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Responding to food, environment and health challenges by changing meat consumption behaviours in consumers

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Abstract

Current meat consumption levels impact environment and health, highlighting a need to reduce meat consumption and increase that of plant-based alternative proteins. There appears to be a lack of awareness amongst consumers as to how meat consumption affects health and climate change, which is likely to undermine intention to change. Of those who intend to change, many do not translate that intention to reduce meat consumption into behaviour change. Consumers appear open to the notion of reducing meat consumption but lack the knowledge, motivation or capability to make such changes. For many, meat eating is a traditional social practice, re-enforced by economics, ecological, technological and institutional factors, including media and marketing. Many food choices are not logical reasoned actions but subconscious, automatic, rapid decisions, relying on heuristic processing and heavily influenced by contextual cues. Promising targets for changing individual consumption patterns could focus on closing the awareness-intention and intention-behaviour gaps. Modifying contextual determinants of food choice, highlighting personally relevant internal motivators related to individual requirements, and aligning such messages with positive re-enforcement about animal welfare and environment would close the awareness-intention gap. A framework of reference for a healthy, sustainable diet, improvements in the range, sensory attributes, convenience and ease of use of meat substitutes, reduction in the meat portion components of ready meals (by substitution with other foods), reformulation of processed products to include a greater proportion of non-meat proteins, economic incentives, and emphasis on the benefits to environment and animal welfare could reduce the intention-behaviour gap. Better alignment of environmental and health messages would concentrate public health messages and effort to create a market environment that facilitates sustainable food choices to produce moderate population level wide-scale changes in plant protein consumption, with significant impact on health and environmental outcomes.

Changes in population, food supply and meat consumption

The human population has grown dramatically in the last two centuries from around 1 billion circa 1800 to 7.3 billion at present, and is expected to reach 8.5 billion by 2030, 9.7 billion by 2050 and 11.2 billion by 2100 (United Nations 2015). As noted by Malthus [1993 (originally in 1798)], populations tend to expand geometrically, limited by subsistence and production, which tend to expand arithmetically (Malthus 1993). Thus, availability of food and resources should ultimately limit population growth. Humans have been remarkably inventive at circumventing environmental constraints on population growth through a combination of technological, agricultural, medical, public health and societal innovations that fix current problems but tend to create new challenges for the future. Solutions to the food chain problems have come at a cost to human health and the environment. Innovations in food production, preservation and storage, science and technology, transport and trade have supported the development of a larger, more migratory human population and a global food supply system, which is extremely complex, reliant on intensive agriculture and extensive food distribution systems. Factors driving the development of the food supply include continuous and dynamic change, exponential growth in efficiency and connectedness (panarchy), and a demand driven economy in which a wide variety of countries and cultures are now responsible for food production and safety (Hueston & McLeod 2012). Such is the complexity of the global food supply system that one food, for example, a Burger King® hamburger, can contain ingredients from approximately 200 global suppliers (Hueston & McLeod 2012). In this rapidly expanding food supply, one food in particular (meat) had been farmed more intensively than ever before, in response to growing consumer preference and demand.

Global meat consumption has almost doubled in the last 50 years from 63 g (person/day) in 1961 to 115 g (person/day) in 2009 (FAOSTAT 2013). The UK has followed similar trends. “Mean consumption of red and processed meat for women aged 19 to 64 years (47g) and 65 years and over (57g) met the current recommendation that adult average intakes should not exceed 70g per day. However, mean consumption for men aged 19 to 64 years (84g) and aged 65 years and over (81g) exceeded the recommendation. Mean consumption of red and processed meat for women aged 19 to 64 years was significantly lower in Years 5 and 6 (combined) (47g) than in Years 1 and 2 (combined) (58g). However, there were no significant

differences in consumption between paired years for men”, (Public Health England 2016 4) Actual intakes could be somewhat higher given that reported energy intakes suggest some degree of under-reporting of total energy intake (8.88 MJ (2111 kcal) for men aged 19 to 64 years, 6.78 MJ (1613 kcal) for women aged 19 to 64 years, 8.14 MJ (1935 kcal) for men aged 65 years and over and 6.35 MJ (1510 kcal) for women aged 65 years and over). These trends in consumption drive production, which has escalated to keep pace with consumer demand (Wellesley *et al.* 2015). While meat can be part of a healthy, balanced diet and is a good source of protein, vitamins and minerals, including iron and zinc, dietary analyses indicate that Western consumers are eating more meat than is good for health and that significant reductions in meat consumption could be achieved without nutritional detriment to the population (Jackson *et al.* 2009). While meat consumption is increasing in the developing world it has plateaued at around twice (thrice in the US) that which optimal for health (balancing nutritional benefits against longer-term health risks such as colon cancer and cardio-metabolic risks) and projected trends suggest global meat consumption is set to rise further into this century (Rob Bailey *et al.* 2014). Currently, 40% of men and 10% of women in the UK exceed 90 g/day of red and processed meat, and those eating this amount of meat are advised by the UK government to cut down (Dibb & Fitzpatrick 2014). It is worth considering consumption in terms of both the amount of meat that is bought and the amount that is eaten. Consumers appear to be buying more food than they eat, increasing food waste (Vandevijvere *et al.* 2015), which is important for an economically and environmentally expensive commodity such as meat. Meat and fish comprise 7% of UK household food that is wasted (The Waste and Resources Action Programme 2009).

Consequences of current levels of meat consumption

It is uncontroversial that current trends in human population growth and meat consumption are unsustainable (Dibb & Fitzpatrick 2014; Friel *et al.* 2009; Jackson *et al.* 2009; Tilman & Clark 2014; Wellesley *et al.* 2015) (Figure 1). In this context, it is worth noting that sustainable diets often refer to the foods people eat while sustainable foods often refer to supply chain and production methods. The Food and Agriculture Organization of the United Nations (FAO) has defined sustainable diets in a manner that integrates these dimensions of sustainability as ‘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 optimising natural and human resources' (Food and Agriculture Organisation of the United Nations 2012). Growing consumption rates of animal meat as a source of dietary protein negatively impact the environment and pose a significant risk to global food security and sustainability. Livestock production is a major contributor to greenhouse gas emissions (GHGE) and resulting climate change. The water footprint per gram of protein from red meat is estimated to be six times larger than for pulses. Intensive livestock production contributes to deforestation and desertification, excretion of pollutants, places greater demands on carbon, nitrogen (use of nitrogenous fertilisers for inefficient feedstocks and nitrous oxide from excreted nitrogen products) and water resources (Janzen 2011). The intensification of meat production directly impacts the relationship between food, environment and human health (Hueston & McLeod 2012; Tilman & Clark 2014; Wellesley *et al.* 2015). The relationship between the global dietary transition (towards more processed foods containing a higher proportion of refined sugars, fats and meat), the environment (GHGE, chemical pollution, land-use, water consumption) and human health (non-infectious diseases such as type 2 diabetes, cancers, heart disease, new and emerging infections) is well documented and has recently been articulated as the diet-environment-health trilemma by Tilman and Clark (2014). In increasingly consumer-oriented societies 'Dietary choices (by consumers) link environmental sustainability and human health' (Tilman & Clark 2014). In particular, high consumption of red and processed meat is associated with increased risk of colorectal cancer and heart disease (related to the high levels of the saturated fat in some meats raising blood cholesterol levels) (Friel *et al.* 2009). High fat meat products can also contribute to higher total energy intake, increasing risk of obesity and type 2 diabetes. Consumer choices, therefore, have the potential to escalate or alleviate the global trends in environmental sustainability and the health of humans through the dual burden of malnutrition [currently affecting the lives of ~57% of human beings (World Health Organisation 2017)], other non-infectious diseases (The Academy of Medical Sciences 2016; World Health Organisation 2013) and new/emerging infections (Hueston & McLeod 2012). Technological solutions to food production *per se* are insufficient to achieve significant benefits to human health or the environment (Friel *et al.* 2009). A healthy diet is not necessarily a sustainable diet (Macdiarmid *et al.* 2012; Macdiarmid 2013). For example, it is estimated that switching from an unhealthy high GHGE diet to a

healthy low GHGE diet (reducing total meat consumption from 212 to 53 g/day) could reduce GHGE by 44%. However, a low meat diet is not necessarily a healthy diet and a healthy diet is not necessarily low in GHGE. It is possible to achieve a healthy diet, which is associated with high GHGE (containing ~96 g total meat per day), or an unhealthy diet that is associated with low GHGE (containing ~66 g total meat per day) (Macdiarmid 2013). It is important therefore to remember that a healthy diet is determined by the balance of food, energy and nutrients consumed. Aligning sustainability and health requires a balance of both foods consumed and the impact their production has on the environment, and there is scope to optimise the choices consumers make to balance benefits to both the environment and human health. Reducing meat consumption from current per capita levels is central to these benefits. To reduce per capita meat consumption, it is important to bring about behaviour change at the level of the average consumer (The Academy of Medical Sciences 2016). These considerations prompt a discussion of why meat consumption is so high and the most feasible pathways to change meat purchase, consumption and hence production in a demand-driven global food economy.

Why we eat too much meat

In all but the poorest countries, and particularly in developed countries, meat consumption and the amount consumed is not a necessity but a choice. However, choices are not necessarily conscious, informed or rational but are often subconscious, automatic, rapid decisions, relying on heuristic processing and heavily influenced by contextual cues (*e.g.* food packaging, portion sizes, product design, salience, labelling and health claims) (Cohen & Babey 2012). The dietary choices made by consumers are affected by a matrix of factors, which enmesh consumers in their current habits, as indicated, as an example, by the bewildering complexity of the obesity systems map (Butland *et al.* 2007). Tradition, culture, gender, identity social values, and socioeconomic status appear to influence current global trends in meat consumption (Beverland 2014). In Western countries, there are traditional associations between meat consumption and concepts of nutritional adequacy, affluence, power, distinction, control and, some argue, masculinity (Beverland 2014; Fiddes 1991). In the same traditional context, vegetarian diets tend to be perceived as being associated with nutritional inadequacy, poverty, weakness, deviance, disruption and femininity (Beverland 2014; Fiddes 1991). There are certainly sex differences in the absolute amount of meat men

and women consume. On average, in the UK, men report consuming 226 g/day while women consume 163 g/day of meat and meat products (England 2014a). This disparity seems slightly larger than mean differences in body size *per se* (Office for National Statistics Statistics 2011). Some evidence suggests that while men eat disproportionately more meat, they are less willing to change their meat consumption (Dibb & Fitzpatrick 2014).

These trends are reinforced by institutional influences from the health professions, press, government and a variety of commercial interests marketers (Wellesley *et al.* 2015; Dibb & Fitzpatrick 2014), who also shape consumer health beliefs and nutritional knowledge. Consumer health beliefs and knowledge are not necessarily strongly aligned with evidence relating dietary intake and composition to longer term-health outcomes. Consumers self-report that health and nutrition are important determinants of their food choices (Grunert *et al.* 2011; Grunert 2005). However taste (i.e. perceived palatability), cost, brand, attractiveness of the product and packaging can have a greater influence on food consumption (Krystallis *et al.* 2008; Williams 2005). Evidence suggests that the nutritional knowledge, including understanding of food labels and health claims, of most consumers is limited (Wills *et al.* 2012). Nutrition knowledge is an important contributor to healthy eating but mainly in those with high levels of such knowledge, rather than the average consumer (Wardle *et al.* 2000). Indeed, in the face of ever shifting media communications about foods, nutrition and health, and an increasing reliance by consumers on digital media as a source of such 'knowledge', it is unsurprising that consumers increasingly distrust the government, business, media and non-governmental organisations (*e.g.* *The Financial Times* 2017) and increasingly value transparency and trust (Food Climate Research Network 2018). Consumers are often 'locked in' (Figure 2) to unsustainable ways of living by physical and institutional constraints (Dibb & Fitzpatrick 2014; Monkhouse & Dibb). Within this framework of influences on consumer behaviour, more immediate factors such as taste, price, convenience, perceived quality, availability, perceived nutritional benefits and health concerns appear to underlie current high levels of meat intake (Jackson *et al.* 2009; Wellesley *et al.* 2015).

Consumer attitudes to meat

Macidarmid *et al.* examined consumer attitudes to meat consumption through 12 focus groups and four individual interviews among Scottish urban and rural consumers. They

identified three dominant themes related to meat consumption: (i) a lack of awareness of the association between meat consumption and climate change; (ii) perceptions of personal meat consumption playing a minimal role in climate change; and (iii) resistance to the idea of reducing personal meat consumption (Macdiarmid *et al.* 2016). This analysis found that people associated eating meat with pleasure, and identified the importance of social, personal and cultural values around eating meat. Scepticism of scientific evidence linking meat and climate change was common. Changing non-food related behaviours was seen by respondents as easier and more important for climate change mitigation, suggesting that health and environmental messaging needs to be made socially and personally relevant and plausible to the general public and that 'if healthy, sustainable dietary habits are to be achieved, cultural, social and personal values around eating meat must be integrated into the development of future dietary recommendations' (Macdiarmid *et al.* 2016).

Generally, consumers appear to be broadly unaware of the need to reduce meat consumption for either environmental or health reasons or that there is a clear relationship between diet, health and the environment (Lea & Worsley 2008; Macdiarmid *et al.* 2016; Tobler *et al.* 2011; Vanhonacker *et al.* 2013). Some research suggests a moral disconnect between meat consumption, health, the environment and animal welfare (Graça *et al.* 2014). Intensive global farming systems have dramatically increased intensity of contact between large numbers of animals and individual humans at the point of food production (increasing the potential for new and emerging infections), but removed consumer perceptions, contact with or experience of the source of that food. Most people would not be able to eat the meat on their plate if they were obliged to slaughter, skin and gut it. While the natural environment has been radically altered to increase the ease and efficiency with which foods are procured, this has the net effect of insulating and blinding consumers to the impact food supply systems have on the future of the ecosystems on which humans ultimately depend. Increasingly, consumers interface with attractively marketed products in which the animal is a pre-packaged ingredient. Environmental and welfare concerns are thus reduced to distal considerations that have little impact on the food choice behaviour of consumers in the supermarket.

Attitudes to changing meat consumption are, at best, ambivalent and do not always strongly predict subsequent behaviour (Macdiarmid *et al.* 2016). The majority of people report being open to changing their diet to help the environment (Dibb & Fitzpatrick 2014). However, a 12-country survey of $\geq 1,000$ participants per country showed that $\geq 90\%$ of respondents describe themselves as meat and dairy consumers (Wellesley *et al.* 2015). In YouGov *Eating Better* surveys only 34% (2013) and 35% (2014) of respondents reported a willingness to consider eating less meat, 20% reported having already reduced meat intake and 30% reported being unwilling to reduce meat consumption (Dibb & Fitzpatrick 2014). Around 50% reported be willing to pay more for 'better' meat (*e.g.* taste, healthier, higher animal welfare, better returns for farmers) (Dibb & Fitzpatrick 2014). Surveys by both YouGov for *Eating Better* and Defra's *Attitudes and Behaviours around Sustainable Food Purchasing* survey suggest that consumers are more concerned with personal health and animal welfare than with the impact of food production on the environment, with 50% of people reporting that meat is the favourite part of their meal (Dibb & Fitzpatrick 2014; Department for Environment 2011). Thus, for many people, concerns about the impact of meat consumption on the environment and animal welfare are low down on the list of factors that shape their choices about meat consumption (Wellesley *et al.* 2015; Dibb & Fitzpatrick 2014).

Many aspects of behaviour change are subject to an intention-behaviour gap in that people develop intentions to alter their behaviour but do not take any action or do not implement their intentions (Sniehotta *et al.* 2005). Meat consumption among consumers is also subject to an intention-behaviour gap such that 'Although a substantial number of consumers in the affluent world may hold the opinion that we have to do something about the environmental and animal welfare problems of modern livestock industry, many consumers do not act or act consistently so' (de Bakker & Dagevos 2012). Part of this gap is due to the matrix of influences that maintain cultural, traditional, economic, convenience and hedonic influences over food choice (Dibb & Fitzpatrick 2014; Fiddes 1991) and part of it is because consumers are only peripherally aware of the relationship between the foods they buy and consume, their own health, the welfare of animals and that of the environment (Macdiarmid *et al.* 2016; Wellesley *et al.* 2015). Despite the cultural and traditional role of meat in the diet, the current escalating global trends in meat production, consumption and waste, there is some evidence that consumer attitudes (or at least awareness) show some potential to change (Wellesley *et al.*

2015). It is, however, important to note that changes to consumer awareness, attitudes or intentions are likely to make a sufficient impact on food, environment and health without a significant change in policy. An increasing number of consumers recognise that life is more nuanced than omnivores versus vegetarians, as exemplified by the increased prevalence of 'flexitarians' – people who do not eat meat some days of the week. In a Dutch survey of 800 consumers, 27% were self-reported meat lovers, eating meat every day and only 4% reported never eating meat. However, 69% self-identified as 'flexitarian' (Dagevos 2014). Environmental concerns are becoming more mainstream as consumers become aware of the role that environmental change is having on climate, although the relationship of such changes to their dietary choices is perhaps less obvious to them. Moral and health concerns about intensive agriculture are gaining mainstream traction and food scares tend to amplify concerns about intensive rearing [*e.g.* Bovine spongiform encephalopathy (BSE) in the 1990s; *Campylobacter* in chicken 2014]. A growing body of high profile reports is increasing consumer awareness of the impact of high levels of meat consumption on human health (Dibb & Fitzpatrick 2014; Friel *et al.* 2009; Hueston & McLeod 2012; Macdiarmid *et al.* 2012; Monkhouse & Dibb 2011; Tilman & Clark 2014; Food Climate Research Network 2018). At a time where consumers are becoming more aware of aspects of the food-environment-health trilemma but are still very resistant to change, it is worth considering the potential barriers and facilitators to changes in meat consumption.

Barriers and facilitators to change in meat consumption

Some of the key factors that leave consumers locked into unsustainable dietary practices as barriers to reducing meat consumption or to increasing consumption of alternative plant-based protein include: (i) the choice architecture in which traditions, cultural frames of reference and habits are maintained; (ii) the prioritising of habits, taste, convenience, price over health and sustainability; (iii) perceptions that meat is good for health and that alternative protein options are not so good for health; (iv) a general lack of consumer awareness in which dietary change is not seen as an important environmental issue by consumers; (v) a general lack of knowledge of the relationship between food, environment and health; (vi) the automaticity of shopping and eating behaviour (*i.e.* that most food selection/purchase choices are not conscious decisions but aspects of habit); and (vii) the fact that in today's social-media society consumers do not have a clear frame of reference for

what a healthy, sustainable diet is. According to a survey conducted in 2010 by the Quorn company, who manufacture alternative plant-based meat-substitute foods, consumers were concerned about the environment and the majority have tried to change habits, with up to 92% agreeing that they regularly recycled domestic waste (Quorn company 2010). But most consumers did not consider the environment when shopping for food. Consumers considered that it is up to manufacturers and the government to ensure that environmentally friendly products are supplied and on sale. Many reported a reluctance to pay more for this, and economic stresses (*e.g.* the recession of 2008/09) tended to lead to a de-prioritisation of environmental concern in the minds of consumers. When asked, if it was established beyond all reasonable doubt that eating meat is very environmentally destructive, would they change their meat consumption patterns. Only 33% of respondents stated that they would change their meat consumption patterns at all and 42% stated that they would carry on eating meat at the same rate as the present. When informed of the health risks of eating too much red meat and asked about the combination of health and environmental reasons for eating less meat, only 27% reported that such information made them consider eating less red meat and 35% reported it had no impact on their intentions to reduce meat consumption (Quorn company 2010). More recently, the 12 countries survey, commissioned by the Chatham House report, revealed a growing awareness amongst consumers of climate change as a global phenomenon and the impact of human activity on the environment. The majority of respondents associated transport emissions with climate change but awareness that meat production significantly affects climate/environmental change was limited (Wellesley *et al.* 2015). Unsurprisingly, this awareness gap appears to be related to consumers' stated lack of intention to change meat and dairy consumption (Wellesley *et al.* 2015). Thus, the intention-behaviour gap is potentially preceded by an awareness-intention gap, which appears variable between countries. Nevertheless this survey did indicate a positive relationship between consumers awareness of carbon footprint of a given behaviour and consumers' stated propensity (or intention) to alter this behaviour, which offers a potential lever point for policy makers (Wellesley *et al.* 2015).

While factors shaping consumer meat consumption behaviour are multiple, complex and powerful, there is some increasing awareness amongst consumers that foods affect health and that the environment requires greater collective responsibility. Most recently the *Action*

on *Sustainable Diets Report* from the Food Climate Research Network has highlighted shifting trends in the growth of sustainable businesses. Sustainable foods are becoming opportunities for rapid market growth, and there are some indications that reducing animal protein consumption forms part of those trends, apparently driven by the 'flexitarian' food trend, particularly in younger consumers (Food Climate Research Network 2018). There is scope to link these concepts in the minds of consumers to lever attitudes to meat consumption.

Pathways to change

Considering the above arguments about current awareness of the impact of, and consumer attitudes to, meat consumption it seems reasonable to suggest that developing pathways towards more healthy and sustainable diets should attempt to reduce current barriers to change, develop strategies that facilitate a shift toward a greater consumption of alternative, plant-based protein, and a gradual reduction in per capita meat purchase, consumption and waste. The *Eating Better* report (2014) identified ten potential drivers for motivating a change in meat consumption. These were: (i) habits; (ii) the cultural significance of meat eating; (iii) cost; (iv) convenience; (v) health; (vi) awareness of the environmental impact of meat consumption; (vii) concern for animal welfare; (viii) concern for provenance and traceability of meat-based foods; (ix) knowledge about alternatives to meat; and (x) consumer reactions to food scares (Dibb & Fitzpatrick 2014). Of these potential drivers, health, animal welfare and cost appear to be promising targets to reduce awareness-intention gaps and move consumers in the direction of closing their intention-behaviour gaps (Dibb & Fitzpatrick 2014). Consumers' understanding of the environmental impact of meat consumption (sustainability), food security and concern for food quality and safety (awareness-intention gap) tend to be less immediate potential drivers for change as they are counterbalanced by factors such as habit, culture, convenience and cost (Dibb & Fitzpatrick 2014; Jackson *et al.* 2009; Macdiarmid *et al.* 2016; Wellesley *et al.* 2015). These potential drivers could be targeted but this would require changing the cultural landscape to enable intentions to be more easily implemented as sustainable changes in behaviour.

De Bakker and Dagevos identified three potential pathways to changing consumer behaviour in relation to meat consumption (Figure 3): (i) achieving sustainable diets by stealth using subtle, sustainable food innovations such as hybrid products marketed as lean, low fat and

healthy; (ii) active engagement of consumers in moderate meat reduction (portion size, meat free days); and (iii) wide-scale cultural change involving societal and structural/economic changes (e.g. production strategies that alter consumption patterns) (de Bakker & Dagevos 2012). While wide-scale changes may have the biggest impact, they are the most difficult to achieve in the near future. Small, subtle changes to product formulation and market offering are likely to have a more modest effect; these tend to be solutions that are more feasible in the medium-term because food choice can be influenced by contextual factors such as packaging, product design, cost, salience that influence heuristic processing.

These perspectives are supported by the WWF-Imperial College report examining the feasibility of possible scenarios in which retailers could help consumers achieve reductions in red meat and dairy food consumption, allowing for individual preferences and choice and without compromising the nutritional adequacy of the diet (Jackson *et al.* 2009). The analysis took account of the likely impact, adoption and ease of implementation of different options. The options most likely to produce the biggest impact on red meat and dairy consumption were increasing the availability of non-meat/dairy substitutes and more widespread control of portion size in meat-based ready meals. The authors noted that ‘moderate reductions across large tracts of the population make a much more conclusive impact than total elimination of the food category by niche groups’. For dairy consumption, the only lever with significant magnitude would be switching to non-dairy alternatives (which could produce nutritional issues in itself such as low iodine intake), a goal more likely to be achieved by a longer-term strategy of changing consumer awareness to influence choice patterns (Jackson *et al.* 2009).

The aggregate effects of wide-scale, small changes would help close intention-behaviour gaps and could be supported by strategies to improve awareness of the relationship between food, health and the environment, closing awareness-intention gaps. Promising targets for changing individual consumption patterns include alignment of environmental and health messages, a framework of reference for a healthy sustainable diet, improvements in the range, sensory attributes, convenience and ease of use of meat substitutes, reduction in the meat portion components of ready meals, reformulation of processed products to include a greater proportion of non-meat proteins, economic incentives and emphasising the benefits

to animal welfare. These approaches appear to be potentially more efficacious in younger people (*i.e.* so-called Generation Z, born between 1995-2010) (Food Climate Research Network 2018). This demographic group is soon likely to contribute up 40% of consumer purchases (Universum 2018). Relatively ineffective attempts to persuade consumers to reduce meat consumption have used external motivators such as emphasising environmental benefits, which are not currently a priority for consumers (Jackson *et al.* 2009; Macdiarmid *et al.* 2016; Tobler *et al.* 2011; Vanhonacker *et al.* 2013; Wellesley *et al.* 2015). Highlighting personally relevant internal motivators related to individual requirements, changing the contextual cues that favour reduced meat choices and tilting the choice architecture in favour of meat reduction are perhaps more likely to produce individually modest effects on a large scale. Aligning such messages with positive re-enforcement about animal welfare and environment, and creating a market environment that facilitates and incentivises sustainable food choices could produce moderate population-wide changes in plant protein consumption, with significant impact on health and environmental outcomes.

It is therefore critical that governments raise consumer awareness of the link between diet, health and environment, and provide the necessary leadership required to affect longer-term changes in consumer behaviour. As noted by Wellesley *et al.* 'Governments are the only actors with the necessary resources and capacities to redirect diets at scale towards more sustainable, plant-based sources of protein' (Wellesley *et al.* 2015). This is a particularly important point given the global complexity of food production and supply systems. Nudges and market forces alone would be insufficient to directionally change consumer behaviour and the forces that enmesh consumers in a web of tradition and culturally determined food choices mitigate against such changes (Dibb & Fitzpatrick 2014; Jackson *et al.* 2009; Wellesley *et al.* 2015). Changing consumer behaviour is hard enough, even in relation to well-established, evidenced-based public health policies (*e.g.* smoking). A concerted approach from experts, opinion leaders, government, the media and industry, if consistently applied over time could produce at-scale changes in the way consumers purchase and eat meat products. Aligning public health and environmental policy could provide a framework of reference for consumers and new opportunities for food production, supply and retail to reduce the dual burden of malnutrition and increase environmental stability, human health and wellbeing. As a global society, there is opportunity to proactively shape a better

environment and citizen health rather than react to the consequences of misaligned food, environment and health policies. In so doing, it may be possible to persuade the four horsemen of the apocalypse to stay in their stable a little while longer.

Figure Legends

Figure 1: The primary domains of environment and health that are impacted by current levels of global meat consumption.

Figure 2: The ISM model categorising the individual (I), social (S) and material (M) contexts that influence or entrench aspects of human behaviour. The model helps explain how individual behaviours are shaped by social factors and material contexts. From Darnton and Horne (2013), reproduced with permission.

Figure 3: Pathways to change. The options to bring about changes in consumer behaviour with respect to meat consumption range from sustainability by stealth, through involvement of consumers in moderate meat reduction to wide scale cultural change.

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