Sustainable Food Systems for a Healthier UK: A discussion paper

Faculty of Public Health and The Soil Association
Kristin Bash and Amanda Donnelly
March 2019

"Food is the single strongest lever to optimize human health and environmental sustainability on Earth."

-Eat-Lancet Commission Report (Willet, et al., 2019)

Executive Summary

The 2011 Foresight Report, The Future of Food and Farming, warned that many systems of food production are unsustainable and that if left as-is, the current food system will 'continue to degrade the environment and compromise the world's capacity to produce food in the future' (Foresight, 2011; p.10). However, public health has not traditionally addressed issues related to the wider food system and its impact on environmental sustainability.

The food system, environmental sustainability and population health overlap in three key areas: climate change; wider environmental damage (air pollution, water pollution, reduction in soil health, loss of biodiversity, land use/deforestation); and antimicrobial resistance (AMR). Through the mechanisms that lead to these issues the food system has a negative impact on both environmental sustainability and on population health.

Actions associated with prevention of climate change, environmental damage and AMR can be identified that also improve environmental sustainability and improve population health. Examples are: prioritising plant proteins, reducing intensive livestock farming methods, reducing food waste, increasing organic and agroecological agriculture, and increasing local and urban food production schemes.

Ten recommendations are made for public health professionals to consider, that support a healthy and sustainable food system for a healthier UK. In summary:

1. Promote diets that prioritise plant-based proteins and a 'less and better' approach to animal-based foods;
2. Advocate for British agriculture policy that accounts for human health;
3. Advocate for all agricultural trade agreements to support public health and environmental sustainability, particularly in the post-Brexit environment;
4. Advocate for reduction in antibiotic use in the livestock sector;
5. Take a global view on food systems and align public health policies with key international agreements;

6. Support regulation for labelling related to food production methods;
7. Stimulate demand for sustainable food including British and local vegetables, pulses and fruits through public procurement, for example, implement DEFRA's Balanced Scorecard across public health sector catering and procurement and support the re-specification of the School Fruit and Veg Scheme to support sustainability;
8. Commission food programmes that support sustainable food systems;
9. Promote and support community-based agriculture schemes that bring farming and green spaces into the urban and peri-urban environments and provide open access and exposure to these green spaces for members of the local community.
10. Develop and support local policies and contracts that aim to reduce wasted food within public sector food provision and wider large-scale catering.

1. Introduction

1.1 Context

In the UK, public health policy relating to food and nutrition has largely focused on influencing dietary behaviours and their related physiological and pathological effects on individual and population health. The Foresight Report (2011) stressed that food and farming are part of a wider system that affects human health (e.g., the Foresight obesity map). However, focus on nutrition and diet-related ill-health is often based on a linear model of cause and effect and may limit understanding of the wider determinants of health associated with food systems.

The food system - including the way food is produced, processed, and distributed - contributes to health at the population and personal level. Looking at the environment alone, the demands of our current food system create a significant impact on local, global and planetary environments. These include our climate, our soil, water and air quality, and levels of antimicrobial resistance (AMR). These impacts in turn have a negative impact on population health.

While it is recognised that there are champions of this wider view of food systems and their importance to public health, this view is not currently embedded within public health training or widely understood, discussed, or advocated for by public health professionals.

1.2 Purpose and scope of paper

The purpose of this paper is to define and discuss the relevance and importance of food systems to population health within the UK, and to provide related recommendations that support the public's health through healthy and sustainable food systems.

In particular, this paper will define and discuss links between the food system, environmental sustainability and population health. It asks the public health community to take a broad focus on food within policy, advocacy, research, programmes and interventions and to consider the sustainability of food systems from an ecological model perspective of public health, for populations now and in the future. This paper will:

- describe known links between food systems, sustainability, and population health, and situate these within a UK context;

- highlight key literature and policy reports that contribute to evidence associated with a healthy and sustainable food system;
- identify and recommend public health action to support positive change in UK dietary behaviours and the UK food system in practice, with potential for co-benefits across health, environment and wider determinants of health.

This paper is limited to the issues connecting sustainable food systems and public health. Topics such as food insecurity, food marketing, community cohesion through food, workforce, education, use of green space, and food safety (among others) are all clearly related and important to the wider discussion of the food system as a whole and its impact on population health. While we acknowledge the importance of these issues, they will not be discussed due to the limited scope of this paper.

2. Food systems, sustainability and population health

The FAO defines a food system as everything involved in food: production, aggregation, processing, distribution, consumption, and disposal (Fao.org, 2019). Relationships between each aspect of the food system, dietary practices, the environment, and population health interact at multiple levels.

The sustainability of this food system intrinsically depends on its ability to produce and make accessible sufficient quantity and quality of food to feed our population, both today and in the future. This includes a dependence on the quality of the air, water and soil required to produce this food, both today and in the future.

In order to present key issues and recommendations within the scope of this paper, we first identify and describe three key areas where the food system overlaps with both environmental sustainability and various population health outcomes:

- climate change and greenhouse gas emissions (GHGE);
- environmental impacts, and;
- anti-microbial resistance (AMR).

2.1 Climate change and greenhouse gas emissions (GHGE)

The relationship between the food system and climate change is strong and it is circular: the changing climate has an impact on population health, the food system contributes to climate change, and climate change has a negative impact on the food system.

Climate change impact on population health

Climate change is created by an increased level of greenhouse gas emissions (GHGE) which limits the atmosphere's capacity to cool itself. Climate change is currently responsible for extreme weather events, hotter and colder weather patterns, rising sea levels, and increased incidence of both drought and flooding, all of which in turn lead to decreases in global food productivity.

Since the start of the industrial revolution (for purposes herein, agreed on as 1840), the increase in greenhouse gas emissions (GHGE) originating from human activity has caused the Earth's temperature to rise by nearly 1-degree Celsius (IPCC, 2018). This temperature

rise has already had an impact on our environment, and since some amount of further warming is inevitable due the amount of GHGE already in the atmosphere, a 1.5-degree Celsius global temperature rise is the limit to which experts agree we should aim to stay below.

However, in order to limit global temperature to below this threshold of 1.5-degrees, GHGE will need to be reduced globally by 45% before 2030 (IPCC, 2018). Our food system has a role within this problem and is therefore a potential area for solution.

Food system contribution to climate change

Globally, agriculture contributes approximately 26% of anthropogenic GHGE, and livestock contributes approximately half of these (14%)(US EPA, 2018; Poore and Nemeck, 2018). By 2050, if current trends continue related to the demand for meat and animal-based food products, the livestock sector could by itself contribute up to 80% of the allowable GHGE limit globally (GRAIN and IATP, 2018).

Of GHGE created from agriculture globally the emissions generated on the farm are responsible for 61% (81% including deforestation). The GHGE from transport contribute only 1 – 12% (Poore and Nemecek, 2018; Weber and Matthews 2008; Garnett 2011).

In the UK, the agriculture sector contributes approximately 10% of in-country anthropogenic GHGE (Committee on Climate Change, 2017). The UK Committee on Climate Change is reviewing the changes to land-use and diets that will support a transition to a net-zero economy in the UK and will be making recommendations in 2019.

It is important to note that agricultural-related GHGE produced within the UK is low in relation to the true impact of our food system, due to the fact that UK livestock production depends on animal feed imports (particularly in the poultry and pig farming sectors), and the majority of soy beans imported for this use are from Argentina and Brazil (Parliamentary Office of Science and Technology, 2017).

Climate change impact on the food system

Increased levels of GHGE and warming global temperatures will have an increasing effect on rainfall variability, vector and pollinator behaviours, and extreme weather conditions, all of which affect crop productivity, and add to uncertainties within the global food system (Wheeler and von Braun, 2013). In 2014, the Intergovernmental Panel on Climate Change (IPCC) concluded that climate change had already substantially decreased crop yields, and that additional reductions are expected (Porter et al., 2014). It is estimated that globally an additional 500,000 deaths will be attributable to climate change effects on food supply by the year 2050 (Springmann et al, 2016).

Increased levels of carbon dioxide (CO_2) in the atmosphere also have a negative impact on the nutritional quality of key staple crops. In a six-year study, crops were grown in conditions reflecting amounts of atmospheric CO_2 estimated for the year 2050. Wheat and rice grown under these conditions had significantly lower levels of protein, zinc and iron; soya grown under these conditions had significantly lower levels of zinc and iron (Myers, et al 2014).

2.2 Environmental impacts

While contribution to climate change is one significant area where the natural world is affected by our food system, there are other areas of the environment that are also directly affected. Table 2 provides a brief summary of the effects of the food system on environment and population health, and the food system's contribution to each issue.

Table 2

	Impact on environment and population health	**Food system contribution**
Air Pollution	Ammonia (NH3) emissions create airborne particulate matter that is harmful to human health, and is a significant contributor to all-cause mortality, particularly related to cardiopulmonary mortality (DEFRA, 2012). Public Health England reports that 5.3% of adult all-cause mortality is attributable to anthropogenic particulate air pollution (PHE, 2018).	In the UK, agriculture (specifically livestock and fertilizer use) accounts for approximately 82% of all NH3 emissions, half of which are from cattle and approximately 14% from poultry farms (DEFRA, 2012). Intensive farming practices are associated with the highest NH3 emissions, both from extensive use of fertilizer, and from solid bio-waste produced within intensive livestock farming.
Fresh water	One third of the world's population now live in areas that suffer from physical water scarcity (Alcamo, et al. 2007; Islam et al., 2007; Kummu, et al. 2010). The World Water Development Report (2018) estimates that more than 5 billion people could suffer water shortages by 2050 due to climate change.	Only three percent of the Earth's water is fresh and useful for humans, and 70% of this is used for agriculture (Aleksandrowicz, 2016). While there is variation within individual crops, livestock use the most water for the fewest calories or grams of protein, particularly in intensive systems. (Poore and Nemecek, 2018; Mekonnen, et al., 2012) When comparing dietary patterns, reduction in meat intake - particularly meat from intensive farming

		methods - contributes most to reduction in overall water footprint (Vanham et al., 2012.
Soil health	Healthy soil – that with sufficient levels of both organic matter and soil carbon- is important to human health in three main ways. Healthy soil: • mitigates GHGE and climate change through its ability to capture and retain carbon (Gattinger et al, 2012); • provides better defence against flooding due to increased ability to absorb and retain excess water (Muller et al, 2016); • increases both the quality and yield of farmed food (Center for Food Safety, 2015).	The Committee on Climate Change has stated that the most productive farmland in the UK risks becoming unproductive within a generation due to loss of soil quality from erosion and loss of soil carbon (Committee on Climate Change, 2015). Soil where organic farming methods are used has higher levels of organic matter and higher levels of soil carbon (Ghabbour et al, 2017; Muller et al, 2016; Gattinger et al, 2012).
Biodiversity	The Earth is currently undergoing the Sixth mass-extinction; the average rate of vertebrate species loss over the last century is up to 100 times higher than the background rate (Cebalos et al., 2015). Within this global context, the UK is among the 'most nature-depleted countries in the world' (State of Nature Report, 2016).	Deforestation and intensive farming practices are damaging to wildlife habitat and have a significant impact on species populations; the extinction of an estimated 33 species is directly linked to the UK food supply alone (WWF, 2017). Organic farming methods support biodiversity and are shown to have 50% more wildlife with a third greater number of species than average, including pollinator species (50% more) and plant species (75% more)

		(Bengtsson et al, 2005; Tuck et al, 2014).
Land use	In 2010 the British livestock industry required an area the size of Yorkshire to produce the soy used in its feed (WWF, 2017).	Approximately 40% of crops grown in the UK are used to feed livestock, but the majority of feed used to feed UK livestock is imported – largely soy from Brazil (Parliament, 2017). Much of this imported soy is grown on deforested land or cleared savannahs, which is a major contributor to biodiversity loss. It also releases large amounts of stored carbon into the atmosphere, thereby contributing to climate change.

2.3 Antimicrobial resistance

Antimicrobial resistance (AMR) refers to the ability of a microbe to stop an antibiotic or antimicrobial medicine from working. It occurs as a natural function of evolution: when microbes are exposed to the antibiotic, any that survive reproduce and pass along their resistance (WHO, 2019).

The prevalence of AMR bacteria is increasing in large part because increased use of antimicrobials increases the exposure of microbes, which in turn increases their chances of developing resistance (O'Neill, 2016).

AMR impact on population health

Antimicrobial resistance (AMR) is a genuine threat to the manner in which modern healthcare is delivered. It is estimated that on a global scale, annually 700,000 deaths are attributable to AMR, and that by 2050 this figure could reach 10 million (O'Neill, 2016).

Food system contribution to AMR

Intensive livestock farming methods that put extreme stress on animals are unsurprisingly not good for their health and often rely on widespread and often prophylactic use of antibiotics and antimicrobials. Antibiotics are often given to animals (particularly pigs and poultry), healthy or unhealthy, to compensate for low-welfare, cramped conditions where disease outbreaks are common and harder to control.

Across the globe, approximately 60% of all antibiotics are used in animal agriculture. In the UK although reductions in farm antibiotic use have been achieved in recent years, approximately 40% of antibiotics are still used in animal agriculture, with 90% of those used

in the pig and poultry industry (Alliance to Save our Antibiotics, 2016). As one example, a 2010/11 survey undertaken by the Department for Environmental and Rural Affairs (DEFRA) found 85% of non-organic dairy farms in the UK used routine antibiotic therapy during the non-lactating phase (Brunton et al, 2012).

A UK review on AMR also concluded there is a direct link between use of anti-microbials in agriculture and the growing prevalence of AMR in the human population (O'Neill, 2016). The WHO also stresses that reliance on antibiotics in farming is a significant contributor to AMR bacteria that affect human health (WHO, 2012).

3. Areas for action

The above three issues (climate change, environmental damage, AMR) are directly influenced by the food system, and have wide impacts on sustainability and population health. However, actions can be focussed in these areas to address both the environmental sustainability issues, and the wider public health impacts. Furthermore, many of these actions hold potential for additional benefit to population health that extends beyond the improvements to sustainability of the food system.

3.1 Prioritise plant-based protein

Current dietary practices in the UK contribute to a growing prevalence of diet-related ill health, including overweight, obesity and related non-communicable diseases (NCDs). Globally, unhealthy diets contribute more to morbidity and mortality than unsafe sex, alcohol, drug and tobacco use combined (Willet, et al 2019). In England, dietary habits are the primary behavioural risk factor for mortality, followed closely by tobacco use (Public Health England, 2017). Diet patterns that support better health outcomes are also associated with a lower environmental footprint.

Public health nutrition guidance

The Eatwell Guide (EWG) is the official dietary guidance issued for the UK and shows main food groups that form a healthy and balanced diet (Gov.uk, 2018). In March 2016, Public Health England (PHE) incorporated sustainability into the EWG and subsequent analysis by The Carbon Trust found a diet based on the EWG has an appreciably lower environmental footprint than the current UK diet (The Carbon Trust, 2016).

The British Dietetic Association (BDA) has published their One Blue Dot guidance and toolkit, which provides information on sustainability issues related to diet and makes recommendations for a healthy and sustainable diet. These include:

- complete exclusion of processed meat;
- limited amounts of red meat (70 grams per day maximum), and;
- a recommendation to reduce animal-based protein in favour of prioritising plant-based protein (BDA, 2018).

Diets high in foods from animal sources are associated with higher rates of morbidity and mortality (Willet et al., 2019; UNSCN, 2017; Schwingshackl et al., 2017). In particular, high consumption of red and processed meat are closely linked with poor health outcomes (Willet, et al. 2019, p.9; BDA, 2017). Diets that prioritise plant-based proteins and limit animal-based proteins generally have a lower GHGE profile, and better population health outcomes (Springmann et al., 2018; Tilman and Clark, 2014).

Diets with a healthier profile have been shown to have lower environmental impacts (Nelson et al, 2016; Springmann et al., 2018). Overall, the largest benefits across several key indicators (e.g., GHGE, land use, eutrophication) are found in eating patterns with the highest reduction in animal-based foods (Poore and Nemecek, 2018; Springmann et al., 2018; Alexandrowicz et al, 2016), although livestock employed in low densities in well-managed agroecological systems can help build soil organic matter (Gattinger et al, 2012; Ghabbour et al, 2017) and can contribute towards an ecologically and socially resilient food system (McIntyre et al, 2009; Poux et al, 2018).

The recently published EAT-Lancet Commission report outlines a healthy diet consisting of increased levels of plant-based foods and low levels of animal-based foods (Willet, et al. 2019). This diet pattern is projected to reduce harmful environmental impacts (climate, fresh water use, biodiversity loss, nitrogen and phosphorous use); to be capable of sustainably feeding the world's population in 2050; and also to prevent approximately 11 million premature deaths among adults globally.

3.2. Reduce intensive livestock farming

Intensive livestock farms contribute to ammonia emissions, water pollution, land—use change (see Table 2) and increased use of antibiotics (see Section 2.3).

Animals can play a positive role within well-managed 'extensive' systems, such as organic (Poux and Aubert, 2018). Grazing animals on permanent pasture can contribute to maintaining and building soil carbon stores, and can also have benefits for wildlife, landscape value, and animal welfare.

By reducing the number and size of intensive livestock farms and transitioning to well-managed extensive systems, several types of environmental and population health impacts can be mitigated. These include but are not limited to: a reduction in NH3 emissions to reduce particulate matter, which is a risk to human health; a reduced need for antibiotic use in livestock production, due to higher animal welfare standards; and a reduction in animal feed requirements, reducing need for crops grown and imported to feed to animals.

UK Agriculture Policy

The EU Common Agriculture Policy (CAP) has been criticized by many for encouraging large-scale and intensive agriculture practices. Whilst the UK, as a member of the EU, has had major influence over the content of the CAP and its implementation domestically, the Government is now in the process of designing a new post-Brexit UK agriculture policy. There is an opportunity to make the case for this to prioritise the health of crops, soil, livestock, and the human population.

As a first step, the Agriculture Bill was published in September 2018. It introduces a system where the largest financial awards will be made to farmers and land managers who provide the greatest environmental benefits. This is widely regarded as a positive aspect of the bill. However, the bill does not make any connection between agriculture, food, and public health. It also makes no mention of, or provide specific support for, organic farming or agroforestry – productive systems of farming proven to have positive and restorative effects on soil, water, air quality, climate change, biodiversity and animal welfare, and reduced antimicrobial use (Environment Food and Rural Affairs Committee, Soil Association written evidence, 2018).

3.3 Reduce wasted food

Globally one third of all food produced is wasted and as it decomposes it creates 4.4 million tonnes of CO2 emissions, which makes food waste responsible for 8% of all CO2 emissions (FAO, 2015), which is estimated to grow to 14% by 2050 if the current trends continue (Hic et al, 2016). The FAO reports that 'food wastage ranks as the third top emitter after USA and China' (FAO, 2015).

In the UK, it's estimated that ten million tonnes of food are wasted every year and that 60% of this waste is avoidable (DEFRA, 2017). It's estimated that £13 billion worth of useable food is wasted in the UK every year: this equates to an average household loss of £470 a year, but households with children averaged a loss of £700 (DEFRA 2017).

Food re-distribution schemes and organisations that promote use of surplus food not only reduce the amount of wasted food within a local area, but can also provide benefits for communities through 'pay as you feel' cafes, for example, The Real Junk Food Café (Therealjunkfoodproject.org, 2019) and other re-distribution approaches.

3.4 Transition to agro-ecological farming systems such as organic

Soil health is key to the sustainability of our food system, and use of pesticides, herbicides and fertilizers are damaging to the health of our soil, while also posing potential human health risks.

Intensive farming methods create risk to food security of future generations through several mechanisms:

- Pesticide use is linked to a decrease in pollinator population, which in turn creates a risk of lowered supply of many varieties of fruit and vegetables (IPBES, 2016)

- Modern agriculture depends on nitrogen fertilizer use which contributes to NH3 emissions, and through runoff into local water systems, creates pollution and 'dead zones' through eutrophication and acidification processes.

- Modern agriculture also depends on phosphorous-based fertilizer, which is a non-renewable resource; global reserves may be depleted in 50-100 years (Cordell, 2009).

The UN Food and Agriculture Organisation says: 'Agroecology is based on applying ecological concepts and principles to optimize interactions between plants, animals, humans and the environment while taking into consideration the social aspects that need to be addressed for a sustainable and fair food system' (FAO.org (2), 2019).

Organic farming is an example of an 'agroecological' approach to food production and aims to produce food in harmony with nature. Organic standards severely restrict pesticide use and prohibit the use of herbicides and manufactured fertilisers. Organic farming thereby provides more environmentally sustainable management of the land and natural environment. Organic standards are legally defined and rigorously inspected, with the environmental benefits of organic supported by longstanding, independent and robust scientific evidence (Bengtsson et al, 2005; Tuck et al, 2014; Ghabbour et al, 2017; Muller et al, 2016; Gattinger et al, 2012; Niggli, 2015; Jones and Crane, 2009).

3.5 Increase in local and urban food production schemes

Local and urban farming schemes operate in pockets all across the UK and are beneficial to both the local communities and to the wider environment.

On a global scale, transportation of all food is estimated to contribute to approximately 10% to the overall GHGE footprint (Weber, et al. 2009). Reducing the miles travelled by food between farm and consumer is one way to reduce the GHGE associated with emissions created through transportation.

Additional co-benefits to population health may be gained by introducing farming into local and urban areas. These include an increase in well-being, physical and mental health gained from access to green spaces (Twohig-Bennett and Jones, 2018; South et al, 2018). Urban

green spaces also improve the quality of the local environment, including reduction in both noise and air pollution levels (Parliamentary Office of Science and Technology, 2016).

Place-based approaches to sustainable food systems

The Sustainable Food Cities programme encourages local cross-sector partnership approaches to actions associated with sustainable food systems and good food for everyone. (Sustainablefoodcities.org, 2019). Place-based strategies and partnership approaches have potential to create more sustainable food systems and to engage people and organisations shifting towards healthy and sustainable food systems at a local level.

Settings-based approaches to support healthy and sustainable food systems

Whole setting approaches to healthy and sustainable food use the context of a community setting to implement policies and practices to support healthy, sustainable eating. A study focussing on the Food for Life Schools Programme, which is a whole setting approach to good food incorporating the Food for Life Served Here Award for healthy and sustainable school meals services, showed that pupils in Food for Life schools were twice as likely to eat five or more portions of fruit ad veg a day compared to pupils in schools not involved in the programme (Jones, et al, 2017).

3.6 Align with international agreements

The UK is a leading voice on two key international agreements that address issues of global sustainability: The Paris Climate Agreement, and The UN Sustainable Development Goals (SDGs). Each address larger issues of sustainability and global justice, and each is tied directly to food system policy.

The Paris Climate Agreement

The aim of the Paris Climate Agreement is to reduce GHGE to a level that will prevent the global temperature from rising more than 1.5 degrees Celsius above the average temperature at the start of the Industrial Revolution (widely agreed to be 1840). However, according to the 2018 report of the Intergovernmental Committee on Climate Change, there is a very limited time within which we can reduce GHGE enough to keep the temperature rise to this level (IPCC, 2018).

Since the Paris Agreement was signed, agriculture in the UK has not reduced its climate impact and is not on track to deliver the modest and agreed reductions in CO2 emissions in England by 2022 (3 million tonnes CO2 equivalent per year) (Committee on Climate Change, 2017). Even so, DEFRA has indicated it will not move beyond the voluntary approach to reducing emissions, which runs the risk of missing the targeted level of reduction and the cost-effective path to 2030 as set out in the fifth carbon budget.

Sustainable Development Goals (SDGs)

Agreed in 2015, SDGs are a set of 17 goals set by the United Nations General Assembly, and aim to address the issues of 'poverty, inequality, climate, environmental degradation, prosperity, and peace and justice' (United Nations Sustainable Development, 2018). The

SDGs are universal, in that all signatory countries are expected to contribute to them internationally and to deliver on them domestically.

The UK government has expressed its commitment to delivering on the SDGs and states the most effective way to do this would be to ensure the SDGs are 'fully embedded in planned activity of each Government department (Gov.uk, 2018).

However, although several SDGs are clearly related to food systems (e.g., SDG 2 - End hunger; SDG 3 - Good health and wellbeing; SDG 12 - Responsible production and consumption; SDG 13 – Climate action; SDG 14 – Life on land), there are currently no actions by The Government within the food system to support delivery of the SDGs.

Brexit

The upcoming split of the UK from the European Union (EU) is difficult to discuss as the details are unknown and speculation is the best there is to go on at the time of writing. What is certain is that, provided the UK does leave the EU, trade agreements both with the EU and the rest of the world will change in relation to our food supply.

In terms of sustainability within the food system (the focus of this paper), the risk lies in any potential degradation of standards, and for our purposes, those food standards that have potential to lead to increased environmental damage and AMR. For example, allowance of poultry raised in highly intensive conditions and with sub-clinical use of low-level antibiotics for purposes of growth enhancement (as is routine within the US poultry industry) would have potential to disadvantage UK farmers who adhere to higher standards and it would support industry practice that undermines the effectiveness of antibiotics for everyone.

For reasons such as this, trade agreements and agriculture policy made post-Brexit must include careful consideration of public health and environmental sustainability issues.

4. Conclusion and recommendations

The UK food system, and its connections with the wider global food system, is not sustainable in its current form. Contributions to climate change, wider environmental damage and the increase in AMR threaten human population health, and the ability of the food system to sustain itself into the future.

Public health has an opportunity to get involved in this discussion and to advocate for and support action to address the many issues around the wider food system and sustainability. These actions can be on a national, regional or local level.

Recommendations that follow are meant to generate ideas for more specific action both at local and national level and they are therefore written to be general in nature. They are recommendations rather than goals in this regard, and it will be left to public health professionals at all levels to identify which recommendations they can engage with and to create local SMART goals to support. Monitoring and surveillance systems should also be developed to evaluate the impact of any changes through the use of a set of robust indicators.

Table 4 – Ten recommendations for the public health community for action to support a healthy and sustainable food system for the UK

No.	Recommendation
1	Advocate for and support initiatives that focus on diets that **prioritise plant-based protein and are lower in animal-based foods**, adopting the 'Less and Better' (i.e., higher welfare animal-based foods consumed less frequently and in lower quantities) approach whenever possible. (Eating Better, 2018)
2	Advocate for an **agriculture policy that considers a whole systems approach to agriculture and human health across the socioeconomic gradient and that places human health at the centre of the policy**. Support for prioritization of horticulture (fruits, vegetables, legumes), especially for farms that employ agro-ecological growing techniques such as organic would allow UK-grown fruit and vegetables to supply more of the UK market.
3	Take an active role in ensuring **agricultural trade agreements and regulation to support public health and environmental sustainability**, particularly in the post-Brexit environment.
4	**Advocate for the reduction of antibiotic use in the livestock sector**, through several mechanisms: • Improved animal welfare standards that improve natural resilience of the animals; • Setting clear targets to reduce antibiotic use 50% by 2020 and 80% by 2050; • Ban animal products imported from countries with less rigorous restrictions on antibiotic use; • Introduce transition funding to support farmers to move toward less intensive systems.
5	Take a **global view on public health policies related to food systems and align with key international goals** of which the UK is a leading signatory (e.g., Sustainable Development Goals, The Paris Climate Agreement)
6	Advocate the introduction of **regulation requiring clear and honest labelling related to production of food**, including labelling for all livestock products. This will empower consumers and level the playing field for farmers.
7	**Stimulate demand for sustainable food including British and local vegetables, pulses and fruits through public procurement**, for example, by: • implementation of DEFRA's Balanced Scorecard across the entire public health sector; institute requirement for procurement decisions to place a weighting of at least 60% on quality relative to cost; • support the re-specification of the School Fruit and Veg Scheme so that a higher percentage of produce is British, local and organic-this will shorten supply chains, reduce pesticide levels, and make produce more acceptable to children.
8	**Commission and support programmes that promote sustainable food systems**, e.g., schemes to promote seasonal, local, organic and responsibly sourced food; schemes that promote plant-based protein sources and animal-based food products from producers who use extensive systems and employ high levels of animal welfare; schemes that engage people and organisations in shifting to healthy and sustainable diets.

9	**Commission and support community-based agriculture schemes** that bring farming and green spaces into the urban and peri-urban environments and provide open access and exposure to these green spaces for members of the local community.
10	**Develop and support local policies and contracts that aim to reduce wasted food within public sector food provision and wider large-scale catering and food businesses**.

5. CPD questions

1. Within the food system, the majority of greenhouse gas emissions (GHGE) are produced through the transportation of foods from their place of origin. TRUE/FALSE

2. Intensive livestock farming practices are associated with which of the following:
    a. Increased levels of ammonia (NH3) emissions
    b. Increased use of antimicrobials
    c. High use of imported feed grains
    d. All of the above

3. Increased levels of carbon dioxide (CO2) in the atmosphere has been shown to decrease nutrient content of staple crops, such are reduced protein, iron and zinc levels in wheat and rice. (TRUE/FALSE)

4. Which of the following statements about food waste is FALSE?
    a. Approximately half of wasted food in the UK is not edible and therefore needs to be disposed of properly
    b. Food waste costs the average UK family with children approximately £700 per year
    c. Globally, approximately one third of all food is wasted
    d. If food waste were a country, it would be the third largest emitter of greenhouse gases, after the USA and China

5. Modern agriculture relies on phosphorous based fertilizer which is a renewable resource, making this a sustainable agricultural practice. (TRUE/FALSE)

6. Since the Paris Agreement on climate change was signed in 2015, agriculture in the UK has not reduced its climate impact. (TRUE/FALSE)

(Answers: 1. FALSE; 2. D; 3. TRUE; 4. A; 5. FALSE; 6. TRUE)

Kristin Bash MFPH
Co-chair FPH Food Special Interest Group
Honorary Lecturer and PhD Candidate
University of Sheffield, School of Health and Related Research (ScHARR)
k.bash@sheffield.ac.uk

Amanda Donnelly
Co-chair FPH Food Special Interest Group
Head of Impact
Soil Association Food for Life
adonnelly@soilassociation.org

6. Selected references

Aleksandrowicz, L., Green, R., Joy, E., Smith, P. and Haines, A. (2016). The Impacts of Dietary Change on Greenhouse Gas Emissions, Land Use, Water Use, and Health: A Systematic Review. *PLOS ONE*, 11(11), p.e0165797.

Alliance to Save Our Antibiotics (2016). *Antibiotic use in the UK dairy sector*. [online] Alliance to Save Our Antibiotics. Available at: http://www.saveourantibiotics.org/media/1762/antibiotic-use-in-the-uk-dairy-sector.pdf.

BDA (2018). *Eating patterns for health and sustainability: A reference guide for dieticians*. One Blue Dot. [online] British Dietetic Association. Available at: https://www.bda.uk.com/professional/resources/obd_ref_guide.pdf [Accessed 5 Dec. 2018].

Bengtsson, J., Ahnstrom, J. and Weibull, A-C. (2005) The effects of organic agriculture on biodiversity and abundance: a meta-analysis. Journal of Applied Ecology. 42 (2)261-269 https://doi.org/10.1111/j.1365-2664.2005.01005.x

British Dietetic Association (2017). *Policy Statement: Sustainable Diets*. Birmingham: BDA.

Brunton, L., Duncan, D., Coldham, N., Snow, L. and Jones, J. (2012). A survey of antimicrobial usage on dairy farms and waste milk feeding practices in England and Wales. *Veterinary Record*, 171(12), pp.296-296.

Campbell, B., Beare, D., Bennett, E., Hall-Spencer, J., Ingram, J., Jaramillo, F., Ortiz, R., Ramankutty, N., Sayer, J. and Shindell, D. (2017). Agriculture production as a major driver of the Earth system exceeding planetary boundaries. *Ecology and Society*, 22(4).

Carbontrust.com. (2016). *The Eatwell Guide: A more sustainable diet. Methodology and results summary.*. [online] Available at: https://www.carbontrust.com/media/672635/phe-sustainable-diets.pdf [Accessed 6 Aug. 2018].

Cassini, A., Högberg, L., Plachouras, D., Quattrocchi, A., Hoxha, A., Simonsen, G., Colomb-Cotinat, M., Kretzschmar, M., Devleesschauwer, B., Cecchini, M., Ouakrim, D., Oliveira, T., Struelens, M., Suetens, C., Monnet, D., Strauss, R., Mertens, K., Struyf, T., Catry, B., Latour, K., Ivanov, I., Dobreva, E., Tambic Andraševic, A., Soprek, S., Budimir, A., Paphitou, N., Žemlicková, H., Schytte Olsen, S., Wolff Sönksen, U., Märtin, P., Ivanova, M., Lyytikäinen, O., Jalava, J., Coignard, B., Eckmanns, T., Abu Sin, M., Haller, S., Daikos, G., Gikas, A., Tsiodras, S., Kontopidou, F., Tóth, Á., Hajdu, Á., Guólaugsson, Ó., Kristinsson, K., Murchan, S., Burns, K., Pezzotti, P., Gagliotti, C., Dumpis, U., Liuimiene, A., Perrin, M., Borg, M., de Greeff, S., Monen, J., Koek, M., Elstrøm, P., Zabicka, D., Deptula, A., Hryniewicz, W., Caniça, M., Nogueira, P., Fernandes, P., Manageiro, V., Popescu, G., Serban, R., Schréterová, E., Litvová, S., Štefkovicová, M., Kolman, J., Klavs, I., Korošec, A., Aracil, B., Asensio, A., Pérez-Vázquez, M., Billström, H., Larsson, S., Reilly, J., Johnson, A. and Hopkins, S. (2019). Attributable deaths and disability-adjusted life-years caused by infections with antibiotic-resistant bacteria in the EU and the European Economic Area in 2015: a population-level modelling analysis. *The Lancet Infectious Diseases*, 19(1), pp.56-66.

Ceballos, G., Ehrlich, P., Barnosky, A., Garcia, A., Pringle, R. and Palmer, T. (2015). Accelerated modern human-induced species losses: Entering the sixth mass extinction. *Science Advances*, 1(5), pp.e1400253-e1400253.

Center for Food Safety (2015) Soil and Carbon Report. [online] Available at: https://soilsolution.org/wp-content/uploads/2016/03/soil-and-carbon-report.pdf

Committe on Climate Change (2015). *Reducing emissions and preparing for climate change: 2015 Progress Report to Parliament Summary and recommendations*. [online] Available at: https://www.theccc.org.uk/wp-content/uploads/2015/06/6.738_CCC_ExecSummary_2015_FINAL_WEB_250615.pdf [Accessed 11 Dec. 2018].

Committee on Climate Change (2017). *Meeting Carbon Budgets: Closing the policy gap, 2017 Report to Parliament*. London, pp.133 - 143.

Cordell, D., Drangert, J. and White, S. (2009). The story of phosphorus: Global food security and food for thought. *Global Environmental Change*, 19(2), pp.292-305.

DEFRA (2012) Department for Farming Environment and Agriculture *Fine Particulate Matter (PM2.5) in the United Kingdom*. London: DEFRA, pp.12 - 15.

DEFRA (2015). *Inventory of Ammonia Emissions from UK Agriculture 2014:*. [online] London. Available at: https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1605231002_nh3inv2014_Final_20112015.pdf [Accessed 3 Jan. 2019].

DEFRA (2017). Food Waste in England: Eighth Report of Session 2016-17. [online] The Department of Food Environment and Rural Affairs (DEFRA) and The House of Commons. Available at: https://publications.parliament.uk/pa/cm201617/cmselect/cmenvfru/429/429.pdf [Accessed 27 Nov. 2019].

Eating Better (2018). *Principles for eating meat and dairy more sustainably: the 'less and better' approach*. [online] Available at: https://www.eating-better.org/uploads/Documents/2018/better_meat_report_FINAL.pdf [Accessed 24 Aug. 2018].

Environment and Rural Affairs Committee Soil Association Written Evidence (2018). Available at: https://www.parliament.uk/business/committees/committees-a-z/commons-select/environment-food-and-rural-affairs-committee/inquiries/parliament-2017/agriculture-bill-17-19/publications/

FAO (2013). Food wastage footprint: Impacts on natural resources (Summary report). [online] Food and Agriculture Organization of the United Nations (FAO). Available at: http://www.fao.org/docrep/018/i3347e/i3347e.pdf [Accessed 23 Jan. 2019].

FAO (2015). *Food wastage footprint & Climate Change*. [online] Food and Agriculture Organization of the United Nations. Available at: http://www.fao.org/3/a-bb144e.pdf [Accessed 1 Mar. 2018].

Fao.org. (2019). *B10 - 2 Food systems and value chains: definitions and characteristics | Climate Smart Agriculture Sourcebook | Food and Agriculture Organization of the United Nations*. [online] Available at: http://www.fao.org/climate-smart-agriculture-sourcebook/production-resources/module-b10-value-chains/chapter-b10-2/en/ [Accessed 6 Jan. 2019].

Fao.org. (2019).- 2 Home | Agroecology Knowledge Hub | Food and Agriculture Organization of the United Nations. [online] Available at: http://www.fao.org/agroecology/home/en/ [Accessed 18 Feb. 2019].

Foresight (2011). *The Future of Food and Farming, Executive Summary*. London: The Government Office for Science.

Garnett, T. (2011). Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain)?. *Food Policy*, 36(1), pp.S23 - S32.

Gattinger, A., Muller, A, Haeni, M., Skinner, C., Fliessbach, A., Buchmann, N., Niggli, U. (2012) Enhanced top soil carbon stocks under organic farming. Proceedings of the National Academy of Sciences of the United States of America. 109(44) 18226-31 https://doi.org/10.1073/pnas.1209429109

Ghabbour, E.A., Davies, G., Misiewicz, T., Alami, R.A., Askounis, E.M., Cozzo, N.P., Filive, A.J., Haskell, J.M., Moy, A.K., Roach, A.C. and Shade, J. (2017) National Comparison of the Total and Sequestered Organic Matter Contents of Conventional and Organic Farm Soils. Advances in Agronomy 146 1-35 https://doi.org/10.1016/bs.agron.2017.07.003

GOV.UK. (2018). *Implementing the Sustainable Development Goals*. [online] Available at: https://www.gov.uk/government/publications/implementing-the-sustainable-development-goals/implementing-the-sustainable-development-goals--2 [Accessed 11 Nov. 2018].

GOV.UK. (2018). *The Eatwell Guide*. [online] Available at: https://www.gov.uk/government/publications/the-eatwell-guide.

GRAIN and the Institute for Agriculture and Trade Policy (IATP) (2018). *Emissions impossible: How big meat and dairy are heating up the planet*. [online] GRAIN, pp.1 - 4. Available at: http:///e/5976 [Accessed 31 Aug. 2018].

Hic, C., Pradhan, P., Rybski, D. and Kropp, J. (2016). Food Surplus and Its Climate Burdens. *Environmental Science and Technology*, [online] 50, pp.4269−4277. Available at: https://pubs.acs.org/doi/pdf/10.1021/acs.est.5b05088 [Accessed 1 Mar. 2019].

House of Commons Environment, Food and Rural Affairs Committee (2016). *Air Quality: Fourth Report of Session 2015-16*. London: House of Commons.

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (2016). *SUMMARY FOR POLICYMAKERS OF THE ASSESSMENT REPORT OF THE INTERGOVERNMENTAL SCIENCE-POLICY PLATFORM ON BIODIVERSITY AND ECOSYSTEM SERVICES (IPBES) ON POLLINATORS, POLLINATION AND FOOD PRODUCTION*. Bonn, Germany: IPBES.

IPCC (2018). *Summary for policymakers*. Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. [online] Geneva, Switzerland: World Meteorological Organization. Available at: https://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf [Accessed 6 Dec. 2018].

Jones, P., Crane, R. (2009). England and Wales under organic agriculture: how much food could be produced? CAS Report 18. Centre for Agricultural Strategy, University of Reading.

Jones, M., Pitt, H., Oxford, L., Bray, I., Kimberlee, R. and Orme, J. (2017). Association between Food for Life, a Whole Setting Healthy and Sustainable Food Programme, and Primary School Children's Consumption of Fruit and Vegetables: A Cross-Sectional Study in England. *International Journal of Environmental Research and Public Health*, 14(6), p.639.

McIntyre BD, et al (2009) Agriculture at a Crossroads: Executive Summary of the Synthesis Report Washington, D.C, Island Press for International Assessment of Agricultural Knowledge, Science, and Technology for Development. https://www.globalagriculture.org/fileadmin/files/weltagrarbericht/IAASTDBerichte/IAASTDExecutiveSummarySynthesisReport.pdf

Mekonnen, M. and Hoekstra, A. (2012). A Global Assessment of the Water Footprint of Farm Animal Products. *Ecosystems*, 15(3), pp.401-415.

Muller, A., Bautze, L., Meier, M. and Gattinger, A. (2016) Organic farming, climate change mitigation and beyond: reducing the environmental impacts of EU agriculture IFOAM EU and FiBL.

Myers, S. (2017). Planetary health: protecting human health on a rapidly changing planet. *The Lancet*, 390(10114), pp.2860-2868.

Myers, S., Smith, M., Guth, S., Golden, C., Vaitla, B., Mueller, N., Dangour, A. and Huybers, P. (2017). Climate Change and Global Food Systems: Potential Impacts on Food Security and Undernutrition. *Annual Review of Public Health*, 38(1), pp.259-277.

Myers, S., Zanobetti, A., Kloog, I., Huybers, P., Leakey, A., Bloom, A., Carlisle, E., Dietterich, L., Fitzgerald, G., Hasegawa, T., Holbrook, N., Nelson, R., Ottman, M., Raboy, V., Sakai, H., Sartor, K., Schwartz, J., Seneweera, S., Tausz, M. and Usui, Y. (2014). Increasing CO2 threatens human nutrition. *Nature*, 510(7503), pp.139-142.

Nelson, M., Hamm, M., Hu, F., Abrams, S. and Griffin, T. (2016). Alignment of Healthy Dietary Patterns and Environmental Sustainability: A Systematic Review. *Advances in Nutrition: An International Review Journal*, 7(6), pp.1005-1025.

O'Neill, J. (2016). *Tackling Antimicrobial Resistance Globally: Final report and recommendations.*. The Review of Antimicrobial Resistance. [online] London. Available at: http://amr-review.org/Publications/html.

Parliamentary Office of Science and Technology (2016). *Post Note 538: Green Space and Health*. London: Houses of Parliament.

Parliamentary Office of Science and Technology (2017). Security of UK Food Supply (POST Note 556). London: Houses of Parliament.

Poore, J. and Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. *Science*, 360(6392), pp.987-992.

Porter, J., Xie, L., Challinor, A., Cochrane, K., Howden, S., Iqbal, M., Iqbal, D. and Travasso, M. (2014). Food security and food production systems. In: C. Field, V. Barros, D. Dokken, K. Mach, M. Mastrandrea, T. Bilir, M. Chatterjee, K. Ebi, Y. Estrada, R. Genova, B. Girma, E. Kissel, A. Levy, S. MacCracken, P. Mastrandrea and L. White, ed., *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. [online] Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, pp.485-533. Available at: https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap7_FINAL.pdf [Accessed 11 Dec. 2018].

Poux X, et al (2018), 'An agroecological Europe in 2050: multifunctional agriculture for a healthy diet, Lessons from a system modelling European food', IDDRI, SciencesPo. https://www.iddri.org/sites/default/files/PDF/Publications/Catalogue%20Iddri/Etude/201809-ST0918-tyfa_1.pdf

Public Health England (PHE) (2017). *Health Profile for England, Chapter Two: major causes of death and how they have changed*. Public Health England.

Public Health England (2019). *Public Health Profiles*. [online] Fingertips.phe.org.uk. https://fingertips.phe.org.uk/search/air%20pollution#page/0/gid/1/pat/6/par/E12000008/ati/102/are/E10000016 [Accessed 3 Jan. 2019].

Schwingshackl, L., Hoffmann, G., Lampousi, A., Knüppel, S., Iqbal, K., Schwedhelm, C., Bechthold, A., Schlesinger, S. and Boeing, H. (2017). Food groups and risk of type 2 diabetes mellitus: a systematic review and meta-analysis of prospective studies. *European Journal of Epidemiology*, 32(5), pp.363-375.

Schwingshackl, L., Schwedhelm, C., Hoffmann, G., Lampousi, A., Knüppel, S., Iqbal, K., Bechthold, A., Schlesinger, S. and Boeing, H. (2017). Food groups and risk of all-cause mortality: a systematic review and meta-analysis of prospective studies. *The American Journal of Clinical Nutrition*, p.ajcn153148.

Soil Association (2017) *Safeguarding the UK's Soils: A policy briefing*. [online] Available at: https://www.soilassociation.org/media/14383/policy_report_2017_soil_policy_briefing_oct17.pdf [Accessed 4 Dec. 2018].

Soil Association (2018) The Benefits of Organic Farming. [online] Available at: https://www.soilassociation.org/media/16745/the-benefits-of-organic-farming-april-2018.pdf [Accessed 18 Feb. 2019].

South, E., Hohl, B., Kondo, M., MacDonald, J. and Branas, C. (2018). Effect of Greening Vacant Land on Mental Health of Community-Dwelling Adults. *JAMA Network Open*, 1(3), p.e180298.

Springmann, M., Mason-D'Croz, D., Robinson, S., Garnett, T., Godfray, H., Gollin, D., Rayner, M., Ballon, P. and Scarborough, P. (2016). Global and regional health effects of future food production under climate change: a modelling study. *The Lancet*, 387(10031), pp.1937-1946.

Springmann, M., Wiebe, K., Mason-D'Croz, D., Sulser, T., Rayner, M. and Scarborough, P. (2018). Health and nutritional aspects of sustainable diet strategies and their association with environmental impacts: a global modelling analysis with country-level detail. *The Lancet Planetary Health*, 2(10), pp.e451-e461.

Sustainablefoodcities.org. (2019). *Sustainable Food Cities Homepage*. [online] Available at: http://sustainablefoodcities.org [Accessed 4 Jan. 2019].

Tilman, D. and Clark, M. (2014). Global diets link environmental sustainability and human health. *Nature*, 515(7528), pp.518-522.

Tuck, S.L., Winqwist, C., Mota, F., Ahnstrom, J., Turnbull, L.A. and Bengtsson, J. (2014) Land-use intensity and the effects of organic farming on biodiversity: a hierarchical meta-analysis. The Journal of Applied Ecology 51(3) 746-755

Twohig-Bennett, C. and Jones, A. (2018). The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. *Environmental Research*, 166, pp.628-637.

United Nations Standing Committee on Nutrition (UNSCN) (2017). *Sustainable Diets for Healthy People and a Healthy Planet*. [online] UNSCN, pp.3-14. Available at: https://www.unscn.org/uploads/web/news/document/Climate-Nutrition-Paper-EN-WEB.pdf [Accessed 1 Nov. 2017].

US EPA. (2018). *Global Greenhouse Gas Emissions Data | US EPA*. [online] Available at: https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data [Accessed 29 Aug. 2018].

Vanham, D., Mekonnen, M. and Hoekstra, A. (2013). The water footprint of the EU for different diets. *Ecological Indicators*, 32, pp.1-8.

Weber, C. and Mathhews, H. (2008). Food-Miles and the Relative Climate Impacts of Food Choices in the United States. Environmental Science and Technology, 42(10), pp.3508

Wheeler, T. and von Braun, J. (2013). Climate Change Impacts on Global Food Security. *Science*, 341(6145), pp.508-513.

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J., De Vries, W., Majele Sibanda, L., Afshin, A., Chaudhary, A., Herrero, M., Agustina, R., Branca, F., Lartey, A., Fan, S., Crona, B., Fox, E., Bignet, V., Troell, M., Lindahl, T., Singh, S., Cornell, S., Srinath Reddy, K., Narain, S., Nishtar, S. and Murray, C. (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy

diets from sustainable food systems. The Lancet. [online] Available at: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)31788-4/fulltext [Accessed 18 Jan. 2019].

World Health Organisation (WHO) (2012). *The evolving threat of antimicrobial resistance Options for action*. Geneva: WHO, pp.50-55.

World Health Organization. (2019). *10 facts on antimicrobial resistance*. [online] Available at: https://www.who.int/features/factfiles/antimicrobial_resistance/en/ [Accessed 8 Dec. 2019].

WWF (2017). *Appetite For Destruction*. [online] WWF. Available at: https://www.wwf.org.uk/updates/appetite-for-destruction [Accessed 5 Oct. 2018].