



Potential Opportunities to Shift Diets and Consumption Patterns

Major transformations are required to create sustainable food systems, but near-term immediate actions can support longer-term, more fundamental transition to sustainability. For incremental steps to contribute to long-term changes, stakeholders should define sustainability, measure unsustainability, and understand what interests, ideas and institutions contributed to the current structures, ideas, institutions, policies, and practices. Such understanding will enable stakeholders to choose near-term actions that can lead towards sustainability.

The tables, below, are intended to provide a starting point for stakeholders who are working to build sustainable food systems and are considering a range of near-term interventions. Much additional experience and knowledge by farmers, peasants, indigenous groups and other practitioners should be consulted for a full understanding of these and additional potential interventions.

The following tables summarize mitigation opportunities, adaptation potential, and food system implications based on global literature on the connections between diets and climate change. We recognize that much of the peer-reviewed literature has focused on diets in high-income countries. Therefore, the opportunities may not be relevant or appropriate for low- and middle-income countries.

Research on Policies and Diets

Scientific evidence has not focused exclusively on diet related studies; many studies have also explored the policy options that might assist in making such dietary shifts. Such efforts are largely focused on two major categories of policies: market-driven efforts or educational efforts to shift behavior (Donati et al., 2016).

Public Understanding. Human perceptions and understanding of the issue of diet-related GHGs are important to inform the development of intervention strategies. Recent evidence in high-income countries indicates that few consumers recognize that eating less meat was a significant way to reduce GHGs (12% of Dutch and 10% of American consumers were aware). Food-related climate mitigation strategies need to be better communicated, but consumers may still be resistant to efforts that prescribe diet shifts particularly reductions in a given food group (de Boer et al., 2016; Macdiarmid et al., 2016; Pohjolainen et al., 2016; Almiron and Zoppeddu, 2015; Neff et al., 2009; Laestadius et al., 2014, 2013).

Market-Driven Policy Options. Most scientific research on market-driven opportunities to induce dietary shifts for GHG benefits have focused on tax and subsidy systems in high-income countries. There have been a few studies exploring opportunities for labeling foods based on their sustainability and health benefits (van Dooren et al., 2017) or exploring labeling opportunities in restaurants (Pulkkinen et al., 2016). Tax-based studies have examined how incorporating the social and environmental costs of GHG emissions into the cost of food might change the prices of certain food groups. Some have argued that such approaches have the potential to create a triple win- improving health, reducing GHG emissions, and increasing revenue (Briggs et al., 2016). However, one of the largest criticisms of such approaches is that such taxes are regressive, having a disproportionate impact on households in the lowest socio-economic class (Kehlbacher et al., 2016) or on low and middle income countries because of their high emission intensities for animal production (Springmann et al., 2017).

Educational Policy Options. The majority of educational efforts have focused on national-level dietary guidelines. Many scholars have pointed towards dietary guidelines as an opportunity to offer guidance on diets that can help reduce environmental impact and offer health benefits within the range of what would be socially acceptable (Horgan et al., 2016). Despite these recommendations, recent evidence finds that only 83/215 countries globally have food-based dietary guidelines. Such guidelines are particularly lacking in low-income countries. Other recent evidence suggests that there may be under investment in sustainable dietary recommendations strategies at the national level (Irz et al., 2016). Even less common are dietary guidelines that offer any guidance on food sustainability (Fischer and Garnett, 2016). Fischer and Garnett offer policy advice in their work about strategies to assist dietary guideline development for sustainability consideration.

Besides educational efforts focused on dietary guidelines, there are more recent efforts to develop technological solutions, particularly “apps” for smartphones (Sullivan et al.). At least one effort is underway currently to develop diet apps for sustainable and healthy eating (Pierniak et al., 2016). Other efforts couple education with institutional settings, particularly in school meal programs and may offer great potential to have a large impact over a significant number of meals (Benvenuti et al., 2016; Wickramasinghe et al., 2016; Ribal et al., 2016).

Research on Technological Options

While a more recent phenomenon, there are increasing efforts to shift dietary patterns through technological efforts mostly focused on lab-generated meat or plant-based alternatives that mimic meat. Such efforts aim to develop a product that is generated with greater efficiencies than achieved throughout livestock currently, and ideally with far less environmental and climate impact. Lab-generated meat is currently possible, albeit at a high cost and a recent LCA review suggests that in-vitro lab generated meat has the worst overall LCA performance compared with other meat alternatives including insect or soy-based plant alternatives (Smetana et al. 2015). Thus, others have suggested that despite early proof of concept, far greater effort and research is needed to take such efforts to an industrial scale (Bhat et al. 2017). Evidence also indicates that overall consumers may have more negative than positive perceptions of in-vitro meat development (Laestadius and Caldwell 2015). Plant-based alternatives to meat have been around for decades, however new technology is generating efforts that aim to produce plant-based alternatives that mimic meat through its taste, texture and characteristics (e.g. meat “bleeds” when it cooks). Commercial efforts are

Opportunities Table: Diet and Consumption Opportunities

Opportunity	Mitigation Potential	Adaptation Potential	Co-benefits	Challenges	Food System Implications
	Qualitative description plus quantitative if available (range of possible emission reductions?)	Qualitative description plus quantitative if available			Potential feedbacks and interactions
Balance energy intake with energy output	Diets that include more energy intake than output can result in greater environmental impact (Nelson et al., 2016; van Dooren et al., 2014) and, in areas of overconsumption, can constitute a notable portion of an individual's diet footprint.	Unknown	Could result in greater available food supply	Ensuring there isn't a loss of nutrients; human behavior shifts,	Reduction in energy intake could allow for greater total energy/calories available globally; however, this won't result in a direct change for food security since distribution and access would still be challenges. May provide some positive health benefits including for obesity.
Switch red meat consumption to other meats including pork, poultry, eggs	Studies have confirmed that shifting from red meat consumption towards pork or chicken can offer a reduction in GHGs (Roy et al., 2012). A UK study suggested that a complete shift from beef to pork and chicken in the average UK diet would result in an 18% reduction in GHG emissions (Hoolohan et al., 2013). Similarly, a 75% reduction of beef and sheep meat replaced by poultry or pork resulted in a 9% reduction in diet GHG emissions and an average of nearly 2,000 deaths averted annually in the UK (Scarborough et al., 2012).	Unknown, but an increase in other animal system production should be considered for climate change impacts on those systems (e.g. heat stress).	Potential reduction in saturated fat intake; potential health benefits	Potential for loss of essential micronutrients	Large shifts in meat consumption would have significant impacts on food systems as 1 billion people globally rely on livestock for their livelihoods. As such, shifts must consider economic opportunities for those working in livestock, which would require fundamental land shifts and new educational and training programs for livestock handlers for new industries.
Switch red meat consumption to vegetarian replacements	Overall, there has been a range of estimates about the effect of GHG reductions in a vegetarian diet compared to a vegan diet (both being compared to an omnivorous diet). Vegetarian diet GHG reductions compared with omnivorous diets have ranged from 47% (Scarborough et al., 2014) to the 20% range (Berners-Lee et al., 2012; Meier and Christen, 2013; Sabate et al., 2015; Soret et al., 2014; van Dooren et al., 2014). Data on dairy and dairy product consumption is variable with some dairy products (cheese) having higher dietary emissions while milk, cream and yoghurt have lower dietary emissions than even some produce.	Unknown, but an increase in cropping systems should be considered for future climate change impacts.	Potential reduction in saturated fat intake; potential health benefits	Potential for loss of essential micronutrients	Large scale shifts towards vegetarianism seems to be unfeasible for public acceptability; however, smaller shifts could significantly increase demand for produce, grains, and vegetarian meat alternatives. This would influence land use and farming, and require educational and training shifts.
Switch red meat consumption to vegan replacements	Overall, there has been a range of estimates about the effect of GHG reductions in a vegetarian diet compared to a vegan diet (both being compared to an omnivorous diet). These have ranged in vegan diets from reductions of 60% (Scarborough et al., 2014) to 53% (Heller and Keoleian, 2015) to 50% (Meier and Christen, 2013) to 42% (Sabate et al., 2015) to less than 37% (Berners-Lee et al., 2012; van Dooren et al., 2014).	Unknown, but an increase in cropping systems should be considered for future climate change impacts.	Potential reduction in saturated fat intake; potential health benefits	Potential for loss of essential micronutrients	Large scale transition to vegan diets is currently unlikely given public acceptance, however, new efforts to design vegan meat replacements could influence this. Like other large dietary shifts, this would result in fundamental land shifts and farming, and necessitate training and education.

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Reduce processed foods	While not often discussed, processed foods including snacks may offer opportunity for reducing diet related emissions (Green et al., 2015; van Dooren et al., 2014).	Unknown	Potential reduction in sodium	Such foods tend to be cheap and accessible while also highly palatable	Reduction in processed food intake could influence supply chains as these products are significant for food processing industry and employment. Shifts from processed foods that are vegetarian to non-vegetarian foods could result in an increase in GHG emissions, so replacement is critical to consider.
Public awareness campaigns	Many existing studies suggest that many consumers are unaware of the contribution of diet to GHG emissions, particularly the role of meat consumption (de Boer et al. 2016; Macdiarmid et al. 2016). This knowledge gap may stem from a lack of media coverage on diet and climate change (Almiron and Zoppeddu 2015; Neff et al. 2009), as well as a lack of non-profit engagement on the topic (Laestadius et al. 2014; 2013).	Unknown		Challenging to measure impact; consumer preferences may not match scientific evidence	Greater consumer awareness of diet and climate change may influence some consumers' behaviors. However, there is clear evidence in other topics that suggest such campaigns may be ineffective to drive actual changes in behavior. A focus on tangible, easy solutions is likely most fruitful.
Food taxes/subsidies	Taxes on foods with higher GHG emissions could cause shifts in dietary consumption as a result of increased prices (up to 40%) (Springmann et al. 2017). Thus, diet GHGs could be reduced possibly up to 20%, but would lead to higher costs for households (Edjabou and Smed 2013).	Unknown	May also provide public health benefits	Such taxes are regressive- low income households and countries would pay significantly more for food (Kehlbacher et al. 2016; Springmann et al. 2017).	Food taxes and/or subsidies would likely cause significant food system impacts, driving some consumers towards different foods and sending price signals to the agriculture industry. Debate about what foods should be taxed/subsidized is critical and must consider public health as well. Further, such taxes would have greater impact on low-income countries and people, which should be considered.
National dietary guidelines	Only four countries currently include sustainability as a component of their dietary guidelines and further, fewer than half of all nations have food-based national dietary guidelines at all (Fischer and Garnett 2016). Dietary guidelines offer an opportunity to display strategies and recommendations to achieve health and well-being while also considering sustainability and GHG emissions.	Unknown	Can increase public awareness and education	Many countries still need to develop any dietary guidelines at all. Dietary guidelines are also sometimes influenced by outside interests	Complementary to public awareness and policies would be consideration of dietary guidelines that include metrics of sustainability. First, however, many countries need to develop any form of dietary guidelines. Inclusions would likely drive policy conversations and institutional policies, but may not directly influence consumers since many do not read or consider dietary guidelines.
Apps and technological education	While there are 40 apps that help people explore their carbon footprints, there are no single apps available for assisting people in making diet choices related to GHG emissions (Sullivan et al.) Apps can be developed to assist people in guiding decisions, and some are in development (Pieniak et al. 2016).	Unknown	Can increase public awareness and education	Technological costs are unknown, uptake and adoption may be challenging	Apps could offer an easy, tangible way for people to better understand diet and climate change and be reminded of alternative choices in key moments of purchasing. This could influence consumer demand, and shift agricultural practices.

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Institutional meal shifts	Changing menu options at institutions (i.e. schools, hospitals, prisons) offers the potential for a large-scale shift. Evidence indicates that it is possible to design meals at the institutional level that maintain nutritional outcomes but can reduce both GHG emissions (up to 24%) and even reduce budgets (up to 15%) (Ribal et al. 2016).	Unknown	May reduce institutional costs	Shift in education of food service workers necessary	Meal shifts at large institutions could have significant impact across food systems (e.g. prisons, schools, hospitals, large companies) and collectively make major changes on diets. Further, potential cost savings could enable such institutions to save money elsewhere, or target savings towards purchase of local, organic or other types of products.