# Trade import/export nitrogen flow estimation for the UK

**Trade import/export nitrogen flow estimation for the UK. January 2024.**

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# Introduction

This project develops a new methodology for import/export of the nitrogen content of materials to and from the UK. It will contribute to a new UK nitrogen balance sheet (NBS) being developed for WWF by UKCEH (Dragosits and Pearson, 2023) that builds on methodologies used for the Scottish Nitrogen Balance Sheet (SNBS) (Scottish Government, 2021) and German nitrogen budget (Umweltbundesamt, 2020) which are both largely based on the United Nations Economic Commission for Europe guidance (UN ECE, 2021). It goes beyond what was possible for the Scottish Nitrogen Balance Sheet (SNBS) as sufficiently detailed and complete statistics for import/export from Scotland to the rest of the UK and internationally do not currently exist.

This study utilised very detailed itemised quantities of imported and exported materials available from FAOSTAT at UK scale. In this short study FAOSTAT data were compiled and combined with appropriate N content values taken largely from the same guidance documents and data sources as for the SNBS, matching those used in the compilation of the other N flows in the UK-NBS (working in close consultation with the parallel project at UK-CEH).

The aim of this study is to estimate flows of N content contained within agricultural and aquatic commodities coming into and out of the UK (i.e. physically, not embedded). This is different from other approaches, such as the ‘nitrogen footprint’ which was developed to estimate the amount of nitrogen lost to the environment during the production, consumption and transportation of commodities consumed within a country and connected to various relevant sectors, whether those commodities are produced domestically or internationally (Galloway et al., 2014). The nitrogen footprint utilises the concept of ‘virtual’ N - the portion of the N that is released to the environment during the production process that is not contained in the product that is consumed (Galloway et al., 2007). Here we consider the nitrogen contained in the traded commodities as a direct input into the UK nitrogen balance sheet.

The flows calculated are just totals and do not specify countries from which they originated, although that may be possible in future projects.

This preliminary study considers UK imports and exports of agricultural and aquatic commodities that are contained in the FAOSTAT and FishStat databases, it does not include consideration of forestry products, chemical products (that would include fertilisers), and import and export of nitrogen to and from the UK via transboundary air and water movements. Air pollution movements are modelled in the 'European Monitoring and Evaluation Programme' for the Convention on Long Range Transboundary Air Pollution.

# FAO Commodity Nitrogen Content Methods

## Available data sources

**Agricultural Commodities**
FAO Supply Utilisation Accounts: https://www.fao.org/faostat/en/#data/SCL
FAO Trade Data: https://www.fao.org/faostat/en/#data/TCL

FAO Forestry Products: https://www.fao.org/faostat/en/#data/FO
FAO Fishery Commodities: https://www.fao.org/fishery/statistics-query/en/trade/trade_quantity

## Timestamp

SEI first analysed the variation in import and export data between years to consider the most meaningful timestamp to use for the study. The finding was that the average over 5 years (2017-2021) helps smooth differences in stock variation i.e. differences between opening and closing stocks between one year and the next e.g. differences caused by international conflicts, bad harvest effects, pandemics etc that effect supply chains.

## Methods for Estimation of Imports and Exports

Trade data was downloaded from FAO sources (links above) for the 436 commodities listed. Only commodities for which nitrogen values could not be determined, including live animals, were excluded from the analysis. This resulted in only 22 of the total 436 commodities being excluded and 99.8% of import mass, and 99.3% of the export mass was accounted for.

All datasets included import and export '*elements*' for commodities with at least one data entry for the 5 years in the period 2017 to 2021 (inclusive). In cases in which entries in this period were missing, an entry with a value of 0 was created.

Values were then averaged across the five years (2017-2021) to give a single value for each element-commodity combination. The datasets were then ordered largest to smallest in terms of mass, and a percentage contribution and cumulative percentage sum was then calculated. The percentage contribution value indicates the percentage a given commodity contributes to the total mass of commodities. The cumulative percentage sum indicates the number of commodities that contribute to a given percentage of the total mass of commodities (see Table 1 and 2). For example, 5 commodities contribute over 22% of the total averaged mass of imported commodities.

**Table 1**. Top five agricultural commodities of the 436 analysed ordered by their percentage contribution to the total mass of imports (tonnes).

| Ranking | Item Code (FAO) | Item Name | Average mass, tonnes (2017 - 2021) | Percentage of Total (%) | Cumulative Sum (%) |
|---|---|---|---|---|---|
| 1 | 56 | Maize (corn) | 2506162.0 | 6.15 | 6.15 |
| 2 | 238 | Cake of soya beans | 2060594.4 | 5.06 | 11.21 |
| 3 | 15 | Wheat | 1884011.5 | 4.63 | 15.84 |
| 4 | 564 | Wine | 1384091.5 | 3.40 | 19.23 |
| 5 | 1232 | Food preparations n.e.c. | 1348579.3 | 3.31 | 22.55 |

**Notes:** (i) the ranking is dependent on the way that the FAO categorises the products, some are aggregate categories e.g. food preparations nowhere else classified (n.e.c.) and for some crops there are multiple derived commodities e.g. soya beans processed into cake of soya beans, soya bean oil, and soya beans (ii) the analysis does not include the extent to which some of these products are imported for processing/manufacture and subsequently re-exported; (iii) the analysis does not specify whether, e.g. wheat, goes into animal feed or human food.

**Table 2**. Top five agricultural commodities of the 436 analysed ordered by their percentage contribution to the total mass of exports (tonnes).

| Ranking | Item Code (FAO) | Item Name | Average mass, tonnes (2017 - 2021) | Percentage of Total (%) | Cumulative Sum (%) |
|---|---|---|---|---|---|
| 1 | 44 | Barley | 1178970.2 | 8.89 | 8.89 |
| 2 | 634 | Undenatured ethyl alcohol of an alcoholic strength by volume of less than 80% vol; spirits, liqueurs and other spirituous beverages | 1081856.4 | 8.16 | 17.05 |
| 3 | 882 | Raw milk of cattle | 782359.7 | 5.90 | 22.95 |
| 4 | 633 | Other non-alcoholic caloric beverages | 569730.0 | 4.30 | 27.24 |
| 5 | 15 | Wheat | 567057.1 | 4.28 | 31.52 |

Data on nitrogen content of each commodity was included in FAO trade data were primarily taken from UN ECE (2021). Where N content was not available, other sources were used including Bach et al (2020), OECD (2013), EU Nitrogen Expert Panel (2016), Mathias et al (2015), and Xu et al (2021). For some products, including infant food, other non-alcoholic caloric beverages, and food preparations which are not classified anywhere else (food preparations (NEC - Nowhere else classified), N content was estimated based on a selection of supermarket products. For example, the FAO category of food preparations NEC are defined as:

*Including both crop and livestock products. Inter alia: homogenized composite food preparations; soups and broths; ketchup and other sauces; mixed condiments and seasonings; vinegar and substitutes; yeast and baking powders; stuffed pasta, whether or not cooked; couscous; and protein concentrates. Include inter alia: turtle eggs and birds' nests.*

As the commodities included in this description can be expected to have a wide range of N values, the average protein content of the highest rating brands of ketchup, soup, vinegar, yeast, stuffed pasta, and couscous were taken from the Sainsbury's website. For products such as feed preparations NEC infant food, and brewing or distilling dregs and waste which are not clearly defined and may have a range in N content, further research is needed to determine appropriate N content values. Commodities for which N values could not be determined, including live animals, were excluded from the analysis. Only 22 of the total 436 commodities were excluded and 99.9% of import mass, and 99.3% of the export mass was accounted for. N was estimated for all aquatic products, but it should be noted that the N values were not highly disaggregated and, following UN ECE (2021), were applied based on 3 broad categories: aquatic animals, fishmeal, and aquatic plants.

The average mass value for each element-commodity combination was then multiplied by its corresponding percentage nitrogen content, yielding the mass of nitrogen imported and exported to/from the UK. The data set was then reordered by largest to smallest nitrogen mass, and a percentage contribution and cumulative sum was taken, as detailed above. Tables 3 and 4 for agricultural products, and Tables 5 and 6 for aquatic products show the top 5 commodities ranked by mass of N.

**Table 3**. Top five agricultural commodities of the 436 analysed ordered by their percentage contribution to the total mass of N imports (tonnes of N).

| Ranking | Item Code (FAO) | Item Name (N, %) | Nitrogen Mass | Nitrogen Mass (% of total N) | Cumulative Sum (%) |
|---|---|---|---|---|---|
| 1 | 238 | Cake of soya beans (5.8) | 120750.8 | 20.1 | 20.1 |
| 2 | 15 | Wheat (2.3) | 43332.3 | 7.2 | 27.3 |
| 3 | 236 | Soya beans (6) | 43316.1 | 7.2 | 34.6 |
| 4 | 654 | Brewing or distilling dregs and waste (7.1) | 37806.1 | 6.3 | 40.9 |
| 5 | 56 | Maize (corn) (1.3) | 32580.1 | 5.4 | 46.3 |

**Table 4**. Top five agricultural commodities of the 436 analysed ordered by their percentage contribution to the total mass of N exports (tonnes of N).

| Ranking | Item Code (FAO) | Item Name (N, %) | Average mass, tonnes (2017 - 2021) | Percentage of Total (%) | Cumulative Sum (%) |
|---|---|---|---|---|---|
| 1 | 1173 | Meat Meal (10.7) | 23932.1 | 11.33 | 11.33 |
| 2 | 44 | Barley (1.7) | 20042.20 | 9.49 | 20.80 |
| 3 | 15 | Wheat (2.3) | 13042.3 | 6.17 | 26.98 |
| 4 | 882 | Raw milk of cattle (1.2) | 9388.32 | 4.40 | 31.43 |
| 5 | 843 | Dog or cat food, put up for retail sale (3.5) | 8307.44 | 3.90 | 35.36 |

*On average between 2017 and 2021, a total of 211,377 tonnes of N were exported in agricultural products from the UK, and 600,108 tonnes were imported, equating to a net import of 388,731 tonnes.*

## Aquatic Products

The analysis accounted for the import and export of 455 aquatic commodities in the FishStat database. Nitrogen content of these commodities was taken from the UNECE (2021) and multiplied by the mass of the imported and exported communities. It was estimated that 33,611 tonnes of nitrogen is imported in aquatic products, while 23,440 tonnes of nitrogen is exported, equating to a net import of 10,171 tonnes of nitrogen. Tables 5 and 6 show the top five aquatic commodities imported and exported respectively.

**Table 5**. Top five aquatic commodities ordered by their percentage contribution to the total mass of N imports (tonnes of N).

| Ranking | FAO ISSCFC code | Item Name (N, %) | Average mass, tonnes (2017 - 2021) | Percentage of Total (%) | Cumulative Sum (%) |
|---|---|---|---|---|---|
| 1 | 081.42.1.5.9.90 | Fishmeals, nei (10.7) | 98497 | 31.4 | 31.4 |
| 2 | 037.1.1.5.6.209 | Skipjack prepared or preserved, not minced, nei (2.8) | 76550 | 6.4 | 37.7 |
| 3 | 034.1.4.3.20 | Atlantic and Danube salmons, fresh or chilled (2.8) | 68460 | 5.7 | 43.4 |
| 4 | 034.4.1.5.2.19 | Cod nei, fillets, frozen (2.8) | 65200 | 5.4 | 48.9 |
| 5 | 292.9.1.78 | Seaweeds and other algae, fit for human consumption, nei (40) | 4366 | 5.2 | 54.1 |

**Note:** n.e.i - nowhere else identified

**Table 6**. Top five aquatic commodities ordered by their percentage contribution to the total mass of N exports (tonnes of N).

| Ranking | FAO ISSCFC code | Item Name (N, %) | Average mass, tonnes (2017 - 2021) | Percentage of Total (%) | Cumulative Sum (%) |
|---|---|---|---|---|---|
| 1 | 034.1.5.7.62 | Atlantic mackerel, fresh or chilled (2.8) | 117414 | 14.0 | 14.0 |
| 2 | 081.42.1.5.9.90 | Fishmeals, nei (10.7) | 23493 | 10.7 | 24.7 |
| 3 | 034.1.4.3.20 | Atlantic and Danube salmons, fresh or chilled (2.8) | 86432 | 10.3 | 35.1 |
| 4 | 034.2.5.7.69 | Mackerels nei, frozen (2.8) | 53378 | 6.4 | 41.5 |
| 5 | 034.1.5.2.51 | Blue whiting (*Micromesistius poutassou*), fresh or chilled (2.8) | 49742 | 5.9 | 47.4 |

**Note**: n.e.i - not elsewhere included

## Summary

On average between 2017 and 2021, a total of 234,817 tonnes of nitrogen were exported in agricultural and aquatic products from the UK, and 633,719 tonnes were imported, equating to a net import of 398,902 tonnes.

This net import of approx. 399kt N /yr compares to the values for other N fluxes in the UK estimated by Dragosits and Pearson (2023) for the NBS UK study:

- **$N_2$ to air from denitrification – 289 kt N /yr**
- **$NO_x$ (206), $N_2O$ (45), $NH_3$ (203) emissions to air – 454 kt N /yr**
- **N to coastal waters – 726 kt N /yr**
- **N for human nutrition – 282 kt N /yr**

# Next steps

- This preliminary study considers UK imports and exports of agricultural and aquatic commodities that are contained in the FAOSTAT and FishStat databases. The analysis could be extended to include forestry and chemical commodities (including the import and export of fertilisers) and import and export of nitrogen to and from the UK via transboundary air and water movements.
- The commodity flows from specific countries could be calculated of relevance to nitrogen flows of interest e.g. related to soya. This could also be associated with the nitrogen footprint in these countries and the calculation of embedded nitrogen in particular commodities.

# Limitations

As an initial scoping exercise, this work has limited budget and timeframes which are reflected in the scope of the exercise. This includes the ability to join all possible datasets and pieces of information together to link up domestic production, imports, processing and uses of commodities; further work could improve the combining of disparate data to better map and model the flows and uses of commodities, and ultimately their nitrogen content. That said, global trade and commodity utilisation form a complex system with insufficient data transparency and availability to precisely map full supply chains, and assumption of mass-balance and homogeneity will always be required in the absence of more specific and detailed data. Even with increased time and resources, limitations would remain. For example, whilst the utilisation of higher resolution trade data would provide the potential for more accurate commodity mapping and tracking, this would in turn increase the burden in other areas of the process and likely be prohibitively intensive in terms of data and time requirements. Although increased levels of accuracy are possible on context-specific bases, such as focused and dedicated LCA analyses, this is not practical or viable at the broad scale or systematic style required to form national level accounts across such a breadth of commodities as in this work.

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