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Chapter 18: Importance of sustainable food environments

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Abstract

Recent political and citizen actions across the world have highlighted the urgent need to change the way we live to mitigate the impact of climate change. Together with transport and energy use, food is one of the three most important parts of our lives where change can make a difference to our environmental impacts. The extent to which changes are made within the wider food system will determine how easy it is for individuals to choose foods that are more sustainable. Many different factors need to be taken into account when assessing the sustainability of our diets - such as how much energy and water is used to farm or cultivate various foods. There are many changes that individuals can make to reduce the impact their diets have on the environment but the largest and most necessary gains will come from regional, national and global changes in the food production systems, food policy and food environment. This chapter reviews the environmental impact of food production, different types of

sustainable dietary patterns and strategies to shift consumption towards more sustainable diets in order to inform discussions about how to feed 9 billion people without destroying planet Earth. Sustainable diets are consistently higher in fruits, vegetables and plant sources of protein and lower in meat and animal products.

18.1 Introduction

In the past decade, more countries have started to incorporate sustainability considerations into their food policies, dietary guidance, and consumer facing programmes (Reynolds et al., 2014). Such recommendations include: consuming a mostly plant-based diet, consuming seasonal and local foods, reducing food waste, consuming fish from sustainable stocks and reducing consumption of red and processed meat, highly-processed foods, and sugar-sweetened beverages. These actions may all seems to be quite distinct; however, due to the complex and multifaceted concepts involved, each of these recommendations contributes to a different (but interrelated) aspect of sustainability. This chapter will explore and introduce this multi-dimensional topic which will almost certainly influence the foods available in the food system and chosen by individuals in years to come.

In the broadest context sustainable diets can be described as "food choices that support life and health within natural system limits into the foreseeable future"(Gussow and Clancy, 1986). However, this definition misses the nuance and breadth of scope that the 2010 FAO definition provides:

"Those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources"(Burlingame and Dernini, 2012)

Yet to operationalise this definition in a practical nutrition setting is challenging. Few policy makers or practitioners have access to information or expertise to balance multiple nutrition, and environment, economic, and socio-cultural dimensions for each dietary recommendation, or policy choice; and so fall back upon the definition that sustainable diets are those that have

a low impact on the environment. Until recently this was often equated to mean that the production and consumption of this diet is associated with lower levels of greenhouse gas (GHG) emissions. Sustainable diets have become almost synonymous with GHG emissions for three reasons: 1) GHG emissions data was one of the first types of environmental impact data widely available for multiple types of food products and production systems. 2) Climate change is one of the largest threats facing humanity, and has knock on effects into other domains of sustainability. 3) The embodied GHG emissions of different foods are correlated to other environmental impacts (including water use, energy use, biodiversity loss and land use(Poore and Nemecek, 2018)).

Communicating what a sustainable diet is to consumers is also challenging. Currently there is limited consumer understanding of what is a sustainable dietary pattern(Van Loo et al., 2017), or which foods have a low environmental impact(Camilleri et al., 2019) – with these two topics becoming easily conflated. However, these again are two different concepts. Indeed, not all foods consumed within a sustainable diet have to be low impact. However, the diet as a whole needs to be within environmental bounds - as will be discussed here.

The act of food production generates environmental impacts at each stage of the food system; from farming and processing, transportation, transit packaging, consumer packaging, warehouse and distribution, to refrigeration and storage at the supermarkets and shops, through to driving home, cooking and waste disposal. As the food that we choose to eat drives food production, changing dietary patterns at a population level or widespread changes in food choice can impact on the environmental impact associated with food production. Additionally changes made across the supply chain of food production can change the environmental impact of specific foods and, if widespread enough, the whole food system.

18.2 Planetary boundaries effected by food production

The planet we live on has finite resources and limits to the amount of environmental damage it can suffer without system collapse. Rockström et al outlined the nine planetary boundary limits within which we expect that humanity can operate safely(Rockström et al., 2009). These earth system processes are climate change; ocean acidification; stratospheric ozone depletion; atmospheric aerosol loading; biogeochemical flows: interference with phosphorus and nitrogen cycles; global freshwater use; land-system change; rate of biodiversity loss; and chemical pollution (See Figure 18.1).

Insert figure 18.1 here

Five of these are greatly affected by food production and should be considered when discussing sustainable food production and therefore sustainable diets (climate change, interference with the global nitrogen and phosphorus cycles, freshwater use, land-system change and biodiversity loss) with special attention given to the three that have already breached the safe operating limits (See Figure 18.1).

Climate change is the planetary boundary most often discussed as it poses an immense threat to global health alongside its impact to the physical environment and the world is now at a critical point for avoiding catastrophic climate change. The global food system is responsible for up to 29% of all anthropogenic GHG emissions (Costello et al., 2009). Changes to the global food system alongside changes to the foods we all eat are essential to reduce global GHG emissions to levels compatible with the Paris agreement.

Human modification of the Nitrogen cycle is particularly notable with more conversion from atmospheric N_2 to reactive forms due to human activities than all other terrestrial processes combined. The main purpose is to enhance food production through fertilization but much is lost to the environment causing pollution of waterways and the atmosphere. Phosphorus is

added in food production as fertiliser and this increased inflow to oceans has been suggested as the main cause of ocean anoxic events causing widespread marine death.

Global manipulations of the freshwater cycle affect biodiversity and ecological functioning which have knock-on effects to food production and food and water security. This manifests through a loss of soil moisture, human water supply and aquatic water needs as well as through impacts in climate regulation.

Land-system change is mainly driven by agricultural expansion and intensification and there is much concern internationally about the conversion of biodiverse rainforests into grazing land for cattle. This threatens biodiversity and is undermining regulatory capacities of the Earth System through impacts on the climate and water systems.

Biodiversity loss is particularly serious, due to biodiversity's importance in sustaining ecosystem functioning. There is concern that non-linear and largely irreversible consequences are likely. Recent biodiversity loss has been due to land-use change, introduction of species and climate change.

One area of biodiversity that deserves further mention is the impact of overfishing on the health of oceans. The consumption of omega 3 fatty acids from fish reduces the risk of cardiovascular disease and regular consumption of fish is therefore recommended widely. These nutrition recommendations do not consider the environmental impact of overfishing or the knock-on effects onto human health. Fish populations have been exploited for many years and regulation is almost impossible to enforce. The extinction of fish species used for food can have significant and catastrophic follow on effects on other species and the ocean ecosystems which can then contribute to ocean dead zones(Jackson, 2008). With the alternative source of fish, aquaculture, having its own environmental impacts such as habitat destruction and overfishing for feed ingredients(Troell et al., 2014).

These planetary boundaries are interrelated with the degradation of one planetary boundary affecting others. Much of the research showing sustainable diets are high in unprocessed plant based foods and low in animal based foods focus on GHG emissions(Drew et al., 2020, Green et al., 2015) with less attention given to the other planetary boundaries(Willett et al., 2019). However, synergies between GHG emission impact of diets and impact on other planetary boundaries such as land use and water use have been shown(Clark et al., 2019, Gephart et al., 2016) and can be seen in Figure 18.2 from the EAT Lancet Commission (Willett et al., 2019). Research into the impact of dietary intake on 'sustainability' should continue to investigate impacts on all relevant planetary boundaries.

Insert figure 18.2 here

18.3 GHG emissions associated with food production and consumption

Each type of food has different environmental impacts in different parts of the food system. This has most recently been illustrated by the meta-analysis conducted by Poore and Nemecek (Poore and Nemecek, 2018), the results of which are presented in Figure 18.3. Overall, animal based foods tend to be much higher in environmental impacts than plant based foods. With the production of a kilogram of beef emitting 60 kilograms of GHG (CO_2-equivalent), Lamb and cheese emit more than 20 kilograms. Poultry and pork are slightly lower at 6kg and 7 kg. For comparison, production of a kilogram of peas emits just 1 kilogram of GHG emissions. The finding that animal products are high impact compared to plant based products holds regardless of the functional unit used (e.g. what the impact is measured against). Figure 18.4 shows this same relationship with the functional unit of "gram of Protein" rather than per kilogram of end product (Ranganathan;, 2016).

Insert figure 18.3 here

Insert figure 18.4 here

For the majority of foods most GHG emissions result from land use change and from processes at the farm stage (including application of fertilizers; and methane from cattle). Combined, land use and farm-stage emissions account for more than 80% of the footprint for most foods.

However, the method of production and where on the planet the food is produced can dramatically alter the environmental impacts of individual foods. This creates opportunities for targeted interventions. For example, for beef, the highest-impact 25% of producers represent 56% of the beef's global GHG emissions (an estimated 1.3 billion metric tons of CO_2-equivalent). Across all products, 25% of producers contribute on average 53% of each food's environmental impact (Poore and Nemecek, 2018).

For many consumers, transport is (incorrectly) thought to be a large contributor to GHG emissions. However, transport is only a small contributor to total emissions. For most food products, transport accounts for less than 10% of total emissions, and it makes up a very small proportion for the largest GHG emitters e.g. In beef production transport accounts for only 0.5% of total emissions. Indeed, all processes in the supply chain after the farm – processing, transport, retail and packaging – mostly account for small shares of total emissions. The small contribution of transport emissions also holds for dietary patterns as well as individual products. In the EU, food transport was responsible for only 6% of emissions associated with dietary intake whilst production of dairy, meat and eggs accounted for 83% of total emissions(Sandström et al., 2018). Notably post-retail transport emissions can be higher than pre-retail, due to the differences in efficiencies of scale. However this is complicated and depends on the food product, amount purchased, and either the frequency and method of travel to and from the store (bike, car, on foot etc.), or the method of delivery by online shopping (Sonesson et al., 2005).

Food loss and waste is a large contributor to food related GHG emissions. It is estimated that approximately 8% of all global GHG emissions caused by humans is related to food waste. This is equal to 24% of total global food emissions. Globally, two-thirds of food loss and waste is from losses in the supply chain which are caused by poor storage and handling techniques; lack of refrigeration; and spoilage in transport and processing. The other third comes from food thrown away by retailers and consumers (Poore and Nemecek, 2018). Food loss and waste can be reduced through changes to the supply chain, by giving consumers better food skills, and through shifting diets to foods that are wasted less. The exact proportion of food loss vs food waste is different for each country, with industrialized food systems - such as the UK and USA - generating more food waste than food loss. In addition, the main food wasters in industrialized food systems are domestic households. For this reason shifting consumer's food waste behaviours (including wasteful dietary patterns) is crucial for shifting towards sustainable diets. Changes to the food environment can reduce food waste. Successful interventions to reduce consumer food waste include changing the size of plate and serving ware, changing nutritional guidance, and information campaigns. Other less validated methods include cooking classes, fridge cameras, food sharing apps, advertising and information sharing (Reynolds et al., 2019a).

18.4 Reduction of GHG emissions from food consumption

Individuals can reduce the environmental impact from food production by choosing to eat foods with low associated environmental impact and through changing their dietary patterns to more sustainable overall diets (see section 7). These decisions can be supported through changes in the food environment and food policy and through pricing mechanisms such as a GHG or red and processed meat tax, making the sustainable choice the easier and more affordable choice.

However, it has been highlighted that many types of sustainable (low GHG emission) diets are not culturally acceptable(Green et al., 2015) (being unpalatable, expensive, too far from what is currently eaten etc.). Thus, it has been proposed that different dietary advice could be given to different sub-populations. One method to group subpopulations is by income. Studies from Australia(Reynolds et al., 2015), the Netherlands(van Dooren, 2018), Japan(Kanemoto et al., 2019) and the UK(Reynolds et al., 2019b) have all shown that different income groups consume different types of foods (and in differing quantities) with different environmental impacts. Due to these different consumption patterns each income groups has different trade-offs and starting points on their pathways towards sustainable diets. The studies have shown that regardless of income, an affordable, healthy, and sustainable diet is possible.

18.5 Global variation in sustainability impacts

GHG emissions generated from the production of food consumed in high income countries is substantially higher that that from people in middle and low income countries. The responsibility for those emissions lies with those consuming diets associated with environmental degradation, putting aside where this food may have been produced. As low and middle income countries develop there is a trend for dietary intake to move towards what is considered ‘more western’ diets i.e. high in meat, dairy and ultra-processed food. And with this trend comes the potential for substantial rises in global GHG emissions and impacts on the other planetary boundaries associated with food production. Due to this current and historical imbalance in responsibility high income countries have a responsibility to lead the way in sustainable food production and consumption. This variation in dietary pattern is also generational, with different generations (with distinct developmental food environments) leading to different dietary choices with their associated environmental impacts. For this reason all ages of consumer must also shift towards a sustainable diet.

18.6 Environmental-health co-benefits of sustainable diets

There are likely to be significant health and environmental co-benefits of shifts in diet towards more sustainable foods. Foods with the highest associated greenhouse gas emission, red and processed meat(Drew et al., 2020), are also associated with increased risks of colorectal cancer(International Agency for Research on Cancer (World Health Organisation), 2015), type 2 diabetes (Forouzanfar et al., 2015) and death from CVD (Abete et al., 2014). Substitutions for meat that have lower GHG emissions such as fruit, vegetables, nuts, seeds and whole grains are associated with a reduction in CVD and some cancers (Forouzanfar et al., 2015).

A number of modelling studies have shown that more sustainable diets are lower in meat intake and higher in fruits, vegetables and whole foods with the associated improvements in health. It has been estimated that global mortality could be reduced by 6-10% and food related GHG emissions by 29-70% by 2050 with shifts towards more plant based diets that are in line with dietary guidelines (Springmann et al., 2016). The EAT Lancet commission estimated that changing global consumption to a healthy sustainable diet could avert 19–24% of deaths per year(Willett et al., 2019). A systematic review found that dietary change could reduce GHG emissions and land use demands by up to 50% compared to current diets (Hallström et al., 2015).

However, not all low emission or low environmental impact foods are healthier and shifts towards some low emission foods, such as sugary food and drink and ultra-processed foods (Drew et al., 2020, Willett et al., 2019) would not confer health benefits.

18.7 Examples of sustainable diets

There are a number of sustainable diets that have been proposed internationally that we can draw on. In all of these diets there is the common element of increases in fruits, vegetables and plant sources of protein and a decrease in meat intake. When this is taken to its full extent you find the vegan diet which excludes all meat, fish, eggs and dairy products and provides nutrition through plant sources. Modelled health benefits of dietary shifts towards sustainable diets are usually greatest for the vegan diet(Drew et al., 2020). A recent trend is also 'plant based diets' which are potentially less strict than vegan diets but follow the same principles. However population diets do not need to shift to completely vegan diets to benefit the environment. Cultural shifts so plant based meals are more normalised with small portions of meat viewed as optional additions would have a large impact on population health and sustainability. These cultural understandings are often more common in low and middle income countries than in high income countries.

In 2011 the WWF-UK "LiveWell 2020" (Figure 18.5) programme was created which aimed to develop diets in the UK, France and Sweden that; decreased GHG emissions by 25% from the current diet, cost no more, met national nutritional guidelines and still resembled current diets sufficiently to be widely and easily accepted. In the UK this reduction in emissions would be achieved by limiting the consumption of animal protein and increasing protein from legumes and nuts; in France by reducing consumption of meat and meat products and increasing consumption of legumes and cereals; and in Sweden by reducing consumption of meat, dairy products, sugar, sweets and fruit based products and increasing consumption of vegetables, cereals, and nuts. In all countries these modelled sustainable diets were cheaper than the current diets. These diets also implied health benefits due to reduced red and processed meat consumption, and increases in the quantities of oily fish, vegetables, and nuts.

Insert figure 18.5 here

In 2019, the EAT Lancet Commission(Willett et al., 2019) proposed an internationally acceptable sustainable diet based on the six planetary boundaries (nitrogen and phosphorus was considered as separate planetary boundaries) that are greatly affected by food production (Rockström et al., 2009). The Commission proposed a 'Great Food Transformation' including a global reference diet to bring these six key earth system processes into safe operating boundaries. The reference diet is high in vegetables, legumes, whole grains, fruit and plant sources of protein and low in animal sources of protein. Modelling on shifting global consumption from current diets to the EAT Lancet reference diet showed substantial benefit to human health, averting about 10·8–11·6 million deaths per year, which is a reduction of 19 to 24% (Willett et al., 2019).

18.8 Moving towards sustainable diets - current best practice

There are many tools and levers that have the potential to shift dietary consumption towards more sustainable foods. These range from education, through changing the food environment to fiscal measures and changes to legislation (Garnett, 2014).

Firstly those that are explicitly about sustainability. A number of countries have incorporated aspects of sustainability into their dietary guidelines, Brazil (Brazil, 2014) and Sweden (Sweden;, 2015) provide two good examples. Other European countries have supporting documents to their guidelines on sustainable dietary intake (Fischer and Garnett, 2016). The Barilla double food pyramid was developed in 2010 and updated in 2016 by the Barilla centre for food and nutrition, a privately held, apolitical and non-profit think tank to show the close alignment between nutritional value and environmental impact (See Figure 18.6).

Insert figure 18.6 here

Food labels on the environmental impact of foods could help to educate the public on what food choices are the most environmentally friendly. Consumers could compare foods across and within food groups. Some have been proposed that include impacts onto GHG emissions, nitrogen, and water footprints (Leach et al., 2016) but these have not been evaluated. In 2008 the European Commission launched a project to create a European method of calculating the environmental impact of products, based on their life cycle and other environmental indicators. This has led to the development of the Product Environmental Footprint (PEF) which has been piloted and consulted on between 2013 and 2019.

There have been a number of initiatives to promote more sustainable food choices that have evolved outside of the influence of government such as meat free Mondays and Veganuary. These could be capitalised on and expanded through support from government. Some institutions, such as the National Health Service in the UK, have a sustainability policy that extends to food provision (Department of Health, 2009).

High GHG emission foods could be taxed to discourage purchase and consumption. Modelling studies have shown a tax on selected meat and dairy products, would result in a 12% reduction in sector GHG emissions (Säll and Gren, 2012). The reduction in global deaths attributable to red and processed meat consumption decreased by 9% with a red and processed meat tax (Springmann et al., 2018).

But many interventions that aim to improve dietary intake for health would also have sustainability co-benefits as outlined above. Shifts towards following the dietary guidelines, taxes on unhealthy food, improvements to the food environment to encourage increased fruit and vegetable consumption and health warning labels on processed meat are likely to improve the sustainability of population dietary intake.

Changes to the food environment (Garnett et al., 2019) and food policy put in place by governments have the potential to make large impacts on both the environmental impact of food consumption and health, including legislation to change industry practices. Putting the responsibility onto individuals to changes their diets in order to decrease the impact of dietary GHG emissions and environmental degradation, although important, will not make the gains needed. A lot of the changes that need to be made are outside of the control of the public and require governments, international bodies and industry to act.

18.9 Future considerations and conclusions

Is it is now common practice in many countries to consider the sustainability of diets and food. Multiple government's dietary advice now include sustainably, alongside health and monetary costs. Future research needs to tackle a lack of understanding in how to implement sub-population level sustainable diets, and assist in shifting food environments (from local to global) towards making sustainable, healthy, low waste, and affordable options the default choice. One of the most difficult challenges is adapting this advice to multiple cultural contexts, with every country and gastronomic cuisine style needing its own advice. This knowledge gap is currently felt in low and middle income countries where there is limited evidence available.

There is a global imperative to change practice to reduce our impact on the environment with climate change being the most immediate focus. Food production, and by extension consumption, impacts on climate change, freshwater use, land-system use, biodiversity and interferes with the global nitrogen and phosphorus cycles. It is therefore imperative that changes are made to current consumption in order to reduce this impact. There are many changes that individuals can make to reduce their environmental food footprint but the largest and most necessary gains will come from regional, national and global changes in the food production systems, food policy and food environment.

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