Global Environmental Change xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

Food choices, health and environment: Effects of cutting Europe's meat and dairy intake

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ARTICLE INFO

Article history:
Received 3 April 2013
Received in revised form 6 February 2014
Accepted 7 February 2014

Keywords:
Human diet
Dietary change
Livestock
Reactive nitrogen
Land use
Greenhouse gas emissions

ABSTRACT

Western diets are characterised by a high intake of meat, dairy products and eggs, causing an intake of saturated fat and red meat in quantities that exceed dietary recommendations. The associated livestock production requires large areas of land and lead to high nitrogen and greenhouse gas emission levels. Although several studies have examined the potential impact of dietary changes on greenhouse gas emissions and land use, those on health, the agricultural system and other environmental aspects (such as nitrogen emissions) have only been studied to a limited extent. By using biophysical models and methods, we examined the large-scale consequences in the European Union of replacing 25–50% of animal-derived foods with plant-based foods on a dietary energy basis, assuming corresponding changes in production. We tested the effects of these alternative diets and found that halving the consumption of meat, dairy products and eggs in the European Union would achieve a 40% reduction in nitrogen emissions, 25–40% reduction in greenhouse gas emissions and 23% per capita less use of cropland for food production. In addition, the dietary changes would also lower health risks. The European Union would become a net exporter of cereals, while the use of soymeal would be reduced by 75%. The nitrogen use efficiency (NUE) of the food system would increase from the current 18% to between 41% and 47%, depending on choices made regarding land use. As agriculture is the major source of nitrogen pollution, this is expected to result in a significant improvement in both air and water quality in the EU. The resulting 40% reduction in the intake of saturated fat would lead to a reduction in cardiovascular mortality. These diet-led changes in food production patterns would have a large economic impact on livestock farmers and associated supply-chain actors, such as the feed industry and meat-processing sector.

1. Introduction

Western diets are characterised by a high intake of animal products, which leads to an intake of saturated fats and red meats that is above dietary recommendations (Linseisen et al., 2009; Ocké et al., 2009; Pan et al., 2012). The consumption of meat, dairy and eggs is increasing, worldwide (FAO, 2006; Kearney, 2010), and this will aggravate the environmental impact related to livestock production (Bouwman et al., 2013; Godfray et al., 2010; Steinfeld et al., 2006; Thornton, 2010). Concerns about animal welfare, reactive nitrogen and greenhouse gas emissions have stimulated public debate in Europe about eating less meat and dairy products (Deckers, 2010a,b; Deemer and Lobao, 2011; Freibauer et al., 2011; Garnett, 2011; Krystallis et al., 2012). This debate draws on a growing consensus in the scientific community about changing 'western' diets possibly having a positive outcome for both human health and the environment (Friel et al., 2009; Godfray et al., 2010; Hawkesworth et al., 2010). There have been numerous life-cycle

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http://dx.doi.org/10.1016/j.gloenvcha.2014.02.004

analyses (de Vries and de Boer, 2010; Nijdam et al., 2012; Weiss and Leip, 2012; Leip et al., 2013), input–output analyses (Tukker et al., 2011) and global assessments (Popp et al., 2010; Stehfest et al., 2013, 2009) of the environmental impact related to meat and dairy consumption and dietary changes. However, these studies do not address the implications for the structure of regional agriculture, even though the expected resource use and environmental impacts of change will manifest themselves the most on that scale. Against this background, the central question being addressed in this article is that of what the consequences would be for the environment and human health if consumers in an affluent world region were to replace part of their consumption of meat, dairy produce and eggs with plant-based foods? This question was explored with a focus on the 27 EU Member States (EU27), a region with a high per-capita intake of animal protein, compared with many other parts of the world.

2. Method and data

2.1. Overview

For this study, a large number of calculation steps were taken to arrive at the final estimates (Fig. S1). To investigate the consequences of dietary change based on reductions in the consumption of meat, dairy and eggs, we developed six alternative diets for the EU27. These diets consist of a 25% or 50% reduction in the consumption of beef, dairy, pig meat, poultry and eggs, which is being compensated by a higher intake of cereals (Table 1, S1). This article only presents the results for the alternative diets with a 50% reduction; those for the 25% reduction option are presented in the supplementary material. We assumed that a reduction in the consumption of meat, dairy and eggs would have a proportional effect on EU livestock production. Fewer livestock would mean a lower demand for feed, including forage (mostly grass and forage maize). The alternative diets therefore would result in opportunities to change the use of some of the land that is currently needed for feeding animals. We explored two scenarios for land that would be affected by such production changes: a greening world and a high prices world. We assessed the effects on greenhouse gas and reactive nitrogen emissions, land use, the use of mineral fertilisers and manure, and on N deposition in Europe. We did not apply a specific time period in the implementation of the alternative diets and land-use scenarios. Furthermore, we only used biophysical models and data to quantify the environmental effects, and only assessed the direct environmental effects on agriculture within the EU. Effects in other regions or other parts of the food chain (e.g. processing, transport, production of mineral fertilisers) were not quantified.

2.2. Alternative diets

We used statistics as compiled by the Food and Agriculture Organization of the United Nations to determine the quantity of commodities used by each EU Member State's food system in 2007 (FAO, 2010). These data represent the national supply. The commodities were aggregated into 12 major commodity groups. However, not all food is consumed, as certain parts are not edible (e.g. bones, peelings) and losses occur during processing, and in retail and preparation (FAO, 2010). Information about these food commodity losses were obtained from the literature (Kantor et al., 1997; Quested and Johnson, 2009). In an alternative approach to determining food losses, we compared FAO supply data with results from national studies that monitor actual food intake (Elmadfa, 2009). The two approaches yielded similar estimates on the relationship between supply and intake. This study is based on data on food commodities as they enter the post-farm food chain. These commodities are consumed both in their basic form (such as eggs or sugar), as well as in processed foods (for example, in bakery products). A 50% reduction diet would cause both forms of consumption to decrease.

The alternative diets that were examined showed contrasting effects of ruminant and monogastric livestock production on resource use and the environment. The production of pig meat, poultry meat and eggs is based almost entirely on cereals and soybean meal, while Europe's grasslands are a major source of feed in the production of beef and dairy. In addition, the literature on life-cycle assessments of food products consistently shows that monogastric meats have smaller carbon and nitrogen footprints than beef (Leip et al., 2013; Lesschen et al., 2011; Weiss and Leip, 2012). The 50% level of reduction was chosen for two reasons. It was expected that, under a 50% reduction in livestock production, most permanent grasslands and domestic by-products would still be used in the agricultural system. With regard to dietary composition, we expect that a 50% reduction in the consumption of livestock products would stay reasonably well within public health guidelines on the intake of proteins, micro-nutrients and vitamins. Maintaining a 50% share of livestock products in the human diet would accommodate a variation in diets among the population, as currently not all individual diets are well-balanced. If the average intake of proteins, iron and vitamins would just match dietary guidelines, there is a risk of deficiency on an individual level (Elmadfa, 2009; Mensink et al., 2013). These considerations, however, certainly do not imply that larger reductions would not be possible.

We assumed that the reduced intake of meat, dairy and eggs would be compensated by an increase in cereals, on the basis of food calorie intake. If the protein intake would drop below the recommended level, pulses (which are high in protein) were added to the scenario diet. The calculations were carried out for each EU Member State and aggregated to the EU27 level. Reductions in consumption were not uniformly applied, but varied per country. In countries with currently low rates of meat and dairy consumption, a lower reduction was assumed, with higher reduction rates for other countries. Consumption levels of sheep and goat meat were maintained at current levels in our alternative diets, because of their role in conserving extensive grasslands in their present state, as these often have both a high biodiversity and

Table 1
Evaluated alternative human diets and corresponding livestock production.

Alternative diet	Human consumption	Livestock production
Reference	Present situation	Present situation
Reference–BF[a]	Present situation	Present situation
−50% beef and dairy[b]	Reduction of 50% in beef and dairy consumption	Reduction of 50% in cattle (in the number of animals)
−50% pig and poultry	Reduction of 50% in pig meat, poultry and egg consumption	Reduction of 50% in pig and poultry production (in the number of animals)
−50% all meat and dairy	Reduction of 50% in all meat, dairy and egg consumption	Reduction of 50% in cattle, pig and poultry production (in the number of animals)

[a] BF = balanced (nitrogen) fertilisation: fertilisation according to crop requirements/recommendation.
[b] The supplementary material also includes the results for three variants of a 25% reduction in consumption: beef and dairy; pig and poultry; and all meats and dairy.

Please cite this article in press as: Westhoek, H., et al., Food choices, health and environment: Effects of cutting Europe's meat and dairy intake. Global Environ. Change (2014), http://dx.doi.org/10.1016/j.gloenvcha.2014.02.004