Supplementary Information and Extended Data

UK's fruit and vegetable supply increasingly dependent on imports from climate vulnerable producing countries.

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Supplementary Tables

Supplementary Table 1: Fresh produce supply and trade statistics (Source DEFRA). *Available at:* *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/822083/hort-dataset-01aug19.xlsx*

*1987 was not available from DEFRA statistics

Year	Metric	Unit	Fruit	Vegetables	Fruit + Vegetables
1988*	UK production	*1000 tonnes*	435.6	2856	3292
	Imports	*1000 tonnes*	2086	719.5	4556
	(Re)exports	*1000 tonnes*	49	39.1	88.1
	Supply produced in UK	**%**	**17.6**	**80.8**	**54.8**
2013	UK production	*1000 tonnes*	522.5	2370	2893
	Imports	*1000 tonnes*	3836	2225	6061
	(Re)exports	*1000 tonnes*	143	80.5	223.5
	Supply produced in UK *(%)*	**%**	**12.4**	**52.5**	**33.1**

Supplementary Table 2. Weighted Percentage of Fruit and Vegetable Supply from Top Countries and Average Rainfall. Average rainfall was determined for each country from data provided by the National Centers for Environmental Information – National Oceanic and Atmospheric Administration (NOAA – Climate Online Data) and stratified based on average rainfall. Percent total fruit and vegetable supply for countries included in each rainfall category (<200, 200-400, >400) is presented in Figure X4 for years 1987, 2000, and 2013.

Countries	**2013**	**2000**	**1987**	**Average Rainfall in growing season (mm)**
Colombia	2.10	0	0	1374
Brazil	2.72	2.56	1.52	1131
Costa Rica	2.92	2.37	0	650
Ecuador	1.44	0	0	556
Dominican Republic	1.61	0	0	483
United States	2.57	5.31	2.71	438
United Kingdom	24.6	37.7	48.0	335
China	4.84	2.75	0	330
India	1.95	0	0	330
Netherlands	5.62	4.36	4.06	329
Belgium	1.93	1.67	1.15	329
South Africa	3.40	3.63	3.04	312
Poland	1.76	0	0	301
France	3.76	5.38	5.86	295
Morocco	1.20	0	0	257
Egypt	1.39	0	0	257
Italy	10.0	11.1	11.7	248
Spain	17.5	14.3	10.4	**184**
Turkey	3.00	3.84	1.79	**157**
Portugal	2.71	2.32	0	**136**
Greece	1.30	2.67	5.48	**130**
Chile	1.64	0	0	**118**
Cyprus	0	0	1.28	**30.1**
Israel	0	0	2.96	**5.49**

Supplementary Table 3. Percent Total Fruit and Vegetable Supply from Countries Based on Average Rainfall Category

Average Rainfall	2013	2000	1987
<200	26.2	23.2	21.9
200-400	60.5	66.6	73.8
>400	13.4	10.2	4.24
Grand Total	100	100	100

Supplementary Table 4. Percent consumption of crops by sex for crops of which >50% are produced in climate vulnerable countries vs "resilient crops" in 2013. NDNS consumption data stratified by sex (supplementary table 4) and country (supplementary table 5) did not show major differences in terms of consumption of crops of which >50% are produced in climate vulnerable countries as compared to more "resilient crops" (those where <50% are produced in climate vulnerable countries).

Crop	Female %	Male %
Tomatoes	20.8	25.8
Bananas	10.2	9.67
Oranges	8.62	10.6
Apples	8.53	8.68
Onions, dry	6.05	6.53
Carrots and turnips	5.88	4.52
Grapes	5.278	4.34
Cauliflower and broccoli	4.23	3.17
Peas, green	3.53	3.73
Tangerines, mandarins, clementine, satsumas	2.77	2.04
Lettuce and chicory	2.68	2.39
Cabbages and other brassicas	2.61	2.33
Cucumbers and gherkins	2.37	1.95
Chillies and peppers, green	2.19	1.92
Pears	2.17	2.37
Strawberries	2.02	1.24
Mushrooms and truffles	1.97	2.24
Peaches and nectarines	1.39	1.33
Sweet corn	1.38	-
String beans	1.18	1.23
Pumpkins, squash and gourds	1.17	-
Plums and sloes	1.05	1.21
Avocados	1.01	-
Mangoes, mangosteens, guavas	0.95	-
Blueberries	-	1.52
Raspberries	-	1.20
Climate Vulnerable Crops	**29.0**	**29.4**
Resilient Crops	**71.0**	**70.6**

Supplementary Table 5. Percent consumption of crops by country for crops of which >50% are produced in climate vulnerable countries vs "resilient crops" in 2013

Crop	England %	Wales %	Scotland %	Northern Ireland %
Tomatoes	22.9	27.5	26.0	23.9
Bananas	9.91	8.95	11.0	12.7
Oranges	9.61	9.23	10.3	10.9
Apples	8.50	8.21	10.5	9.13
Onions, dry	6.34	5.01	7.00	6.00
Carrots and turnips	5.09	5.88	6.16	6.43
Grapes	5.01	4.60	3.34	3.68
Cauliflower and broccoli	3.68	3.75	3.80	5.26
Peas, green	3.54	4.87	4.03	3.82
Lettuce and chicory	2.69	1.89	1.67	1.71
Cabbages and other brassicas	2.57	2.89	1.09	2.67
Tangerines, mandarins, clementines etc	2.38	2.26	2.83	2.92
Cucumbers and gherkins	2.32	1.76	1.18	
Pears	2.26	2.21	2.38	2.94
Chillies and peppers, green	2.09	1.49	2.20	2.15
Mushrooms and truffles	2.08	2.40	2.40	2.02
Strawberries	1.71	1.58	1.04	1.39
Peaches and nectarines	1.39	-	1.72	-
String beans	1.26	1.46	-	-
Blueberries	1.25	-	-	-
Plums and sloes	1.18	-	-	-
Sweet corn	1.14	1.17	-	2.49
Raspberries	1.06	-	-	-
Grapefruit and pomelos	-	1.74	-	-
Pineapples	-	1.16	1.30	-
Climate Vulnerable Crops	**29.3**	**27.9**	**28.7**	**30.0**
Resilient Crops	**70.7**	**72.1**	**71.3**	**70.0**

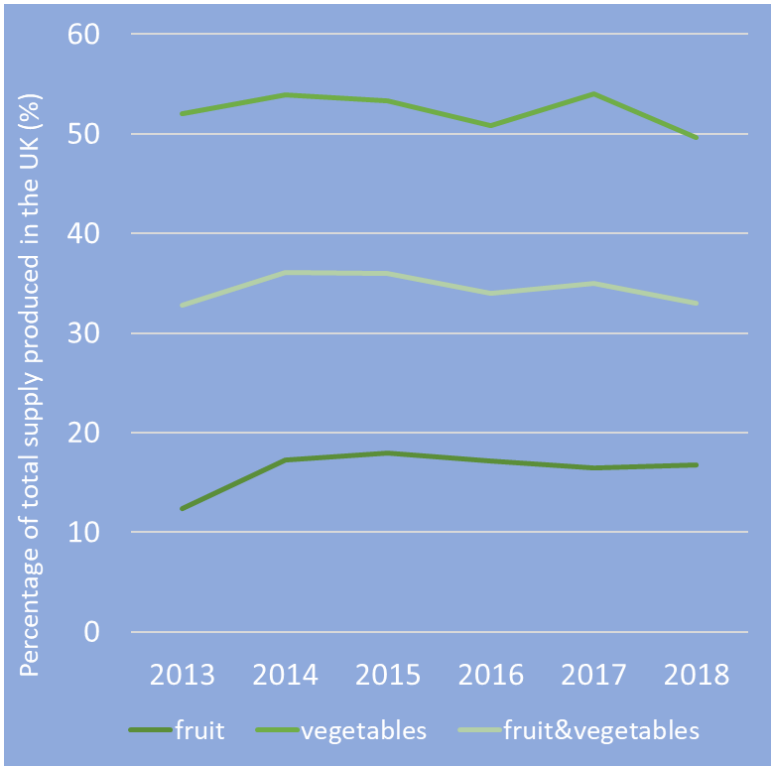
Supplementary Table 6. Percent consumption of crops by income group in 2013. Consumption patterns across income groups varied slightly in terms of amount consumed, and variety of fruits and vegetables consumed. High income households consumed slightly more citrus and berries (26%) compared to low income households (23%).

Crop	High Income %	Middle Income %	Low Income %
Tomatoes	21.2	26.6	23.4
Bananas	9.17	11.4	9.48
Apples	8.60	8.53	8.53
Oranges	8.28	10.2	10.3
Onions, dry	6.20	6.04	7.20
Grapes	4.88	5.41	4.92
Carrots and turnips	4.83	5.38	5.51
Peas, green	3.59	3.17	4.06
Tangerines, mandarins, clementines, satsumas	3.36	1.90	1.67
Cauliflower and broccoli	3.29	3.38	3.73
Lettuce and chicory	2.97	2.25	2.26
Cabbages and other brassicas	2.87	2.36	2.42
Chillies and peppers, green	2.45	1.54	1.80
Mushrooms and truffles	2.42	1.80	1.89
Cucumbers and gherkins	2.07	2.21	2.45
Pears	1.85	2.26	2.82
Raspberries	1.84	-	-
Blueberries	1.53	1.53	-
Strawberries	1.44	1.45	1.83
Pumpkins, squash and gourds	1.29	-	-
Sweet corn	1.25	-	1.00
String beans	1.23	1.57	-
Peaches and nectarines	1.19	-	1.75
Grapefruit and pomelos	1.12	-	-
Avocados	1.07	-	-
Sweet Potatoes	-	1.52	-
Mangoes, mangosteens, guavas	-	-	1.58
Plums and sloes	-	-	1.36
Citrus and berries	**25.6**	**26.4**	**23.3**
Apples and Pears	**10.5**	**10.4**	**11.3**

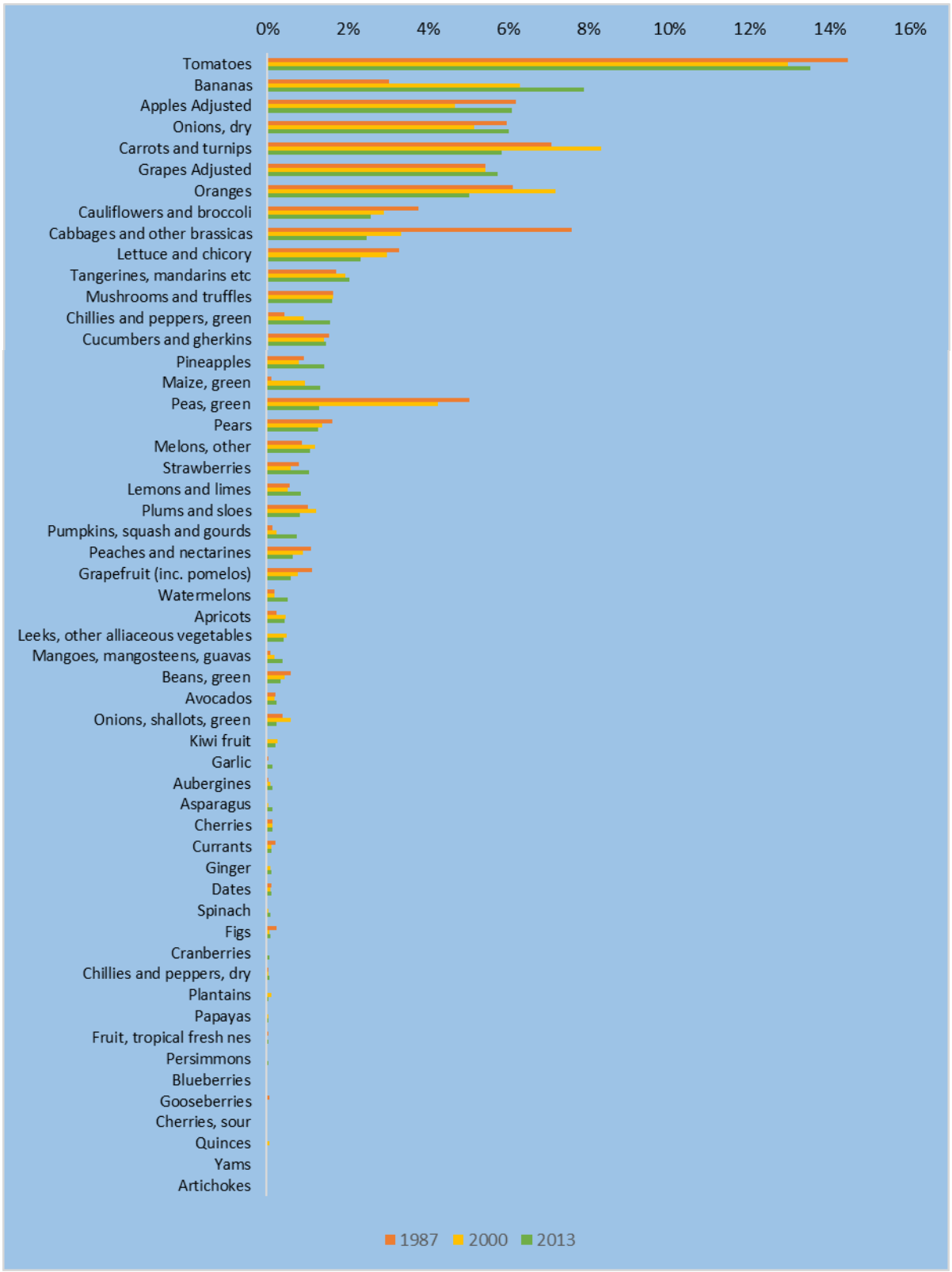
Supplementary Table 7: Non-starchy fruit and vegetable crop aggregates supplied for the UK market. Main fruit and vegetable crop aggregates by crop family and examples of the main crops in each aggregate.

Crop family	*Main crops from each family (UK supply)*
Solanaceae	tomatoes, chillies, peppers
Berries	bananas, grapes, raspberries, strawberries, blueberries, melons
Citrus fruits	oranges, tangerines
Leafy vegetables & brassicas	cabbages, lettuce, spinach, cauliflower
Pommes	apples, pears
Root vegetables	carrots, onions, beetroot
Cucurbitaceae	cucumbers, pumpkins, squash, melons
Legumes	peas, beans
Fungi	mushrooms, truffles
Drupes	peaches, plums
Poaceae	sweet corn
Bromeliaceae	Pineapples
Caracacea	Papayas

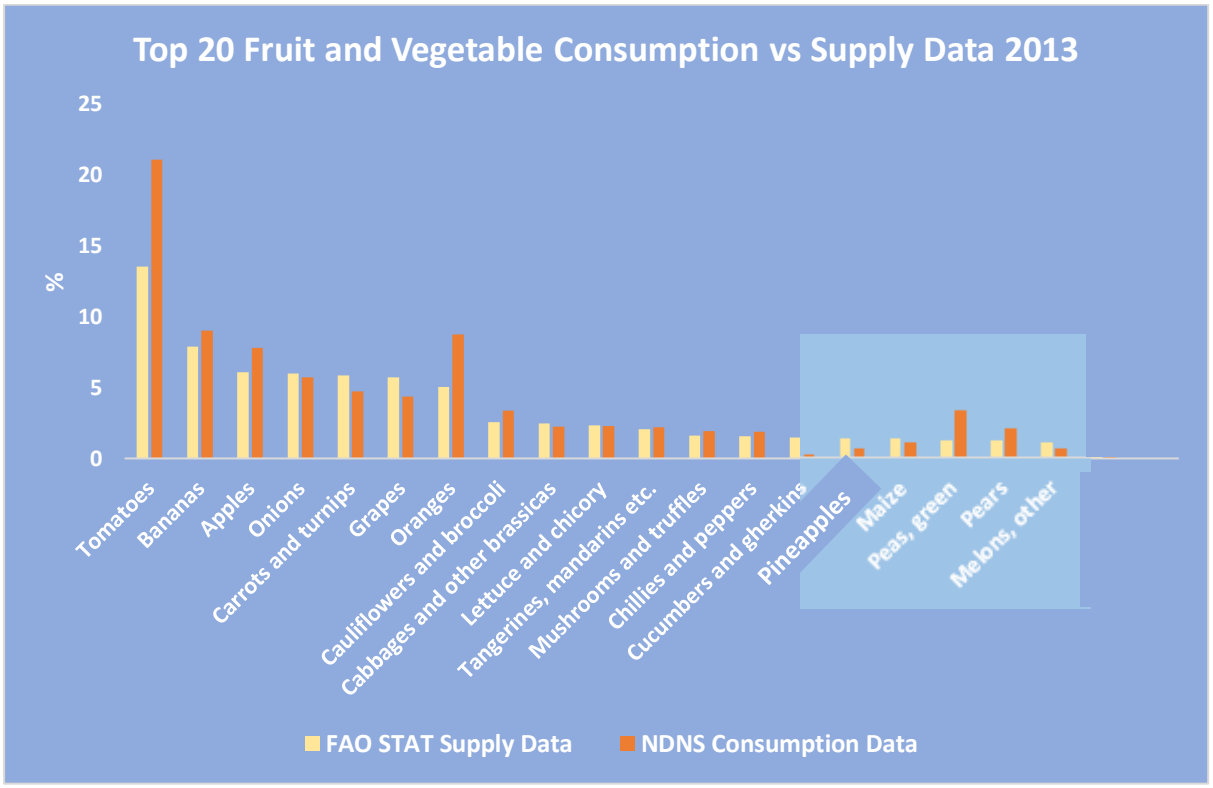
Supplementary Figures



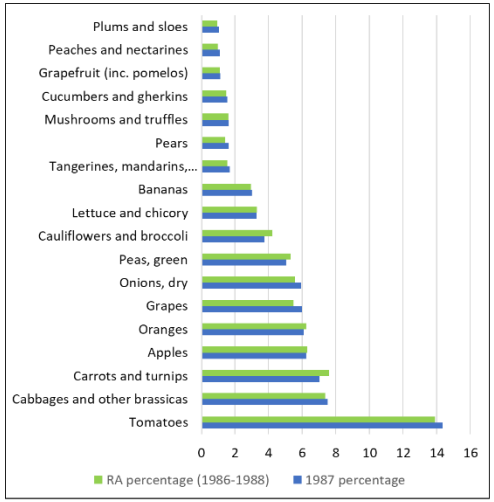
Supplementary Figure 1. Proportion of fruit and vegetable supply produced in the UK since 2013. *Proportion of fruit and vegetable supply produced in the UK since 2013 (last year considered in this study)*

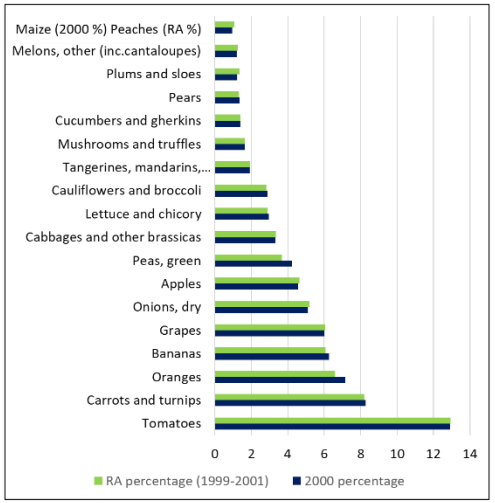


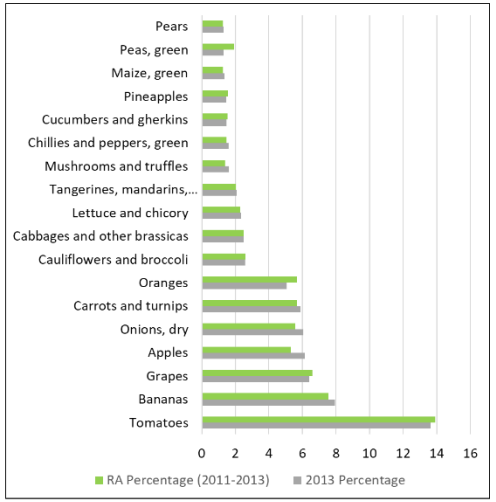
Supplementary Figure 2. Percent share of all fruit and vegetable supply for years 1987, 2000, and 2013. A large number of fruits and vegetables were supplied infrequently and/or in small quantities and were therefore excluded from the analysis. For each year (1987-2013), the top 18 crops were selected for inclusion in the analysis. Supplementary figure 2 shows all crop supply percentages for years 1987, 2000, and 2003. For intermediate years, please contact the author.

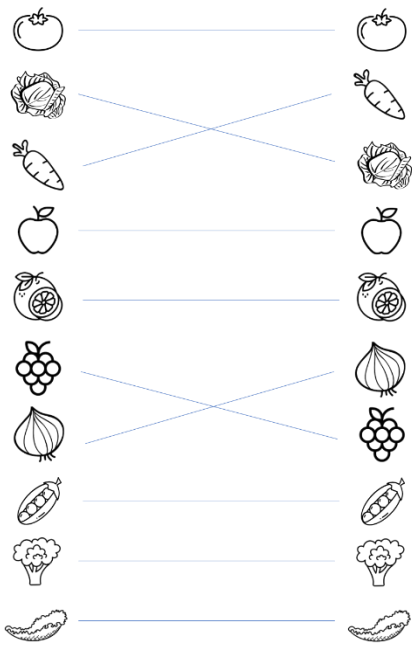


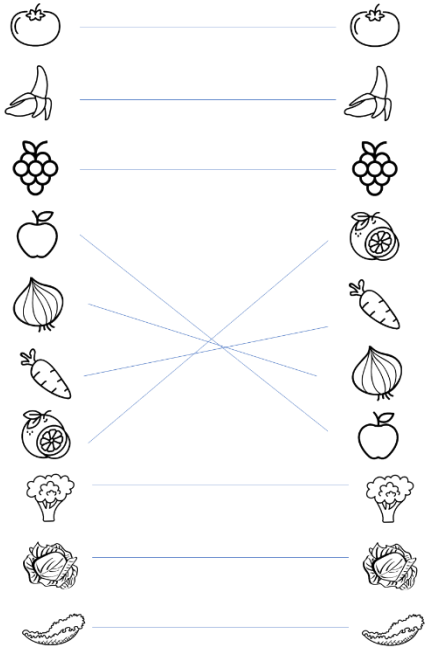
Supplementary Figure 3. 2013 Fruit and Vegetable Consumption vs Supply Data for the top 20 crops. We compared the FAOSTAT fruit and vegetable *supply data* and the NDNS fruit and vegetable *consumption data* to determine whether the FAOSTAT data could be used as a proxy of fruit and vegetable consumption in the UK. As 2013 was the only year the two datasets overlapped, we have only compared data for that year. Supplementary figure 3 shows the top 20 crops for the supply data and corresponding supply and consumption percentages which indicates that supply data is comparable to consumption data for 2013. The NDNS consumption data included Strawberries, Peaches/Nectarines, Green beans, and Blueberries in their top 20 crops, which were not in the top 20 for the supply data. However, these four fruits and vegetables only accounted for 5% of total consumption in the UK.


Plums and sloes
Peaches and nectarines
Grapefruit (inc. pomelos)
Cucumbers and gherkins
Mushrooms and truffles
Pears
Tangerines, mandarins,...
Bananas
Lettuce and chicory
Cauliflowers and broccoli
Peas, green
Onions, dry
Grapes
Oranges
Apples
Carrots and turnips
Cabbages and other brassicas
Tomatoes
0 2 4 6 8 10 12 14 16
RA percentage (1986-1988)
1987 percentage


Maize (2000 %) Peaches (RA %)
Melons, other (inc.cantaloupes)
Plums and sloes
Pears
Cucumbers and gherkins
Mushrooms and truffles
Tangerines, mandarins,...
Cauliflowers and broccoli
Lettuce and chicory
Cabbages and other brassicas
Peas, green
Apples
Onions, dry
Grapes
Bananas
Oranges
Carrots and turnips
Tomatoes
0 2 4 6 8 10 12 14
RA percentage (1999-2001)
2000 percentage


Pears
Peas, green
Maize, green
Pineapples
Cucumbers and gherkins
Chillies and peppers, green
Mushrooms and truffles
Tangerines, mandarins,...
Lettuce and chicory
Cabbages and other brassicas
Cauliflowers and broccoli
Oranges
Carrots and turnips
Onions, dry
Apples
Grapes
Bananas
Tomatoes
0 2 4 6 8 10 12 14 16
RA Percentage (2011-2013)
2013 Percentage





Supplementary Figure 4: Sensitivity analysis comparing a 3-year rolling average to single year measurement. *A. The % of total supply for each individual crop; B. Differences between fruit and vegetable supply top 10 comparing single year estimates with 3-year rolling averages.*

Supplementary Notes

Supplementary Note 1

Cleaning NDNS consumption data to derive grams of primary crop equivalent produced

We included raw and/or cooked fruits, yellow, green and red vegetables, dried fruit, fruit juices, smoothies, products containing tomato puree and Brassicaceae (mostly leafy vegetables and a few spices).

The clear majority of individuals (98.7%) reported food consumption over four days: records of those with incomplete food diary were corrected by adding their mean consumption per day measured over the recorded period to derive an approximation of their 4-day consumption.

(1) $$c_4 = 4 * \frac{c_i}{i}$$

Where: c = individual consumption per day; and i = the number of days of dietary data per individual

For each food item, the "primary fruit or vegetable crop" was determined based on the composition of ingredients. Foods with no clear primary crop were listed as "mixed fruits/vegetables". Unprocessed food items were included by weight (in grams consumed) of primary crop. The weight (in grams) of primary fruit or vegetable per gram of each dried, juiced, or otherwise processed food item was derived by using Primary Crop Equivalent conversion factors, as defined by Kastner *et al* (2011) (33).

We excluded the category "mixed fruits/vegetables" from the data – which comprised 3.4% of fruit and vegetable consumption in the UK – as this category lacked detail to identify country of origin.

References in Supplementary Information

1. Kastner T, Kastner M, Nonhebel SJEE. Tracing distant environmental impacts of agricultural products from a consumer perspective. 2011;70(6):1032-40.