**Supplementary Tables for:**

**Rebound effects could offset more than half of avoided food waste and loss**

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**Table 1 | Price elasticities of demand.** Range of estimates for elasticities of demand for different income regions from Green et al (2013). While Green et al analyzed 10 food groups, our study included equivalents for Fruits and Vegetables, Meat, Dairy, Cereals, and Fats and Oils only.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low Income** | | | **Middle Income** | | | **High Income** | | |
|  | **n = 1412** | | | **n = 827** | | | **n = 1124** | | |
| **Food Groups** | *Low* | *Average* | *High* | *Low* | *Average* | *High* | *Low* | *Average* | *High* |
| Fruits & Vegetables | -0.77 | -0.72 | -0.66 | -0.71 | -0.65 | -0.59 | -0.59 | -0.53 | -0.48 |
| Meat | -0.83 | -0.78 | -0.73 | -0.78 | -0.72 | -0.66 | -0.66 | -0.60 | -0.54 |
| Dairy | -0.84 | -0.78 | -0.73 | -0.78 | -0.72 | -0.66 | -0.66 | -0.60 | -0.54 |
| Cereals | -0.66 | -0.61 | -0.56 | -0.61 | -0.55 | -0.49 | -0.48 | -0.43 | -0.36 |
| Fats and oils | -0.65 | -0.60 | -0.54 | -0.60 | -0.54 | -0.47 | -0.48 | -0.42 | -0.35 |

**Table 2 | Food type key.** This key translate correlates the FAO food types to the nearest equivalent of food types used by Green et al 2013.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Green et al 2013** | | **FAO Food Types** | | | | **Green Equivalency** | | |
| 1 | Fruits & Vegetables | 1 | Cereals | | | 6 | | |
| 2 | Meat | 2 | Fruits and Vegetables | | | 1 | | |
| 3 | Fish | 3 | Meat | | | 2 | | |
| 4 | Dairy | 4 | Milk | | | 4 | | |
| 5 | Eggs | 5 | Oilcrops and Pulses | | | 7 | | |
| 6 | Cereals | 6 | Roots and Tubers | | | 6 | | |
| 7 | Fats & Oils |
| 8 | Sweets, confectionary, & sweetened beverages |  |  |  |  |  |  |  |
| 9 | Other |  |  |  |  |  |  |  |
| 10 | All food groups combined |  |  |  |  |  |  |  |

**Table 3 | Region-income-group key.** This key determines SDG regions of interest as high, middle, or low income as determined by Green et al 2013 and the World Bank.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Green et al 2013** | | **SDG Region** | | **Green Equivalency** | |
| 1 | Low | 1 | Australia and New Zealand | 3 | High |
| 2 | Middle | 2 | Central and Southern Asia | 2 | Middle |
| 3 | High | 3 | Eastern and South-Eastern Asia | 2 | Middle |
|  |  | 4 | Latin America and the Caribbean | 2 | Middle |
|  |  | 5 | Northern America and Europe | 3 | High |
|  |  | 6 | Oceania (excluding Australia and New Zealand) | 2 | Middle |
|  |  | 7 | Sub-Saharan Africa | 1 | Low |
|  |  | 8 | Western Asia and Northern Africa | 2 | Middle |

**Table 4 | Price elasticities of supply .** Price elasticities of supply as determined by the USDA Economic Research Service (ERS) SWOPSIM Model Appendix Table 755. We map the SDG regions and food types to the SWOPSIM model categories as follows: We assume meat and milk are livestock products while the remaining food types are crops. Northern America and Europe are assumed to have supply elasticities estimated for the “United States” region in the SWOPSIM model; Australia and New Zealand are assumed to have supply elasticities from “Other developed-market economies” region in the SWOPSIM model; the remaining regions are given the corresponding “Rest of the World” region supply elasticities from the SWOPSIM model.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Region/Food Type* | *Australia and New Zealand* | *Central and Southern Asia* | *Eastern and South-Eastern Asia* | *Latin America and the Caribbean* | *Northern America and Europe* | *Oceania (excluding Australia and New Zealand)* | *Sub-Saharan Africa* | *Western Asia and Northern Africa* |
| *Cereals* | 0.35 | 0.29 | 0.29 | 0.29 | 0.31 | 0.29 | 0.29 | 0.29 |
| *Fruits and Vegetables* | 0.35 | 0.29 | 0.29 | 0.29 | 0.31 | 0.29 | 0.29 | 0.29 |
| *Meat* | 0.60 | 0.49 | 0.49 | 0.49 | 0.63 | 0.49 | 0.49 | 0.49 |
| *Milk* | 0.60 | 0.49 | 0.49 | 0.49 | 0.63 | 0.49 | 0.49 | 0.49 |
| *Oilcrops and Pulses* | 0.35 | 0.29 | 0.29 | 0.29 | 0.31 | 0.29 | 0.29 | 0.29 |
| *Roots and Tubers* | 0.35 | 0.29 | 0.29 | 0.29 | 0.31 | 0.29 | 0.29 | 0.29 |

**Tables 5 | Aggregated food supply for human consumption for all regions and food types.** Food supply values calculated using Equation 3b for all region and food type combinations using FAOSTAT data from the year 2019. For a more detailed aggregation process, see Supplementary Data 1.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Food Supply (Mt)** | | | | | | |
| *Food Type / Region* | *Cereals* | *Fruits and Vegetables* | *Meat* | *Milk* | *Oilcrops and Pulses* | *Roots and Tubers* |
| *Australia and New Zealand* | 2.39E+07 | 7.22E+06 | 3.45E+06 | 4.68E+07 | 3.07E+06 | 1.90E+06 |
| *Central and Southern Asia* | 8.49E+08 | 3.36E+08 | 1.42E+07 | 2.62E+08 | 1.11E+08 | 9.14E+07 |
| *Eastern and South-Eastern Asia* | 1.43E+09 | 9.99E+08 | 1.24E+08 | 6.66E+07 | 6.13E+08 | 2.57E+08 |
| *Latin America and the Caribbean* | 3.49E+08 | 1.50E+08 | 4.30E+07 | 1.02E+08 | 1.60E+08 | 5.43E+07 |
| *Northern America and Europe* | 1.06E+09 | 2.86E+08 | 1.28E+08 | 5.68E+08 | 2.03E+08 | 1.39E+08 |
| *Oceania (excluding Australia and New Zealand)* | 1.37E+06 | 3.59E+06 | 7.24E+05 | 1.05E+05 | 4.96E+06 | 2.54E+06 |
| *Sub-Saharan Africa* | 3.11E+08 | 1.34E+08 | 1.09E+07 | 3.15E+07 | 7.54E+07 | 3.52E+08 |
| *Western Asia and Northern Africa* | 2.80E+08 | 1.48E+08 | 1.33E+07 | 7.39E+07 | 3.52E+07 | 2.46E+07 |

**Tables 6 | Consumer food price indices by region.** Consumer food price indices from 2019 provided by FAOSTAT.

|  |  |
| --- | --- |
| **Region** | **Consumer Price, Food Indices** |
| Australia and New Zealand | 103.79 |
| Central and Southern Asia | 128.24 |
| Eastern and South-Eastern Asia | 110.37 |
| Latin America and the Caribbean | 139.22 |
| Northern America and Europe | 104.65 |
| Oceania (excluding Australia and New Zealand) | 106.89 |
| Sub-Saharan Africa | 151.64 |
| Western Asia and Northern Africa | 145.98 |

**Tables 7 | Food loss and waste percentages by region.** Food loss is determined using officially reported data from FAOSTAT supply utilization accounts. For food waste, we sum food waste across all regions from the 2021 Food Waste Index (FWI) report. Note that because the UNEP report does not distinguish between differences in in food types, we assume the same fraction of food wasted for each food type. For a more detailed calculation and assumptions, see Supplementary Data 1.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Food Loss (tonnes)** | | | | | | |
| *Food Type / Region* | *Cereals* | *Fruits and Vegetables* | *Meat* | *Milk* | *Oilcrops and Pulses* | *Roots and Tubers* |
| *Australia and New Zealand* | 32578 | 318195 | 0 | 16575 | 6725 | 31873 |
| *Central and Southern Asia* | 7439096 | 26529304 | 32970 | 4101106 | 1406225 | 10163465 |
| *Eastern and South-Eastern Asia* | 9231692 | 70753491 | 523688 | 1437025 | 1376443 | 6279558 |
| *Latin America and the Caribbean* | 4066350 | 12653765 | 486422 | 2837753 | 416845 | 2515427 |
| *Northern America and Europe* | 3096841 | 12384451 | 250263 | 226253 | 292025 | 5691997 |
| *Oceania (excluding Australia and New Zealand)* | 1738 | 264635 | 580 | 1327 | 22655 | 161229 |
| *Sub-Saharan Africa* | 4780094 | 11427810 | 36779 | 1036772 | 1602835 | 12904918 |
| *Western Asia and Northern Africa* | 3178059 | 11719339 | 64343 | 1390285 | 284740 | 2522037 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Food Waste (tonnes)** | | | | | | |
| *Food Type / Region* | *Cereals* | *Fruits and Vegetables* | *Meat* | *Milk* | *Oilcrops and Pulses* | *Roots and Tubers* |
| *Australia and New Zealand* | 428599 | 793381 | 532100 | 651574 | 32253 | 267017 |
| *Central and Southern Asia* | 57549974 | 56798905 | 2778599 | 37637199 | 7574131 | 12483126 |
| *Eastern and South-Eastern Asia* | 59714024 | 140328951 | 20163570 | 7772545 | 5668945 | 20769739 |
| *Latin America and the Caribbean* | 13217756 | 19702451 | 7718198 | 9731096 | 2048717 | 5353139 |
| *Northern America and Europe* | 17110314 | 31728966 | 13326441 | 20292089 | 1111377 | 11203361 |
| *Oceania (excluding Australia and New Zealand)* | 152570 | 649778 | 148228 | 15437 | 120362 | 407871 |
| *Sub-Saharan Africa* | 40416885 | 37871788 | 3734401 | 7373014 | 6415517 | 51013243 |
| *Western Asia and Northern Africa* | 19479217 | 26770831 | 3004221 | 8968743 | 1691539 | 3977919 |

**Tables 8a-d | Aggregated results for all regions and food types.** Median rebound percent (R) (a), the change in the market quantity traded (∆T) (b), waste avoided (∆W) (c), and loss avoided (∆L) (d) for all region and food type combinations.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1. **Rebound Percent (%)** | | | | | | | |
| *Food Type / Region* | *Cereals* | *Fruits and Vegetables* | *Meat* | *Milk* | *Oilcrops and Pulses* | *Roots and Tubers* | *Fish and Seafood* |
| *Australia and New Zealand* | 0.58 | 0.64 | 0.53 | 0.53 | 0.58 | 0.58 | 0.58 |
| *Central and Southern Asia* | 0.64 | 0.69 | 0.57 | 0.58 | 0.64 | 0.65 | 0.64 |
| *Eastern and South-Eastern Asia* | 0.64 | 0.68 | 0.57 | 0.57 | 0.64 | 0.64 | 0.64 |
| *Latin America and the Caribbean* | 0.65 | 0.69 | 0.57 | 0.58 | 0.64 | 0.65 | 0.65 |
| *Northern America and Europe* | 0.58 | 0.64 | 0.53 | 0.53 | 0.58 | 0.58 | 0.58 |
| *Oceania (excluding Australia and New Zealand)* | 0.64 | 0.69 | 0.57 | 0.59 | 0.64 | 0.65 | 0.64 |
| *Sub-Saharan Africa* | 0.68 | 0.71 | 0.60 | 0.61 | 0.67 | 0.68 | 0.68 |
| *Western Asia and Northern Africa* | 0.65 | 0.69 | 0.58 | 0.58 | 0.64 | 0.65 | 0.65 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1. **Change in the quantity traded (Mt)** | | | | | | | |
| *Food Type / Region* | *Cereals* | *Fruits and Vegetables* | *Meat* | *Milk* | *Oilcrops and Pulses* | *Roots and Tubers* | *Fish and Seafood* |
| *Australia and New Zealand* | -8.02E-02 | -4.14E-02 | -1.26E-01 | -1.49E-01 | -4.84E-03 | -4.65E-02 | -8.02E-02 |
| *Central and Southern Asia* | -7.84E+00 | 1.45E-01 | -5.82E-01 | -6.81E+00 | -9.19E-01 | 1.14E+00 | -7.84E+00 |
| *Eastern and South-Eastern Asia* | -7.70E+00 | 1.95E+00 | -4.16E+00 | -1.24E+00 | -5.85E-01 | -1.67E+00 | -7.70E+00 |
| *Latin America and the Caribbean* | -1.03E+00 | 1.26E+00 | -1.50E+00 | -1.24E+00 | -2.32E-01 | -1.30E-01 | -1.03E+00 |
| *Northern America and Europe* | -2.69E+00 | -1.82E+00 | -3.09E+00 | -4.75E+00 | -1.51E-01 | -6.73E-01 | -2.69E+00 |
| *Oceania (excluding Australia and New Zealand)* | -2.66E-02 | -1.15E-02 | -3.13E-02 | -2.79E-03 | -1.44E-02 | -1.95E-02 | -2.66E-02 |
| *Sub-Saharan Africa* | -4.92E+00 | -1.35E+00 | -7.27E-01 | -1.14E+00 | -5.07E-01 | -3.81E+00 | -4.92E+00 |
| *Western Asia and Northern Africa* | -2.41E+00 | -1.54E-01 | -6.11E-01 | -1.49E+00 | -2.12E-01 | 1.25E-01 | -2.41E+00 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1. **Waste Avoided (Mt)** | | | | | | | |
| *Food Type / Region* | *Cereals* | *Fruits and Vegetables* | *Meat* | *Milk* | *Oilcrops and Pulses* | *Roots and Tubers* | *Fish and Seafood* |
| *Australia and New Zealand* | 2.14E-01 | 3.97E-01 | 2.66E-01 | 3.26E-01 | 1.61E-02 | 1.34E-01 | 2.14E-01 |
| *Central and Southern Asia* | 2.88E+01 | 2.84E+01 | 1.39E+00 | 1.88E+01 | 3.79E+00 | 6.24E+00 | 2.88E+01 |
| *Eastern and South-Eastern Asia* | 2.99E+01 | 7.02E+01 | 1.01E+01 | 3.89E+00 | 2.83E+00 | 1.04E+01 | 2.99E+01 |
| *Latin America and the Caribbean* | 6.61E+00 | 9.85E+00 | 3.86E+00 | 4.87E+00 | 1.02E+00 | 2.68E+00 | 6.61E+00 |
| *Northern America and Europe* | 8.56E+00 | 1.59E+01 | 6.66E+00 | 1.01E+01 | 5.56E-01 | 5.60E+00 | 8.56E+00 |
| *Oceania (excluding Australia and New Zealand)* | 7.63E-02 | 3.25E-01 | 7.41E-02 | 7.72E-03 | 6.02E-02 | 2.04E-01 | 7.63E-02 |
| *Sub-Saharan Africa* | 2.02E+01 | 1.89E+01 | 1.87E+00 | 3.69E+00 | 3.21E+00 | 2.55E+01 | 2.02E+01 |
| *Western Asia and Northern Africa* | 9.74E+00 | 1.34E+01 | 1.50E+00 | 4.48E+00 | 8.46E-01 | 1.99E+00 | 9.74E+00 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1. **Loss Avoided (Mt)** | | | | | | | |
| *Food Type / Region* | *Cereals* | *Fruits and Vegetables* | *Meat* | *Milk* | *Oilcrops and Pulses* | *Roots and Tubers* | *Fish and Seafood* |
| *Australia and New Zealand* | 1.63E-02 | 1.59E-01 | 0.00E+00 | 8.29E-03 | 3.36E-03 | 1.59E-02 | 1.63E-02 |
| *Central and Southern Asia* | 3.72E+00 | 1.33E+01 | 1.65E-02 | 2.05E+00 | 7.03E-01 | 5.08E+00 | 3.72E+00 |
| *Eastern and South-Eastern Asia* | 4.62E+00 | 3.54E+01 | 2.62E-01 | 7.19E-01 | 6.88E-01 | 3.14E+00 | 4.62E+00 |
| *Latin America and the Caribbean* | 2.03E+00 | 6.33E+00 | 2.43E-01 | 1.42E+00 | 2.08E-01 | 1.26E+00 | 2.03E+00 |
| *Northern America and Europe* | 1.55E+00 | 6.19E+00 | 1.25E-01 | 1.13E-01 | 1.46E-01 | 2.85E+00 | 1.55E+00 |
| *Oceania (excluding Australia and New Zealand)* | 8.69E-04 | 1.32E-01 | 2.90E-04 | 6.64E-04 | 1.13E-02 | 8.06E-02 | 8.69E-04 |
| *Sub-Saharan Africa* | 2.39E+00 | 5.71E+00 | 1.84E-02 | 5.18E-01 | 8.01E-01 | 6.45E+00 | 2.39E+00 |
| *Western Asia and Northern Africa* | 1.59E+00 | 5.86E+00 | 3.22E-02 | 6.95E-01 | 1.42E-01 | 1.26E+00 | 1.59E+00 |

**Table 9 | Environmental impact factor key.** Equivalents for FAO food types analyzed and food groups for categories with impact factors in the 2019 FAO State of Food and Agriculture (SOFA) Report. Note that we create a 5th impact factor type by using a weighted food supply average of categories 1 and 4 from the 2019 FAO SOFA Report to more accurately reflect the impact of Oilcrops and Pulses (column 2).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **2019 SOFA Report** | | **FAO Food Type** | | **Key** |
| 1 | Cereals and Pulses | 1 | *Cereals* | *1* |
| 2 | Fruits and Vegetables | 2 | *Fruits and Vegetables* | *2* |
| 3 | Meat and Animal Products | 3 | *Meat* | *3* |
| 4 | Roots, Tubers, and Oilbearing Crops | 4 | *Milk* | *3* |
|  |  | 5 | *Oilcrops and Pulses* | *5\** |
|  |  | 6 | *Roots and Tubers* | *4* |
|  |  | 7 | *Fish and Seafood* | *3* |

**Table 10 | Environmental impact factors.** 2019 State of Food and Agriculture impact factors for food loss and waste. We create a production-weighted average to represent Oilseeds and Pulses (column 5) for ease of analysis among food types (see Table 9 for equivalencies).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Carbon Impact Factor (Tonne of CO2 eqv/Tonne of food lost)** | | | | | |
| Food Type / SDG Region | Cereals and Pulses | Fruits and Vegetables | Meat and Animal Products | Roots, Tubers, and Oilbearing Crops | Average Oil/Pulses |
| Australia and New Zealand | 1.6 | 1.8 | 1.4 | 1.6 | 1.6 |
| Central and Southern Asia | 2.2 | 1.1 | 2.3 | 1.0 | 1.8 |
| Eastern and South-Eastern Asia | 2.6 | 1.0 | 5.6 | 1.0 | 1.2 |
| Latin America and the Caribbean | 1.7 | 1.1 | 4.4 | 1.3 | 1.5 |
| Northern America and Europe | 1.5 | 1.5 | 1.6 | 0.7 | 1.1 |
| Oceania (excluding Australia and New Zealand) | 2.3 | 1.1 | 3.6 | 2.3 | 2.3 |
| Sub-Saharan Africa | 1.9 | 0.5 | 2.3 | 0.5 | 1.4 |
| Western Asia and Northern Africa | 0.5 | 1.0 | 4.2 | 1.1 | 0.8 |
|  |  |  |  |  |  |
| **Water Impact Factor (m3 /tonne of food lost)** | | | | | |
| Food Type/ Region | Cereals and Pulses | Fruits and Vegetables | Meat and Animal Products | Roots, Tubers, and Oilbearing Crops | Average Oil/Pulses |
| Australia and New Zealand | 57.3 | 212.9 | 82.0 | 96.7 | 85.0 |
| Central and Southern Asia | 609.1 | 266.7 | 564.6 | 741.8 | 656.2 |
| Eastern and South-Eastern Asia | 130.0 | 301.8 | 181.6 | 17.9 | 32.6 |
| Latin America and the Caribbean | 146.9 | 271.8 | 168.1 | 28.0 | 100.1 |
| Northern America and Europe | 64.3 | 242.3 | 65.2 | 39.7 | 50.7 |
| Oceania (excluding Australia and New Zealand) | 354.3 | 301.8 | 174.7 | 14.0 | 24.5 |
| Sub-Saharan Africa | 146.7 | 239.9 | 161.5 | 147.9 | 147.1 |
| Western Asia and Northern Africa | 538.0 | 226.8 | 977.3 | 624.1 | 581.0 |
|  |  |  |  |  |  |
| **Land Impact Factor (ha/tonne of food lost)** | | | | | |
| Food Type/Region | Cereals and Pulses | Fruits and Vegetables | Meat and Animal Products | Roots, Tubers, and Oilbearing Crops | Average Oil/Pulses |
| Australia and New Zealand | 0.8 | 0.1 | 2.5 | 0.0 | 0.2 |
| Central and Southern Asia | 0.4 | 0.1 | 12.6 | 0.2 | 0.3 |
| Eastern and South-Eastern Asia | 0.3 | 0.1 | 11.8 | 0.2 | 0.2 |
| Latin America and the Caribbean | 0.6 | 0.1 | 4.0 | 0.2 | 0.4 |
| Northern America and Europe | 0.3 | 0.1 | 1.2 | 0.1 | 0.2 |
| Oceania (excluding Australia and New Zealand) | 0.5 | 0.1 | 4.5 | 0.3 | 0.3 |
| Sub-Saharan Africa | 0.9 | 0.1 | 17.0 | 0.6 | 0.8 |
| Western Asia and Northern Africa | 0.9 | 0.1 | 29.1 | 0.2 | 0.6 |

**Table 11 | Results for environmental impacts.** Global quantities for possible impact avoided without rebound effects (column 1) and the actual impact avoided with rebound effects (column 2) in environmental impacts due to rebound effects of avoided food waste and loss. Column 3 represents the percent offset due to rebound effects.

|  |  |  |  |
| --- | --- | --- | --- |
| **Environmental Impact** | **Possible impact avoided without rebound effects** | **Actual impact avoided with rebound effects** | **Offset (%)** |
| Emissions (Mt CO2 eqv) | 804.6 | 295.7 | 63 |
| Water (m3) | 1.45\* 1011 | 5.06\* 1010 | 65 |
| Land (ha) | 9.38 \* 108 | 3.86 \* 108 | 59 |