POLITECNICO di Milano

P.za L. da Vinci, 32 – 20133 Milano – Italy

CONVENZIONE TRA IL MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE ED IL POLITECNICO DI MILANO DEL 24 MARZO 2014 PER L'ATTUAZIONE DELLE METODOLOGIE DI CALCOLO DELL'IMPRONTA DI CARBONIO E DI COMPENSAZIONE DELLE EMISSIONI DI CO2 DI EXPO 2015

Extended abstract sul carbon footprint del cibo

Dipartimento di Energia

Carbon footprint of Italian eating habits: how consumer food choices might lead to a reduction of greenhouse gas emissions

Abstract

The production and consumption of food is responsible for a large portion of anthropogenic greenhouse gas (GHG) emissions. The carbon footprint of the Italian food system was estimated with a "cradle to grave" approach, including post-production food waste. In order to evaluate the mitigation potential of consumers' behavioural changes, a database was compiled with approximately 1,200 values of carbon footprint of food and beverage products, obtained by a systematic review of scientific literature. Then, three alternative diet scenarios, comparable in terms of both energy and protein content, were considered: the same diet with a shift from beef to poultry meat, the typical Mediterranean diet, and a vegetarian diet. Results show that per-capita food-related GHG emissions could be reduced by up to 36%, combining dietary changes and food waste reduction.

1. Introduction

To stabilize greenhouse gas (GHG) concentration in the atmosphere and thereby limit the global warming, the reduction of GHG emissions in the coming decades will have to be very consistent and should cover all sectors; not only the energy system that holds the main responsibility for direct global emissions (IPCC, 2014). Based on actual and expected increases in food consumption, the available projections indicate that, without actions, the GHG emissions from the agricultural sector will rise (Tilman and Clark, 2014). This aspect has been considered for the first time in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report – Working Group III (IPCC, 2014); direct GHG emissions from agricultural activities related to food production are reported to be 10-12% of total GHG emissions worldwide, 2-4% less than the total direct emissions from transport. It is therefore of great interest to compare the contribution to GHG emissions of different food products, in order to assess the benefits that could result from a global transition to food products associated with low emissions.

2. Carbon footprint of Italian eating habits

In order to carry out the analysis, a database of approximately 1,200 carbon footprint of products (CFPs) was set up. The database is organised in 320 food and drink items, and aggregated into 48 product categories. The CFP values (from cradle to retail, excluding related food waste) were gathered from scientific literature data. For the construction of the database

the following sources were used: a database published by the Barilla Centre for Food & Nutrition (BCFN) (BCFN, 2014), three recent scientific articles (BCFN, 2014; Hoolohan et al., 2013; Killian et al., 2013; Saxe et al., 2012), a publication of the Product Sustainability Forum (PSF) (Fisher et al., 2013), three technical publications for coffee (Büsser et al., 2008; Chayer and Kicak, 2015; Humbert et al., 2009), and various Environmental Product Declarations (EPDs) published in the International EPD® System (The International EPD® System, 2015).

Figure 1 shows the resulting CFPs of the most significant food and beverage categories, together with the main statistics for each product group: minimum and maximum values, median, mean, and interquartile range (25% and 75%).

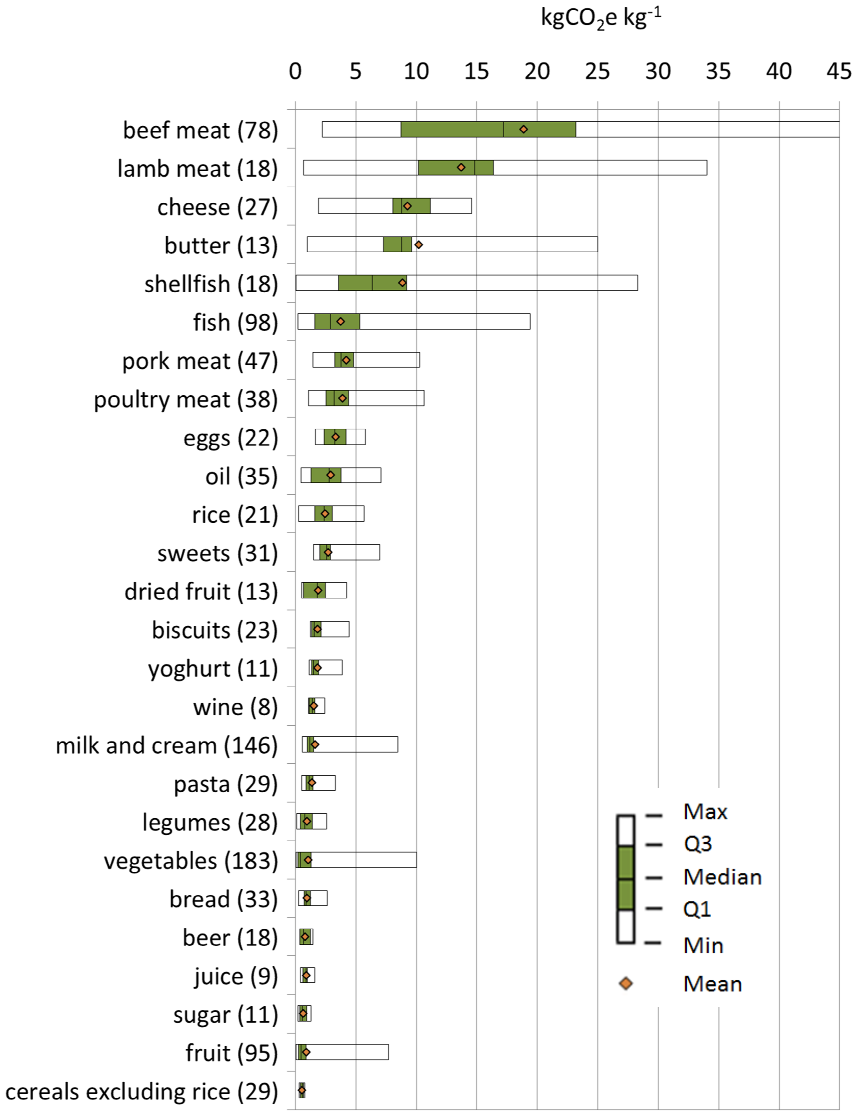

Figure 1: CFP values (cradle to retail) for 26 different food groups considered in the database (in brackets: number of data collected for each category). For beef meat, the maximum value is out of range and is equal to 69 kgCO_2e kg^{-1}.

2.1. Carbon footprint of different types of diets

Globally, one third of edible food produced for human consumption is lost every year (Gustavsson et al., 2011). Therefore, it is important to consider in the CFP assessment the food made available to consumers, not only the amount they actually eat. The annual food balance prepared by the Food and Agriculture Organization (FAO) Statistics Division (FAOSTAT) for each country provides an essential starting point for the study. The most recent food balance sheet for Italy (2011) (FAOSTAT, 2014) contains information on food available to consumers in terms of quantity (considering domestic production, imports, and exports) as well as energy (kcal), protein, and fats. In the FAOSTAT balance sheets, food and drinks are broken down into 69 product groups, and the total availability of food amounted to 828 kg inhabitant^{-1} year^{-1} (edible and non-edible fraction). For each of these 69 product groups, a corresponding item was identified in the database (Figure 1) and the average "cradle to retail" CFP value calculated. Some food items require to be cooked before consumption (*e.g.* rice, meat); to take into account heat used in the preparation stage of these products, specific emissions for cooking were added using the representative data reported in BCFN (2014). By multiplying each of the 69 product groups in the FAOSTAT balance sheet by these specific life cycle emission factors, the impact of the Italian diet was estimated taking into account both food actually consumed and food wasted at point of sale and by the final consumer. The result is 5.4 kgCO_2e inhabitant^{-1} day^{-1}. Considering the entire Italian population (59.5 million people) (ISTAT, 2013), food-related emissions amount to 117 MtCO_2e year^{-1}, 3% less than the direct emissions from the total transport sector in Italy (ISPRA, 2014).

The amount of edible products that are wasted annually (134 kg inhabitant^{-1} year^{-1}: 25% at the distribution stage, and 75% by households and in the food service sector) and the relative GHG emissions (271 kgCO_2e inhabitant^{-1} year^{-1}) were calculated assuming plausible values for the edible portion of each type of food and applying the average FAO percentages of European edible food that is wasted at the distribution and consumption stages (Gustavsson et al., 2011). Thus the maximum mitigation potential of cutting out all avoidable post production food waste in the current Italian food system is 14% of current GHG emissions from food production and consumption.

In order to estimate potential reductions of GHG emissions by dietary changes, three alternative diet scenarios, comparable in terms of both energy (about 2,600 kcal inhabitant^{-1} day^{-1}) and protein content with the current Italian diet, were considered: the same diet with a shift from beef to poultry meat, the typical Mediterranean diet as indicated by the Italian

National Institute for Research on Food and Nutrition (INRAN, 2003), and a vegetarian diet as indicated by the Italian Association for Cancer Research (AIRC, 2015). The CF of the four diet scenarios is reported in Table 1. Each scenario was analysed with or without the assumption of totally eliminating food waste both at distribution and final consumption stages.

Table 1: CF of different dietary scenarios.

Scenario	**CF of diet [kg CO_2e inhab^{-1} day^{-1}]**	**Reduction compared to the baseline [%]**
Baseline: current Italian diet	5.4	-
Baseline b: Baseline + no waste	4.7	14%
Scenario 1: baseline with a shift from beef to poultry meat	4.7	12%
Scenario 1b: Scenario 1 + no waste	4.1	24%
Scenario 2: Mediterranean diet	4.7	13%
Scenario 2b: Scenario 2 + no waste	4.0	26%
Scenario 3: vegetarian diet	4.1	24%
Scenario 3b: Scenario 3 + no waste	3.4	36%

Cutting out all avoidable post-production food waste in the current Italian food system leads to a 14% in GHG emissions from the current food consumption. The largest reduction in GHG emissions is achievable with the vegetarian diet (24% reduction), whereas following the Mediterranean diet and changing beef with poultry meat in the current Italian diet could lead to a 13% and 12% reduction, respectively. Obviously, higher emissions reductions could be achieved combining dietary changes and tackling food waste in the post-production supply chain (up to 36% in case of the vegetarian diet).

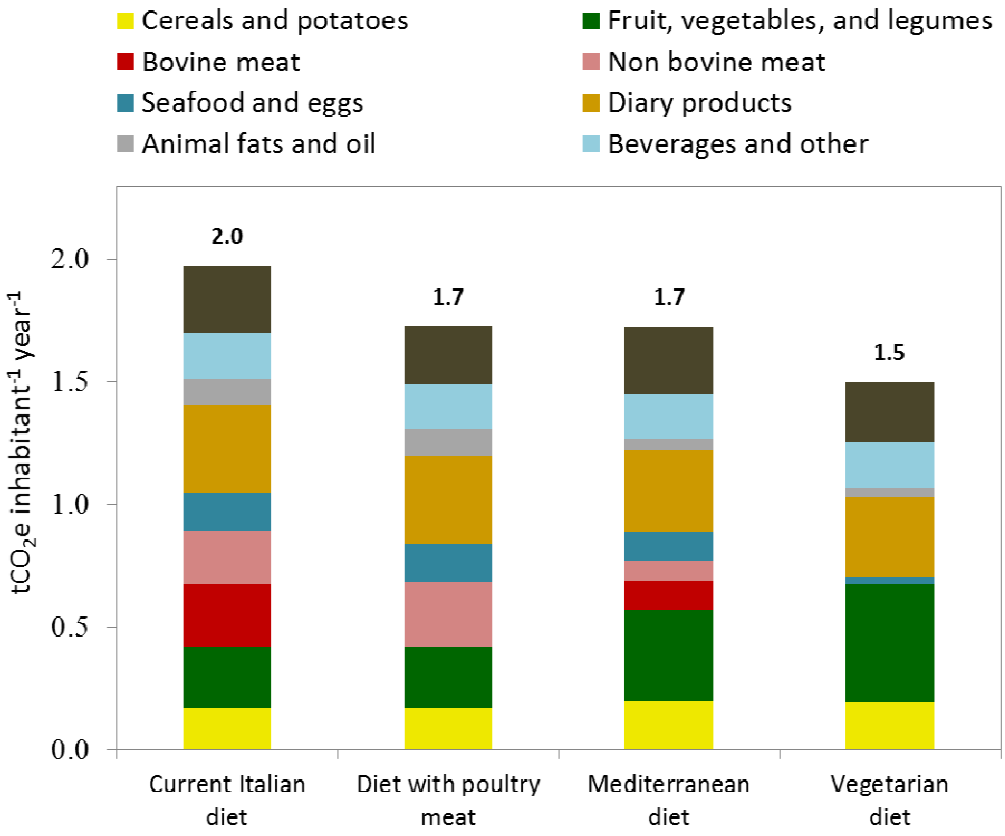

Figure 2: CF (tCO2e inhab^{-1} year^{-1}) of the four diet scenarios.

3. Conclusion

The results presented here indicate that substantial reductions of carbon footprint of eating behaviour can be obtained by reducing food waste, *via* a lower consumption of meat and a higher intake of vegetable protein, or by just preferring chicken or pork over beef. These measures can also have important added benefits for human health, *e.g.* reducing the risk of developing cardiovascular disease and certain types of cancer (Rohrmann et al., 2013; Tilman and Clark, 2014).

Moreover, dietary changes can play an important role in future climate change mitigation policies (Cassidy et al., 2013; Stehfest et al., 2009a; Steinfeld and Gerber, 2010). The transition to a diet with a lower meat consumption could have a huge effect on global agricultural land use (Stehfest et al., 2009b), and also could have positive effects on biodiversity (Tilman and Clark, 2014).

This study, using only GHG emissions as indicator, does not evaluate all environmental impacts generated from food production activities, as well as other socio-economic implications and agro-economic consequences of possible dietary transitions (Stehfest et al., 2009b). With

the aim of planning practical solutions to promote consumers behavioural changes toward a more sustainable diet, future research is needed to explore more in depth the connections between diet, heath, environment, economy, and society.

Finally, it should be remembered that per capita meat consumption is very unequal, for example in sub-Saharan Africa it is one eighth relative to industrialized countries. In poorest countries where nutrition is insufficient and unbalanced meat represents the most concentrated source of vitamins and minerals (Godfray et al., 2010). Therefore, the lowering of meat consumption levels could start in countries where they are already excessive (*e.g.* from a nutritional point of view) (Godfray et al., 2010), *i.e.* countries that are expected to lead the way in reducing GHG emissions.

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