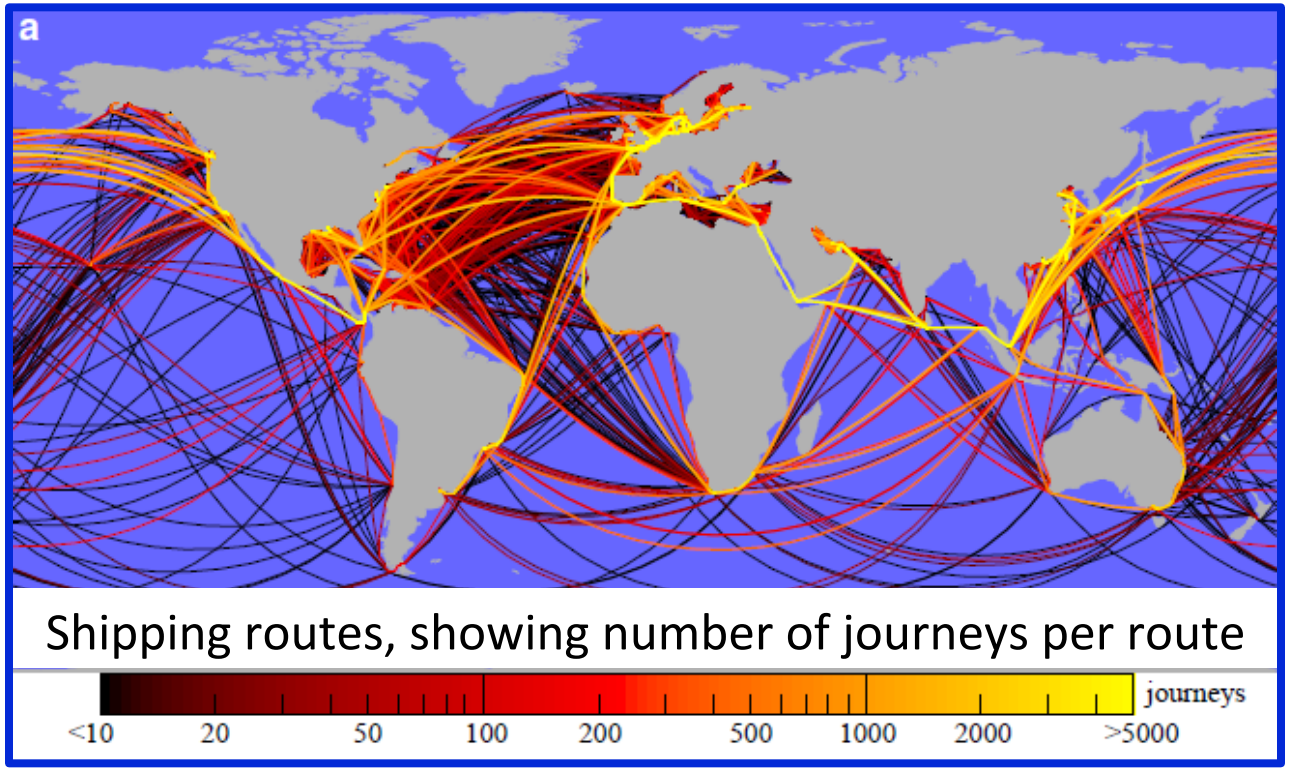
Analysis of international trade of reactive nitrogen as food and fertilizer



Allison Leach, James Galloway, Justin Kitzes, Jan Willem Erisman, Albert Bleeker

Planet Under Pressure
Nitrogen: Too much of a good thing
26 March 2012

Kaluza et al., 2010

Overview of Talk

1. Why is N trade important?
2. Food: Trade of N embedded in food
    1. **US, Netherlands, Brazil, Japan**
    2. Total trade & bilateral trade of food N (2007)
3. Fertilizer: Brief overview
4. Summary



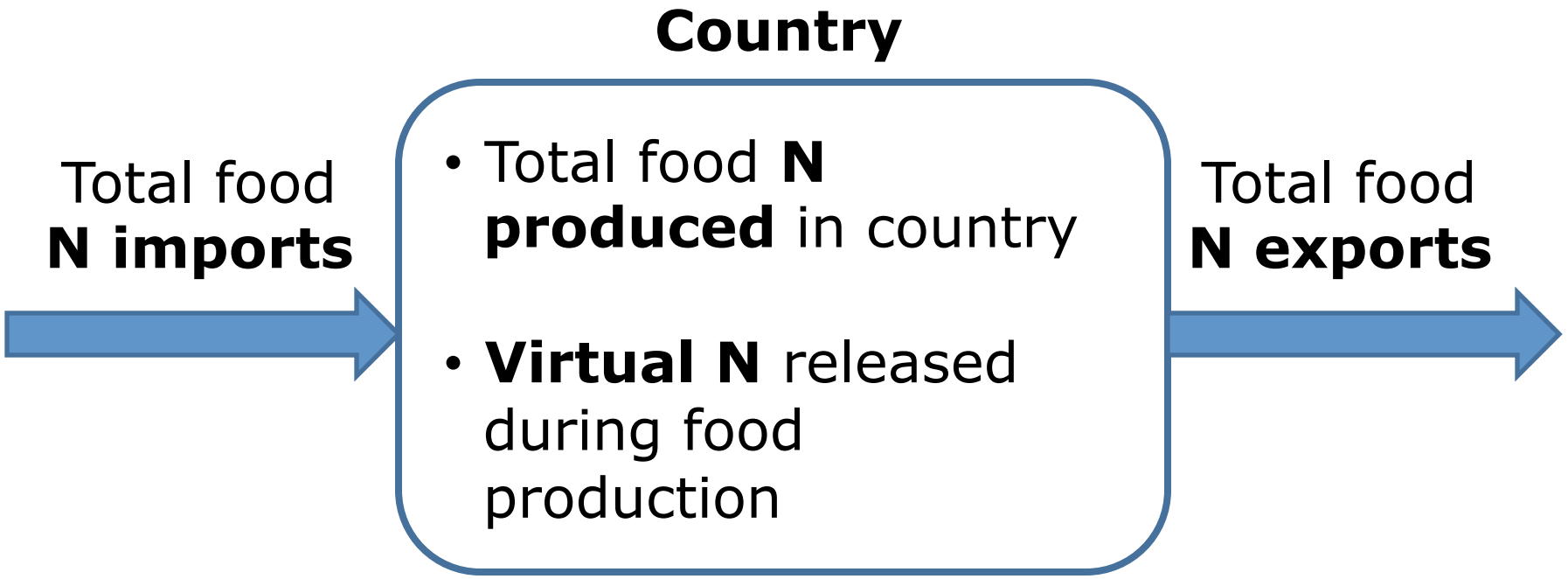
Why is the trade of N important?

- Sustains global population

- Provides foreign currency for all countries
  - Especially developing countries

- Factors to consider for N trade
  1. Amount N traded
  2. Associated Virtual N
  3. Economic cost of environmental damage

Total Food N Trade Overview



Countries: US, Netherlands, Brazil, Japan

- Trade data calculated by food category
- Includes food and animal feed
- Data source: FAOSTAT

Total Food N Trade, *Tg N*

Food N Imports

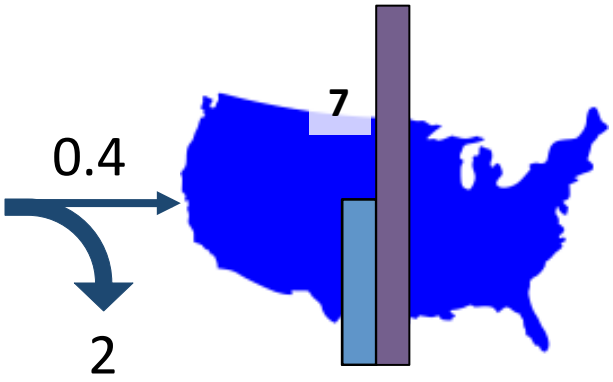
Food N produced within country:

Remaining N

Virtual N from in-country production:

From remaining N

United States *15*



Total Food N Trade, *Tg N*

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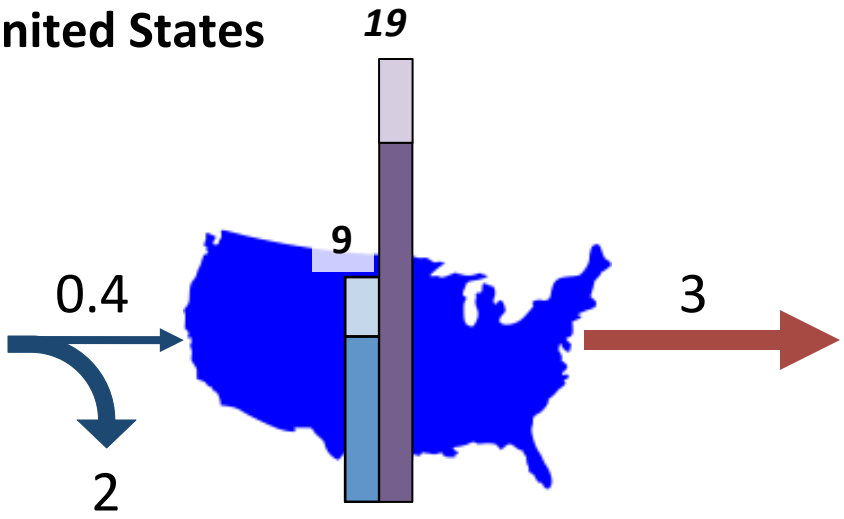
United States



Biggest exports: Cereals, Oilcrops

Total Food N Trade, *Tg N*

Food N Imports
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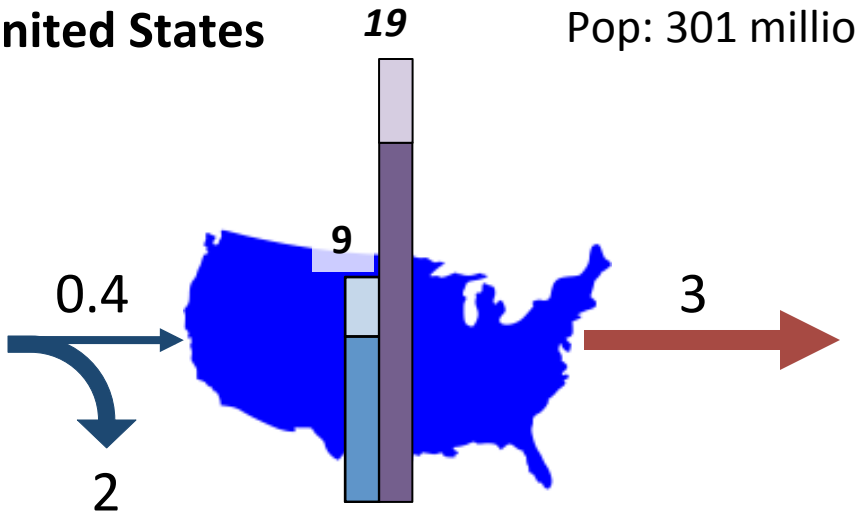
United States

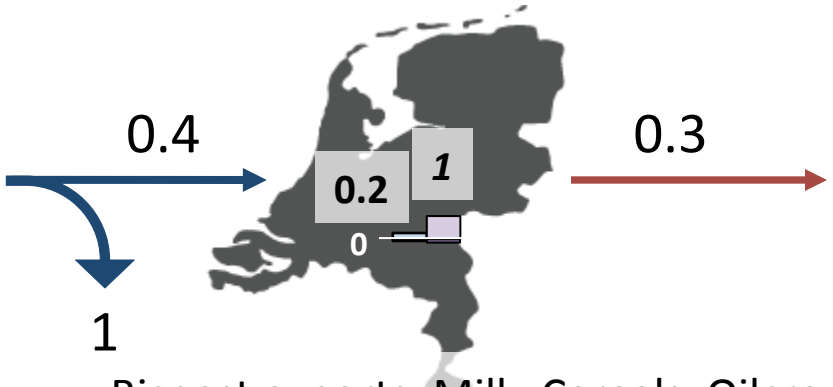
Pop: 301 million



Biggest exports: Cereals, Oilcrops

Netherlands

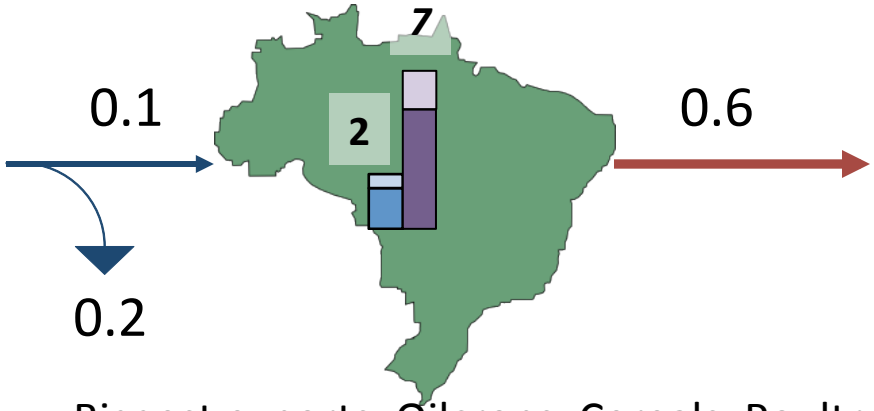
Pop: 17 million



Biggest exports: Milk, Cereals, Oilcrops

Brazil

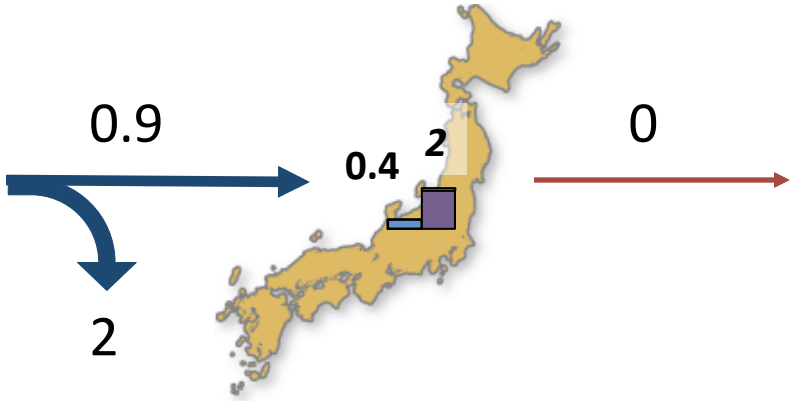
Pop: 190 million



Biggest exports: Oilcrops, Cereals, Poultry

Japan

Pop: 127 million



Biggest exports: Fish

Total Food N Trade, *kg N*

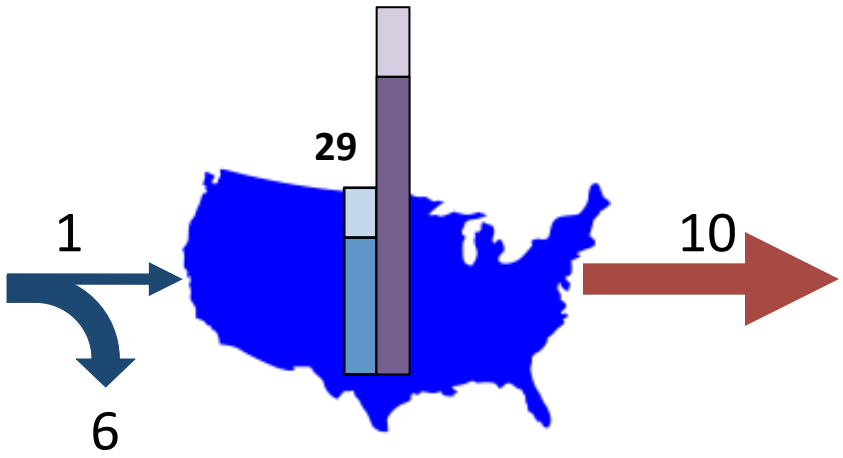
Standardized by population

Note: Scale of graphs changed

Food N Imports
Food N Exports
Food N produced within country:
Exported N
Remaining N
Virtual N from in-country production:
From exported N
From remaining N

United States

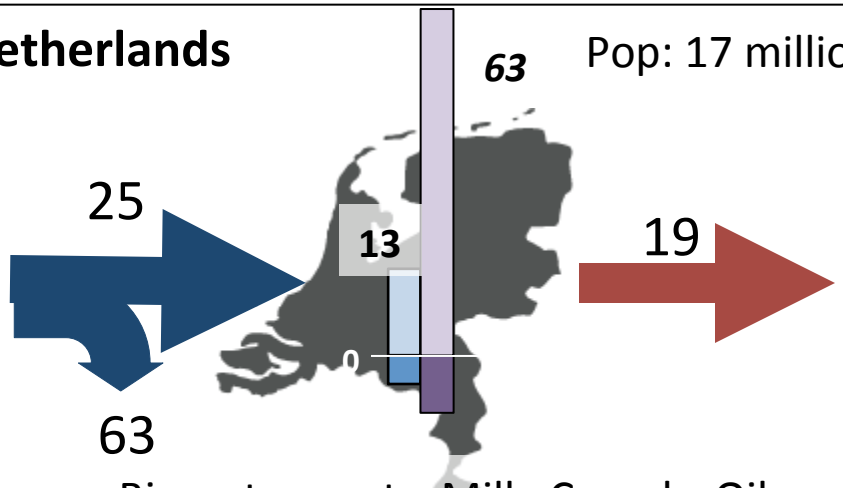
Pop: 301 million



Biggest exports: Cereals, Oilcrops

Netherlands

Pop: 17 million



Biggest exports: Milk, Cereals, Oilcrops

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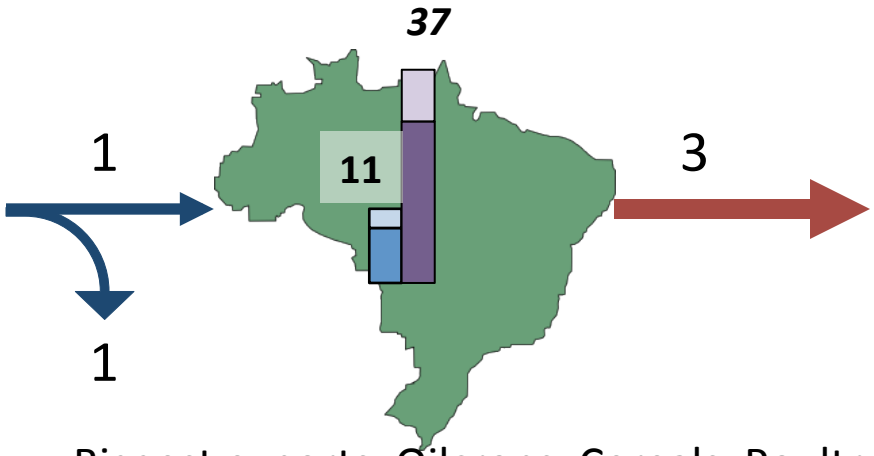
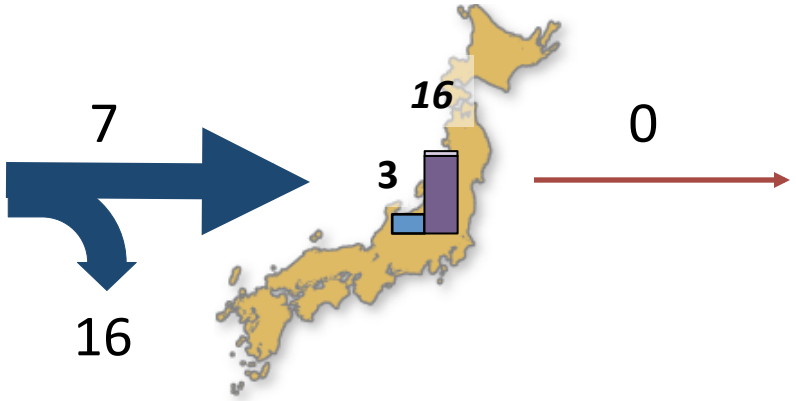


Biggest exports: Oilcrops, Cereals, Poultry

Japan

Pop: 127 million



Biggest exports: Fish

N imports to the US

Total Food N *(Tg N)*

Numbers at start of arrows = Virtual N released
Arrows show relative magnitude of imports, **> 0.05 Tg N**

Final number in country = Total imported food N
Data include animal feed; they do not include fish/seafood

N exports from the US

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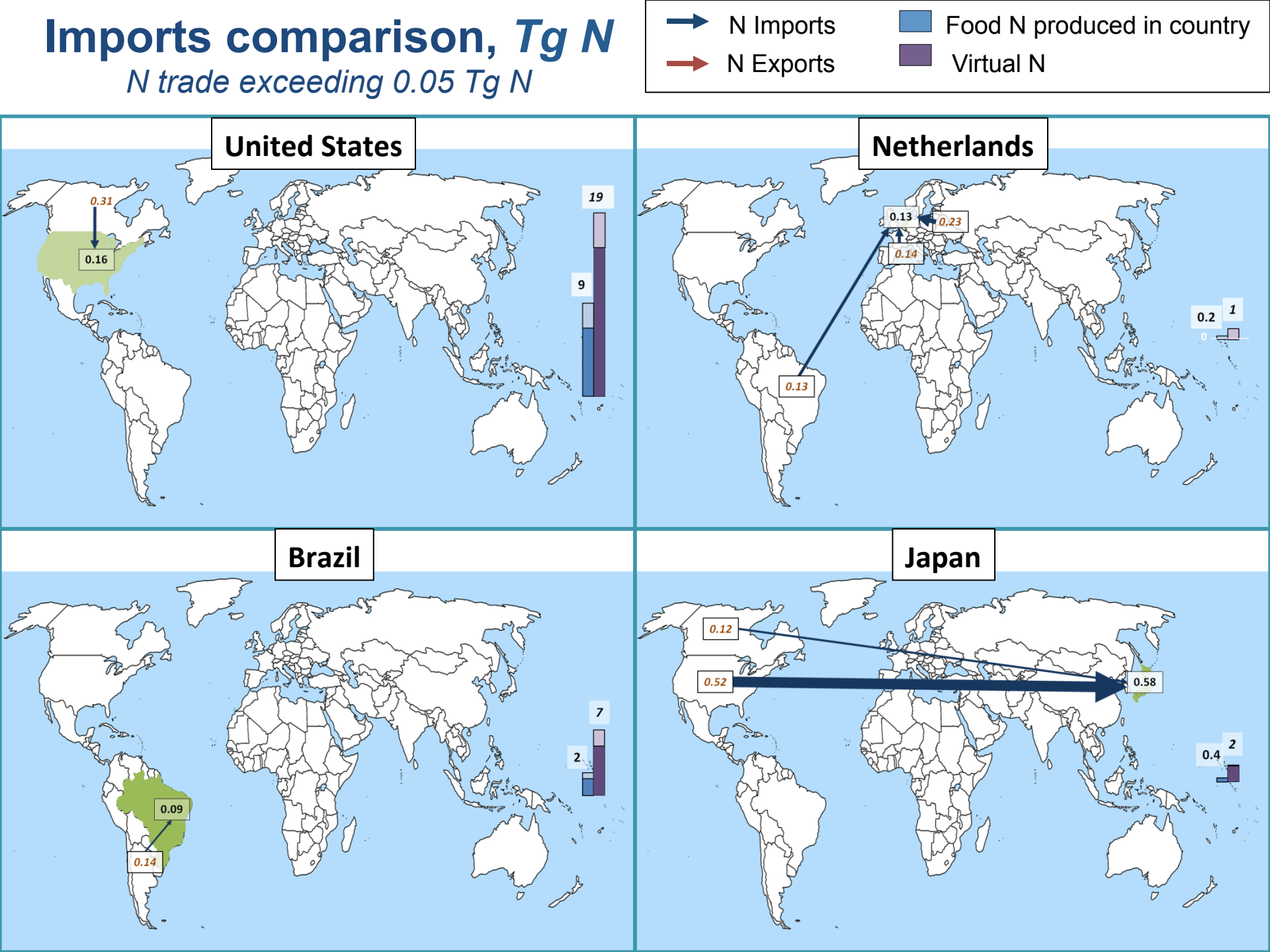
Imports comparison, *Tg N*

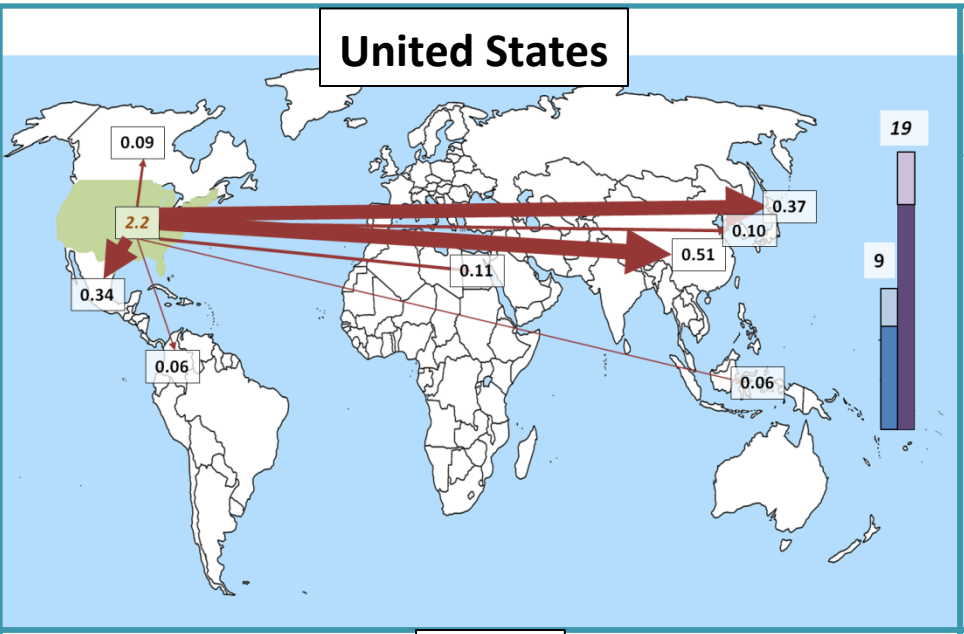
N trade exceeding 0.05 Tg N



Exports comparison, *Tg N*

N trade exceeding 0.05 Tg N

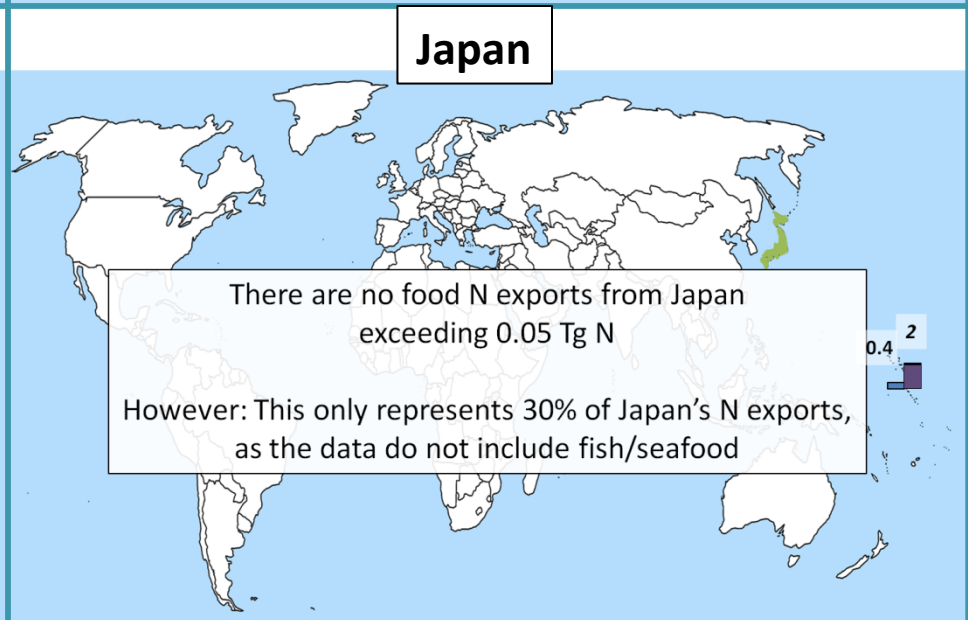
United States



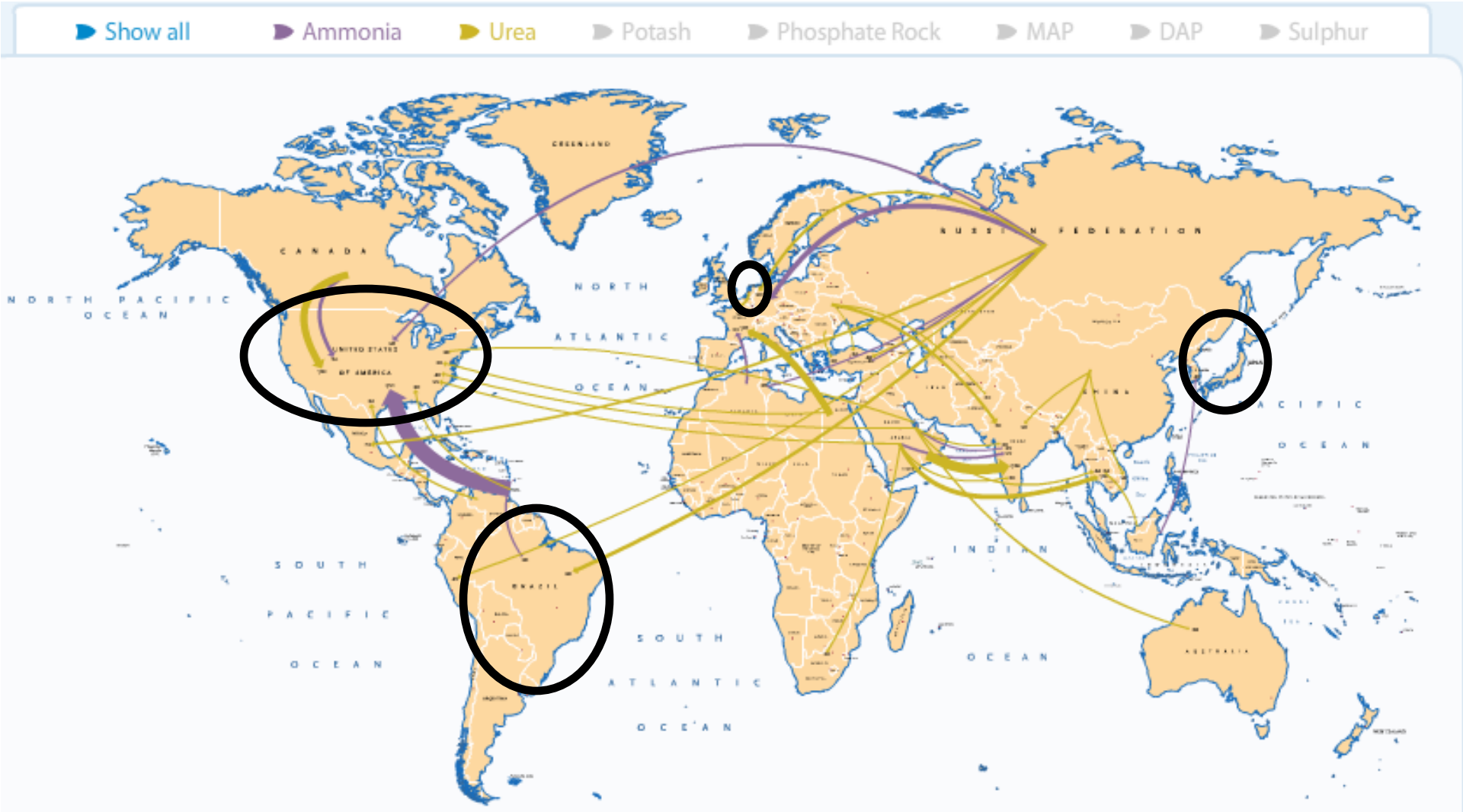
Netherlands

Brazil

Japan



International Fertilizer N Trade



Global ammonia and urea trade

International Fertilizer Industry Association and the ICIS

N Trade: Environmental Burden or Benefit?

United States

Burden (food),
Benefit (fertilizer)

Netherlands

Burden & Benefit

Brazil

Burden

Japan

Benefit

Cost of environmental damage from food N exports

3.5 Tg Virtual N from exports

€ 28 billion to repair the damage

1.2 Tg Virtual N from exports

€ 14 billion to repair the damage

1.6 Tg Virtual N from exports

€ 12 billion to repair the damage

0.1 Tg Virtual N from exports

€ 0.4 billion to repair the damage

There are no policies that address the cost of N-related environmental damage caused by the production of exported goods

Summary

1. Significant amount of N is traded internationally as food and fertilizer
2. Environmental damage from food production is borne by the producing country
3. Current policies do not take this environmental (and economic) damage into account




Thank you!

Economic N footprint of food

Steak

Grocery store cost: 7 Euro
Health/environment cost: 1.9 Euro
Total cost = 8.9 Euro

Chicken Breast

Grocery store cost: 3 Euro
Health/environment cost: 1.1 Euro
Total cost = 4.1 Euro

Broccoli

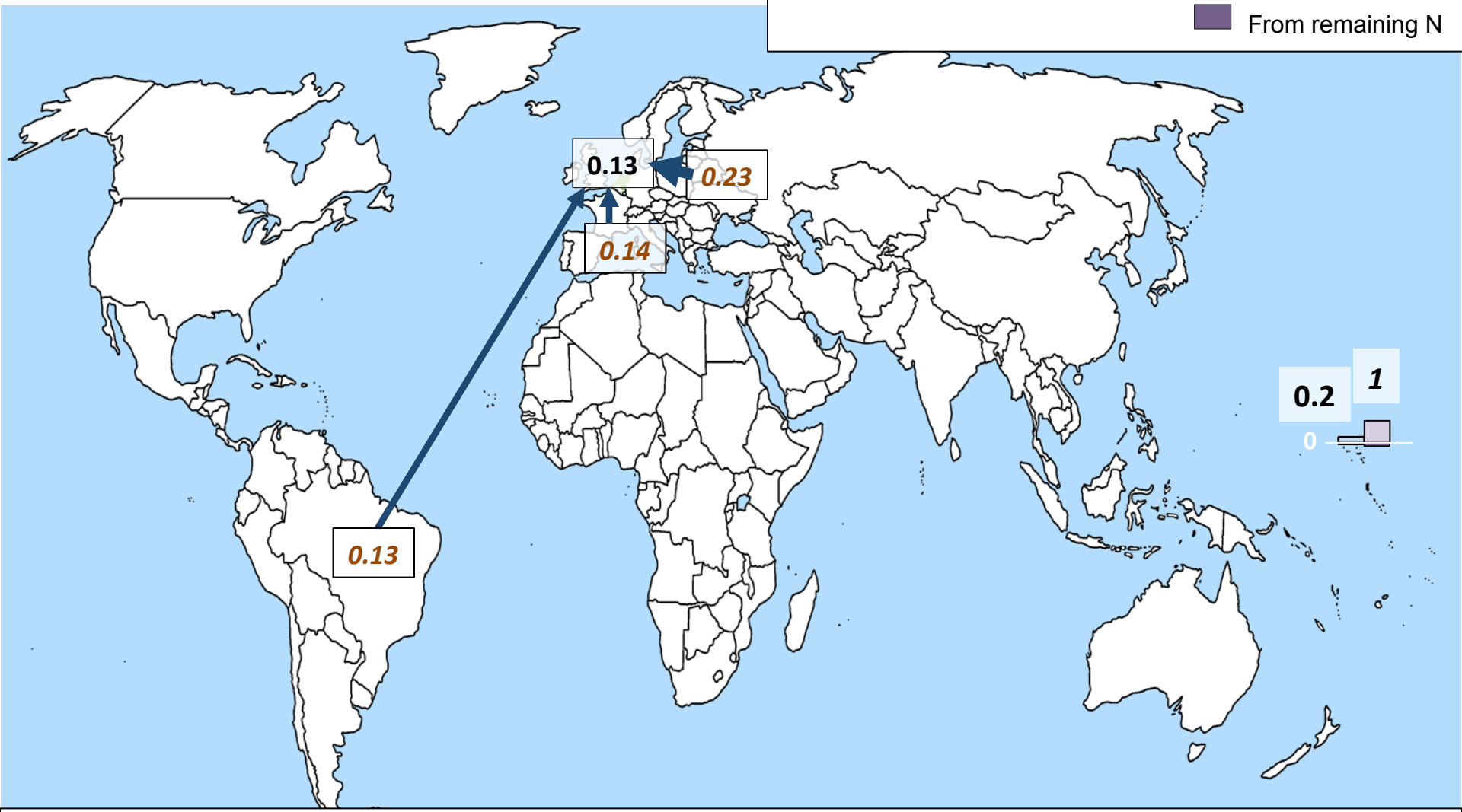
Grocery store cost: 1.5 Euro
Health/environment cost: 0.2 Euro
Total cost = 1.7 Euro

Milk

Grocery store cost: 1 Euro
Health/environment cost: 0.4 Euro
Total cost = 1.4 Euro

N imports to the Netherlands

Total Food N *(Tg N)*

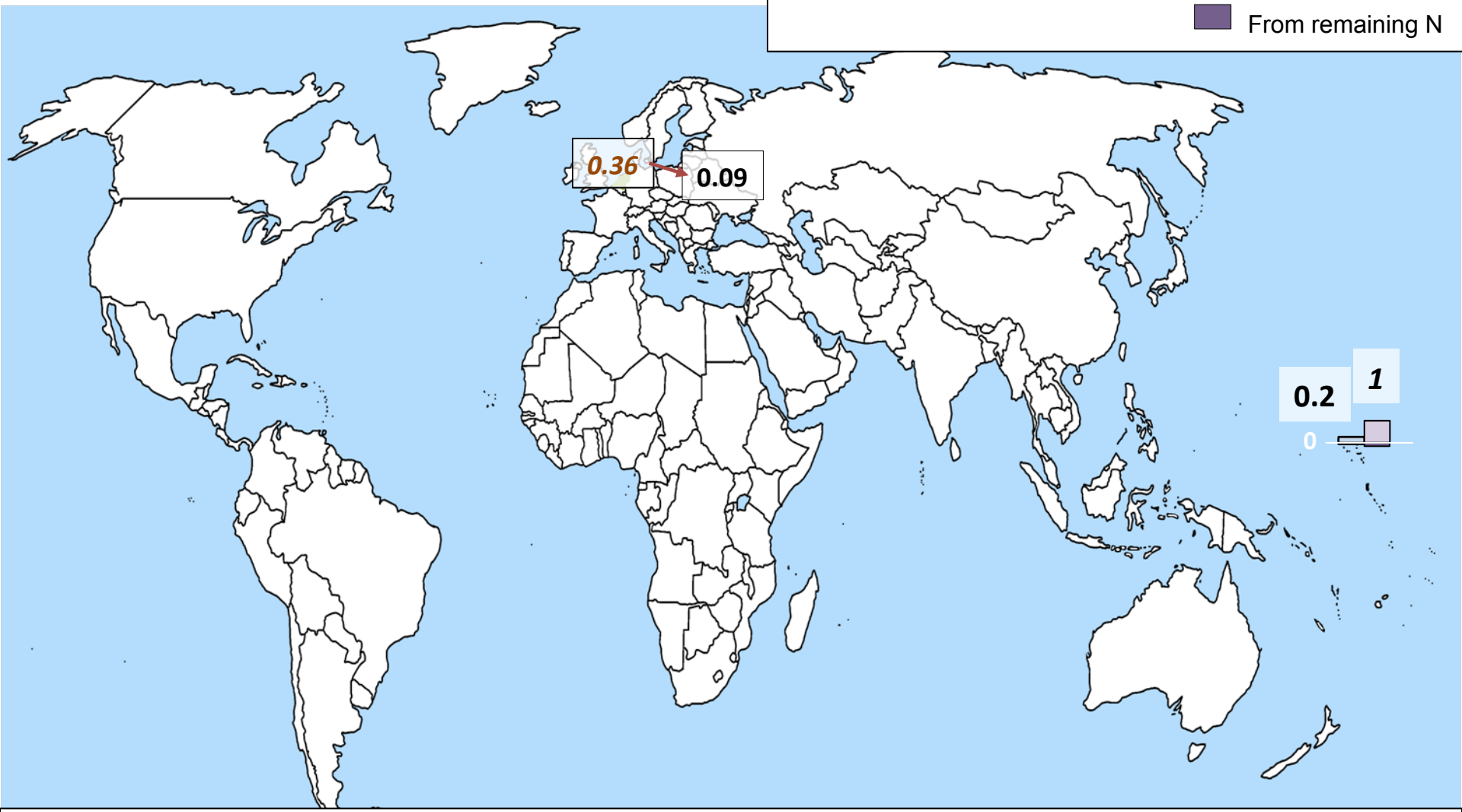


Notes

Numbers at start of arrows = Virtual N released in a country
Arrows show relative magnitude of imports, **> 0.05 Tg N**

Final number in country = Total imported food N
These data include animal feed

N exports from the Netherlands
Total Food N *(Tg N)*



Notes

Numbers at start of arrows = Virtual N released in a country
Arrows show relative magnitude of imports, **> 0.05 Tg N**

Final number in country = Total imported food N
These data include animal feed

N imports to Brazil:
Total Food N *(Tg N)*

Notes

Numbers at start of arrows = Virtual N released in a country
Arrows show relative magnitude of imports, **> 0.05 Tg N**

Final number in country = Total imported food N
These data include animal feed

N exports from Brazil:
Total Food N *(Tg N)*

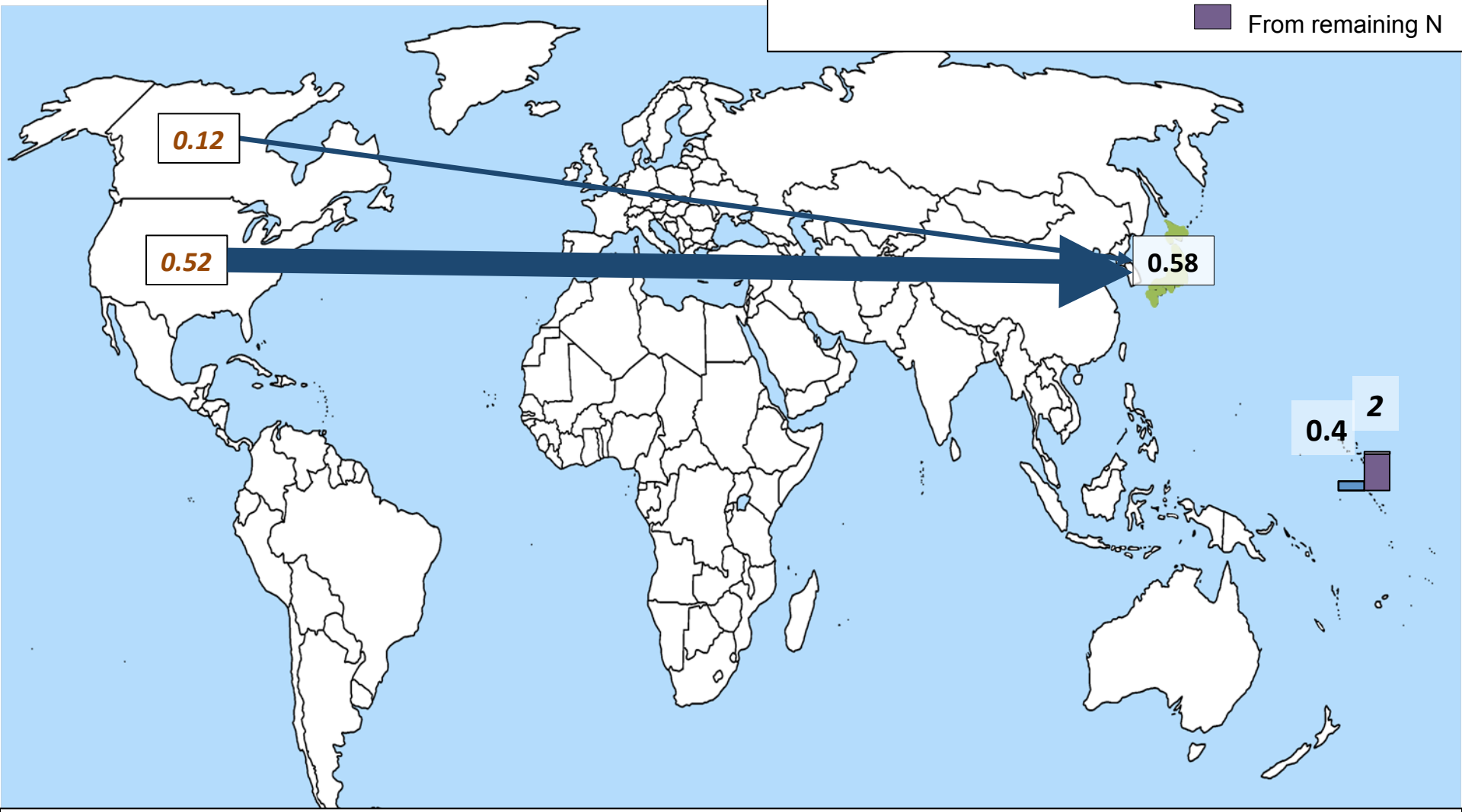
Notes

Numbers at start of arrows = Virtual N released in a country
Arrows show relative magnitude of imports, **> 0.05 Tg N**

Final number in country = Total imported food N
These data include animal feed

N imports to Japan:

Total Food N *(Tg N)*



Notes

Numbers at start of arrows = Virtual N released in a country
Arrows show relative magnitude of imports, **> 0.05 Tg N**

Final number in country = Total imported food N
These data include animal feed

Nitrogen imports to the United States: Cereals N *(Tg N)*

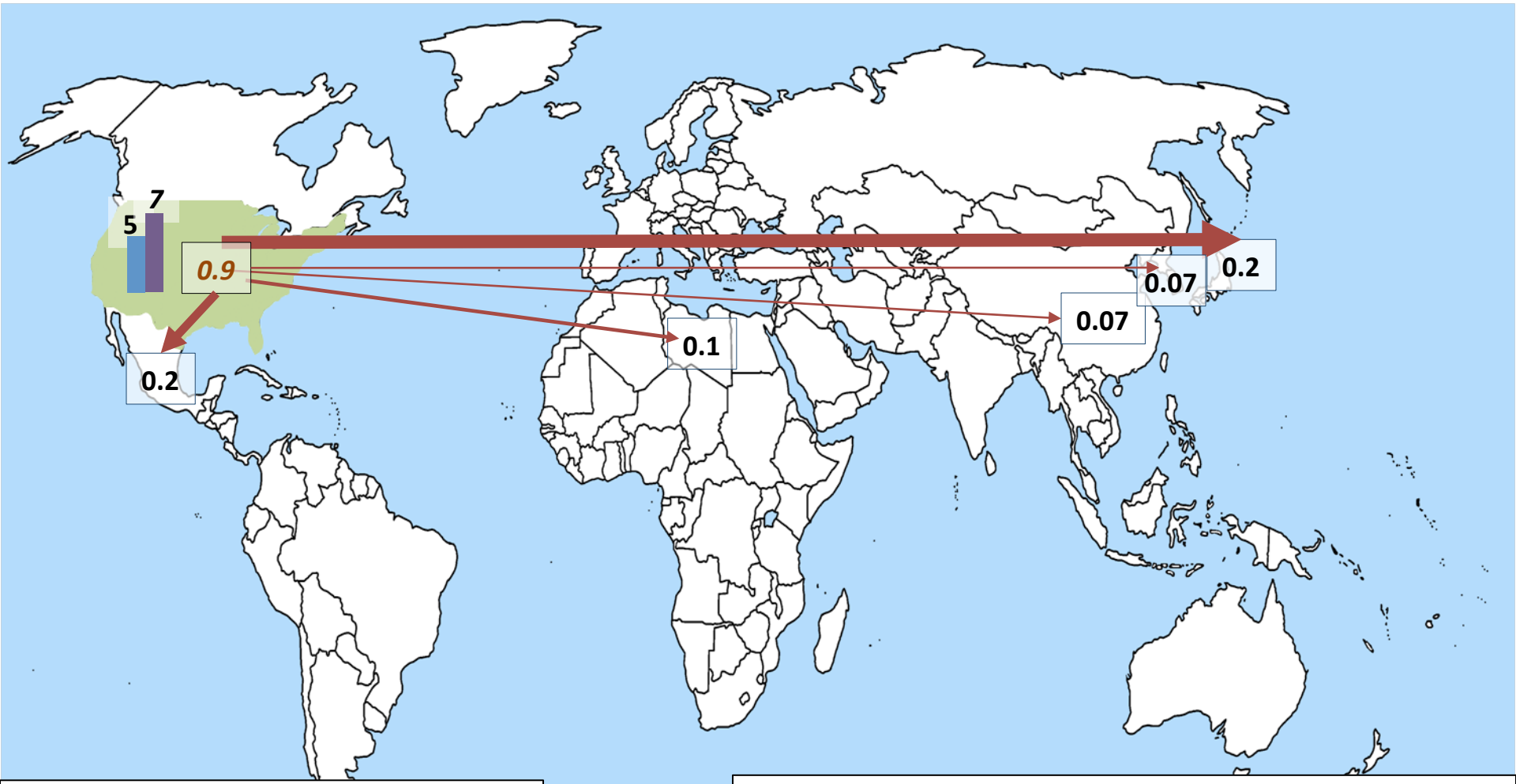
Legend

- Cereals N Imports
- Cereals N produced in US
- *Virtual N from US cereals production*

Notes

Numbers at start of arrows = Virtual N released in a country
Final number in US = Total imported food N
Arrows show relative magnitude of imports, **> 0.05 Tg N**
These data include animal feed

Nitrogen exports from the United States: Cereals N *(Tg N)*



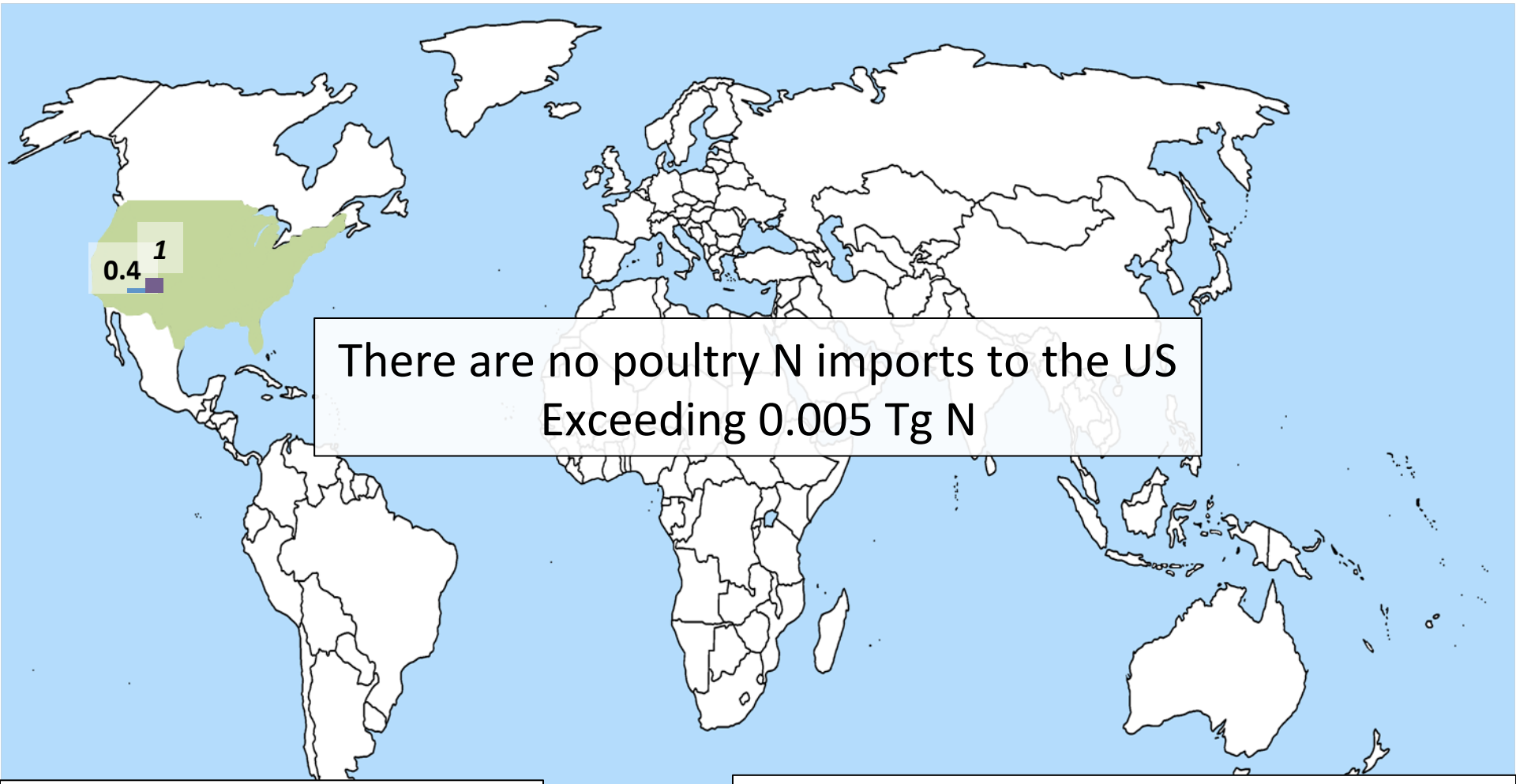
Legend

- Cereals N Exports
- Cereals N produced in US
- *Virtual N from US cereals production*

Notes

Number at start of arrows = Total Virtual N released in US
Numbers in specific countries = Cereals N exported to a country
Arrows show relative magnitude of imports, **> 0.05 Tg N**
These data include animal feed

Nitrogen imports to the United States: Poultry N *(Tg N)*



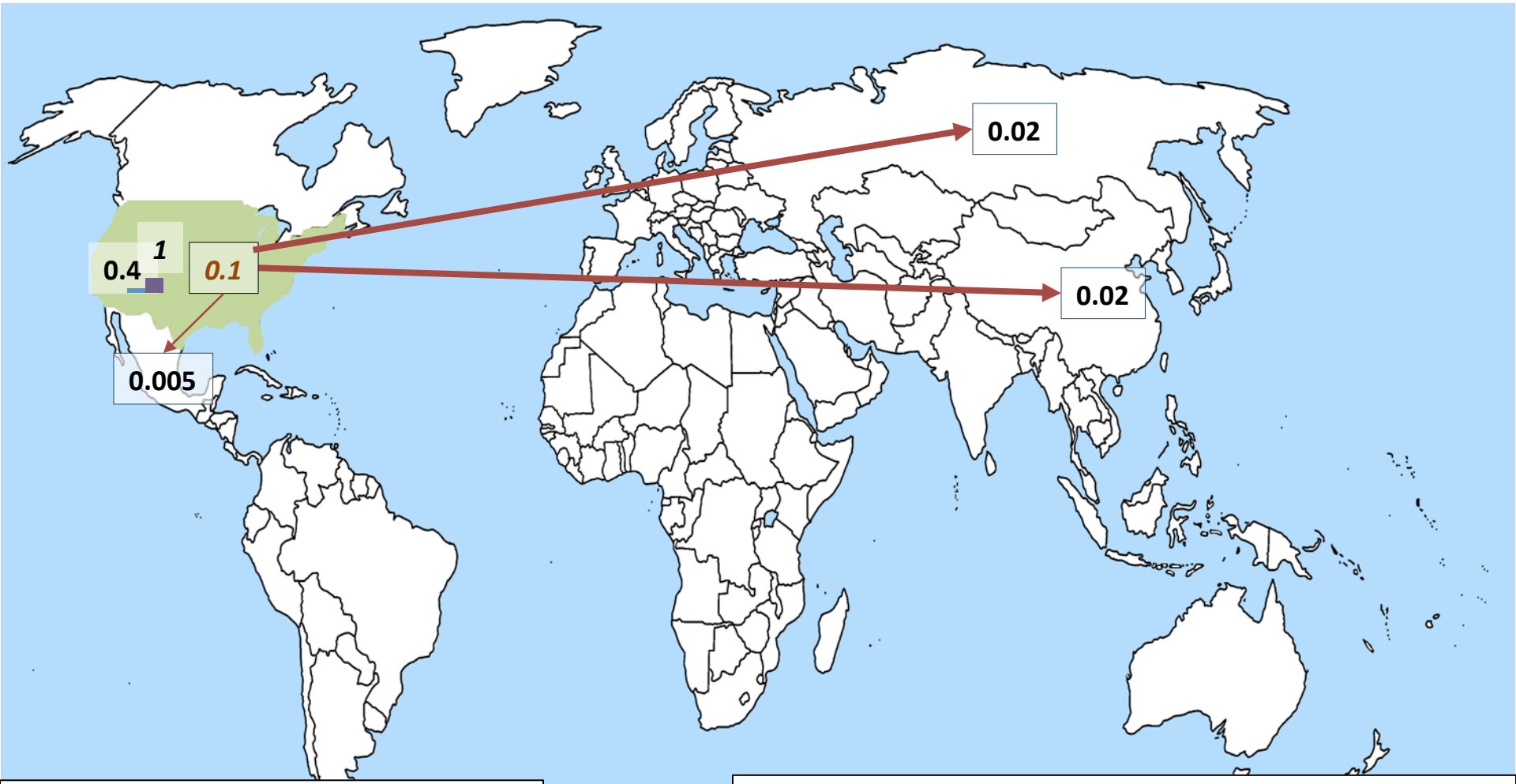
Legend

- Poultry N Imports
- Poultry N produced in US
- *Virtual N from US poultry production*

Notes

Numbers at start of arrows = Virtual N released in a country
Final number in US = Total imported food N
Arrows show relative magnitude of imports, **> 0.005 Tg N**
These data include animal feed

Nitrogen exports from the United States: Poultry N *(Tg N)*



Legend

- Poultry N Exports
- Poultry N produced in US
- *Virtual N from US poultry production*

Notes

Number at start of arrows = Total Virtual N released in US
Numbers in specific countries = Poultry N exported to a country
Arrows show relative magnitude of imports, **> 0.005 Tg N**
These data include animal feed

Results: Total Food N Trade

US	Production	Imports	Exports	US Supply
Food weight, *Tg food*	857	71	175	753
Food N, *Tg N*	9	0.4	3	7
Virtual N*, *Tg Virtual N*	18	2	3	N/A

Netherlands	Production	Imports	Exports	NL Supply
Food weight, *Tg food*	39	46	43	43
Food N, *Tg N*	0.2	0.4	0.3	0.3
Virtual N*, *Tg Virtual N*	0.9	1	1	N/A

Brazil	Production	Imports	Exports	BR Supply
Food weight, *Tg food*	893	13	84	822
Food N, *Tg N*	2	0.1	0.6	2
Virtual N*, *Tg Virtual N*	7	0.2	1	N/A

Japan	Production	Imports	Exports	JP Supply
Food weight, *Tg food*	64	58	1	120
Food N, *Tg N*	0.4	0.9	0	1
Virtual N*, *Tg Virtual N*	2	2	0.1	N/A

Bilateral Food N Trade: Procedure

1. Started with FAOSTAT food trade matrix

2. Because food trade matrix has secondary products (e.g. bread), conversion factors were used to convert them into primary product equivalents (e.g. wheat)

3. Food trade matrix categories were mapped to the desired food product categories

4. Remaining calculations same as total food N trade calculations, as described earlier (total N, Virtual N)

Issues with bilateral food trade analysis

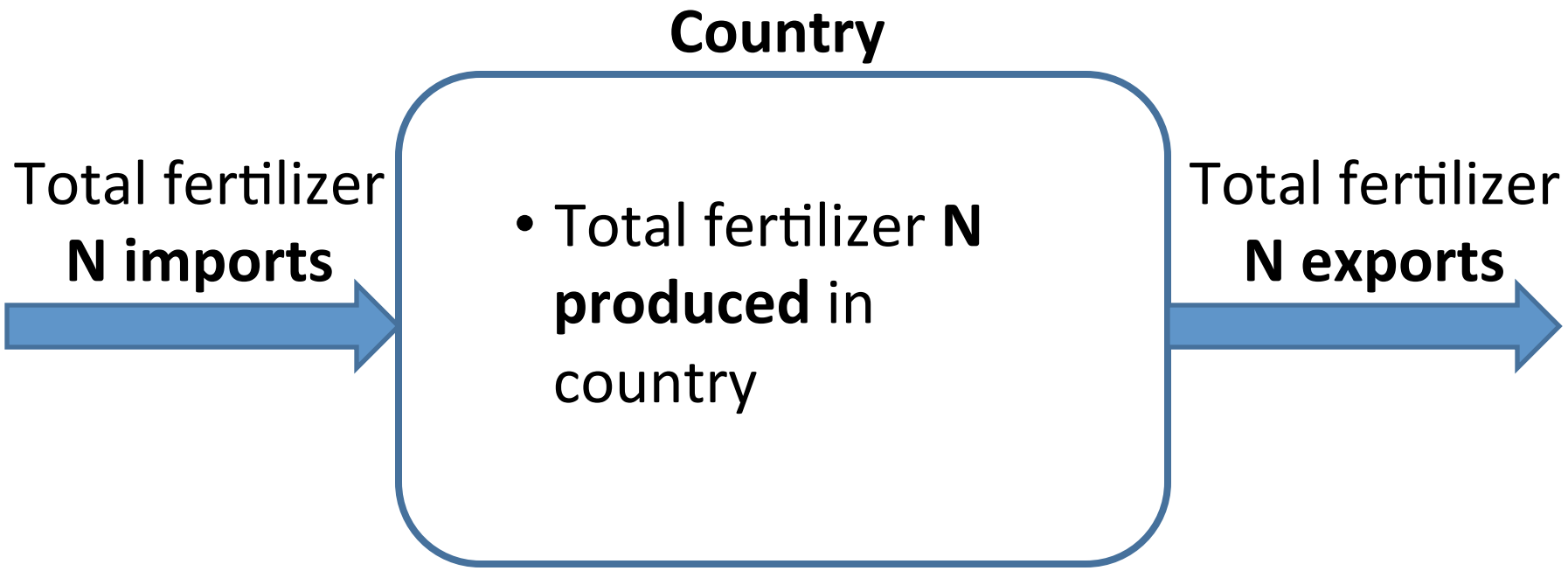
1. "Single step" trade analysis
   - Difficult to track products with more than one step
   - If a product is grown in country A, then shipped from B → C, trade may only be reported from B → C, depending on how countries report data

2. Secondary products
   - Data reported in secondary products (e.g. bread), whereas we need data in primary products (e.g. wheat)
   - Use factors to convert secondary products into primary products

3. Location of livestock feed
   - Feed imported into a meat-producing country becomes part of that's country's footprint, even though it was produced in another country

4. Virtual N from food production
   - Use the US Virtual N Factors to estimate food production N, which assumes that all countries produce food similarly to the US

Fertilizer N Trade



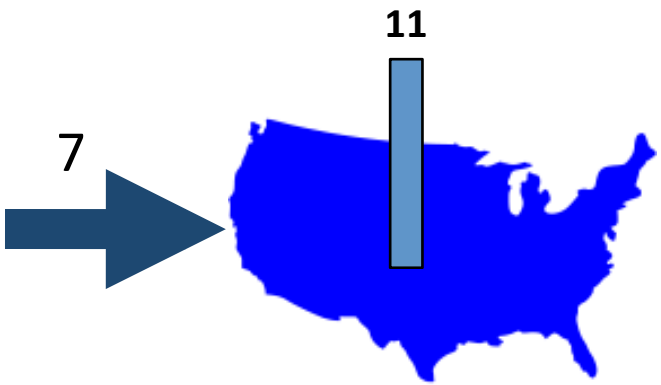
- Fertilizer forms: ammonia and urea
- Note: No Virtual N here

Total Fertilizer N Trade, *Tg N*

Fertilizer N Imports Fertilizer N Exports

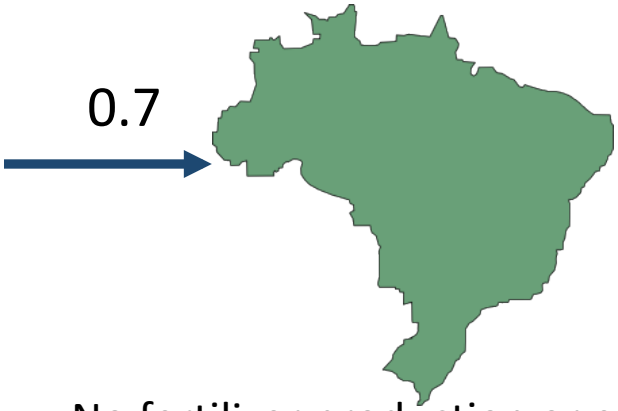
Fertilizer N produced within country: Remaining N

Note: Fertilizer trade exceeding 0.3 Tg fertilizer product, fertilizer production exceeding 1 Tg fertilizer product



Biggest exports: Cereals, Oilcrops

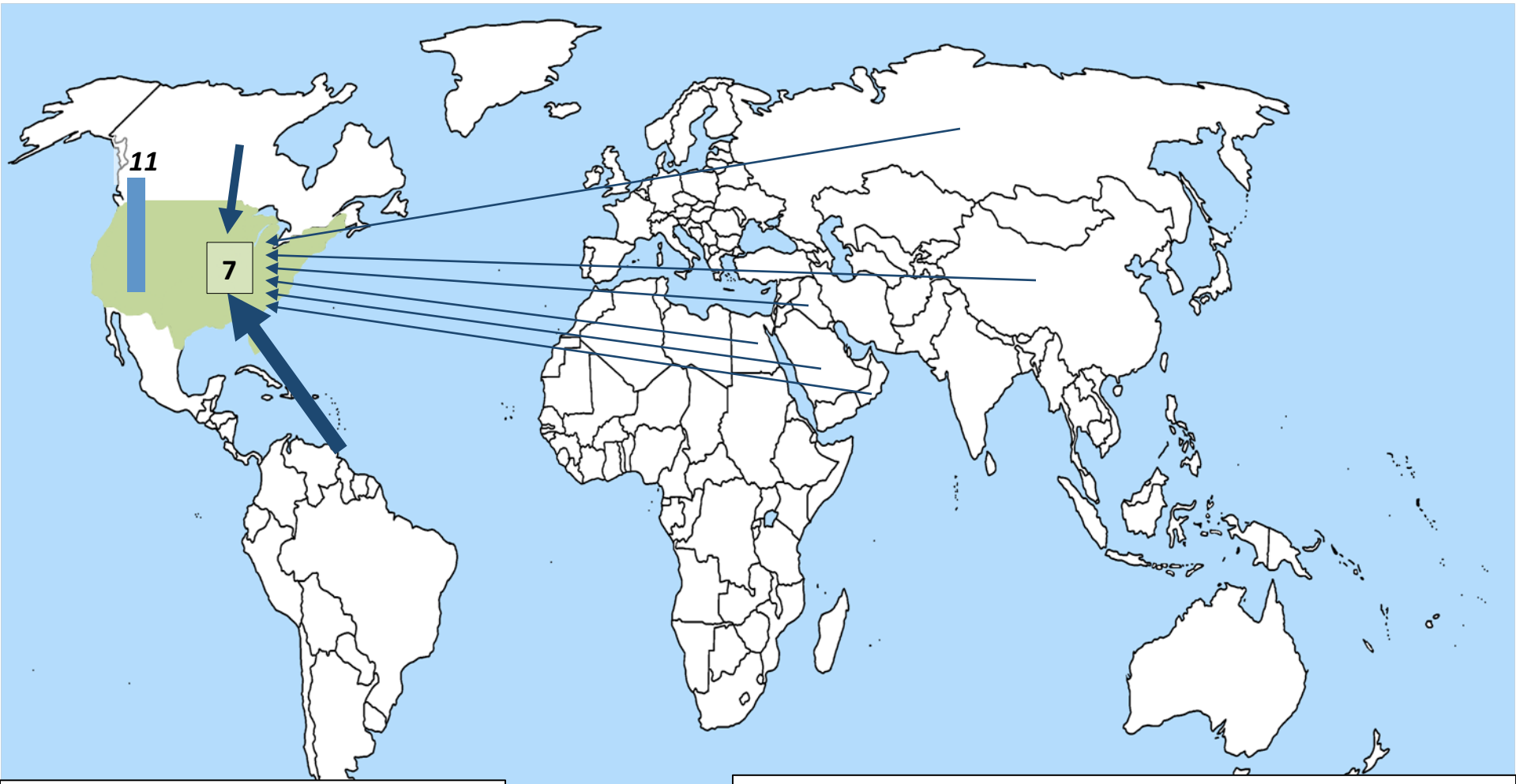
No fertilizer production or trade



No fertilizer production or exports

No fertilizer production or trade

Nitrogen imports to the United States: Fertilizer N *(Tg N)*



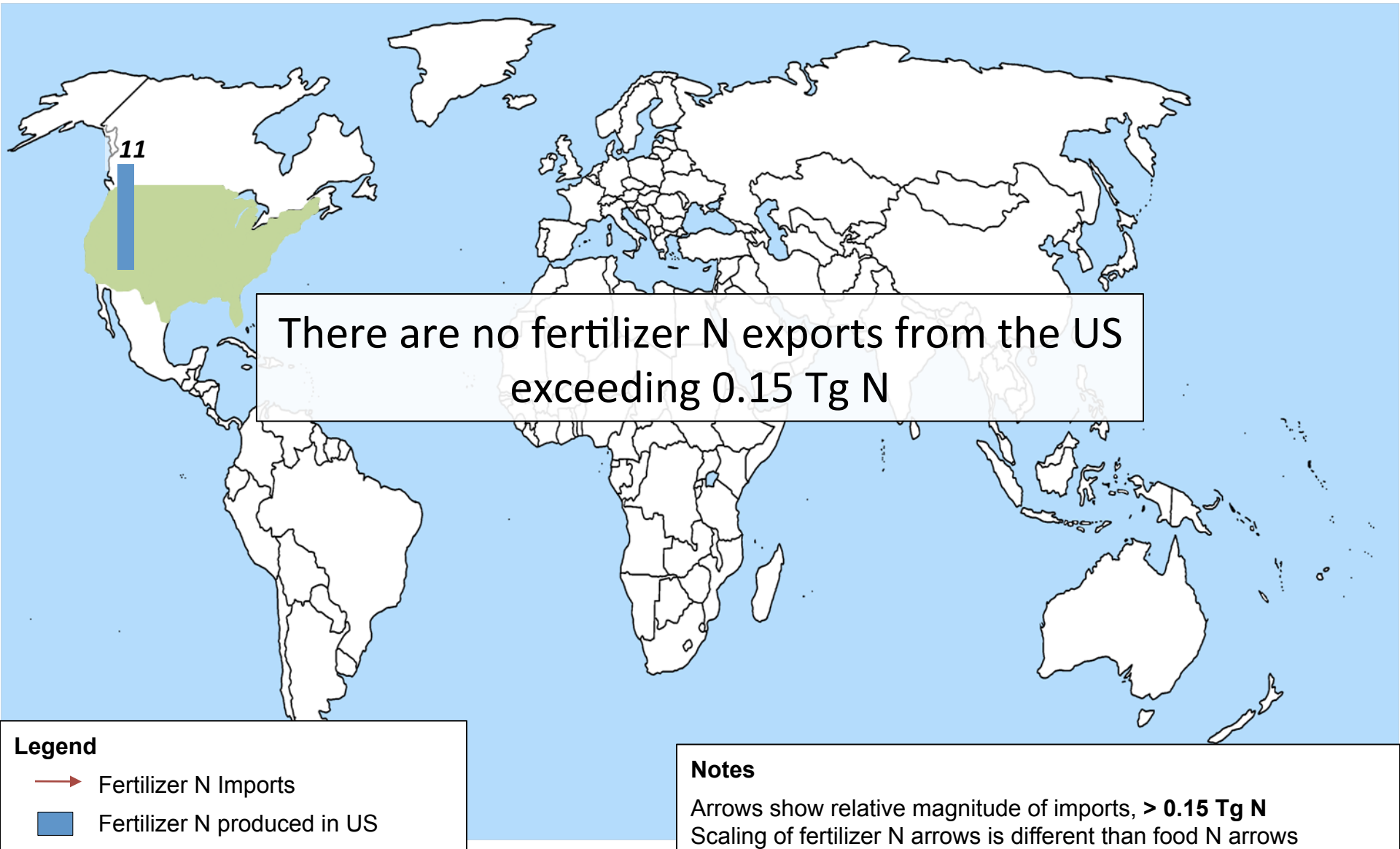
Legend

- Fertilizer N Imports
- Fertilizer N produced in US

Notes

Final number in US = Total imported fertilizer N
Arrows show relative magnitude of imports, **> 0.15 Tg N**
Scaling of fertilizer N arrows is different than food N arrows
Do not have Virtual N estimates for fertilizer production

Nitrogen exports from the United States: Fertilizer N *(Tg N)*



Results: Fertilizer

Total Fertilizer Trade for US, 2007				
	Imports	Production	Exports	US Supply
Fertilizer *(Tg fertilizer)*	9	16	0	25
Fertilizer N *(Tg N)*	6	11	0	17

Notes:
Only included trade exceeding ~150,000 tonnes fertilizer N
Fertilizer in the forms of ammonia and urea

What is Needed?

- **Awareness** in a country that action is needed to limit impacts of N losses
- **Policy** instruments in the country to limit N losses
- **International harmonization** of environmental regulations so countries are not disadvantage in trade