting from productivity enhancing technologies, financing and market access. While these small farms of the peasant food web provide 70% of total food eaten globally (ETC Group 2015) and harvests 60-70% of food crops from 20-30% of arable

land, the larger farms of industrial agriculture food system provide 30% of all food consumed globally and uses 70-80% of world's arable land. Small farms of the peasant food web will likely continue to dominate the agricultural landscape in LMICs, especially in Africa and Asia, for at least the next two to three decades.

The increase in global food production can be largely attributed to the green revolution (Pingali 2012). The production of cereal crops tripled in the last fifty years with only a 30% increase in land area cultivated. Using petroleum-based fertilizers and chemical pesticides, expanded irrigation, and genetically modified disease-resistant cultivars, cereal production (wheat, rice, maize) doubled in Asia between 1970 and 1990. This success was concentrated in areas where irrigation water, infrastructure (roads) and access to markets (input and output) as well as credit were well developed. In areas without these conditions, such as in Africa, the impact of the green revolution was less impressive. Even where the green revolution was successful in raising productivity this was concentrated in the richer larger landholders, as the poorer farmers of the peasant food web could not afford to pay for these inputs. The green revolution thus gave impetus to the development of agribusiness (Engdahl 2007), designed to increase the flow of food crops from the places of production through the space of flows, to the place of consumption. The number of actors providing the inputs needed to achieve increased production through the industrial agricultural system is very limited (ETC Group 2013). A few big multinational conglomerates, including Monsanto and DuPont, Syngenta and Bayer, Dow, and BASF, are controlling 75% of all private sector plant breeding research, 60% of the commercial seed market and 76% of global agrochemical sales.

Furthermore, over the last century, "three-quarters of the varietal genetic diversity of agricultural crops have been lost." Just twelve crops and fourteen animal species now provide most of the world's food. Biodiversity is an essential condition for developing agriculture throughout the world, particularly in the LDCs, where agriculture accounts for 70 percent of GDP. Since the 1900s, some 75 percent of plant genetic diversity has been lost as farmers worldwide have left their multiple local varieties and landraces for genetically uniform, high-yielding varieties (FAO 2004).

Around 56 billion land animals are estimated to be reared and slaughtered for human consumption annually (Koneswaran & Nierenberg, 2008). These estimates vary considerably however, largely depending on terminology and definitions used. According to FAO (2016) there are 21.7 billion livestock while other estimates are that 65 billion land animals a year are being slaughtered, and 88% of these are chickens (Friends of the Earth Europe and the Heinrich Boell Foundation 2016). It is agreed that factory farms are the most rapidly growing system of farm animal production (FAO 2009), providing 72% of poultry, 43% of eggs, and 55% of pork globally. Furthermore, about a third of global cereal production and just over 90% of soy bean production is used to feed farm animals (FAO 2002).

Capture fisheries production increased from 69 million to 93 million tons during the last three decades, whilst world aquaculture production increased from 5 million to 63 million tons (World Bank 2013). Aquaculture will provide close to two thirds of global food fish consumption by 2030 as catches from wild capture fisheries level off and

demand from an emerging global middle class, especially in China, substantially increases. However, if it is to sustain its contribution to world fish supplies, aquaculture must reduce wild fish inputs in feed and adopt more ecologically sound management practices (Naylor et al, 2000).

Human breastmilk production rarely gets considered in food balance sheets or economic statistics (Smith 2013). Around 130 million babies are born every year and in theory mothers could be producing an average of 750ml of breastmilk a day for that year if they exclusively breastfed for the first six months and continued breastfeeding until 12 months. This would give a total production of 35 billion litres of human milk a year, but how much of this potential is realized is difficult to estimate. Even in LMICs only 37% of mothers with babies under six months of age are exclusively breastfeeding at any one time (Victora et al 2016) although the prevalence of exclusive breastfeeding among infants younger than six months in LMICs increased from 33% in 1995 to 39% in 2010 (Cai et al 2012).

Food trade

The passage of food through the space of flows, begins with it being traded, and then it may or may not be processed before being sold to the consumer. With increasing urbanization of the population, the distances travelled from production to consumption have obviously increased. Since the early seventies and the development of the Washington consensus on the conditionality for Structural Adjustment Programs (SAPs) from the International Monetary Fund (IMF), LMICs have been increasingly encouraged to open up to free trade, privatize national industries, and reduce state support to local agricultural production (Weis 2007). The conditionality for SAPs was the precursor to the conditions of free trade agreements, including the General Agreement on Tariffs and Trade (GATT) and the North American Free Trade Agreement (NAFTA) all developed through the World Trade Organization (WTO). The WTO and the IMF are the principal institutions that govern trade in the space of flows of the modern global food system. Many have protested about the inclusion of food and agricultural products in the deliberations of the WTO, especially the campaign for Peoples Food Sovereignty (Rosset 2006).

The amount of food calories traded on the international market is about 20% and had more than doubled between 1986 and 2009 (D´Odorico et al 2014). Policies of trade liberalization have facilitated the rising availability and consumption of relatively cheap meat, dairy products and processed foods in LMICs (Thow & Hawkes 2009). Imported foods tend to be cheaper because of continued state support to the industrial agriculture system in HICs, and their dumping of cheaper food commodities onto the world market. Food is now a major component of international trade, accounting for 10 percent of all global trade (FAO 2011), and the aggregate value of agricultural exports passing through the international “space of flows” was expected to reach a record US$1.29 trillion in 2011.

Growing industry concentration has led to a situation where just a few companies control large shares of the flow of food through the space of flows (FAO 2002). In the USA Cargill is number one in terms of domestic grain handling, as well as grain and soybean exports but also the second largest compound feed producer and the number three turkey producer. In 2003 four firms (Archer Daniels Midland, Bunge, Cargill, and

Louis Dreyfus) controlled 73 per cent of the global grain trade (Murphy et al 2012). Furthermore, these multinational corporations are highly diversified and integrated both vertically and horizontally; for example, Cargill, ADM, and Bunge not only account for more than 60 per cent of total financing of soy production in Brazil, but they also provide the seed, fertilizer, and agrochemicals to the growers, and subsequently buy the soy and store it in their own facilities. The big traders also transport commodities in their own rail cars and ships. They also carry out research and development, bringing new varieties of seeds onto the market that are resistant to their weed killers for example. Questions have already begun to arise concerning the intellectual property rights on these genetically modified grains (Tansey & Rajotte 2008), as well as how to equate the human right to food convention and international trade policies framework with regard to these staple food products (Kent 2005).

It has been argued that on balance the net flow of food trade is from the poor to the rich countries (Kent 1982), and that is certainly the case for animal protein foods. But increasingly the flow is in the other direction for ultra-processed foods. Multinational retailers have introduced into LMICS the types of supply chain seen before in HICs, based around tight vertical coordination, centralised purchasing, and sophisticated marketing (Mazzocchi et al 2012). They accelerate the rate at which local firms adopt these strategies and tailor them to local needs, and in doing so provide employment and generate income locally. Most of the profits however still revert to the head office of the chains located in HICs (Hawkes 2005).

Food processing

Globally, processed foods now account for 80 percent of country level food sales (Mazzocchi et al 2012), that is foods sold through retail outlets. Ten big food and beverage companies generate revenues of more than US$1.1billion a day (OXFAM 2013) and together they are part of an industry valued at US$7 trillion, larger than the energy sector and representing roughly ten percent of the global economy. Although spending on processed foods is still lower in LMICs (US$143 per capita per year in lower-middle income countries and US$63 per capita in low-income countries), it is growing at 28 percent and 13 percent a year respectively in those country groups.

Global dietary diversity is decreasing, with 80 percent of the population consuming just four staple foods, which are wheat, rice, maize, and potatoes (Henry et al 1998). These four staple foods are transformed into a vast array of processed food products, with more than 1,500 produced from wheat alone. Ultra-processed products are becoming dominant in the global food system (Monteiro et al 2013). These foods are formulations of several ingredients which besides salt, sugar, oils and fats, include food substances not used in culinary preparations in the home, such as flavours, colours, sweeteners, emulsifiers and other additives. They contribute almost 60% of the energy and 90% of added sugars consumed by the USA population (Martinez Steele et al 2016).

Chemical food additives are used to make processed foods look, smell, and taste better, as well as to improve their shelf life. These include a large assortment of colourings, preservatives, antioxidants, emulsifiers, stabilizers, anti-caking agents, and flavour enhancers. In 2000, the food industry spent US$20 billion on such additives, and the average consumption was 7kg per person a year in industrialized countries (Millstone and Lang 2003). The approval for use of these food additives is currently determined by

national and international food safety authorities, led by the Codex Alimentarius Commission (2016). The Codex is recognized by the WTO as an international reference point for the resolution of disputes concerning food safety and consumer protection, thus lending it greater authority.

Food retail

Global food retail sales are about US$4 trillion annually, with supermarkets/hypermarkets accounting for the largest share of sales (Meade 2017). The urban demand for food in LMICs is expected to more than double in the next decade. It will be responsible for almost the entire growth in global food demand, spiking from about 40 percent to some 60 percent by 2050. The emergence of supermarkets in LMICS is leading to a radical change in the global food marketing and distribution system (Reardon et al 2003). Structural changes in the food distribution system, which took fifty years to unfold in the United States, have taken place in little more than a decade in Latin America. In China, where no supermarkets existed in 1989, annual supermarket sales were US$100 billion in 2008 (Reardon & Gulati 2008). Unlike higher income countries (HICs), where supermarkets are often the principal, if not only, source of fruits and vegetables (Larson et al 2009), supermarkets in LMICs are often distribution channels for cheap processed foods including less than healthy snacks and "junk" food, as well as being venues for fast food chains.

Food consumption

Globally, food consumption per person measured as dietary energy intake, increased by 15% in the thirty years up to 2000 (Kearney 2010). In the same period annual meat consumption in LMICs rose from 10 kg to 26 kg per person (WHO/FAO 2002). Global consumption of milk and dairy products also doubled to 45 kg, and the average global supply of fat increased by 20 g per capita per day. The type of carbohydrate in the diet also changed, with decreases in complex carbohydrates such as starchy foods (for example, whole grain cereals and legumes) and an increase in refined sugar. The average global consumption of fish increased from 13.4 kg per capita in 1990 to 16.3kg per capita in 1999 (FAO 2003). The concept of this "consumption" is more related to food purchased than actually intake, as it doesn't take into consideration food waste.

Food lost and wasted along the way from field to fork may be as much as a third, amounting to about 1.3 billion tons per year (FAO 2011). In medium- and high-income countries food is wasted to a significant extent at the place of consumption, often meaning that it is discarded even if it is still suitable for human consumption. In low-income countries food is lost mostly during the early and middle stages of the food supply chain, i.e. at the place of production, and much less food is wasted at the place of consumption.

How our food system impacts the sustainable development goals

The major concern is that not only is our current food system unsustainable, but it is also contributing to increasing global malnutrition, thereby doubly threatening the achievement of SDG2.

Furthermore, there is evidence that our food system is also impacting negatively on at least five other SDGs, including: SDG3 on our good health and well-being; SDG 13 on climate change; SDG 14 on life below water; SDG 15 concerning life on land; and last but not least, SDG 12 for achieving responsible consumption and production.

Our food system and SDG2

Ending hunger, achieving food security and improved nutrition and promoting sustainable agriculture are all the intention of SDG2. Our focus here is on ending hunger, achieving food security and improving nutrition. Sustainable agriculture gives equal weight to environmental, social, and economic concerns (Brodt et al 2011), and for this reason is discussed separately in relation to the other SDGs.

Despite the impressive increases in food production and consumption in the last few decades hunger and food security remain an everyday challenge for the 815 million hungry people worldwide, including some 520 million in Asia, 243 million in Africa, and 42 million in Latin America and the Caribbean (FAO, IFAD, UNICEF, WFP, WHO. 2017). In spurring agricultural capitalism, the green revolution seems to have succeeded amply in producing more food. But the vastly increased availability of calories has not ended hunger, the original justification for the revolution (Vanhaute 2011). A key factor of success in reducing undernourishment has to be inclusive economic growth at the bottom of the economic pyramid. Inclusive here meaning being in stable, strong communities, where people care about one another's well-being and work and play together (Kent 2016). A case for a long green revolution has been made, which includes a range of agroecological systems with contrasting systems of governance, innovation and distribution, ranging from state to multinational and philanthropic entities. Such mechanisms must now begin to enhance the productivity of small farms and strengthen social protection mechanisms in LMICS, as these are key factors for promoting inclusive economic growth, achieving food security and ending hunger.

On a global basis nutrition is not improving in a way that will see the SDG met. Some 155 million children under the age of 5 years are stunted, 51.7 million are wasted and 41 million are overweight or obese (FAO, IFAD, UNICEF, WFP, WHO. 2017), and although the child undernutrition (stunting and wasting) rates are decreasing, the reduction rates are not sufficient to meet the SDG targets, plus child overweight and obesity is increasing. But equally as worrying is that some 2 billion adults, almost a third of the global population, were overweight and obese in 2014 (Ng et 2014), and between 1980 and 2013 this prevalence rose by 27.5 percent in adults and 47.5 percent in children and adolescents. The increase in prevalence of overweight and obesity has been greater in LMICs than HICs for the last three decades (Finnucane et al 2011). The governments of LMICs are thus increasingly confronted with a double burden of malnutrition (Shrimpton and Rokx 2012), i.e. both overnutrition and undernutrition, often occurring together in the same communities and even the same household.

Traditional thinking that "eating too much" and "moving too little" are the causes of the rising global obesity problem is increasingly coming under scrutiny (Shrimpton et al 2017). Average adult weight began to increase by 1.5kg a year in the early eighties in the USA and the main drivers were the consumption of processed foods, and especially

of potato chips and sugar sweetened beverages (SSBs) (Mozaffarian et al 2011). While recently commenting on the lack of progress in obesity prevention, a hypothesis was resurrected that obesity is a hormonal, regulatory fat accumulation disorder, triggered not by energy imbalance but by the quality and quantity of the carbohydrates in the diet (Taubes 2013). Others have also suggested that overeating may be secondary to a diet-induced metabolic dysfunction, caused by eating too many refined carbohydrates (Ludwig & Friedman 2014). A recent dynamic time series analysis of US and global population data sets suggests that while increases in carbohydrate consumption are associated with increasing weight, increases in fat consumption are associated with decreasing weight (Riera-Crichton & Teft 2014). Thus, it seems probable that what is eaten is as important as how much is eaten in the causality of obesity.

Our food system and SDG3

Ensuring healthy lives and promoting well-being for all at all ages is the concern of SDG3. Breastfeeding is the most important start to life in terms of feeding patterns (Victora et al 2016). Appropriate breastfeeding practices prevent child morbidity due to diarrhoea, respiratory infections, and otitis media. Where infectious diseases are common causes of death, breastfeeding provides major protection, but even in high-income populations it lowers mortality from causes such as necrotising enterocolitis and sudden infant death syndrome. Available evidence also shows that breastfeeding helps nursing women by preventing breast cancer, and suggests beneficial effects on ovarian cancer and diabetes in mothers, as well as helping prevent overweight and diabetes in breastfed children. Despite these benefits, in 2013, only about two fifths of infants in LMICs with data were exclusively breastfed for the first six months of life, and three quarters were still being breastfed at 12-15 months. Rates in HICs are less sure, but are much lower at all ages (Rollins et al 2016).

What we eat is now the major risk factor for the global burden of disease, with six of the top ten risk factors being food and nutrition related (GBD 2013 Risk Factors Collaborators. 2015), including dietary risks, high blood pressure, child and maternal malnutrition, and overweight and obesity. One of the targets of the SDG is to reduce by one third premature mortality from non-communicable diseases (NCDs) which kill 40 million people each year, equivalent to 70% of all deaths globally (WHO 2011). NCDs disproportionately affect people in LMICs where more than three quarters of global NCD deaths occur. Cardiovascular diseases such as heart attacks and stroke account for about a half of NCD deaths. Over the next 20 years, the cost of treating NCDs and cumulative output losses globally are likely to be at least US$30 trillion and US$47 trillion, respectively, representing 48 percent and 75 percent, respectively, of global GDP in 2010 (Bloom et al 2011).

Systematic reviews find that unprocessed red meats, processed meats, sugar-sweetened beverages, high glycaemic load foods, trans-fats, and sodium are the principal dietary factors that increase the risk of cardiovascular disease and diabetes (Micha et al 2017). The proportion of energy contributed by dietary fats exceeds 30% in the HICs, and in nearly all other regions this share is increasing, even though the WHO recommendation is not more than 30% (WHO 2003). It is not clear if the nutrient composition data used to calculate these figures take into consideration the changes in the composition of meat produced in the industrial agricultural system. Animals fed grain instead of the grass and other organisms normally eaten in the wild, tend to have a higher fat content and a

different fatty acid composition. Chickens coming from modern factory farms not only have a higher fat content in their meat, but also as a higher ratio of omega 6 to omega 3 fatty acids as compared to free range chickens (Wang et al 2009). Lowering the omega-6/omega-3 ratio found in the diets of HICS is important for reducing the risk of many of the NCDs (Simopoulos 2008) and in the prevention and management of obesity (Simopoulos 2016).

Global assessments of sugar intake as a percentage of energy intake range from 20.0% to 38.4% in young children and 13.5–24.6% in adults (Newens & Walton 2016). WHO recommends that adults and children should maintain a reduced intake of free sugars over the life course, and this should be less than 10% of total energy intake (WHO 2015). Various systemic reviews and meta-analyses provide evidence that consumption of SSBs (Malik et al 2006) or free sugars (Te Morenga et al 2012) promotes weight gain in adults and children. Per capita sugar consumption is strongly associated with the prevalence of diabetes mellitus in a 165-country analysis, with the strongest association found in the Asia region (Weeratunga et al 2014). Another problem is that many processed foods have a high glycaemic index (Fadet et al 2017), with blood sugar levels remaining high for a long period after the food is eaten. Consumption of higher glycaemic index foods are associated with increased risk of type 2 diabetes (T2D) (Bhupathiraju et al 2014) and Coronary Heart Disease (CHD) (Fan et al 2012). Trade liberalization is considered to be driving the NCD epidemic in Asia (Baker et al 2014). Evolving layers of the international and regional trade regimes have facilitated increased market penetration by transnational tobacco, alcohol and ultra-processed food corporations and thereby driven consumption of these risk commodities in Asia.

Globally, an estimated 422 million adults were living with diabetes in 2014, compared to 108 million in 1980 (WHO 2016). Most diabetic patients (over 90%) suffer from T2D, which occurs when the body cannot effectively use the insulin it produces. The global prevalence (age-standardized) of diabetes has nearly doubled since 1980, rising from 4.7% to 8.5% in the adult population. This reflects an increase in associated risk factors such as being overweight or obese. Diabetes caused 1.5 million deaths in 2012. Higher-than-optimal blood glucose caused an additional 2.2 million deaths, by increasing the risks of cardiovascular and other diseases. Forty-three percent of these 3.7 million deaths occur before the age of 70 years, and this percentage is higher in LMICS than in HICs.

Our food system and SDG 13

The goal is to take urgent action to combat climate change and its impacts, and was the focus of December 2015 Paris Agreement which entered into force in November 2016. All 195 signatory countries agreed to work to limit global temperature rise to well below 2 degrees Celsius, and given the grave risks, to strive for 1.5 degrees Celsius (IPPC 2014). Each of the last three decades have been successively warmer at the Earth’s surface than any preceding decade since 1850. Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of energy accumulated in the last decades, and increasing by 0.11 degrees Celsius from 1971 to 2010. Warming of the climate system is unequivocal as the atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen.

Global warming is caused by greenhouse gases (GHG), which trap the heat of the sun in the atmosphere. Carbon dioxide (CO2) is the principal GHG and for many thousands of years the atmospheric CO2 level was below 300 parts per million (ppm) until it went above this level in 1950 and has continued to rise ever since (Luthi et al 2008), with 2016 the first year it didn't fall below 400ppm. Other GHGs that are potentially as important as CO2, include methane (CH4), which has 23 times the warming potential of CO2, and nitrous oxide (N2O) which has 300 times the warming potential of CO2. About 40% of the heat trapped by anthropogenic GHGs is due to gases other than CO2, primarily CH4 (Shine & Sturgess 2007). Furthermore, N20 has become the dominant ozone-depleting substance emitted in the 21st century (Ravishankara et al 2007).

At least a quarter of global GHG emissions come from the agriculture sector (Tubiello et al 2014), a close second to the electricity and heat production sector. Within the agricultural sector GHG emission come mostly from the cultivation of crops and livestock, and from deforestation. Livestock alone contributes at least 18 percent of annual global GHG emissions (FAO 2006), which is greater than the transport sector. Some argue that livestock and their by-products account for about half of GHG emissions (Goodland & Anhang 2009), but regardless of the exact amount, the agricultural sector obviously has enormous potential for reducing GHG emissions. This is especially the case because CH4, which mainly comes from livestock, has a half-life in the atmosphere of just 8 years versus at least 100 years for CO2. Thus, if CH4 emissions were curtailed the effect on global warming would be seen reasonably rapidly. A study modelling consumption patterns in the United Kingdom estimated that a 50 per cent reduction in meat and dairy consumption, if replaced by fruit, vegetable and cereals, could result in a 19 per cent reduction in GHG emissions, in addition to up to almost 43,600 fewer deaths per year (Scarborough et al 2012).

Our food system and SDG14

The goal of conserving and sustainably using the oceans, seas and marine resources is under serious threat and our food system contributes significantly to this. The adverse impacts include ocean acidification, marine pollution and overfishing and these are seriously jeopardizing efforts to protect large portions of the world's oceans.

The world's oceans are warmer now than at any point in the last 50 years. As the seas get warmer, more atmospheric CO2 dissolves in the sea, making it more acidic, with a 30% increase in acidity since pre-industrial times (Caldeira & Wickett 2003). One of the most important implications of the changing acidity of the oceans is that many marine photosynthetic organisms, such as corals, make shells and plates out of calcium carbonate (CaCO3). This process of 'calcification' is progressively impeded as the water becomes more acid. If the globe continues to warm and CO2 concentrations continue to rise, ocean acidification could slow coral growth by as much as 50% by 2050, with enormous negative consequences for coral reef ecosystems globally (The Royal Society 2005).

At least 60% of 'commercial' fish populations are fully fished and 29% are fished at a biologically unsustainable level and therefore overfished (UNEP 2016). Only 10 percent of all large fish—both open ocean species including tuna, swordfish, marlin and the large ground fish such as cod, halibut, skates and flounder are left in the sea today, as

compared to pre-industrial levels (Myers and Worm 2003). Marine biodiversity loss is increasingly impairing the ocean's capacity to provide food, maintain water quality, and recover from perturbations (Worm et al 2006).

Global trends point to continued deterioration of coastal waters owing to pollution and eutrophication. Of the 63 large marine ecosystems evaluated under the Transboundary Waters Assessment Programme, 16 per cent are in the “high” or “highest” risk categories for coastal eutrophication. They are located mainly in Western Europe, Southern and Eastern Asia, and the Gulf of Mexico (IOC-UNESCO & UNEP. 2016). Eutrophication is due to excessive nutrients in water, frequently a result of run-off from land, which causes dense plant growth and the death of animal life from lack of oxygen. Only 15-20% of the total input in the form of nitrogen- and phosphorus fertilizers used in the industrial agriculture system is embedded in the food that reaches the consumers’ plates, implying very large nutrient losses to the environment, including run-off into coastal waters.

Plastic is another major contributor to oceanic pollution. Some 12m tonnes of plastic enters the world’s oceans every year with 80% coming from land-based sources (Jambeck et al 2015). In the sea plastic eventually fragments and becomes particles which stay in the environment forever (Li et al 2016). More than 5 trillion plastic pieces weighing over 250,000 tons are thought to be afloat at sea at any one time (Eriksen et al 2014). The plastic debris typically accumulate in large garbage patches called gyres which collect in the middle of the oceans, some larger in size than Texas (Maximenco et al 2012). Among the most common items are “disposable” plastic bags, cups, straws, and implements used in our food chain. But only half of plastic debris floats, the rest sinks to the ocean floor. Both macro and microplastic fragments, which are the end product of plastic degradation, pose a serious risk to organisms as they can enter the food chain and potentially facilitate absorption of toxic hydrophobic contaminants (Cole et al 2011).

Our food system and SDG15

The goal is to sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss. Progress towards the goal is at best considered very precarious (Tittensor et al 2014) with some considering that another mass extinction is already upon us (Ceballosa et al 2017). The current food system is one of the greatest threats to SDG15 as over 60% of global terrestrial biodiversity loss is related to food production, while ecosystem services supporting food production are often under pressure (UNEP 2016). A third of soils under the control of the industrial agricultural system are moderately to highly degraded due to erosion, nutrient depletion, acidification, salinization, compaction and chemical pollution.

In the global food chain, there has been a rapid concentration of market power away from the primary food producers into the hands of a limited number of traders, processors and retail companies (IAASTD 2009). While these companies make their profit in the space of flows, they pay nothing for the damages done in the places of production or consumption. Deforestation in the Amazon as an example has largely been driven by the clearing of trees for cattle to graze (Margulis 2004), or to plant soya beans, largely for use in animal feed (Barona et al 2010). From the “place of

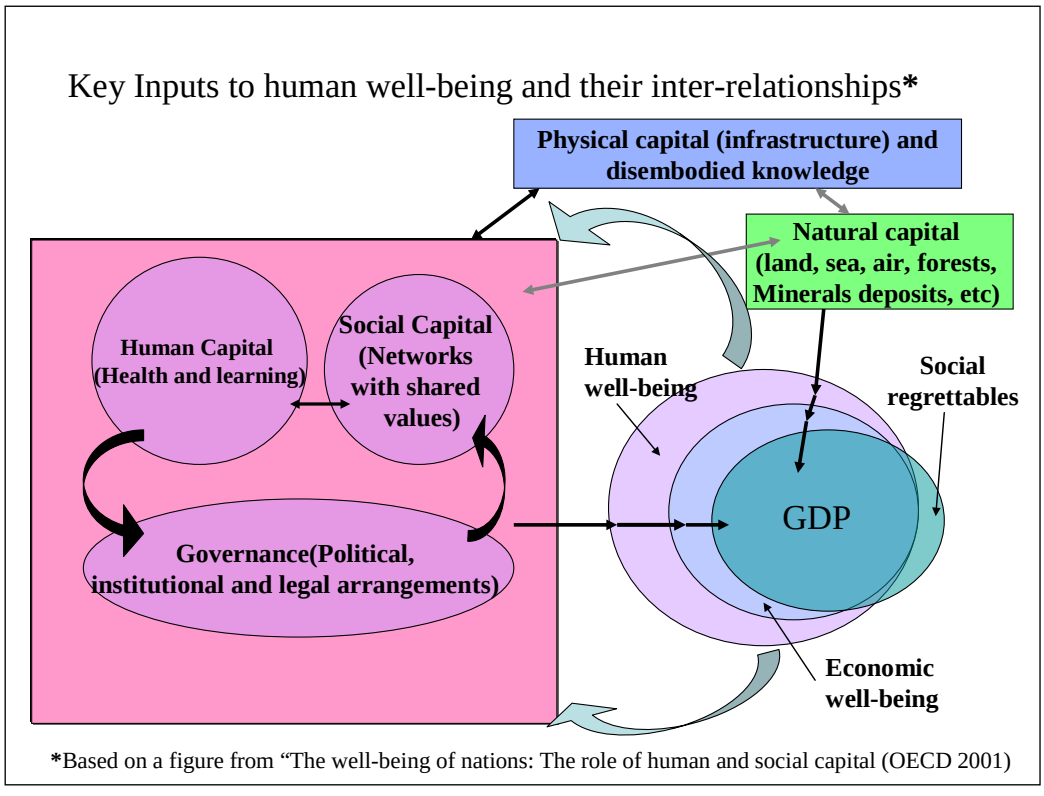
production" in the Amazon, soy beans are purchased by traders and exported, passing through the "space of flows" to somewhere like the UK for example, where they are fed to chickens in factory farms very often owned by Cargill, the same trading company. The chicken meat is then distributed across the UK and Europe through chains of supermarkets and fast food restaurants, before final arrival in the place of consumption.

Our food system and SDG 12

The goal to ensure sustainable consumption and production patterns must surely give enormous priority to fixing the food system. As shown in Figure 2, sustainable development requires governance mechanisms that ensure that regrettable effects are minimal (OECD 2001). The global food system is currently making enormous contributions to global warming and consequent ocean acidification, as well as biodiversity loss and the obesity and diabetes epidemics, to name just a few of its socially regrettable effects. The areas where changes need to be fostered are in the production, marketing and consumption of food, including energy use and transport (Tukker et al 2008).

The five principles of sustainable agriculture (FAO 2014) include the requirement for responsible and effective governance mechanisms which provide legal and institutional environments that strike the right balance between private and public-sector initiatives, and ensure accountability, equity, transparency and the rule of national laws as well as international treaties. Such efforts must strive to build on and strengthen the linkages between social capital, human capital and governance as indicated in Figure 2. Some of the matters that such governance mechanisms should be trying to ensure, if sustainable food consumption and productions patterns are to be achieved, are further described in the paragraphs below.

Figure 2. Sustainable development components



*Based on a figure from "The well-being of nations: The role of human and social capital (OECD 2001)

Government subsidies and development aid for food production need to prioritize helping family agriculture in small farming communities develop diversified agroecological systems that use the minimum of chemical inputs, with the minimum of soil disturbance, an increased use of organic matter, a combination of livestock and crops, with inter and intra species diversity (IPES-Food 2016). This will lead to improved soil health and fertility, creation of habitats for wild biodiversity, and increased soil CO2 sequestration. A growing body of operational experience with development aid points to a large spectrum of approaches that deliver productivity and resilience gains in agriculture alongside lower emissions (World Bank 2015). Important among these are silvopastoral livestock systems, agroforestry, intercropping, diversification of production systems toward less water- and emission intensive crops. All of this could help the restoration of nutrient cycles, higher water retention, encouragement of natural pollination, resilience of agroecosystems to stresses and the restoration of degraded land.

All such development aid efforts should be concentrated on the small farms in current LMICs, where improving agricultural performance will be central to addressing the poverty and food insecurity challenges of the future. Three-quarters of poor people still live in rural areas, and nearly two-thirds of the world's poor people work in agriculture (World Bank 2015). Food demand is projected to rise by at least 20 percent globally over the next 15 years, with the largest increases projected in Sub-Saharan Africa, South Asia, and East Asia.

Shortening food chains is an important step to ensuring more sustainable consumption in HICs. The longer the passage of food through the "space of flows" the greater the production of CO2 the greater the environmental impact. Farmers markets are an important way not only to reduce "food miles" but also to ensure that less intensively produced healthy food is available to local consumers. Plus, they can also help to reduce packaging (Friends of the Earth 2000). Community-Supported Agriculture (CSA)is another model from the USA that connects the producer and consumers more closely by allowing the consumer to subscribe to the harvest of a certain farm or group of farms. It is an alternative socioeconomic model of agriculture and food distribution that allows the producer and consumer to share the risks of farming, and has an overarching goal of strengthening a sense of community through local markets (Adam 2006). Experiences in the Americas and Europe (CEPAL/FAO/IICA 2014) have demonstrated how short food supply chains linking local farms producing fruit and vegetables to farmers markets in urban areas can improve food and nutritional security, not just for consumers but also for small scale (non-industrial) farmers, their families, and communities.

While improving access to natural food products, either because of prices or proximity, is key for improving the people's diets, alone this is not enough. The food industry spends at least US$ 40 billion a year globally on advertising processed foods (Millstone & Lang. 2003). Some consideration must therefore be given to controlling the advertising of processed foods, particularly to children, who are the ones most likely to be targeted (Consumers Union. 2003). Campaigns are also needed in urban areas especially, to inform people of the multiple benefits of consuming natural products produced locally as opposed to highly processed alternatives from the industrial food system. The promising French EPODE community-based approach for preventing childhood obesity uses such methods with promising early signs of success (Borys et al 2016).

Interest in using taxation to control the consumption of unhealthy foods has increased since the UN General Assembly recommended “fiscal measures” to improve diets, to address NCDs as a matter of priority in national development plans (UNGAS 2011). The use of fiscal measures could cause problems with the WTO (Sim 2015), but these could be surmounted if political will was sufficient. There is considerable evidence that taxation of SSBs can lead to reduced consumption reflected in less child obesity (Nakhimovsky 2016). To achieve this the tax should be at least 20% of the value of the food. Proceeds from such taxes should be used to promote the production of more healthy foods such as fruit and vegetables, produced locally. Despite recognition that the obesity epidemic will not be reversed without government leadership, regulation and investment in programmes, so far governments have largely abdicated the responsibility, leaving it to individuals, NGOs and the private sector to resolve. Parliamentarians surely have a key role to play. (Swinburn et al 2011).

Fiscal measures could and should also be used to reduce the consumption of the most environmentally damaging foods such as meat, and especially beef. It has been proposed that to keep GHG emissions to 2000 levels the projected 9 billion inhabitants of the world in 2050 need to consume no more than 70-90 grams of meat per day each, as compared to the current 100g a day (McMichael et al 2007). Surcharges of 40% on beef and 20% on milk would be sufficient to deter people from consuming so much of these less healthy foods and compensate for climate damage (Springmann et al 2017). These taxes would need to be applied on both imported and locally produced beef and milk.

Financial subsidies for the industrial food system in HICs surely need redirecting. In 2010 the European Union and the United States government together spent around US$ 70 billion to subsidize mainly large-scale farmers to produce grains such as corn, soy and wheat (Ortiz et al 2011), much of which are used to intensively rear animals in factory farms. These subsidies are provided to keep meat prices cheaper, despite the knowledge that the greater the support to animal based food systems the greater the environmental footprint (Aleksandrowicz 2016). In contrast, fish farming should be subsidized because it offers a more environmentally friendly means of providing high quality protein (Bene et al 2014). Subsidies should be directed at supporting fruit and vegetable production or fish farming, and developing linkages to local farmers markets. In Brazil, 30% of the funding for school meals are used to purchase food from local farms, and 70% of the food must be considered a “basic food,” meaning it cannot be ultra-processed (Jaime et al 2013).

Corporate social responsibility is another area that could and should be intensified. A recent 70% decline in deforestation in the Brazilian Amazon has been attributed to the enforcement of laws, as well as other interventions in soy and beef supply chains, suggesting that it is possible to improve the management of such systems (Nepstad et al 2014). In an effort to make the global food system both more just and sustainable, OXFAM has developed a score card which it is using to rank the big 10 food and beverage companies (OXFAM 2013). OXFAM recognizes that many companies have made several important commitments to address their social responsibility and sustainability. However there continues to be a serious disconnect between the industry’s broader public promises to achieve sustainability and the actual policies which govern their supply chains. Companies know and disclose too little about the

injustices flourishing in their supply chains, and continue to cherry-pick initiatives to highlight as part of their public relations efforts.

Conclusions and recommendations

The major conclusion is that our current food system is doing enormous damage and needs to be fixed. It is the industrial component of the global food system that is the greatest culprit. Not only can the negative effects of our industrial food system be measured on our health but also on many aspects of our environment, and unless we fix it many if not most SDGs will not be met. These include:

- SDG2 on achieving food security and improved nutrition will not be met because the current industrial agricultural food system is fuelling the obesity epidemic affecting a third of the global population.
- SDG 3 on healthy lives will not be met because the diet provided by our industrial agriculture food system is a major cause of the global burden of disease, and especially of NCDs, the major cause of mortality. Cardiovascular diseases and diabetes are spiralling out of control in LMICS especially.
- SDG 12 to ensure sustainable consumption and production patterns could best be met if we reduce meat consumption. That way we would not only be healthier but we would also reduce global warming, one of the most serious problems facing mankind today. This is especially because the rapidly growing livestock sector, which alone is a bigger GHG producer than the transport sector, is the principle source CH4. If we cut meat production because of CH4s short half-life, the levels in the atmosphere can fall quickly thus meeting the commitment of the Paris Agreement to limit temperature rise to less than 2 degrees.
- SDG13 on combating climate change will not be met because the industrial agricultural food system is a major contributor to global warming. But nobody pays attention to that. Livestock alone contributes more greenhouse gases than the transport sector, but the livestock industry continues to grow unhindered. Everybody talks about alternative energy, but nobody talks about alternative foods.
- SDG14 concerning conservation of our oceans will not be met because 80% of commercial fish populations are already being fished at unsustainable levels. In addition to which coastal waters are also being polluted due to fertilizers in the water that runs off agricultural land, leading to eutrophication. The sea is also getting warmer and so absorbing more CO2, making it more acidic with enormous negative consequences for coral reef ecosystems. Plastic, a major part of which from our food system, is also accumulating in the sea with great negative consequences and the degradation products (micro plastic particles) are re-entering the food chain.
- SDG 15 will not be met because over 60% of global terrestrial biodiversity loss is related to food production and a third of soils under care of the industrial agricultural system are moderately to highly degraded.

These conclusions lead to several recommendations, most of which relate to the need to create more awareness and to try to mobilize public opinion with the hope that more appropriate action will be taken. These include:

- Greater awareness must be created that the agriculture sector, and especially the industrial food system meat producers, are among the biggest contributors to global warming, and perhaps the one that can be most easily reigned in. The place to start

must be among civil society and the NGO community, since a push for change is unlikely to come from anywhere else.

- Development aid should prioritize small farms in LMICS, to develop diversified agroecological systems. These should build on indigenous knowledge and use a combination of silvopastoral livestock systems, agroforestry and intercropping with the minimum of chemical inputs and soil disturbance.
- Financial subsidies for the industrial food system to produce grain and feed it to animals in factory farms should be removed. The production of fruits and vegetables in peri urban areas, and linking these to farmers markets in urban suburbs are the areas that urgently need more priority and promotion, and where subsidies should be channelled.
- In all HICs fiscal measures should be introduced to reduce the consumption of the most health threatening and environmentally damaging food. These should include SSBs and meat products. The proceeds of such taxes should be used to promote the production and consumption of fruit and vegetables through local farmers markets.
- Controls should be introduced on the advertising of processed foods, especially those directed at children. Campaigns should be developed to inform people of the multiple benefits of consuming fruit and vegetable produced locally.
- Corporate social responsibility to make the industrial food system less damaging should be encouraged. But this will require much greater public recognition of the damage being done. This is the task the NGO community must surely take upon itself. But who is going to lead?
- Local governments in urban areas must be encouraged through SDG 11 goals and targets to support the development of small scale urban family agriculture and the infrastructure for farmers markets as part of SGD 11 on sustainable cities and communities.

It is encouraging to see that the UNSCN has taken a very similar position to those stated here (UNSCN 2017). It considers that developing a global food system to deliver healthy diets for a growing population, while reducing the environmental impact and reining in climate change, is one of the greatest global challenges of our time. Furthermore, it proposes that taking the commitments of the ICN2 Rome Declaration and the recommendations of the ICN2 Framework for Action (FFA) under the broad umbrella of the SDGs, the Nutrition Decade declared by the UN General Assembly offers a time-specific window for concerted action on human and planetary health, through the translation, integration and implementation of commitments into national policies and climate actions.

The UNSCN proposes that coherent public policies are required, from production to consumption across sectors. Coherent action and innovative food-system solutions are required to ensure access to sustainable, balanced and healthy diets for all. Policy cohesion needs to be achieved via institutional and cross-sectoral collaboration, as well as good governance, and needs to be approached from a human rights perspective. Rural and urban planners need to consider the distribution and trade of their foods, favouring local and fresh products rather than ultra-processed foods from abroad. Under the broad umbrella of the SDGs, the UN Decade of Action on Nutrition offers a time-specific window for the translation and integration of joint action on agricultural production, human health and the environment into national policies and climate actions.

There is obviously a need for some serious strategic thinking here. But where is that likely to take place? The SCN could potentially facilitate such strategizing, but is it

willing and able to do that? In many ways, the UN agencies are too constrained by their member governments, and they in turn by the big food and agriculture lobbies. But perhaps this is something that the Committee on Food Security at FAO could take up with the UN General Assembly.

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