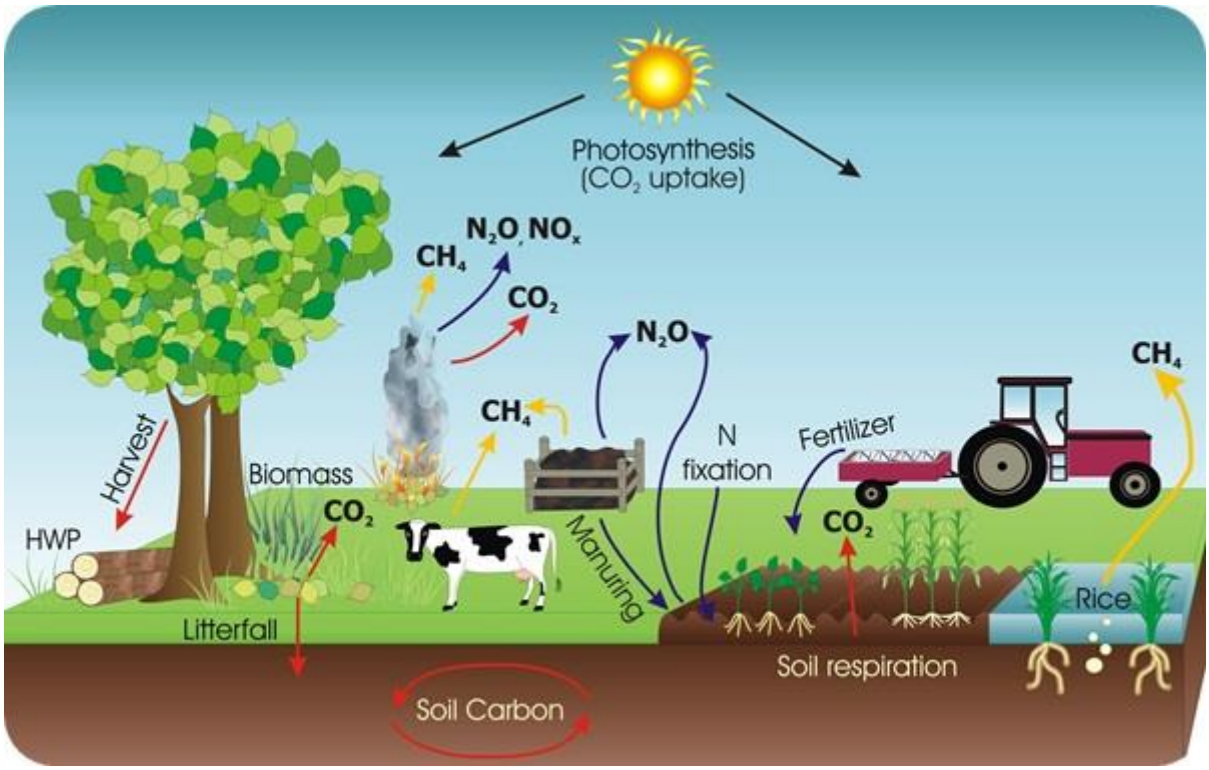
CLIMATE AND CLEAN AIR COALITION TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

Scientific Advisory Panel Briefing

Impacts of Dietary Choices on SLCPs and Health

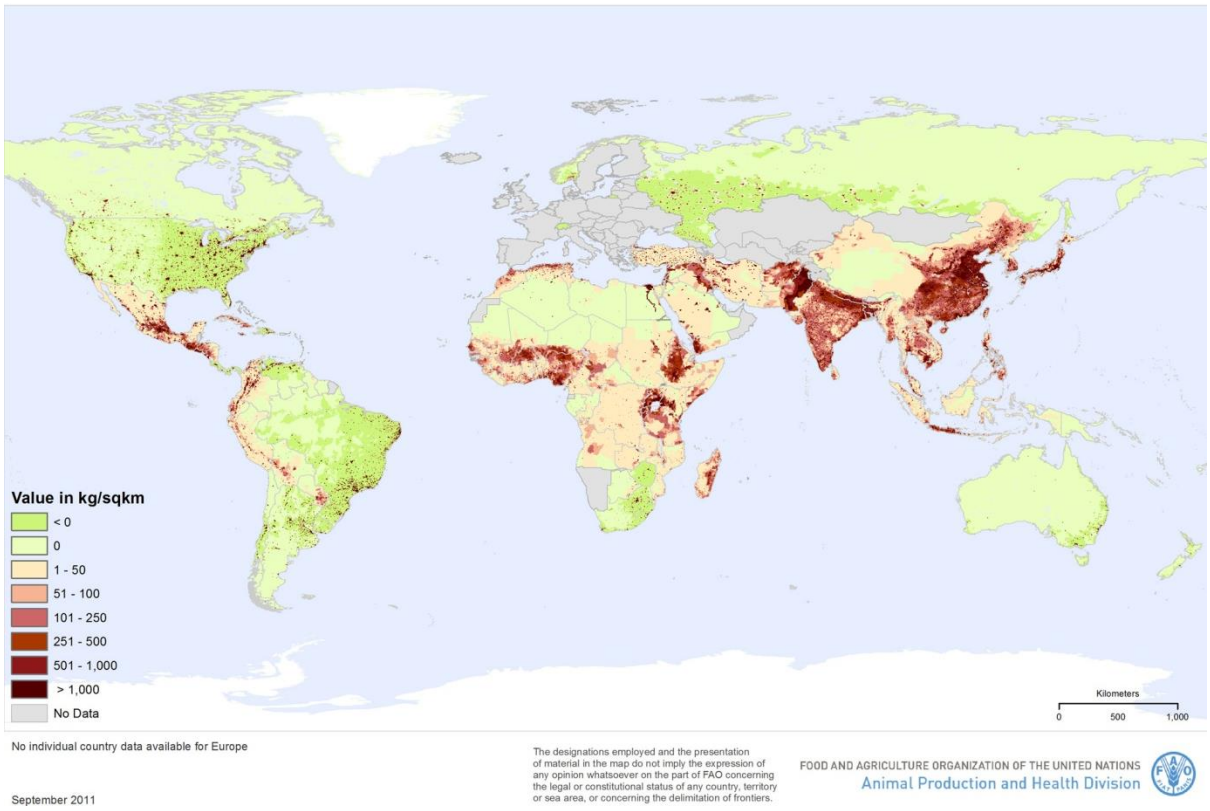
Agriculture, food and other land use are major contributors to GHG emissions, including those of SLCPs. According to the IPCC the AFOLU sector is responsible for just under 25 % of anthropogenic GHG emissions, mainly from deforestation and agricultural emissions from livestock, soil and nutrient management.[i] Sources of CH_4, CO_2, and N_2O related to agriculture are shown in Figure 1[ii]

Figure 1 – Agricultural Emissions Sources and Sinks



Methane, particularly from ruminant livestock and rice paddies, is the major SLCP which can be influenced by dietary choices. Demand for animal products is rising rapidly, particularly in emerging economies. Global emissions from enteric fermentation grew from 1.4 to 2.1 Gt CO_2eq/yr between 1961 and 2010, with average annual growth rates of 0.70%[iii] In general as per capita income increases demand for animal products also increases. One example is the projected growth in beef demand see Figure 2. Although projections for the AFOLU sector as a whole suggest it will contribute a declining share of global GHG emissions in the future, largely as a result of declining rates of tropical deforestation, the growing demands for animal products suggest a increasing contribution from this source. Because of the pronounced inequities in consumption of animal products it is projected that even by 2050 the per capita demand for meat will still be much greater in high income countries than in low and middle income countries.[iv]

Figure 2 – Growth in Demand for Beef 2000 - 2030[1]

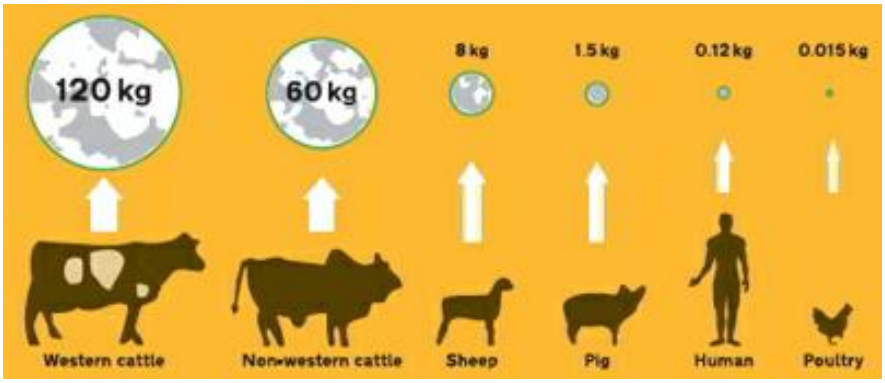


Agriculture and livestock in particular also have a range of other environmental impacts including reduced biodiversity (e.g. as result of intensification of food production with monocultures and extensive use of pesticides etc) and excessive nutrient loading of aquatic systems from fertilizer use, leading to eutrophication of marine and freshwater ecosystems. As methane is a precursor of tropospheric ozone strategies to reduce methane will also benefit health and the environment through reduced levels of ozone.

There are limitations to current data on life cycle analysis of emissions from food and agricultural systems which are restricted in geographic scope and quality. This has led to proposals to establish a global database of LCA measures and other initiatives to improve data availability.[v] Whilst improving the quality of emissions data is essential for more accurate estimates of mitigation strategies it is already apparent that animal products have higher GHG emission profiles than plant products and ruminants (cattle and sheep) have higher emissions per kg than pork or poultry (2) *see* Figure 3.[vi]

Figure 3 – Methane emissions per animal per year[2]

[1] http://www.fao.org/ag/againfo/resources/en/glw/Layers_JPG/Gl_Beef_GrowthDemand0030.jpg
[2] http://www.worldfuturecouncil.org/2326.html



Reducing food waste is a commonly proposed approach to reducing the requirements for food which does have considerable potential in both high and low income settings. Overall between 30-50% (1.2–2 billion tonnes) of food produced worldwide is never consumed. Large proportions of food are wasted in both high and low income countries but the pattern differs in that a greater proportion is wasted closer to consumption in high income settings.[vii]

In low income countries there is extensive spoilage during storage for example as a result of aflatoxin contamination (produced by strains of *Aspergillus flavus*) of maize groundnuts and other staples with major implications for human health in terms of increased risk of liver disease including cancer(particularly when it coexists with Hepatitis B infection) and probably under-nutrition.[viii] This could be exacerbated by climate change in the absence of effective interventions, one of which is the use of non-toxic strains of Aspergillus – aflasafe-to compete with toxic strains. This approach is being scaled up in Africa.[ix]

Overall between 30% and 50% of food bought in developed countries is thrown away by the purchaser and much food is never harvested because it does not meet local standards for appearance even though it is perfectly safe to eat – in the UK for example 30% of the vegetable crop is lost or this reason.[x]

Energy use varies greatly according to crop, from 3 calories per calorie of food in the case of plant foods to 35 calories required for one calorie of beef. Much of this energy is derived from fossil fuels and beef also uses about 50 times as much water on average. Thus there is great potential to improve food availability and reduce GHG emissions by policies to reduce waste and influence dietary choices. Any effects on health of reduced food waste are likely to be indirect (except for the example of aflatoxin reduction above) as a result of greater affordability, particularly for low income populations.

A recent systematic review of several databases in mid-2014 identified 21 primary studies modelling the GHG emissions related to a dietary pattern published since 1995. Diets containing a higher ratio of plant to animal products were generally associated with lower GHG emissions; however, the results varied across countries and studies.[xi] All but 2 of the studies suggested that consuming less animal products resulted in lower GHG emissions. In one case the authors matched diets on the basis of the calories needed to replace a 20% meat reduction.[xii] In the other study diets were matched according to nutrient levels and the researchers found that replacements for eggs and dairy were more costly and had greater GHG emissions for the equivalent nutrient levels.[xiii] In the majority of studies, where reductions in animal product consumption were associated with lower emissions, the differences were in the range of 20-40%. For example, a study of 6 dietary scenarios using life cycle analysis suggested potential GHG savings of 22% and 26% can be made by changing from the current UK-average diet to a vegetarian and a vegan diet, respectively.[xiv]

Different approaches have been used to estimate the likely health benefits from low GHG emission diets. One approach was to estimate the likely health benefits as a result of decreases in saturated fat intake from animal sources (largely ruminant in origin) and replacement with unsaturated fats from plant sources leading to projected reductions in ischaemic

heart disease.[xv] The assumption was that reduced consumption would result from reductions in production. Other studies have estimated the health effects of changes in consumption of major food groups using established epidemiological estimates of changes in disease burden. Examples include reduced ischaemic heart disease, stroke and some types of cancer from increasing non-starchy vegetable and fruit consumption or reduced risks of type 2 diabetes, stroke, and colorectal cancer from decreased consumption of red and processed meat in high consuming populations.[xvi]

There are some concerns about the affordability of such diets, for example an Australian study found that healthier and more sustainable dietary options were unaffordable for many low income families.[xvii] Other studies have found no increase in cost or lower cost of more sustainable healthy diets, suggesting that the costs depends on the options chosen and local availability. A recent study using optimization modelling to ensure diets conform to WHO dietary recommendations and remained affordable, suggested that if the average UK dietary intake were optimized to comply with WHO recommendations an incidental reduction of 17% in GHG emissions would be observed . Such a dietary pattern would contain fewer animal products and savory snacks and more fruit, vegetables, and cereals. It would save an estimated almost 7 million years of life lost prematurely in the UK over the next 30 years and increase average life expectancy by over eight months, primarily due to reduced coronary heart disease. Diets that result in additional reductions in GHG emissions could achieve further net benefits for health. However GHG emissions reductions of greater than 40 % would be difficult to achieve whilst ensuring acceptability and the health benefits may decrease.[xviii]

Animal products can provide an important source of nutrients to some poor communities, particularly to growing children and therefore policy solutions need to take into account local context and nutritional requirements. Pastoralist communities in particular depend on their livestock for survival and may live in locations where productive agriculture is infeasible.

Successful food and agricultural policies will need to address several challenges simultaneously – food insecurity and under-nutrition , particularly in Sub-Saharan Africa, emission of GHGs (including SLCPs), wider issues of sustainability including biodiversity loss and overfishing, and the burgeoning epidemic of diet-related non-communicable diseases. Currently substantial proportions of the world crops are not used directly for feeding humans but rather for feeding livestock (with resulting conversion inefficiencies) and for biofuels, such that 41% of the calories available from global crop production are lost to the food system.[xix]

Garnett has proposed three approaches to food sustainability, defining them as efficiency oriented, demand restraint, and food system transformation.[xx] The efficiency-oriented perspective focuses on food production and proposes technological innovations and managerial changes as key to achieving food system sustainability. The demand restraint approach, in contrast, perceives the challenge as unsustainable consumption patterns, necessitating reduced consumption of high impact foods. The third perspective, food system transformation, proposes socio-economic structural change to achieve social justice and environmental sustainability. It seems likely that all three approaches will be needed to address the challenges of feeding a growing world population in the face of global environmental changes.

---

[i] Smith P., M. Bustamante, H. Ahammad, H. Clark, H. Dong, E.A. Elsiddig, H. Haberl, R. Harper, J. House, M. Jafari, O. Masera, C. Mbow, N.H. Ravindranath, C.W. Rice, C. Robledo Abad, A. Romanovskaya, F. Sperling, and F. Tubiello, 2014: Agriculture, Forestry and Other Land Use (AFOLU). In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

[ii] http://www.nrel.colostate.edu/projects/ghg-resources.html

[iii] FAOSTAT, 2013. FAOSTAT database. *Food and Agriculture Organization of the United Nations*. Available at: http://faostat.fao.org/.

[iv] http://www.fao.org/docrep/014/i2280e/i2280e.pdf Looking ahead in world food and agriculture:Perspectives to 2050 Edited by Piero Conforti

[v] Swiss Center for Life Cycle Inventories, Ecoinvent Databaseversion 2.0. http://www.ecoinvent.org/home/; Peano, L.; Loerincik, Y.; Humbert, S.; Gaillard, G.; Nemecek,T. The LCA world food database project: Towards more accurate LCAs on agricultural and food products. In 8th International Conference on LCA in the Agri-Food Sector, Saint-Malo, France, INRA, 2012; p891; USDA National Agricultural Library, LCA Digital Commons.http://www.lcacommons.gov/; Roches, A.; Nemecek, T.; Gaillard, G.; Plassmann, K.; Sim, S.; King, H.; i Canals, L. M. MEXALCA: A modular method for the extrapolation of crop LCA. Int. J. Life Cycle Assess. 2010, 15 (8), 842−854.

[vi] FAOSTAT, 2013. FAOSTAT database. *Food and Agriculture Organization of the United Nations*. Available at: http://faostat.fao.org/.

[vii] Institution of Mechanical Engineers (2013). Global Food. Waste Not, Want Not. Institution of Mechanical Engineers. http://www.imeche.org/knowledge/themes/environment/global-food

[viii] Liu Y. & Wu F. (2010). Global burden of aflatoxin-induced hepatocellular carcinoma: a risk assessment. *Environmental health perspectives*, 118, 818-24.

[ix] Atehnkeng J., et al. (2008). Evaluation of atoxigenic isolates of Aspergillus flavus as potential biocontrol agents for aflatoxin in maize. *Food additives & contaminants. Part A, Chemistry, analysis, control, exposure & risk assessment*, 25, 1264-71.

[x] Institution of Mechanical Engineers (2013). Global Food. Waste Not, Want Not. Institution of Mechanical Engineers. http://www.imeche.org/knowledge/themes/environment/global-food

[xi] Joyce A , Hallett J , Hannelly T , Carey G The impact of nutritional choices on global warming and policy implications: examining the link between dietary choices and greenhouse gas emissions Energy and Emission Control Technologies 2014 :2. 33-43

[xii] Vieux F, Darmon N, Touazi D, Soler LG. Greenhouse gas emissions of self-selected individual diets in France: changing the diet structure or consuming less? *Ecol Econ*. 2012;75:91–101.

[xiii] Wilson N, Nghiem N, Ni Mhurchu C, Eyles H, Baker MG, Blakely T. Foods and dietary patterns that are healthy, low-cost, and environmentally sustainable: a case study of optimization modeling for New Zealand. *PLoS One*. 2013;8(3):e59648.

[xiv] Berners-Lee M, Hoolohan C, Cammack H, Hewitt CN. The relative greenhouse gas impacts of realistic dietary choices. *Energy Policy*. 2012;43:184–190.

[xv] Friel S, Dangour AD, Garnett T, Lock K, Chalabi Z, Roberts I, Butler A, Butler CD, Waage J, McMichael AJ, Haines A. Public health benefits of strategies to reduce greenhouse-gas emissions: food and agriculture. Lancet 2009; 374: 2016-25

[xvi] Milner J , Green R, Dangour A D , Haines A, Chalabi Z et al under review Health effects of adopting low greenhouse gas emission diets in the UK

[xvii] Barosh L, Friel S, Engelhardt K, Chan L. The cost of a healthy and sustainable diet – who can afford it? *Aust N Z J Public Health*. 2014;38:7–12.

[xviii] Green R, JMilner J, Dangour AD , Haines A, Chalabi Z et al UK food-based greenhouse gas emissions are reduced through healthy and realistic dietary change under review; Milner J , Green R, Dangour A D , Haines A, Chalabi Z et al under review Health effects of adopting low greenhouse gas emission diets in the UK

[xix] Cassidy E.S., West P.C., Gerber J.S. & Foley J.A. (2013). Redefining agricultural yields: from tonnes to people nourished per hectare. *Environmental Research Letters*, 8, 034015.

[xx] Garnett, T. Food sustainability: Problems, perspectives and solutions. Proc. Nutr. Soc. 2013, 72 (01), 29−39.