**Appendix**

**Appendix A: Supplementary health methods**

Health methods were based on a similar methodology to that applied in by Springmann et al. in “Mitigation potential and global health impacts from emissions pricing of food commodities” (Springmann et al., 2016).

Number of deaths avoided as a result of diet- and weight-related factors were calculated based on population attributable fractions (PAFs), which characterises the number of disease-attributed deaths avoided when the level of risk exposure transitioned from business-as-usual conditions to those in each of the mapped scenarios. PAFs were calculated using Eq. (A.1):

 Eq. (A.1)

where:

RR(x) = relative risk of disease for a given risk factor level x

P(x) = number of people in the population with a risk factor level x in the business-as-usual scenario

P’(x) = number of people in the population with a risk factor level x in the mapped reduction scenario

Three key risk factors were considered in this study: the burden of coronary heart disease (CHD), stroke and cancers related to excessive meat consumption—each of these carry a level risk dependent on diet-related factors (i.e. level of meat, and red meat intake), and weight-related factors (risk factor based on being clinically overweight or obese). The total PAF (PAFtot) is therefore given as the combined sum of these independent risk factors (PAFi) in Eq. (A.2).

 Eq. (A.2)

To convert this change in risk exposure to number of avoided deaths, independent PAF values were multiplied by their disease-specific death rates (DR) and the number of individuals within a population (P) as in Eq. (A.3):

 Eq. (A.3)

Since disease death rates vary by demographic, population (P) figures were differentiated based on age group and country; and death rates (DR) by age group, and disease. DR values were acquired from the Global Disease Burden project, which defines death rates across 235 mortality causes and 20 age groups (Lozano et al., 2012).

**Diet-related risk factors**

Diet-related risk factors (RR) were based on several assumptions: that the total population was subject to the risk associated with its regional consumption level, c; that risk begin increasing above zero meat intake levels; and these risks have no upper limit. In this assessment, the assumed serving size, s, of meat was taken to be 100g. The risk factor for a given country was therefore defined by Eq. (A.4):

 Eq. (A.4)

This yields a PAF calculation defined by Eq. (A.5):

 Eq. (A.5)

Where c(ref) denotes the consumption level in business-as-usual assumptions, and c(scn) is the level of consumption under meat substitution scenarios.

**Weight-related risk factors**

This analysis considered the number of deaths avoided as a result of a reduction in weight-related disease burden as a result of a reduction in BMI through meat substitution. The relationship between national average BMI and caloric intake was established based on global datasets from the FAO and WHO for the years 1980-2009 (Springmann et al., 2016). This yields the polynomial relationship, Eq (A.6):

 Eq. (A.6)

Where kcal(r) denotes the average daily caloric consumption in a given country and BMI(r) its average BMI value.

Caloric intake and resultant BMI values by country were retrieved from FAO databases (FAO, n.d.), and BMI adjustments in each scenario made based on the change in caloric intake (using nutritional composition values in Table A2) which would occur from the relevant level of meat substitution.

This combined FAO and WHO database also allowed for the calculation of the relationship between average BMI in a given country with the prevalence of overweight individuals (%) (Eq. (A.7)); and the prevalence of obese individuals (%) (Eq. (A.8)). This relationship yielded the following relationships, with an R2 value of 0.73 and 0.97 respectively:

 Eq. (A.7)

 Eq. (A.8)

For each risk category, PAFs were then calculated by Eq. (A.9):

 Eq. (A.9)

Where PPw is the percentage of the population in the overweight-obese or obese categorisation; and P is the individuals in a given population.

**Changes in mortality**

To derive the number of premature deaths avoided, Δdeaths was calculated independently for each of the risk factors, then combined to given the total number of deaths avoided (Eq. (A.10)):

 Eq. (A.10)

**Relative Risk Factors**

The relative risk factors (RR) used for calculation of PAF values by disease were derived based on pooled analyses of cohort studies (Prospective Studies Collaboration et al., 2009) and meta-analysis of cohort and case-control studies (Chen et al., 2013; Micha et al., 2010; World Cancer Research Fund, 2007) utilised in Springmann et al.’s “Mitigation potential and global health impacts from emissions pricing of food commodities” (Springmann et al., 2016). The RR factors applied in this analysis are summarised in Table A4.

**Appendix B: Supplementary Tables**

**Table B1: Population and estimated 2020 meat consumption patterns within the 40 countries included in this analysis.** Population figures have been attained from the UN Population Division (United Nations, 2015) and meat consumption projections from the OECD-FAO Agricultural Outlook (OECD, 2016) for 2020.

**Average per capita consumption (kgyear-1)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Country** | **2020 Population (thousands)** | **Beef** | **Pig** | **Poultry** | **Sheep** |
| Australia | 25598 | 22.1 | 20.6 | 43.5 | 7.1 |
| Canada | 37600 | 17.5 | 16.8 | 35.1 | 0.9 |
| Israel | 8718 | 20.4 | 1.5 | 57.6 | 1.8 |
| Japan | 125039 | 6.8 | 15.2 | 13.9 | 0.1 |
| New Zealand | 4730 | 13.9 | 18.1 | 39.5 | 2.2 |
| Russian Federation | 142898 | 11.5 | 21.4 | 27.9 | 1.2 |
| South Africa | 56669 | 10.7 | 3.4 | 32.9 | 3.1 |
| United States of America (USA) | 333546 | 25.5 | 23.4 | 49.4 | 0.3 |
| Norway | 5494 | 16.4 | 23.9 | 23.9 | 4.8 |
| Switzerland | 8654 | 20.9 | 29.1 | 16.3 | 1.4 |
| Iceland | 342 | 17.4 | 4.96 | 17.0 | 8.1 |
| Ukraine | 43679 | 7.1 | 14.9 | 25.9 | 0.4 |
| EU28 | 507889 | 10.8 | 32.6 | 23.5 | 1.8 |
|  |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Per 100g product** | **Beef** | **Pigmeat** | **Poultry** | **Lamb** | **Quorn™ Mycoprotein** |
| Calories (kcal) | 150 | 326 | 122 | 263 | 85 |
| Protein (g) | 18.5 | 11 | 12.3 | 13.5 | 11 |
| Fat (g) | 7.9 | 31 | 7.7 | 22.8 | 3 |
| Fibre (g) | 0 | 0 | 0 | 0 | 6 |
| Zinc (mg) | 4.1 | 0.7 | 2.1 | 3.3 | 9 |
| Iron (mg) | 2.7 | 0.7 | 0.5 | 1.4 | 0.5 |
| Vitamin B12 (μg) | 2 | 1 | Trace | 2 | 0 |
|  |  |  |  |  |  |

**Table B2: Nutritional composition of average meat commodities and Quorn™ mycoprotein products.** Nutritional composition of meat commodities and mycoprotein based on published nutritional assessments (Denny et al., 2008; Edwards & Cummings, 2010; FAO, 2001; Finnigan, 2010; T. Finnigan et al., 2016).

**Table B3: Greenhouse gas (GHG) intensity of commodity production.** Average GHG intensity (kgCO2ekg-1) of meat and substitute production based on life-cycle analysis (LCA). Meat intensities were assumed based on global average values from FAO full value chain assessments (Gerber et al., 2013), and Quorn™ mycoprotein based on comparable LCA methodologies (Finnigan, 2010; Smetana et al., 2015).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Beef** | **Pigmeat** | **Poultry** | **Lamb** | **Quorn™** **Mycoprotein** |
| GHG intensity (kgCO2ekg-1 product) | 53.05 | 6.08 | 5.76 | 25.58 | 5.6 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Risk factor** |  **CHD** |  **Stroke** |  **Cancer** |
| Meat consumption | 1.25 | 1.1 | 1.16 |
| Overweight | 1.31 | 1.07 | 1.1 |
| Obese | 1.78 | 1.55 | 1.4 |

**Table B4: Relative Risk (RR) parameters for coronary heart disease (CHD), stroke and cancer (forms related to meat consumption and obesity) by factor.**