**The future of meat and dairy consumption in the UK: exploring different policy scenarios to meet net zero targets and improve population health**

**Appendix 1**

**Fiscal scenario method**

To calculate the change in meat, dairy and fruit and vegetable consumption as a consequence of changed prices, we used UK specific price elasticities estimated by Defra using 2009 Family Food data (1). Compensated unconditional price elasticities were available for the whole sample and for the lowest quintile of equivalised household income; uncompensated unconditional price elasticities, which are more disaggregated, were only available for the whole sample. For the uncompensated unconditional price elasticities we mapped the elasticities to the food groups in our dietary analyses as follows: beef, pork, sheep, chicken, dairy (weighted sum of milk, cream, and other dairy), fruit (weighted sum of fresh fruit and tinned and dried fruit) and vegetables (weighted sum of fresh vegetables and canned vegetables). Average weighted price elasticities are shown in **Table 1S**. We assume that price responsiveness remains the same over the study period. For each food item the change in consumption was obtained by the following formula:

Δ*di* = Σ*di* *\** Δ*pi \** $ε\_{ij}$

Where Δ*di*  and Δ*pi* denote percentage changes in demand (*d*) and price (p) for food item *i ,* and$ε\_{ij}$represents a matrix of own-price and cross-price elasticities. **Figure S2** shows the predicted change in demand for foods following a 10% tax (meat and dairy) and subsidy (fruit and vegetables) using both the compensated and uncompensated price elasticities models.

**Innovation scenario method**

To estimate the proportion of meat and dairy that would be substituted with alternative products we multiplied BAU 2030 consumption by the proportional reduction of meat and dairy according to the market share reported in the discrete choice experiments after excluding those who already do not consume meat and dairy proteins. The potential market shares for plant-based meat and cultured meat estimated by the discrete choice experiments were 22% and 9% respectively. This means that if the choice was available between conventionally farmed meat and meat alternatives and the price and taste were assumed to be the same, 69% of consumers would choose conventionally farmed meat and 31% would choose plant-based meat or cultured meat. As there was no discrete choice study predicting dairy alternative market share, we used the same market share as for meat but assumed all substitutions will be with plant-based milk alternatives (31%). We excluded 4% of non-meat consumers (vegetarian or vegan) and 5% of non-dairy consumers based on national survey data from 2018 (2). We therefore estimated that 27% of all meat and 26% of all dairy consumed in 2030 will be substituted for either plant-based or laboratory produced meat and dairy proteins if these were readily available, reasonably priced and had an acceptable taste. To calculate the market share for the lowest income group, we used the data point percentage difference in market share for income categories reported by Van Loo (3). The income categories in the paper were not directly comparable to our sample; we therefore averaged the difference in market share compared to the lowest income category across all income groups and used the inverse.

We assumed that meat and dairy will be substituted with the ingredients making up meat and dairy alternatives according to current market availability and future predictions. The main ingredients of currently available meat analogues are soy proteins, pea proteins, wheat gluten and mycoprotein, which is the product of fermentation from a type of fungus(4). The main ingredients of dairy alternatives are soy, nuts, especially almond, coconut and oat. Cultured meat is composed primarily of animal cells, with the process starting from stem cells, taken from the adult animal or from an embryo. The cells are bathed in a liquid growth medium, then placed in a bioreactor where they grow and proliferate(5). The bulk feedstock of the growth medium has been proposed to come from plant-based constituents, such as soy, wheat and maize or from cyanobacteria hydrolysate(6).

References

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| **Table S1.** Weighted average own and cross-price elasticities of selected food groups |
| **Food affected by a price change** | **Cereals** | **Vegoils** | **Fruit** | **Vegetables** | **Pulses** | **Potatoes** | **Sugar** | **Dairy** | **Eggs** | **Beef** | **Sheep** | **Pork** | **Poultry** |
| Beef  | -0.0037 | -0.0020 | 0.0056 | 0.0000 | 0.0000 | -0.0030 | -0.0030 | 0.0000 | 0.0000 | -0.5940 | -0.0090 | -0.0419 | -0.0590 |
| Lamb  | -0.0010 | -0.0040 | 0.0020 | 0.0000 | 0.0000 | -0.0010 | -0.0010 | 0.0000 | 0.0000 | -0.0120 | -0.5510 | -0.0267 | 0.0010 |
| Pork meat  | -0.0010 | -0.0010 | 0.0020 | 0.0000 | 0.0000 | -0.0010 | -0.0010 | 0.0000 | 0.0000 | -0.0490 | 0.0530 |  | 0.0040 |
| Bacon & ham  | -0.0040 | -0.0020 | 0.0073 | 0.0000 | 0.0000 | -0.0030 | -0.0040 | 0.0000 | 0.0000 | -0.0530 | 0.0000 |  | -0.0020 |
| Sausages  | -0.0010 | -0.0010 | 0.0020 | 0.0000 | 0.0000 | -0.0010 | -0.0010 | 0.0000 | 0.0000 | -0.0980 | -0.1420 |  | -0.0080 |
| Pork Total  | -0.0025 | -0.0015 | 0.0046 | 0.0000 | 0.0000 | -0.0020 | -0.0025 | 0.0000 | 0.0000 | -0.0642 | -0.0257 | -0.7070 | -0.0022 |
| Poultry  | -0.0050 | -0.0030 | 0.0090 | 0.0000 | 0.0000 | -0.0040 | -0.0050 | 0.0000 | 0.0000 | -0.0840 | 0.0440 | 0.0331 | -0.9000 |
| Fresh fruit  | 0.0171 | 0.0020 |  | 0.0008 | 0.0000 | 0.0060 | 0.0060 | 0.0000 | 0.0010 | -0.0060 | -0.0020 | -0.0049 | -0.0100 |
| Tinned fruit  | 0.0102 | 0.0010 |  | 0.0000 | 0.0000 | 0.0040 | 0.0030 | 0.0018 | 0.0000 | -0.0040 | -0.0010 | -0.0032 | -0.0060 |
| Fruit juice  | 0.0000 | 0.0000 |  | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0010 | 0.0000 | -0.0010 | -0.0010 | -0.0007 | -0.0010 |
| Fruit Total  | 0.0122 | 0.0014 | 0.9263 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | -0.0017 | -0.0037 | -0.0074 |
| Fresh Vegetables | 0.0000 | 0.0000 | 0.0000 |  | -0.1920 | 0.0000 | 0.0000 | 0.0047 | 0.0030 | 0.0010 | 0.0010 | 0.0010 | 0.0010 |
| Canned Vegetables | 0.0000 | 0.0000 | 0.0000 |  | 0.5860 | 0.0000 | 0.0000 | 0.0010 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Vegetables Total  | 0.0000 | 0.0000 | 0.0000 | -0.9106 | -0.0097 | 0.0000 | 0.0000 | 0.0039 | 0.0023 | 0.0008 | 0.0008 | 0.0008 | 0.0008 |
| Cheese  | -0.0037 | 0.0000 | -0.0020 | -0.0025 | -0.0010 | -0.0030 | -0.0030 |  | 0.0230 | -0.0010 | -0.0010 | -0.0010 | -0.0010 |
| Cream  | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |  | -0.0070 | 0.0000 | 0.0000 | 0.0000 | -0.0010 |
| Milk  | 0.0025 | 0.0000 | -0.0036 | -0.0053 | -0.0030 | -0.0060 | -0.0060 |  | -0.0100 | -0.0020 | -0.0010 | -0.0010 | -0.0020 |
| Other dairy  | -0.0037 | -0.0020 | -0.0020 | -0.0025 | -0.0010 | -0.0030 | -0.0030 |  | 0.0750 | -0.0020 | -0.0010 | -0.0010 | -0.0020 |
| Dairy Total  | 0.0012 | -0.0003 | -0.0032 | -0.0047 | -0.0025 | -0.0053 | -0.0053 | -0.7900 | 0.0049 | -0.0019 | -0.0010 | -0.0010 | -0.0019 |
| Price elastics data taken from Tiffin, 2011 (25). Average weighted price elasticities for main food groups were calculated by multiplying own and cross price elasticities of individual foods by their proportional consumption within the main food groups  |

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| **Table S2.** Food groups and footprint measures (per kg) used to calculated GHG emissions and water use |
|  | GHG Emissions (kg CO2eq, IPCC2013 incl CC feedbacks) | Water Use (L) | Scarcity Weighted Water Use (L eq) |
| **Cereals** |  |  |   |
| Wheat & Rye (Bread) | 1.6 | 648 | 31,837 |
| Maize (Meal) | 1.7 | 216 | 6,646 |
| Oatmeal | 2.5 | 482 | 11,608 |
| Rice | 4.5 | 2,248 | 56,564 |
| Pasta | 1.6 | 769 |   |
| **Vegetable oils** |  |   |
| Soybean Oil | 6.3 | 415 | 20,946 |
| Palm Oil | 7.3 | 6.4 | 208 |
| Sunflower Oil | 3.6 | 1,008 | 34,215 |
| Rapeseed Oil | 3.8 | 238 | 1,724 |
| Olive Oil | 5.4 | 2,142 | 113,626 |
| Oils Misc. |  |  |   |
| **Fruit** |  |  |   |
| Citrus Fruit | 0.4 | 83 | 3,386 |
| Bananas | 0.9 | 115 | 1,744 |
| Apples | 0.4 | 180 | 1,858 |
| Berries & Grapes | 1.5 | 420 | 12,420 |
| Other Fruit | 1.1 | 154 | 4,905 |
| **Vegetables** |  |  |   |
| Peas | 1.0 | 397 | 13,299 |
| Tomatoes | 2.1 | 370 | 15,756 |
| Onions & Leeks | 0.5 | 14 | 374 |
| Root Vegetables | 0.4 | 28 | 747 |
| Brassicas | 0.5 | 119 | 4,854 |
| Other Vegetables | 0.5 | 103 | 7,367 |
| **Pulses** |  |  |   |
| Lentils | 2.8 | 1,246 |   |
| Other Pulses | 1.8 | 436 | 15,429 |
| **Nuts and seeds** |  |   |
| Sunflower seeds | 1.9 | 561 |   |
| Nuts | 0.4 | 4,134 | 83,077 |
| Groundnuts | 3.2 | 1,852 | 54,853 |
| **Potatoes** | 0.5 | 59 | 2,924 |
| **Sugar and preserves** |  |  |
| Cane Sugar | 3.2 | 620 | 29,118 |
| Beet Sugar | 1.8 | 218 | 1,056 |
| **Dairy** |  |  |  |
| Cheese | 24 | 5,605 | 99,739 |
| Milk | 3.2 | 628 | 16,127 |
| Butter, Cream & Ghee | 1.0 | 27.8 | 1275 |
| **Meat** |  |  |   |
| Bovine Meat (beef herd) | 27 | 1,451 | 36,558 |
| Bovine Meat (dairy herd) | 33 | 2,714 | 80,899 |
| Lamb & Mutton | 28 | 1,803 | 51,740 |
| Pig Meat | 12 | 1,796 | 50,660 |
| Poultry Meat | 10 | 660 | 17,051 |
| Buffalo | 1.9 | 561.1 | 0 |
| **Eggs** | 4.7 | 578 | 18,565 |
| **Fish** |  |  |   |
| Fish (farmed) | 14 | 3,691 | 115,829 |
| Crustaceans (farmed) | 27 | 3,515 | 93,740 |
| Fish (capture) | 1.4 | 3.5 | 18 |
| Crustaceans (capture) | 6.4 | 3.5 | 18 |
| **Dairy and meat alternatives** |   |
| Soymilk | 1.0 | 28 | 1,275 |
| Tofu | 3.2 | 149 | 5,451 |
| Almond milk | 0.7 | 371 | 20027 |
| Oat milk | 0.9 | 48 |   |
| Rice milk | 1.2 | 270 |   |
| **Alcoholic beverages** |  |   |
| Barley (Beer) | 1.2 | 17 | 982 |
| Wine | 1.8 | 79 | 2,298 |
| **Stimulants** |  |  |   |
| Coffee | 29 | 26 | 659 |
| Tea | 21 | 20 | 0 |
| Dark Chocolate (70% cocoa) | 34 | 564 | 17,206 |
| Milk Chocolate | 23 | 1,651 | 17,206 |
| Values from Poore. & Nemecek (2018) |
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| Observed and forecasted UK food consmption (g/d/pp) for selected foods and drinks |
| **Vegetable oils** | **Fish** |
| Chart  Description automatically generated | Chart  Description automatically generated |
| **Soft drinks** | **Alcoholic drinks** |
| Chart  Description automatically generated | Chart, line chart  Description automatically generated |
| **Tea, coffee and cocoa drinks** |  |
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**Figure S1.** Trajectories of past and predicted business as usual (BAU) estimated consumption of selected foods and drinks in the UK. X axis shows year and Y axis shows estimated consumption in grams per person per day.

**Figure S2**. Effect of a 10% meat and dairy tax and a 10% subsidy on fruit and vegetable using different price elasticities

Levels 2 unconditional uncompensated models produced lower across food groups cross-elasticities compared to conditional uncompensated models as substitutions were more likely to be within food groups (i.e. substituting fresh vegetable with processed vegetable or expensive meats with cheaper ones)

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| 1. Food intake in 2019
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| 1. Predicted changes in food intake between 2019 – 2030
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**Figure S3.** Baseline and predicted changes in food intake among low income and the whole sample in the Family Foods survey