A Primer on the Carbon and Water Footprint in our Food Consumption

The Reform Group, 23rd Energy Forum, Oct. 13th-19th, 2019

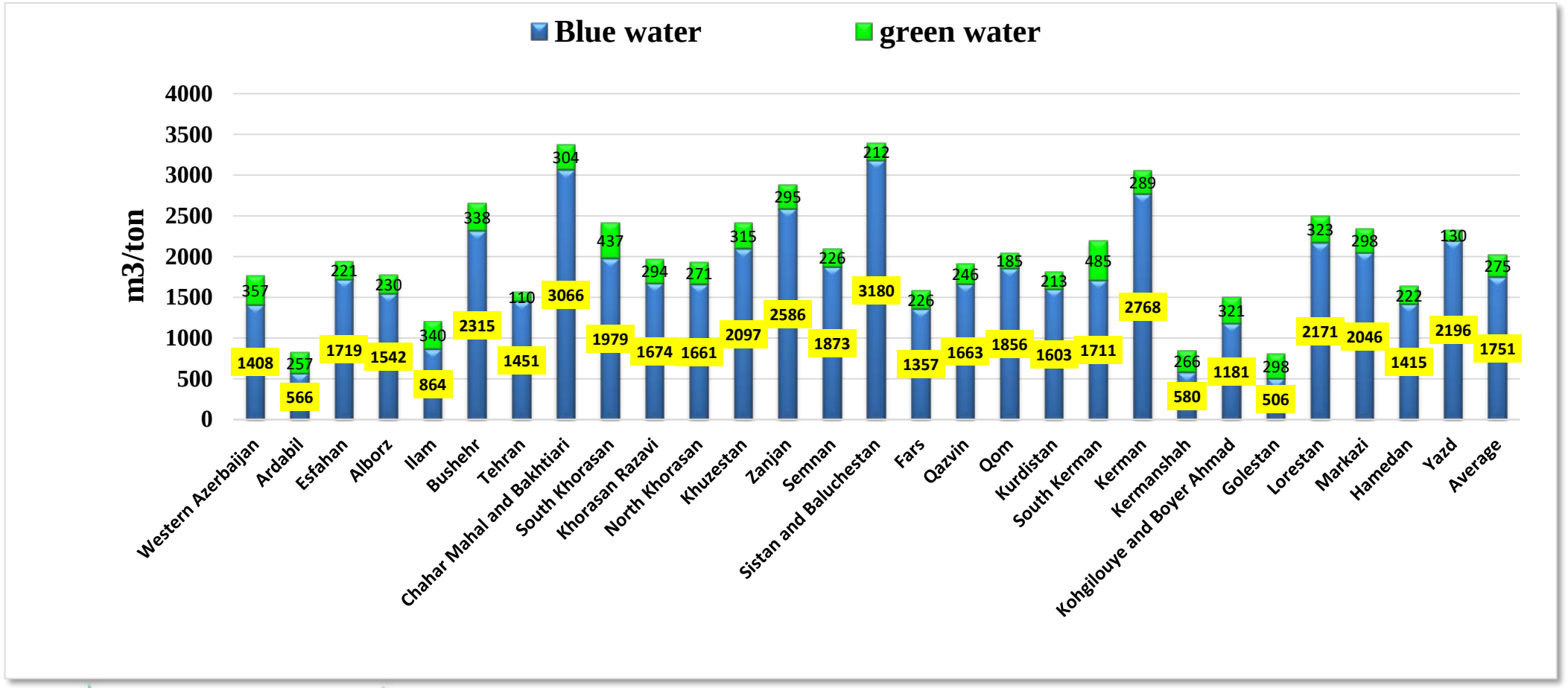
Bahram Taheri

October 18, 2019

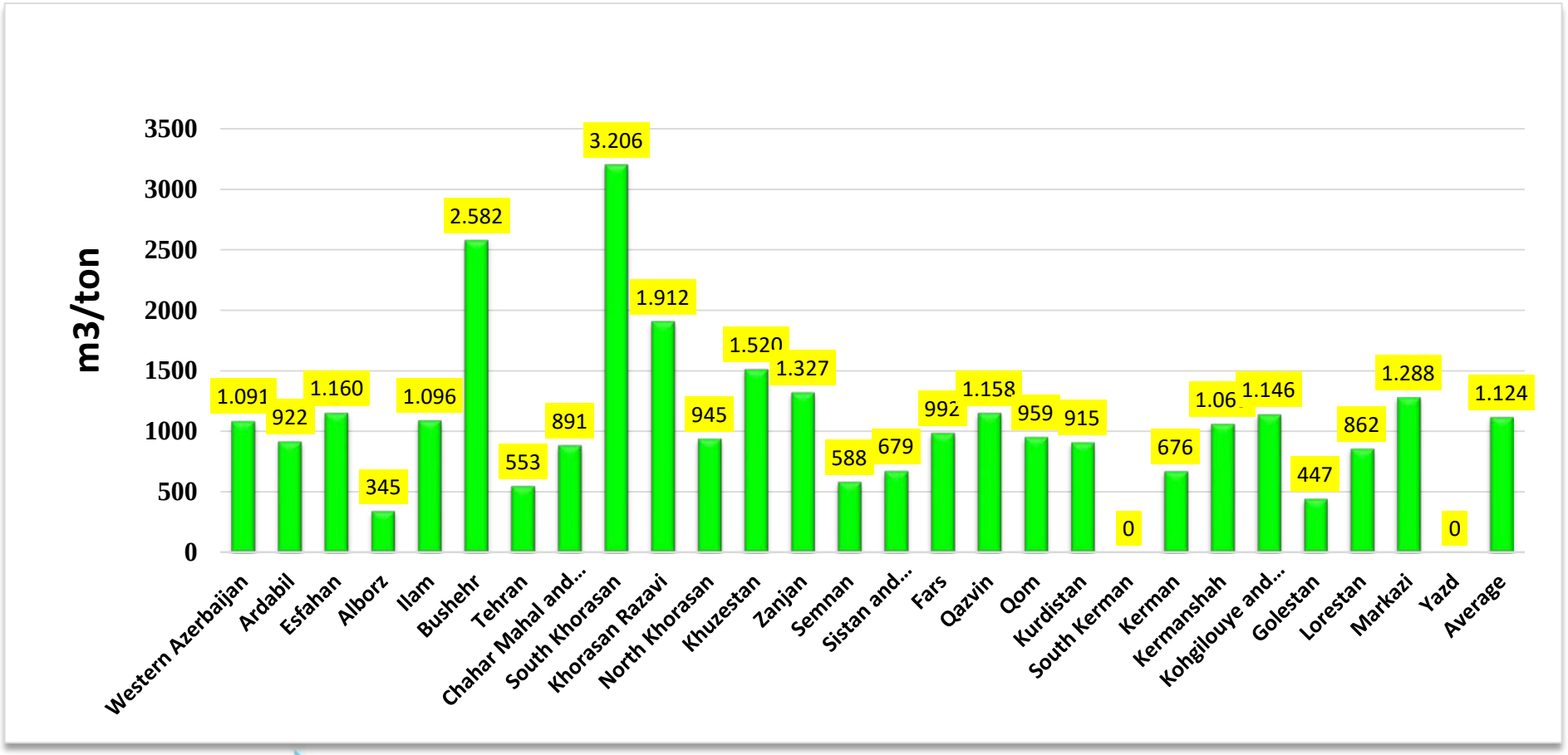
Schloss Leopoldskron, Salzburg,Austria


بسم الله الرحمن الرحيم

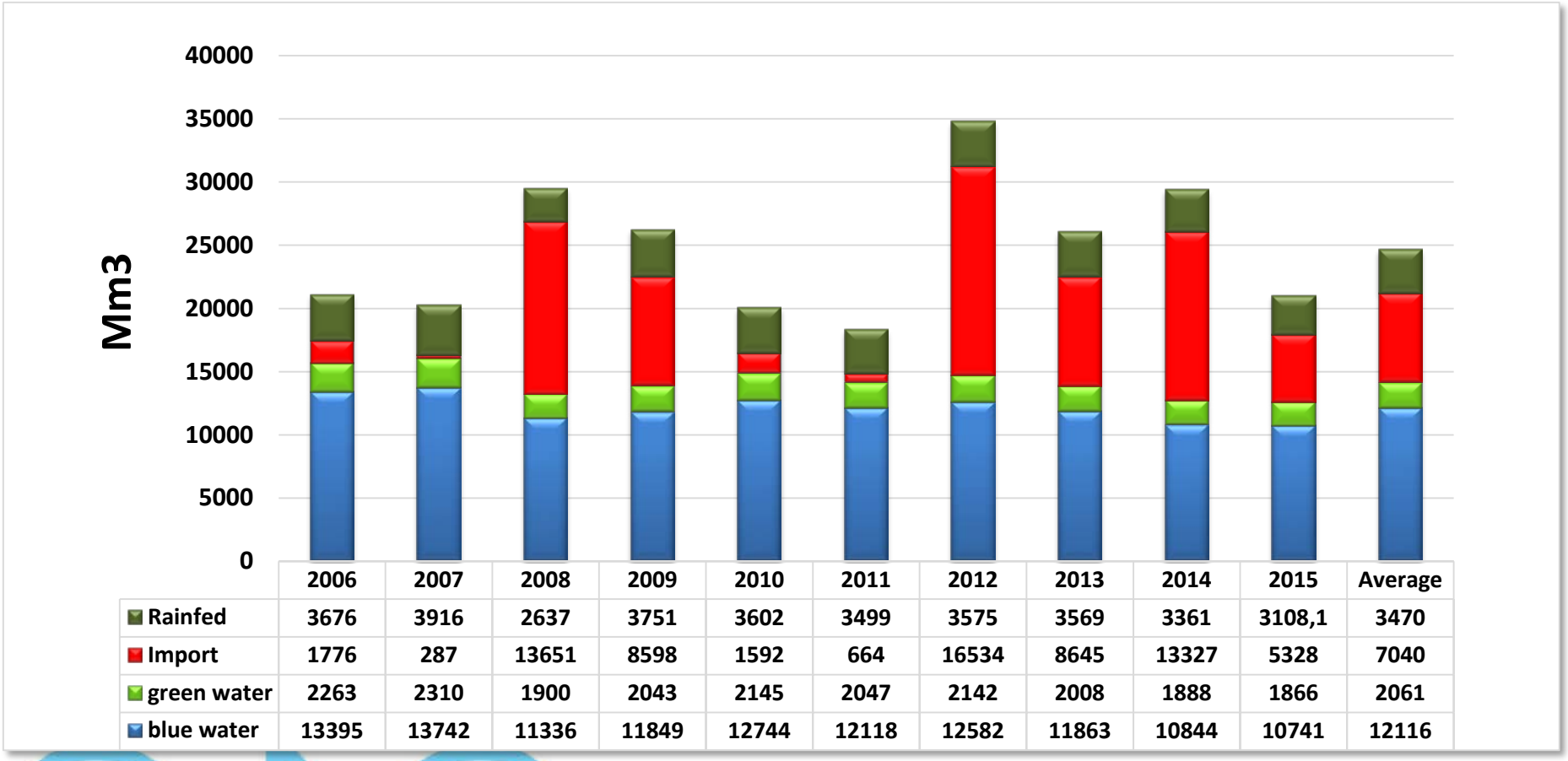
Wheat Virtual Water based on the applied water



Rainfed wheat Virtual Water

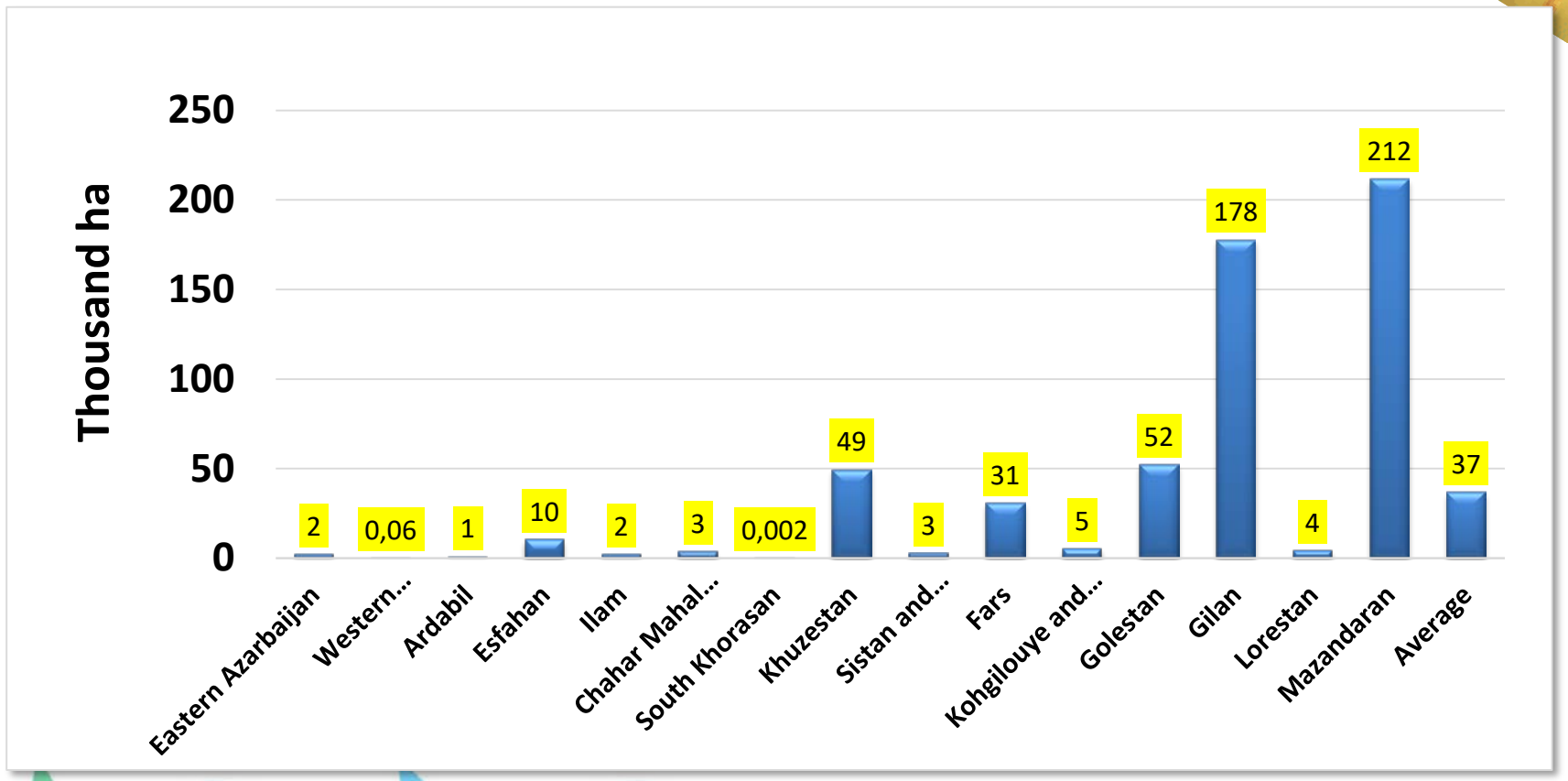


Wheat Virtual-Water “Flows” for 2006-2015

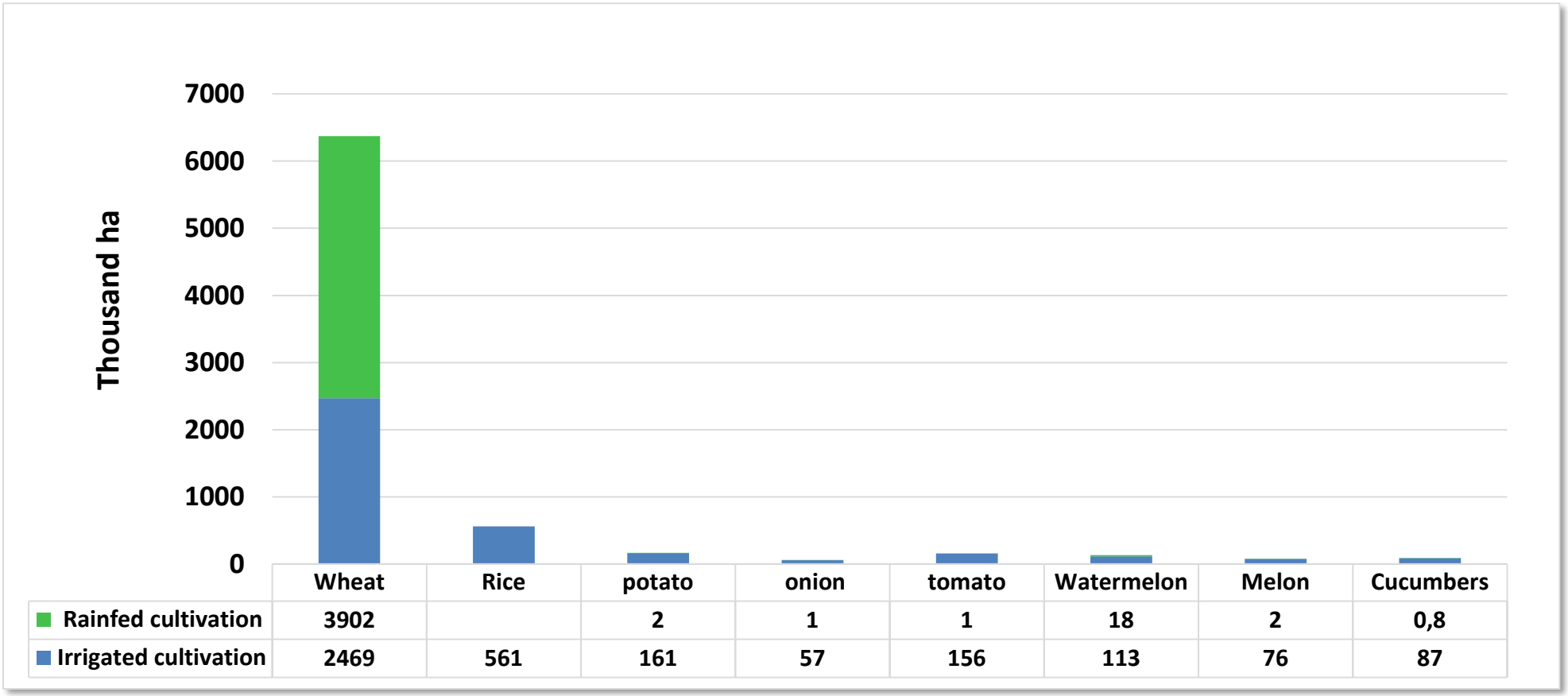


	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
Rainfed	3676	3916	2637	3751	3602	3499	3575	3569	3361	3108,1	3470
Import	1776	287	13651	8598	1592	664	16534	8645	13327	5328	7040
green water	2263	2310	1900	2043	2145	2047	2142	2008	1888	1866	2061
blue water	13395	13742	11336	11849	12744	12118	12582	11863	10844	10741	12116

Average Rice cultivation for 2006-2015

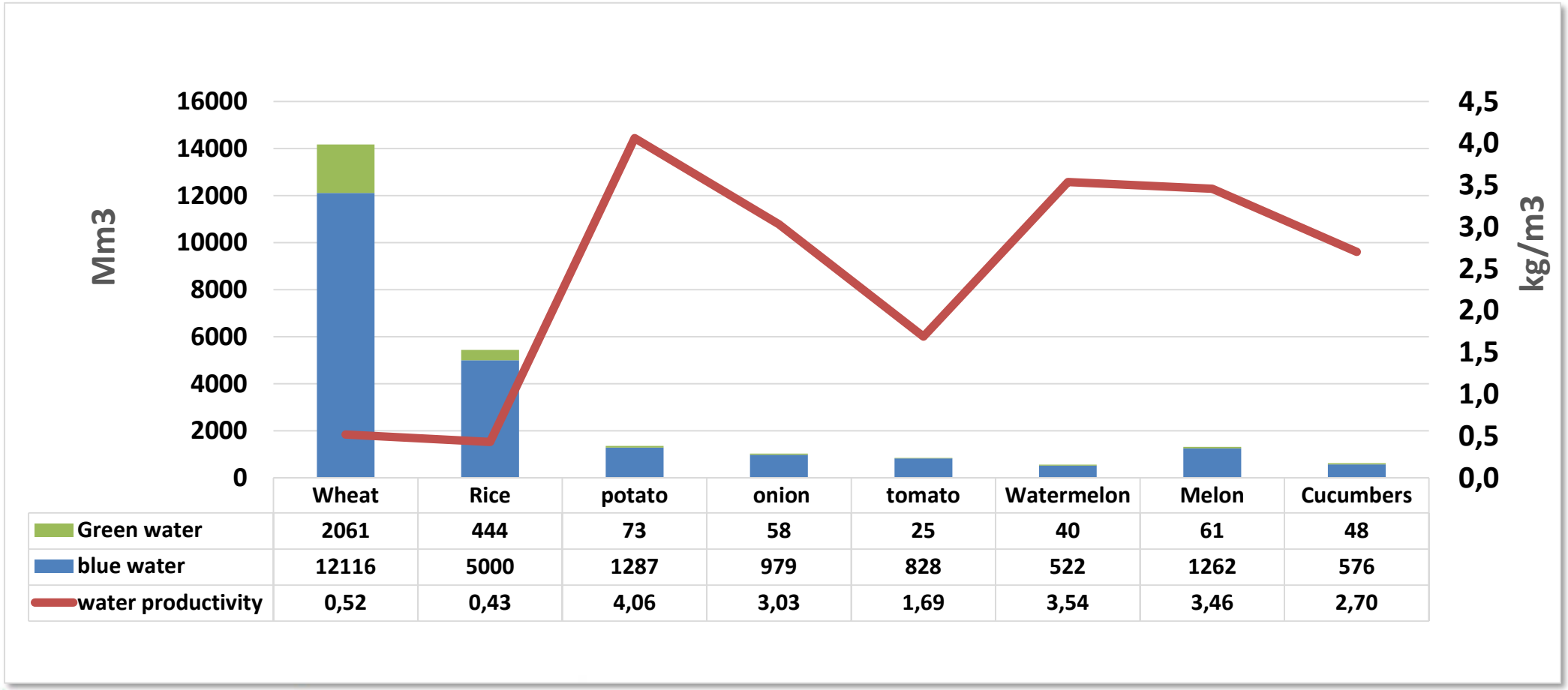


The average level of crops cultivation for 2006-2015



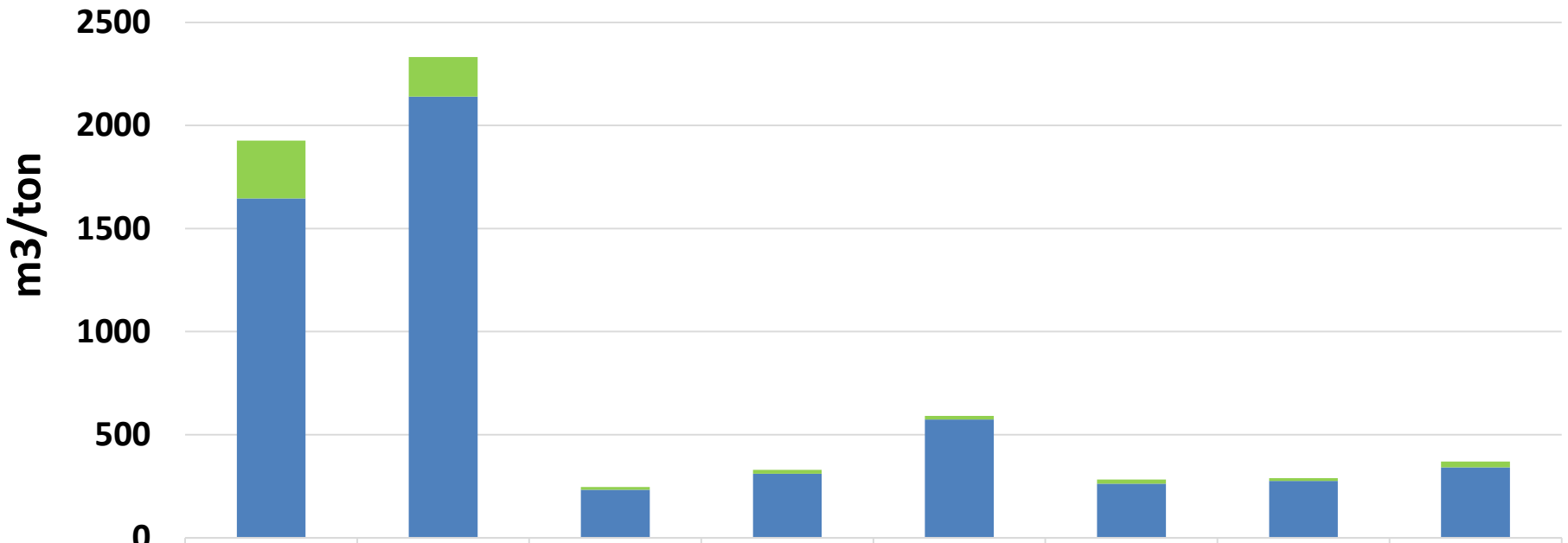
	Wheat	Rice	potato	onion	tomato	Watermelon	Melon	Cucumbers
Rainfed cultivation	3902		2	1	1	18	2	0,8
Irrigated cultivation	2469	561	161	57	156	113	76	87

Crops water use and water productivity



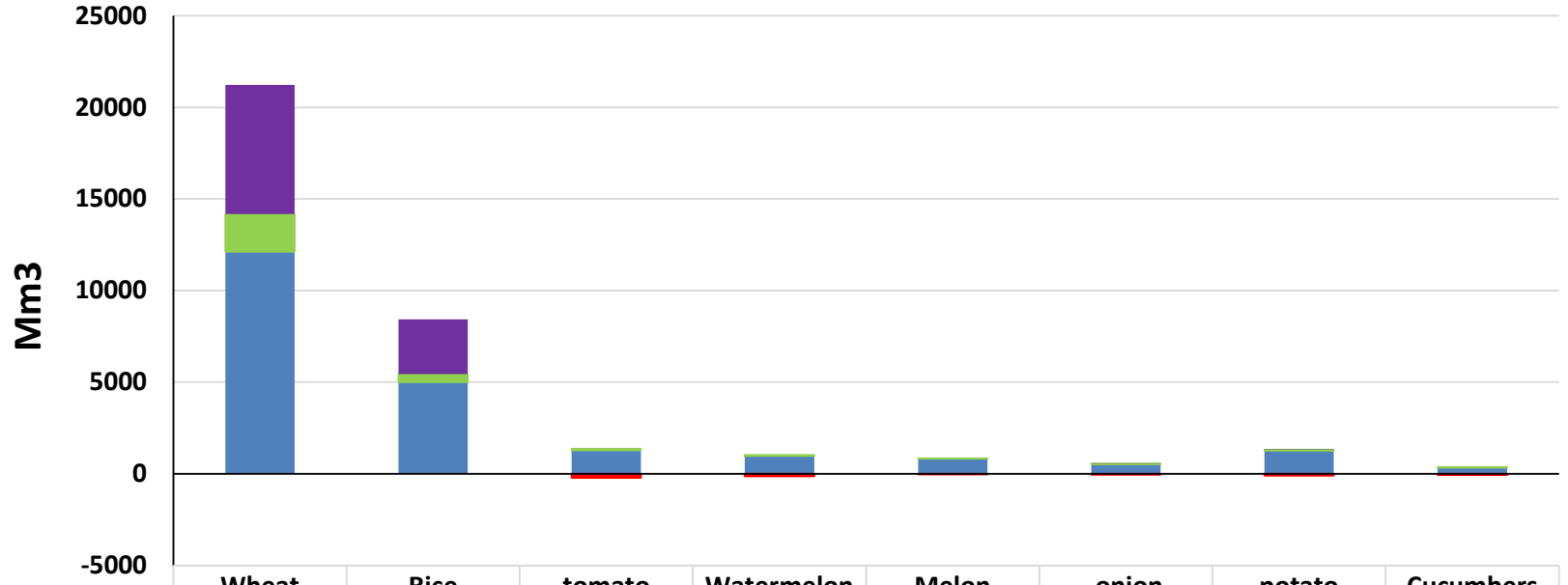
	Wheat	Rice	potato	onion	tomato	Watermelon	Melon	Cucumbers
Green water	2061	444	73	58	25	40	61	48
blue water	12116	5000	1287	979	828	522	1262	576
water productivity	0,52	0,43	4,06	3,03	1,69	3,54	3,46	2,70

Crops virtual water



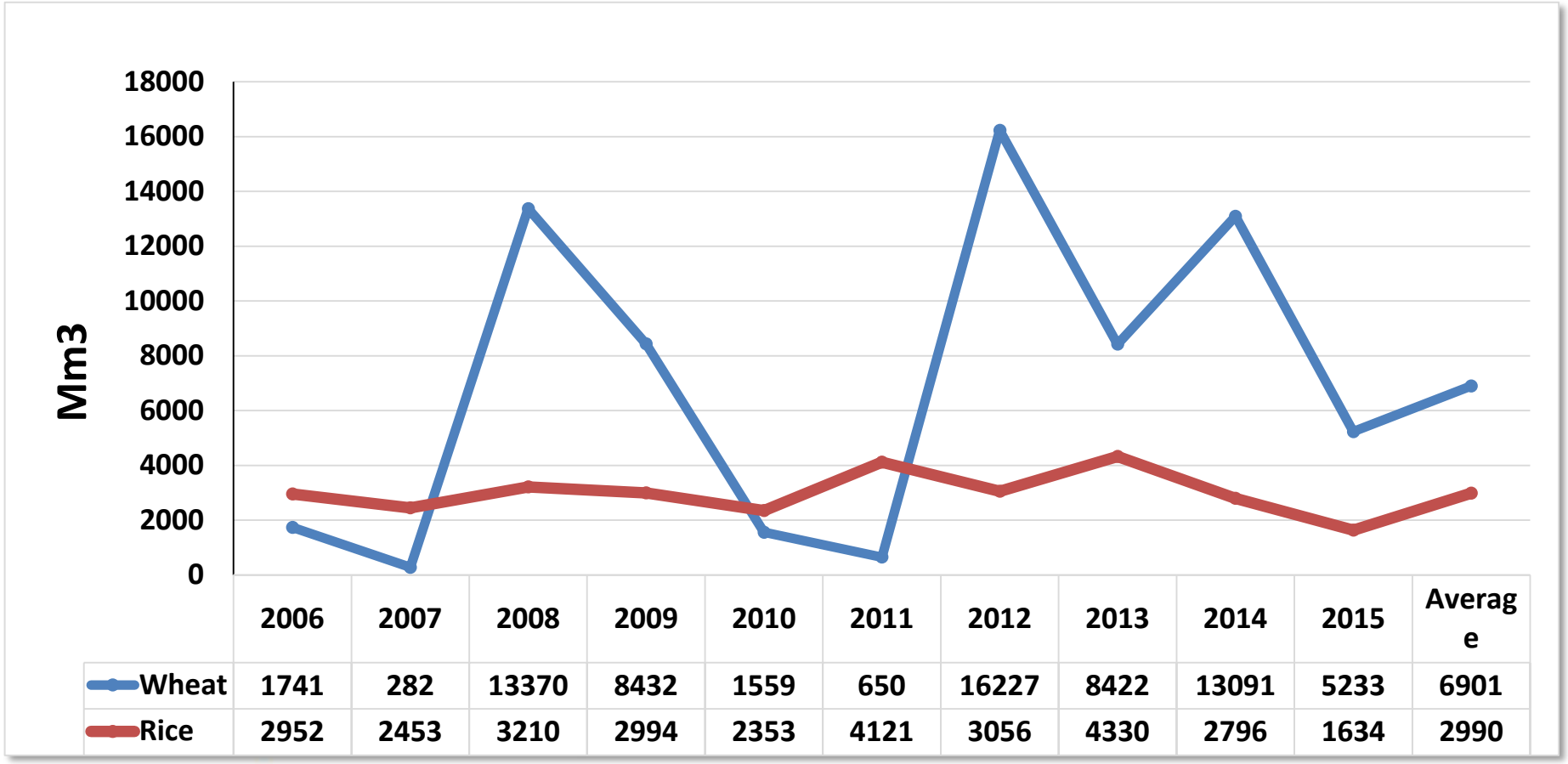
	Wheat	Rice	potato	onion	tomato	Watermelon	Melon	Cucumbers
Green water	280	191	13	18	17	20	13	28
Blue water	1647	2140	233	311	574	262	276	342

Crops Virtual-Water “Flows” for 2006-2015



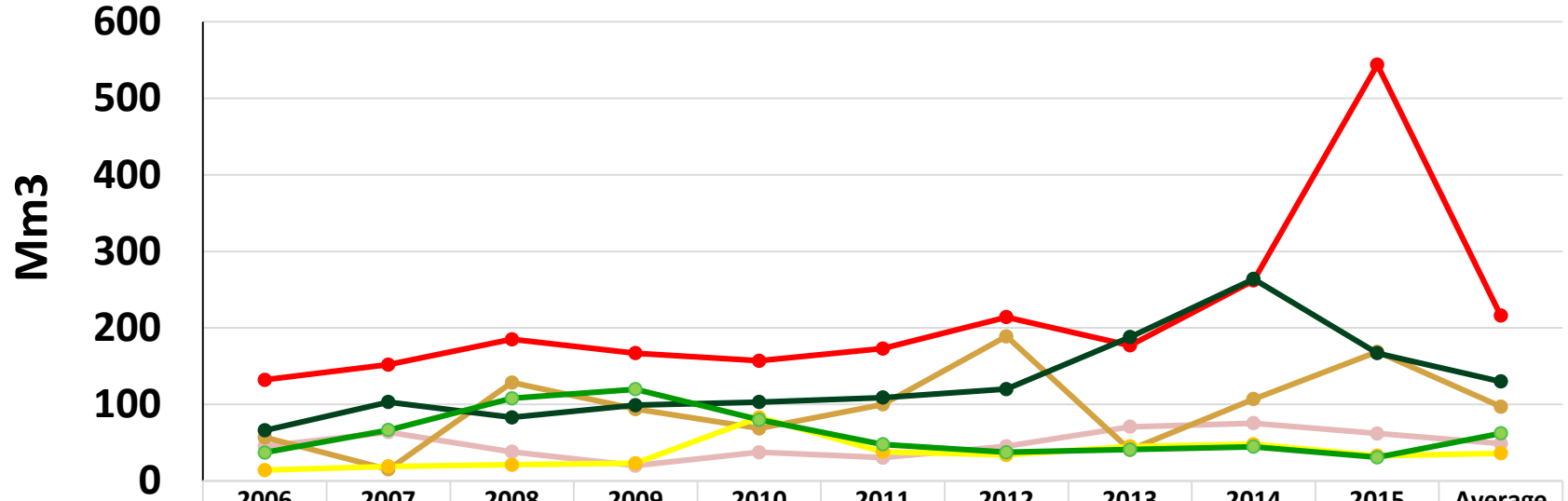
	Wheat	Rice	tomato	Watermelon	Melon	onion	potato	Cucumbers
Import	7040	2990	0	0	0	1	7	0
Export	0	0	-210	-129	-36	-47	-99	-62
green water	2061	444	73	58	25	40	61	28
blue water	12116	5000	1289	979	828	522	1261	342

Virtual water “Import”



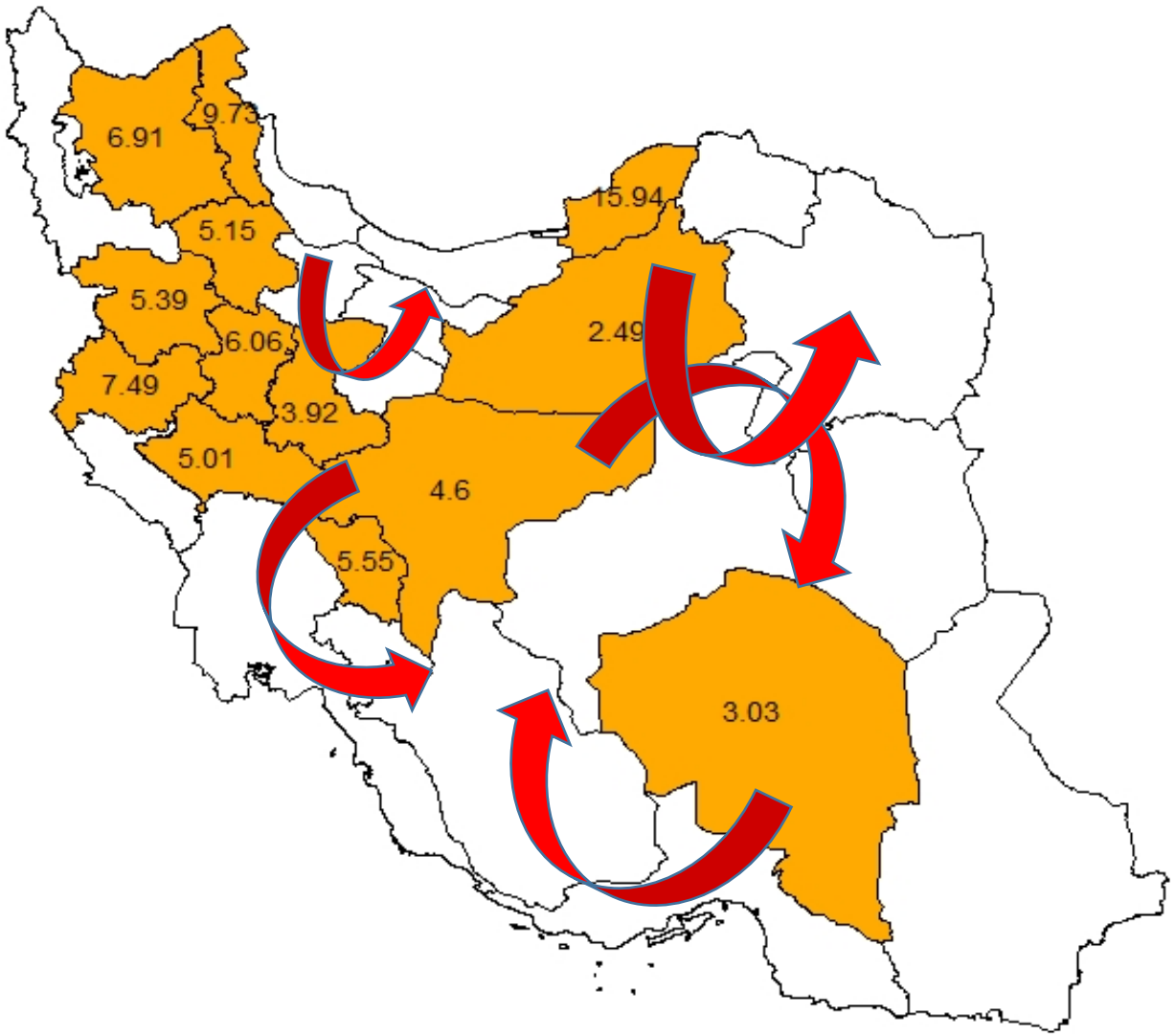
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
Wheat	1741	282	13370	8432	1559	650	16227	8422	13091	5233	6901
Rice	2952	2453	3210	2994	2353	4121	3056	4330	2796	1634	2990

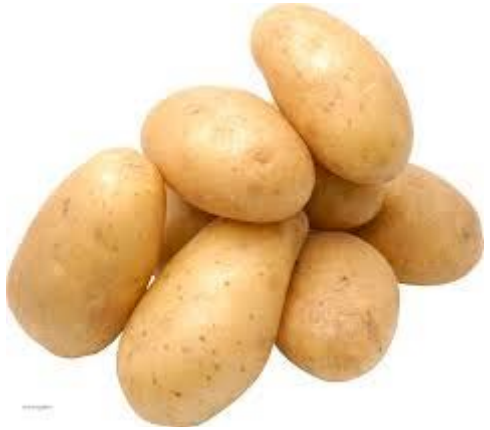
Virtual water “Export”



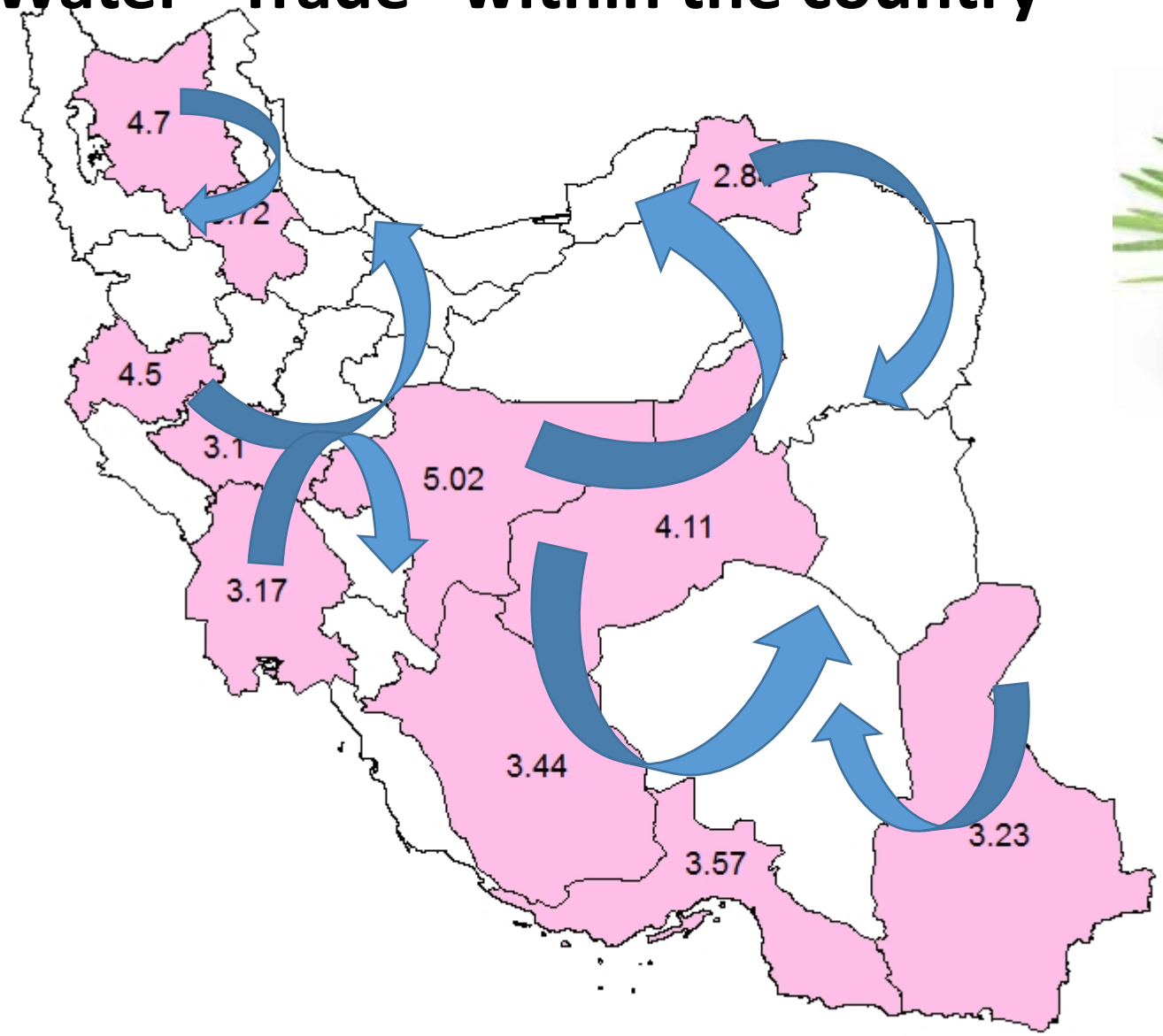
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
onion	45,4	63,8	38,1	20	37,5	30,4	45,3	70,8	75,4	61,9	49
tomato	132	152	185	167	157	173	214	177	262	544	216
potato	57	15	128,6	94	68,7	100	189	40,5	107	168,7	97
watermelon	66	103	83	99	103	109	120	188	264	167	130
melon	14	19	21	23	83	38	34	45	48	33	36
Cucumbers	37	66	108	120	80	48	37	41	45	31	62

Potato Virtual-Water “Trade” within the country

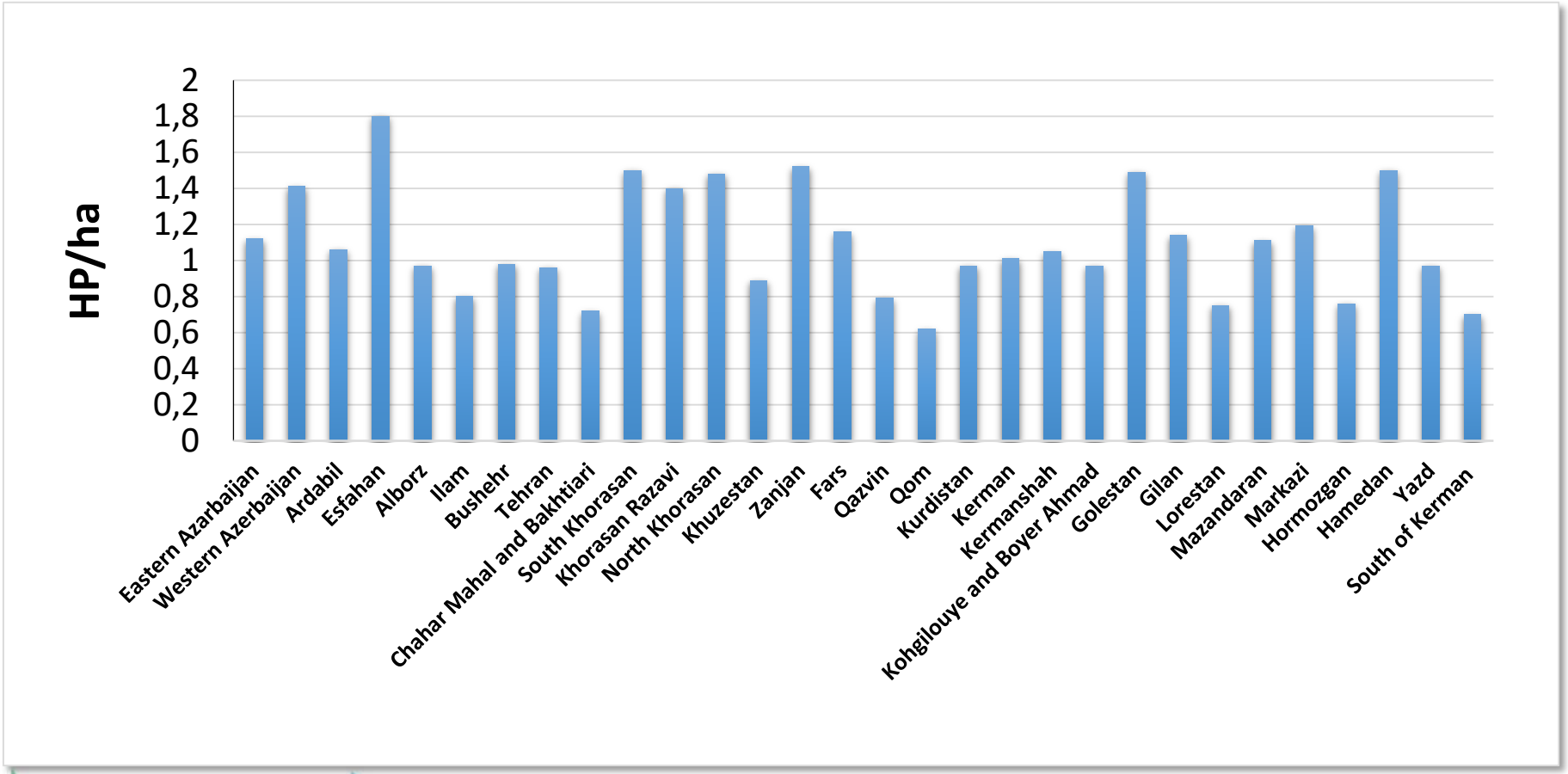




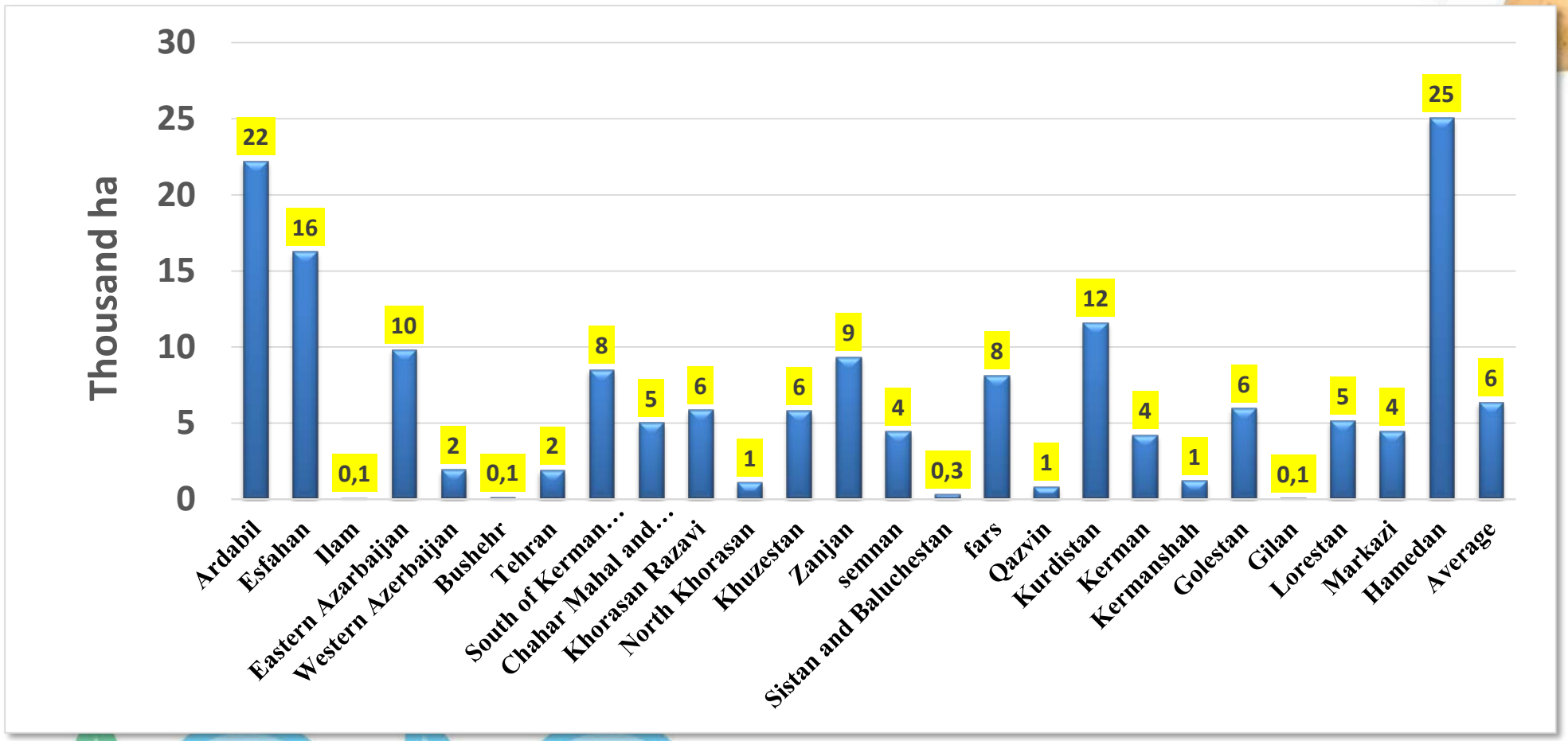
Onion Virtual-Water “Trade” within the country



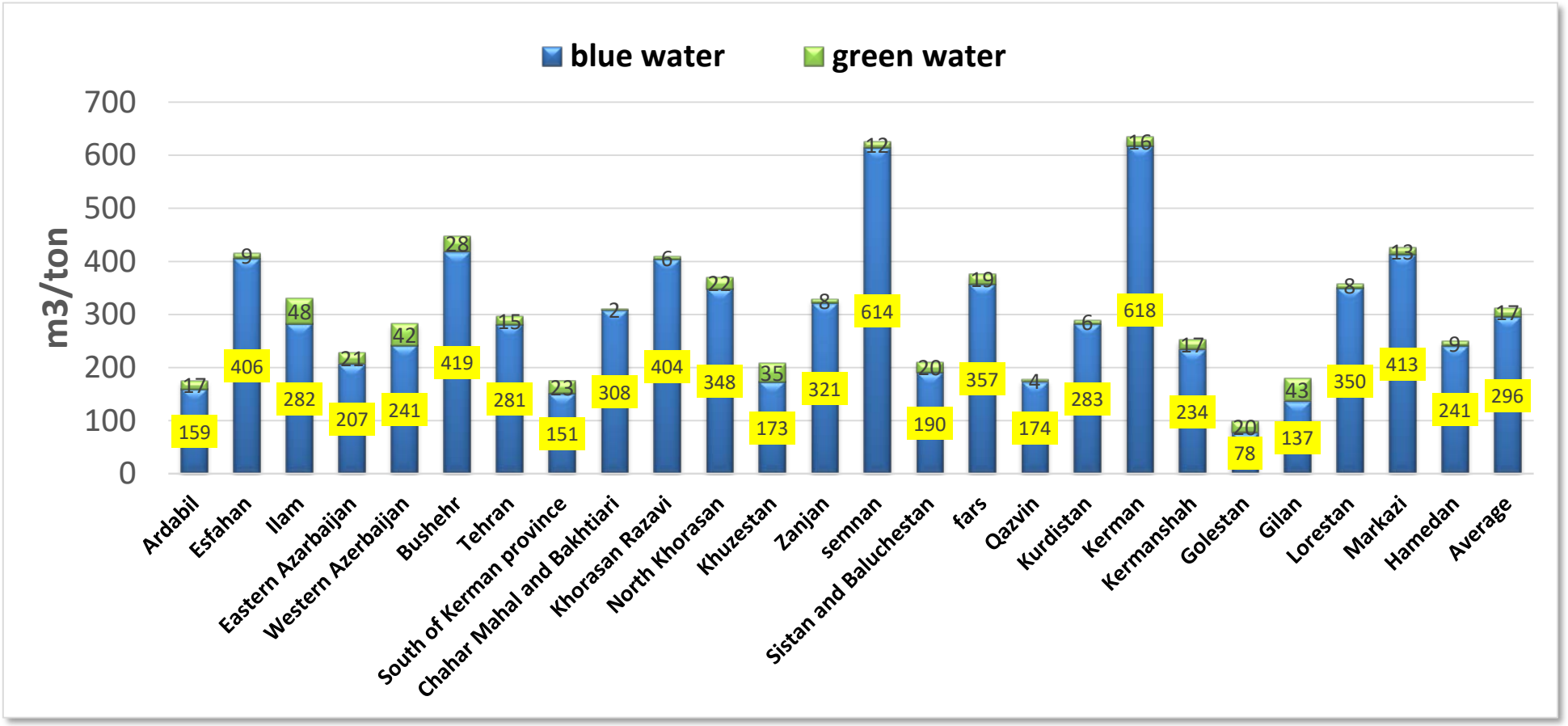
1- Technology development



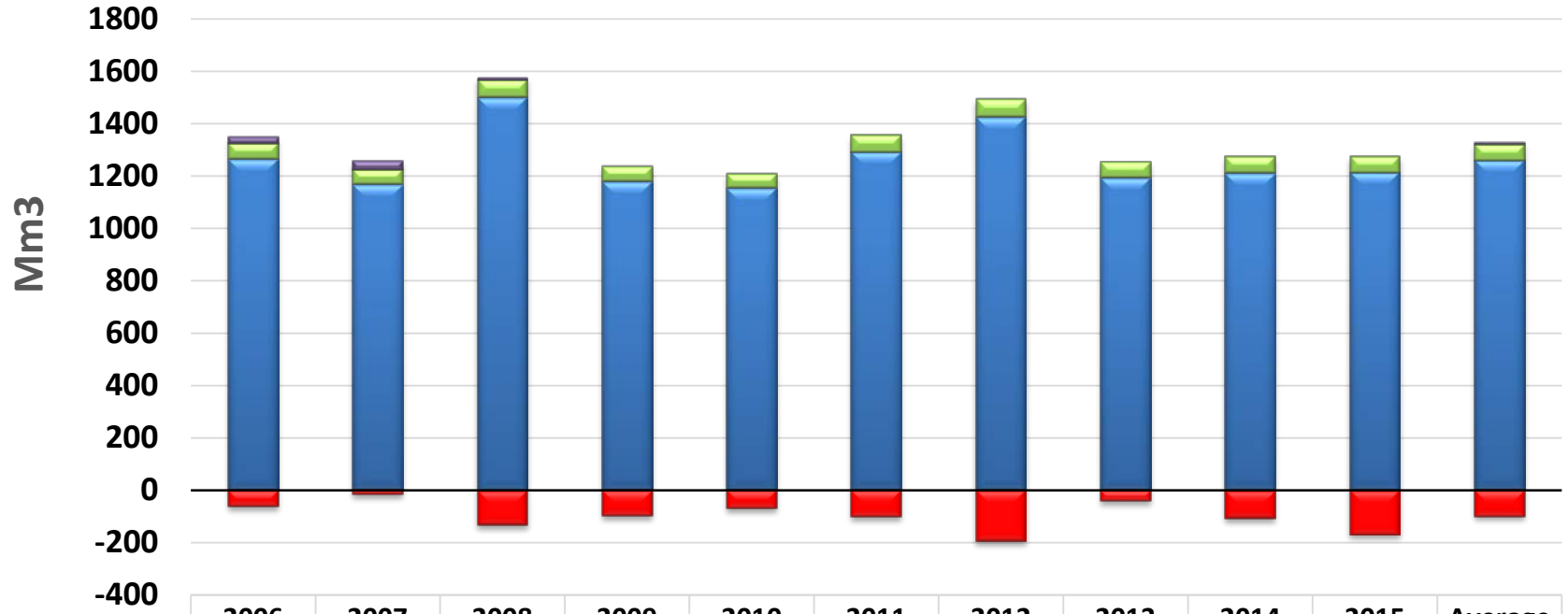
Average Potato cultivation for 2006-2015



Potato Virtual Water based on the applied water

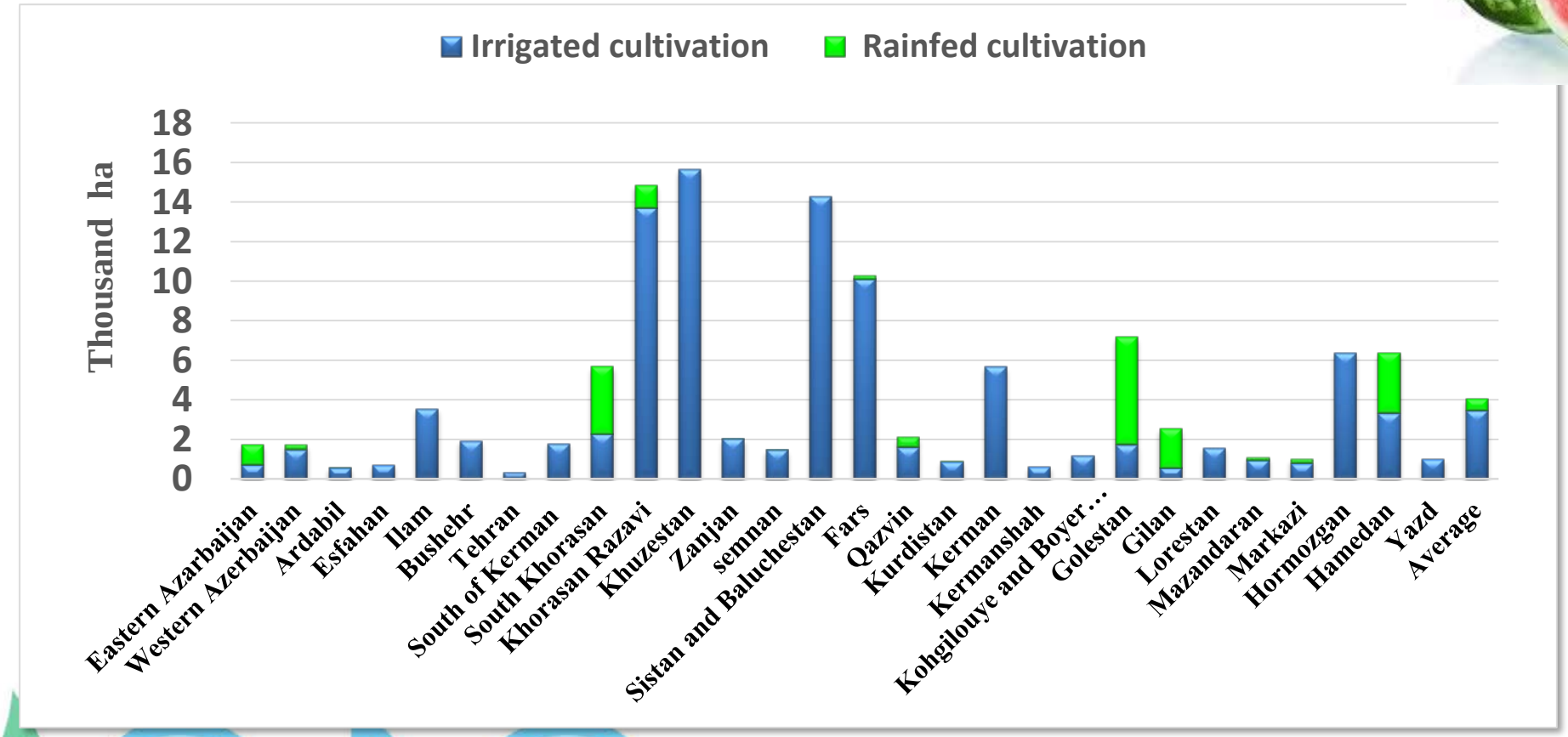


Potato Virtual-Water “Flows” for 2006-2015

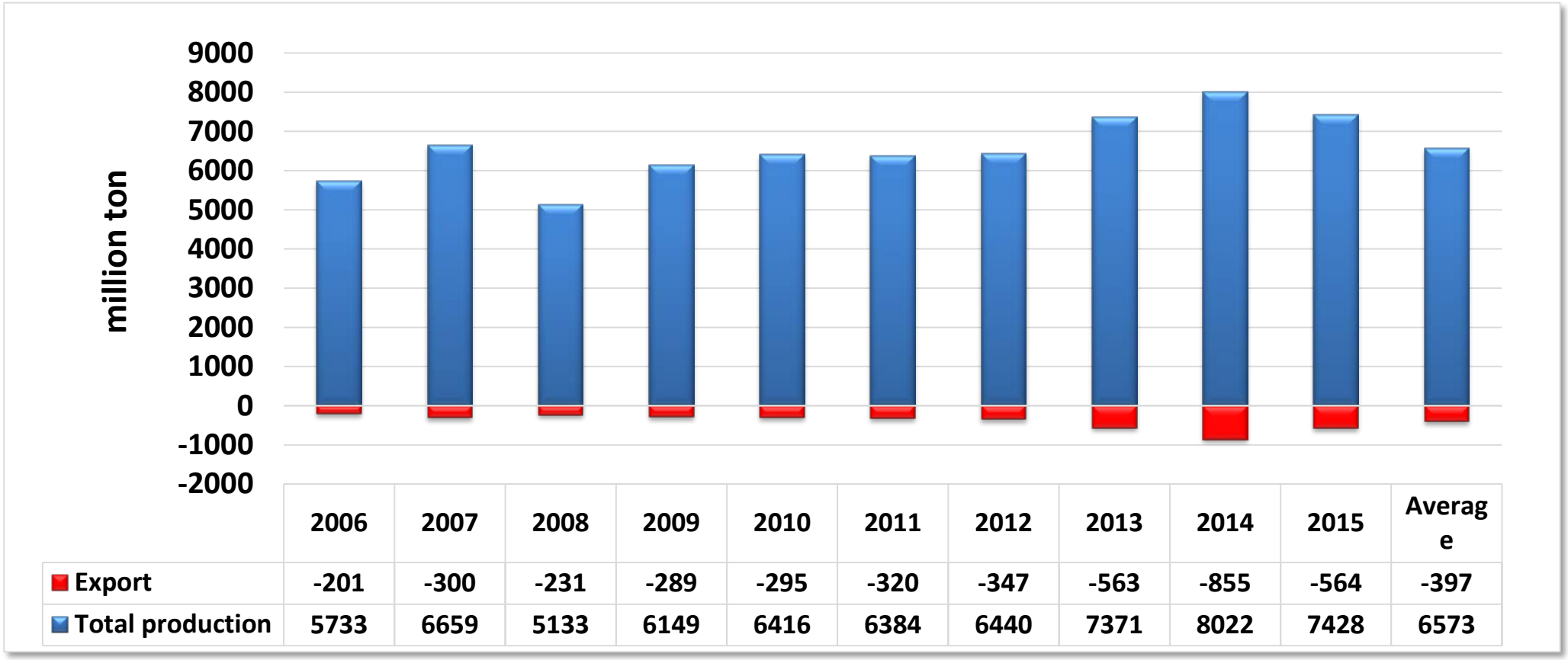


	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
Import	25	35	9	0	0	0	0	0	0	0	7
Export	-60	-15	-133	-96	-70	-102	-194	-41	-108	-168	-99
green water	59	55	66	57	53	65	67	60	62	62	61
blue water	1266	1169	1501	1180	1156	1293	1427	1194	1212	1213	1261

Average Watermelon cultivation for 2006-2015

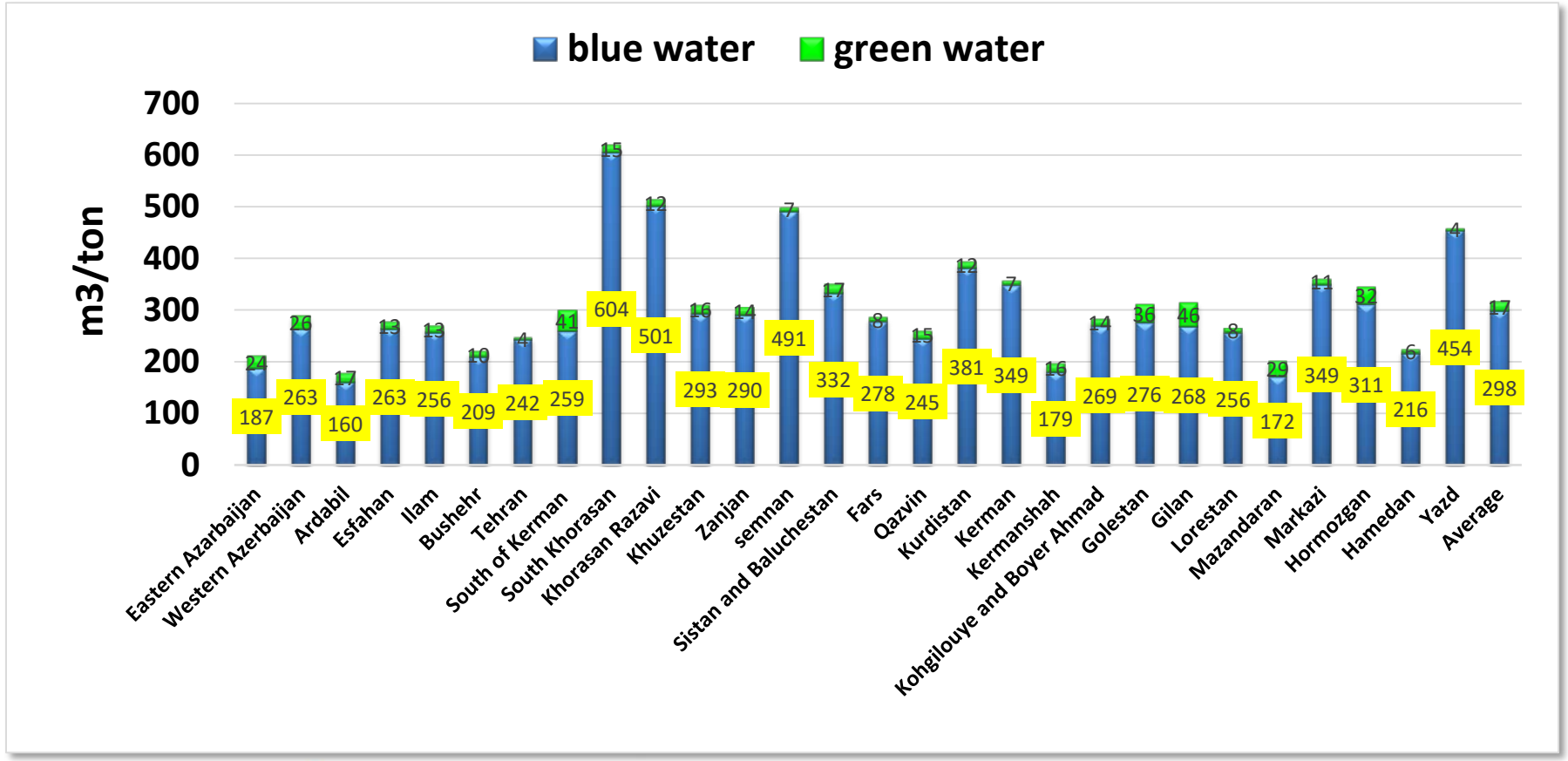


Average Watermelon Production for 2006-2015

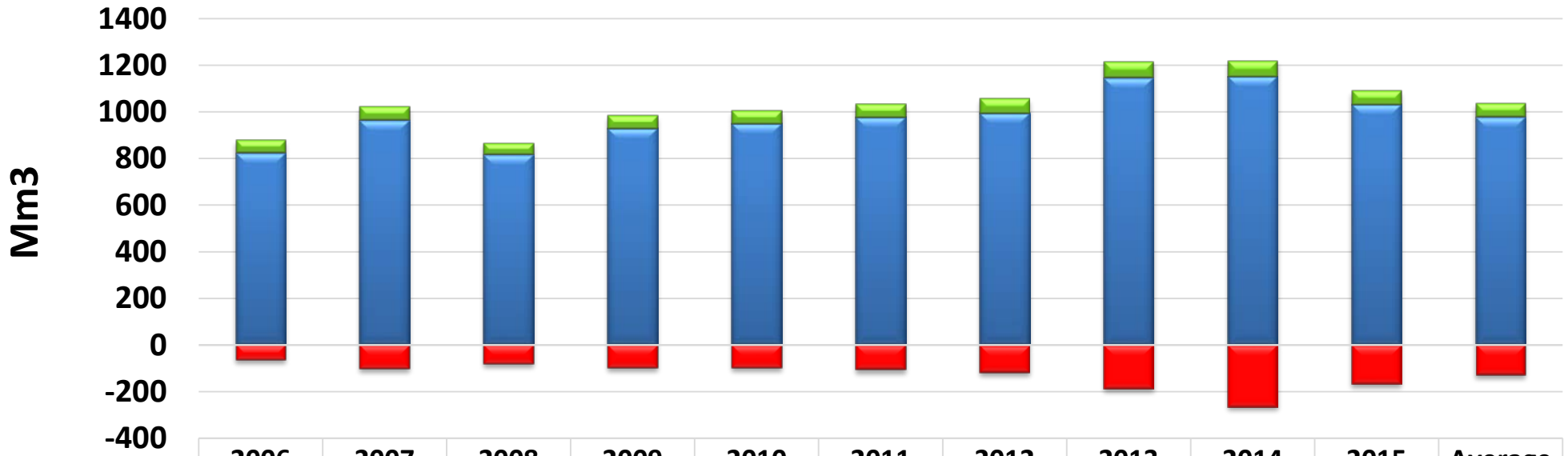


	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
Export	-201	-300	-231	-289	-295	-320	-347	-563	-855	-564	-397
Total production	5733	6659	5133	6149	6416	6384	6440	7371	8022	7428	6573

Watermelon Virtual Water based on the applied water

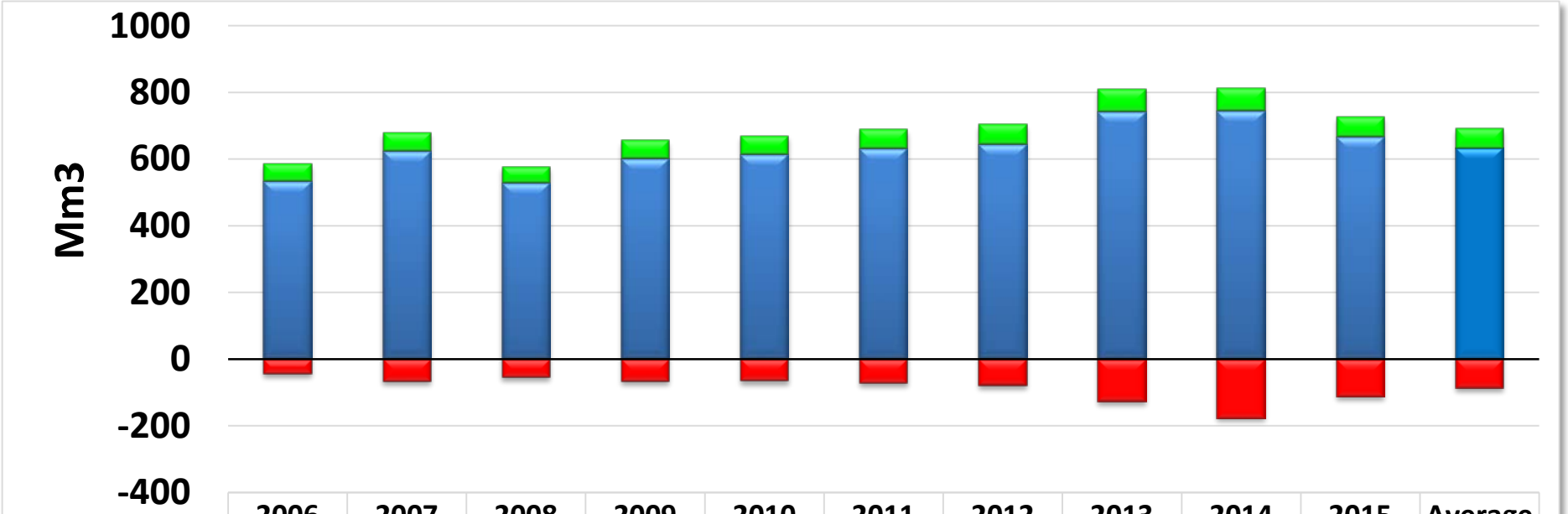


Watermelon Virtual-Water “Flows” for 2006-2015



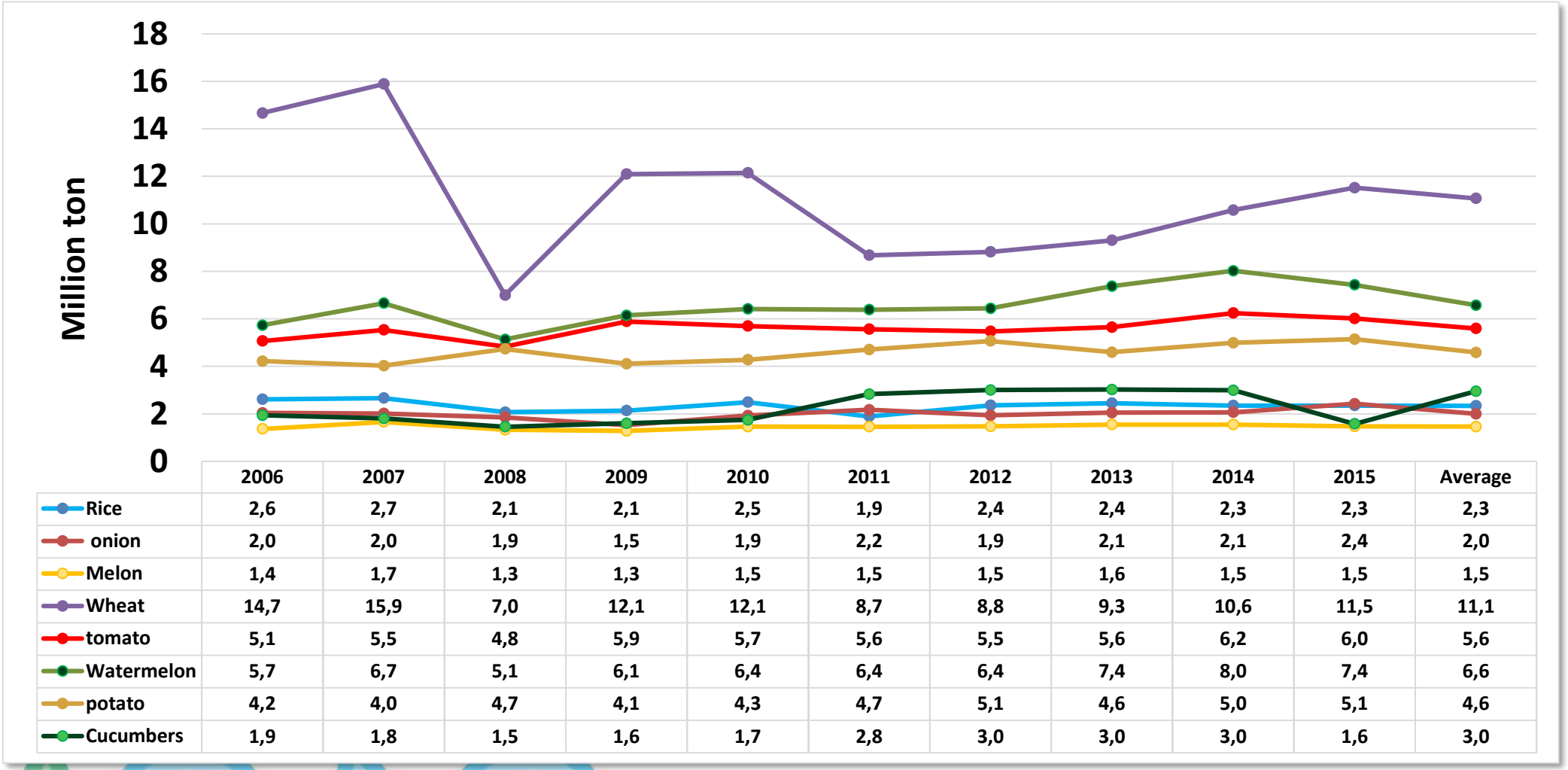
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
Export	-65	-101	-82	-98	-98	-107	-118	-189	-264	-168	-129
green water	52	57	48	54	56	57	60	68	67	59	58
blue water	825	964	818	929	950	977	996	1147	1151	1032	979

Watermelon Virtual-Water "Flows" By using drip irrigation systems



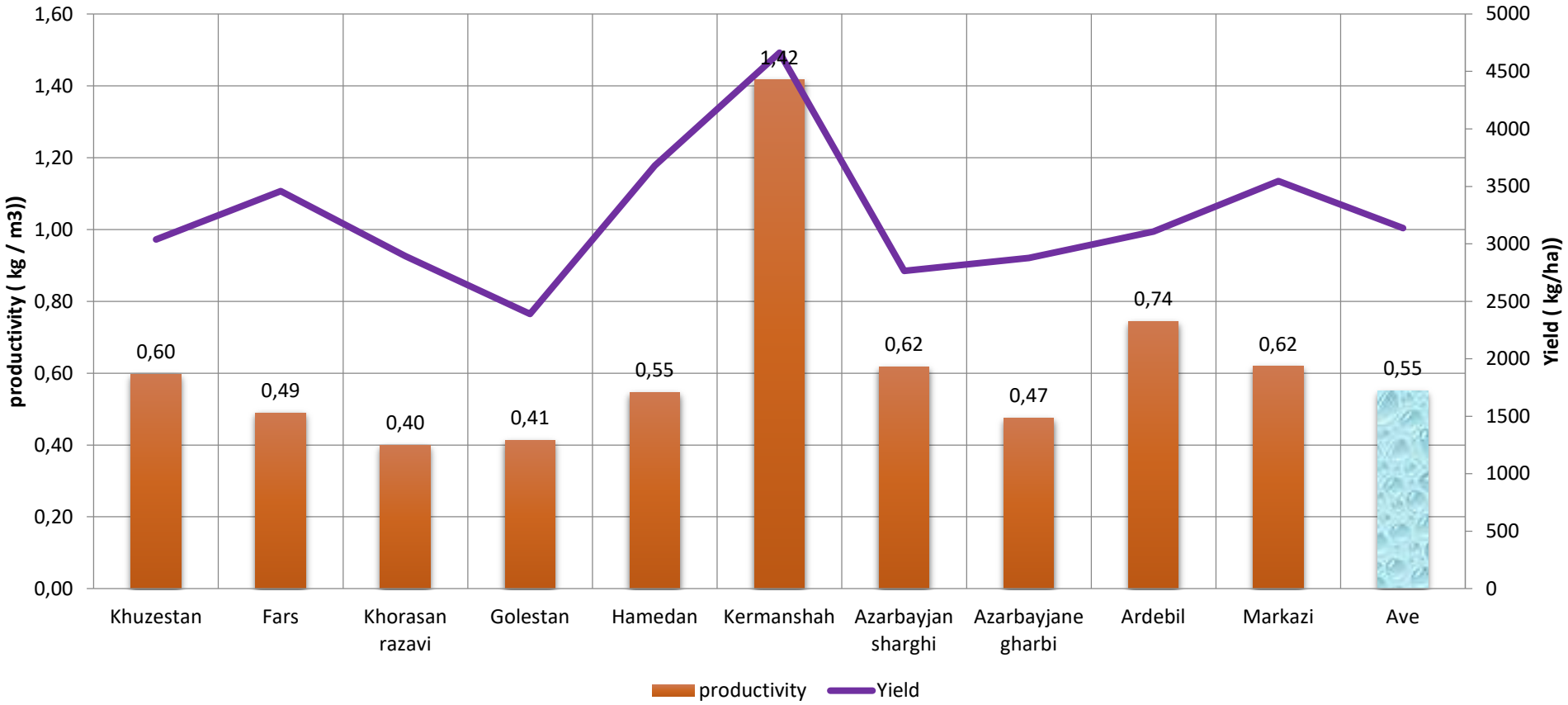
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
Export	-43	-67	-54	-66	-65	-71	-79	-126	-176	-112	-86
green water	52	57	48	54	56	57	60	68	67	59	58
blue water	534	624	529	601	615	632	644	742	745	668	633

Crops production for 2006-2015



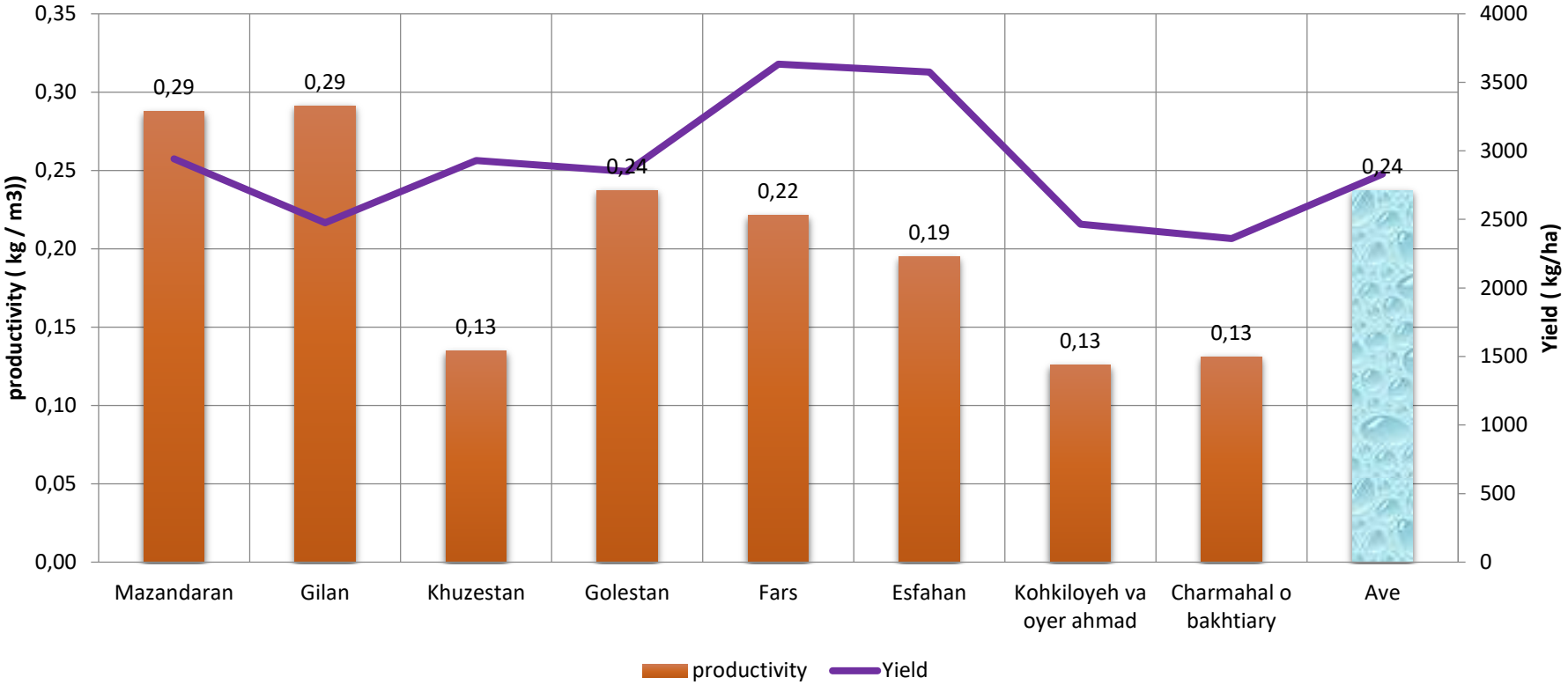
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
Rice	2,6	2,7	2,1	2,1	2,5	1,9	2,4	2,4	2,3	2,3	2,3
onion	2,0	2,0	1,9	1,5	1,9	2,2	1,9	2,1	2,1	2,4	2,0
Melon	1,4	1,7	1,3	1,3	1,5	1,5	1,5	1,6	1,5	1,5	1,5
Wheat	14,7	15,9	7,0	12,1	12,1	8,7	8,8	9,3	10,6	11,5	11,1
tomato	5,1	5,5	4,8	5,9	5,7	5,6	5,5	5,6	6,2	6,0	5,6
Watermelon	5,7	6,7	5,1	6,1	6,4	6,4	6,4	7,4	8,0	7,4	6,6
potato	4,2	4,0	4,7	4,1	4,3	4,7	5,1	4,6	5,0	5,1	4,6
Cucumbers	1,9	1,8	1,5	1,6	1,7	2,8	3,0	3,0	3,0	1,6	3,0

Wheat water productivity in major production area



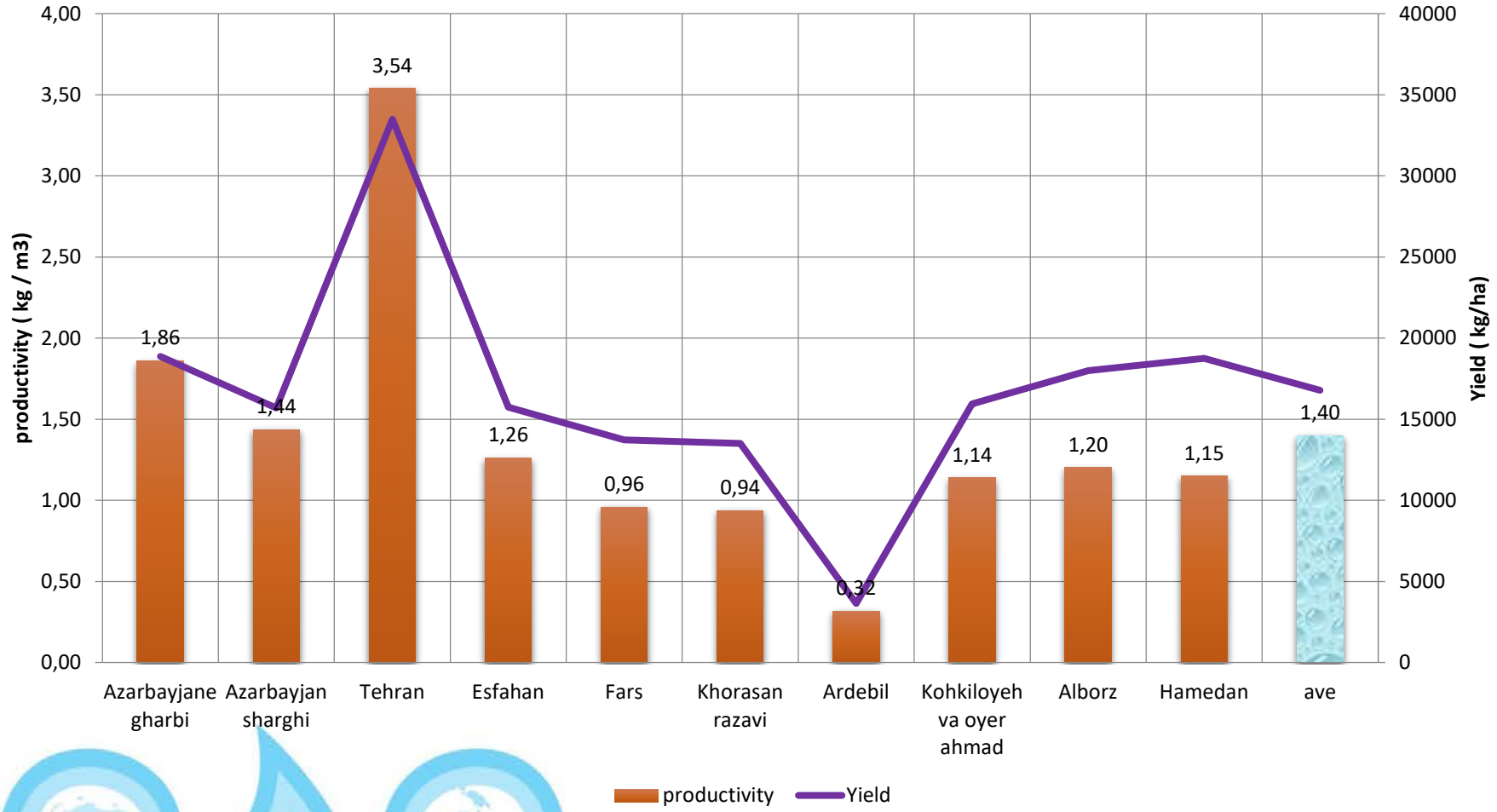
Word water productivity (F.A.O,2007) : 0.75

Rice water productivity in major production area



Word water productivity (F.A.O,2007) : 0.44

Apple water productivity in major area

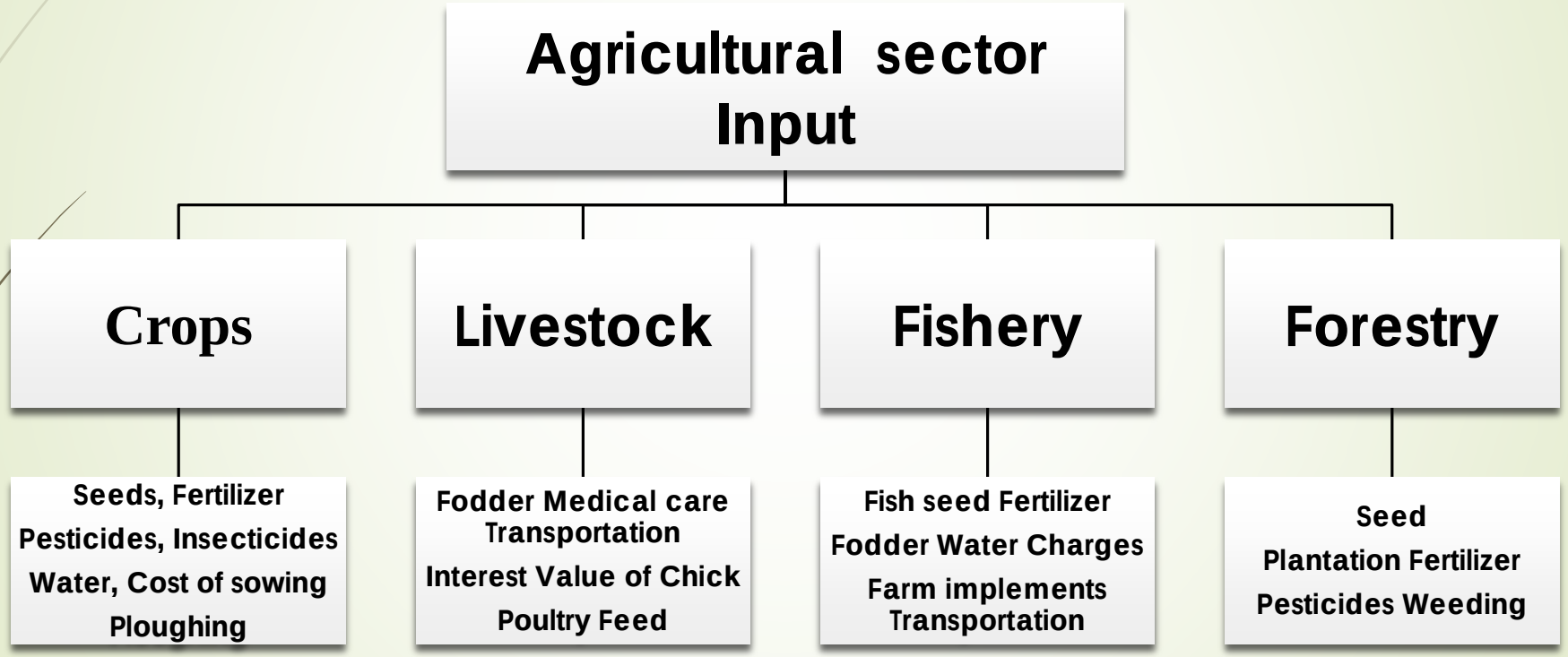


Word water productivity (F.A.O,2007) : 1.43

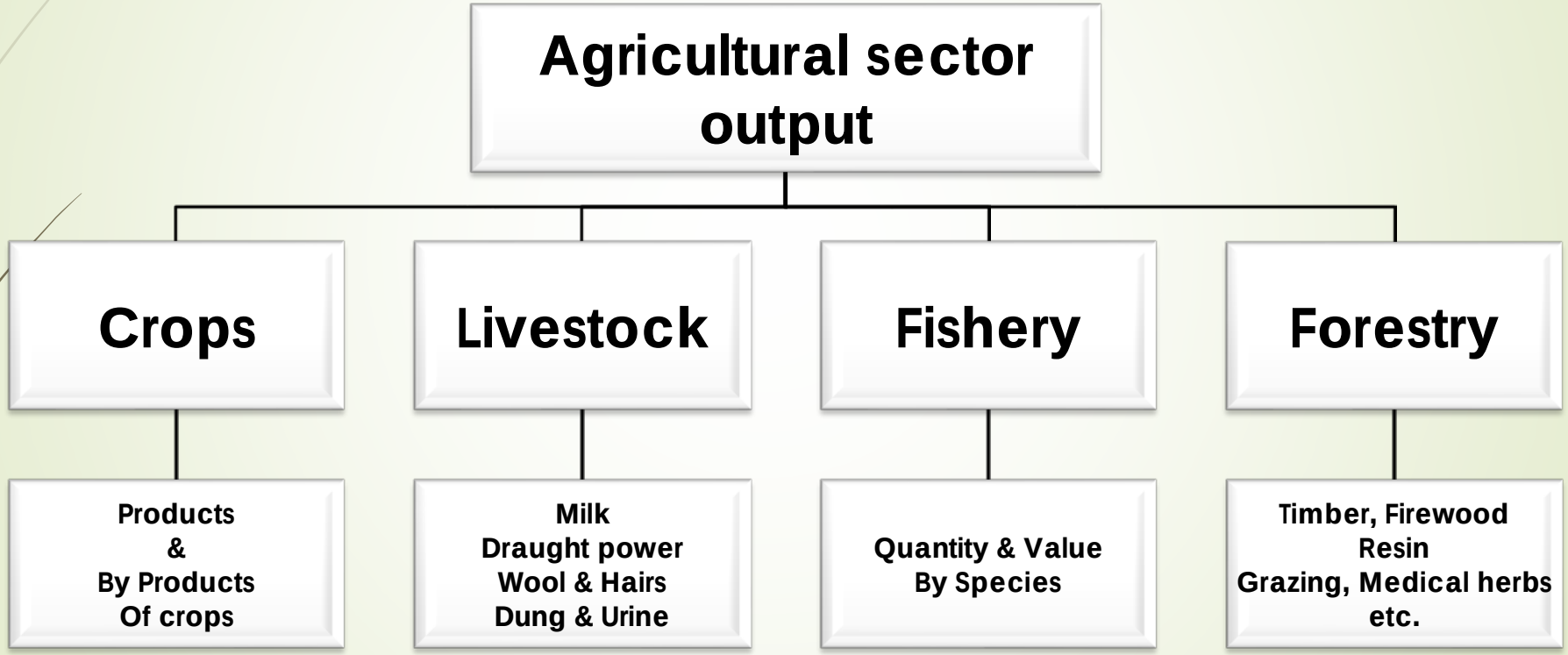
Sectors of Agriculture

- Agriculture sector is mainly divided into the following four sub-sectors:
  i. Crops
  ii. Livestock
  iii. Fishery (Aquaculture)
  iv. Forestry (Silviculture)

In-Put Structure of Agriculture Sector



Output Structure of Agriculture Sector

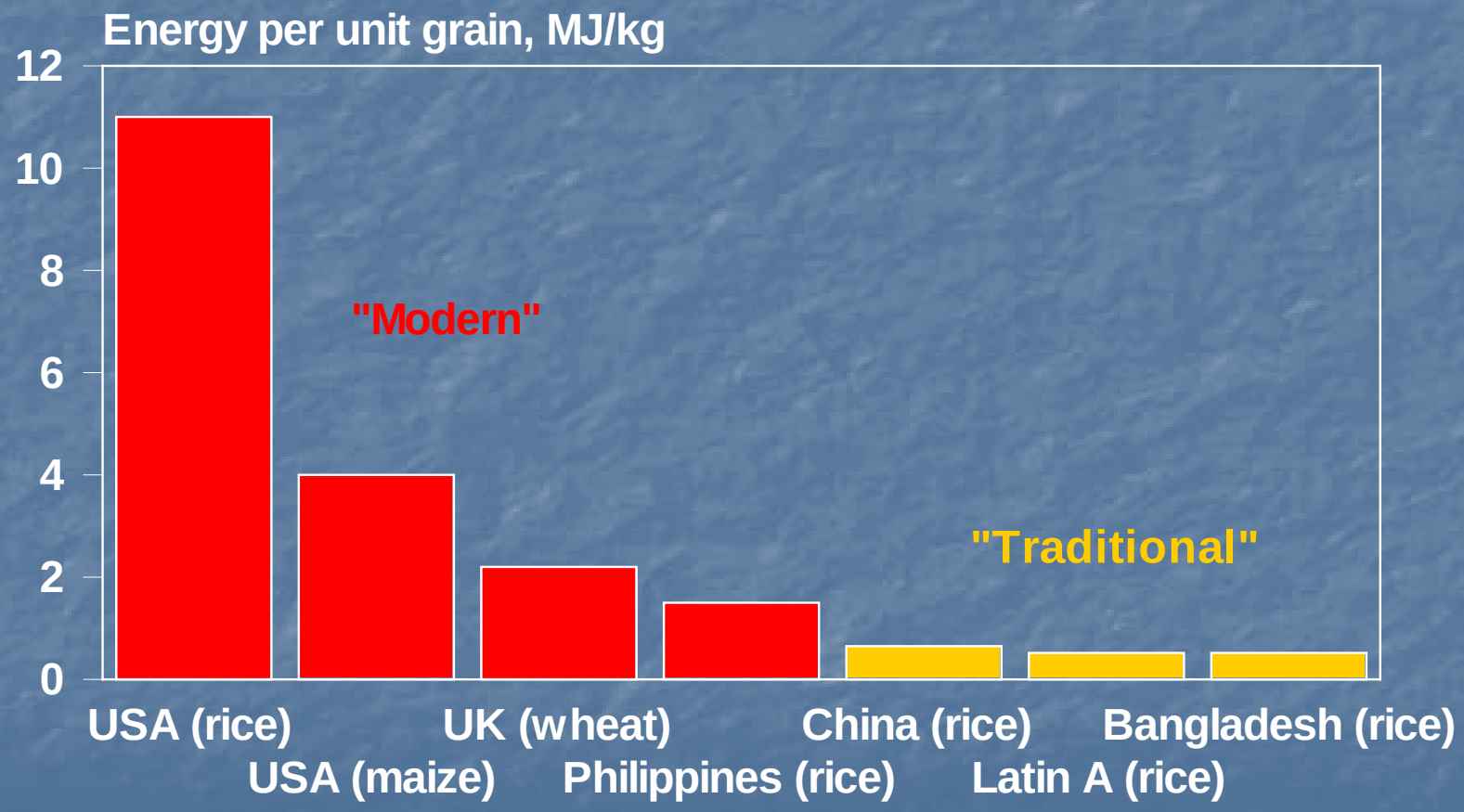


In the USA approximately 1400 liters of oil equivalents are expended to feed each citizen; energy consumption is broken down

- **31% manufacturing inorganic fertilizers**
- **19% operation of field machinery**
- **16% transportation**
- **13% for irrigation**
- **8% raising livestock [not feed lot feed]**
- **5% crop drying**
- **5% pesticide production**
- **8% other inputs**

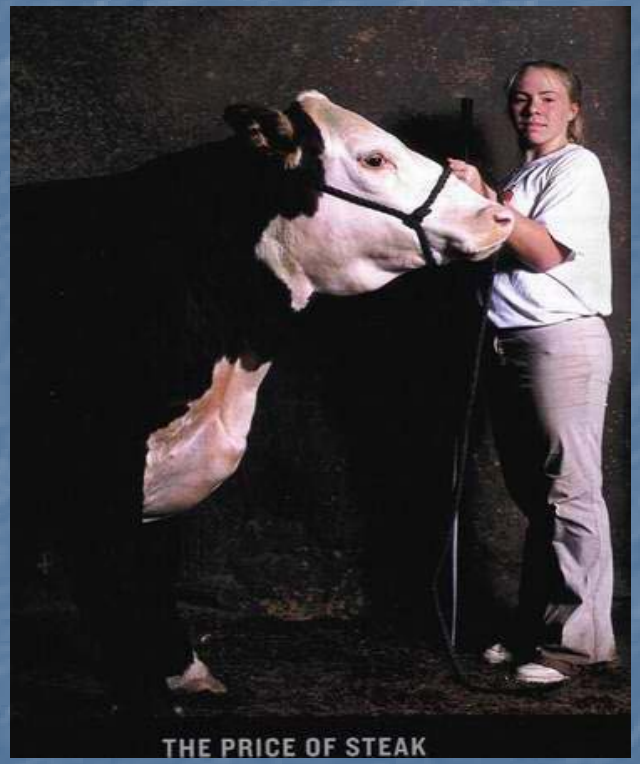
Does not include energy costs of packaging, refrigeration,transport to outlets and energy for cooking

Use of energy for grain production "modern" vs "traditional" systems



Source: Pretty 1995

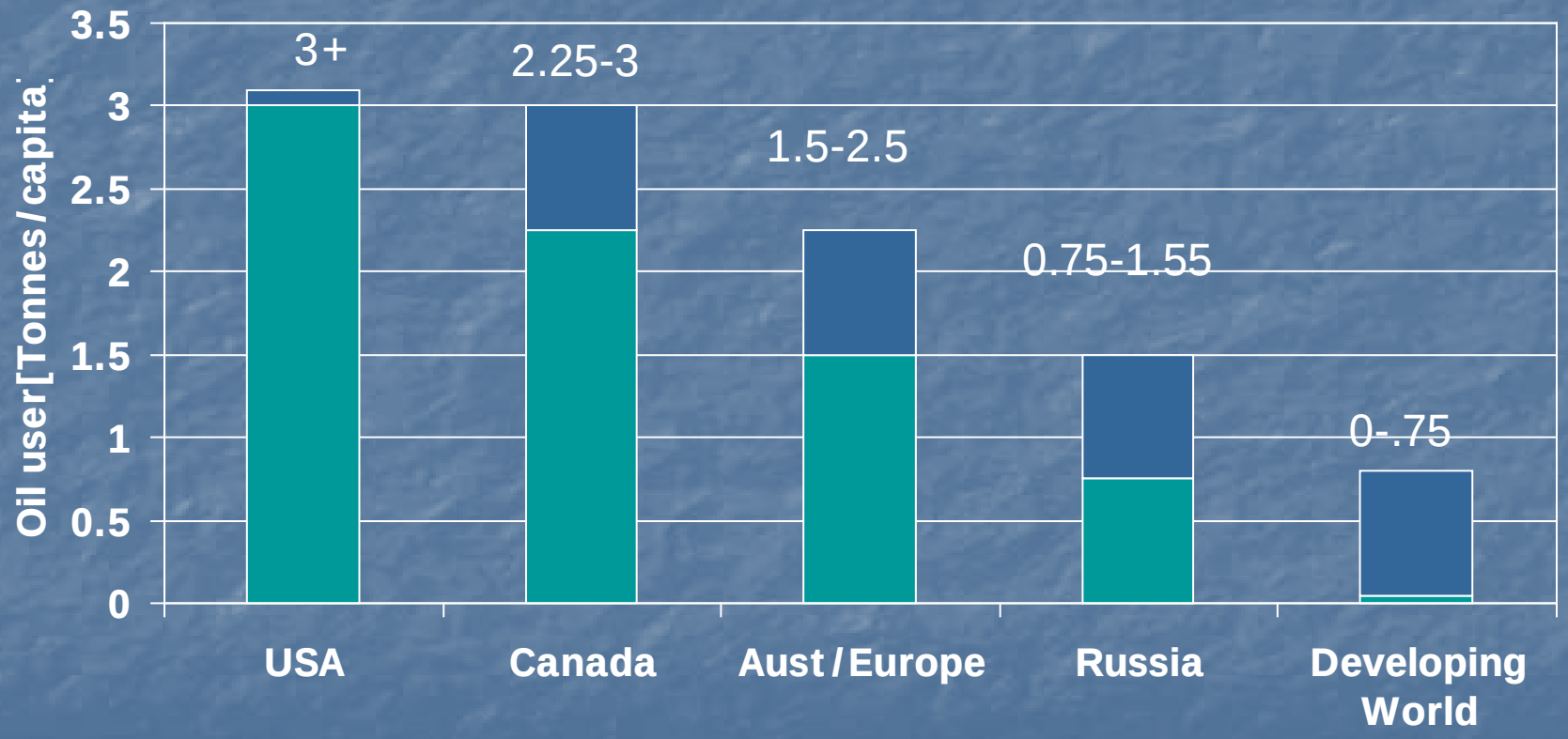
The price of steak from grain fed ruminants must be measured in terms of oil costs involved in growing the feed, managing and marketing the meat



1 kg of beef requires approximately 5.7 litres of oil. Or to produce this little beauty at 600kg live weight 1075 litres of oil

National Geographic June 2004

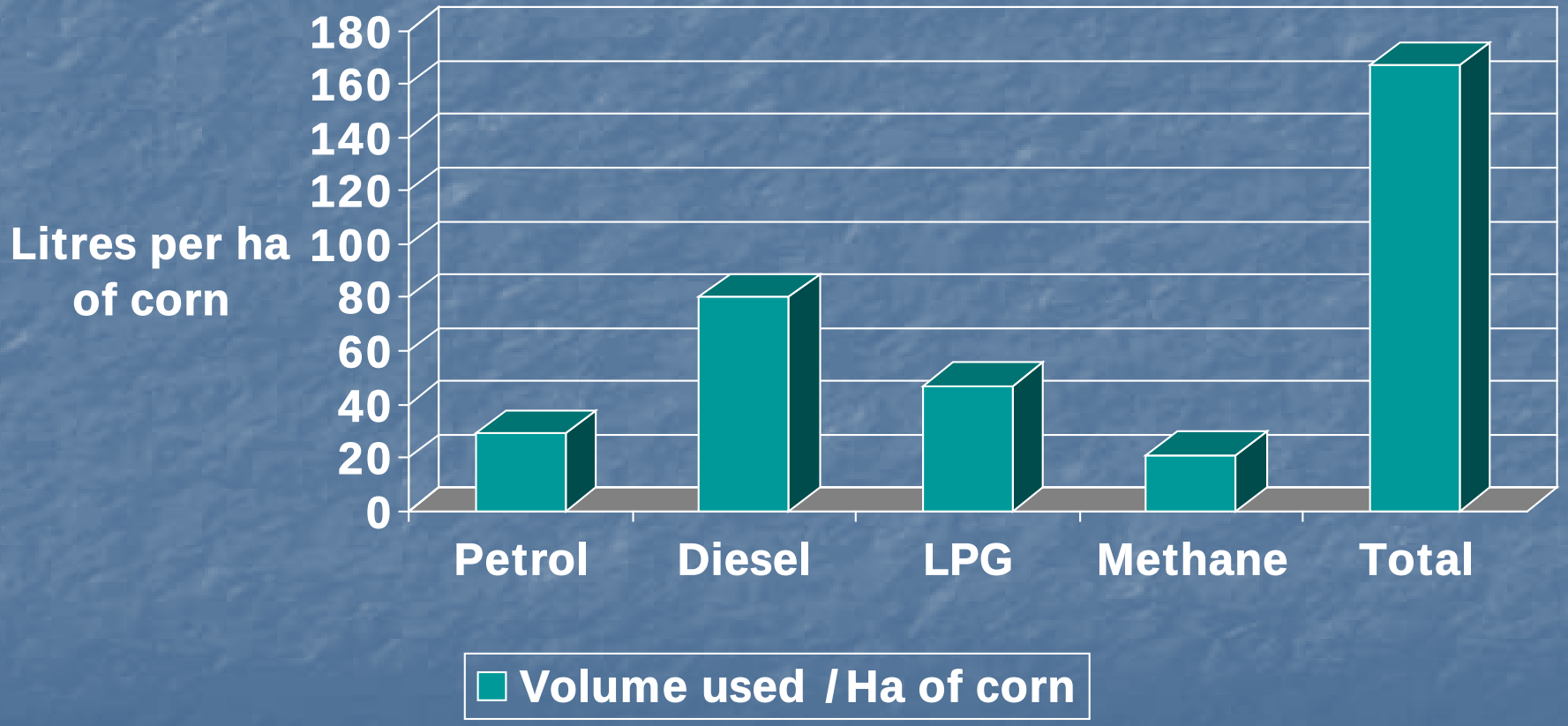
Oil Utilization Per Capita in Developed and Developing Countries [China/Indonesia/Africa/South America]



The More Rural The Population The Lower The Energy Requirements

Country	Energy Use [10^{12} kcal]	Per Capita Use[10^{6} kcal]	% population in Agric.
US	18400	77	2.6
Brazil	600	4	37
India	900	1	62
Kenya	12	0.6	75

The fossil fuel used in producing a hectare of corn [approx 7200kg/ha]



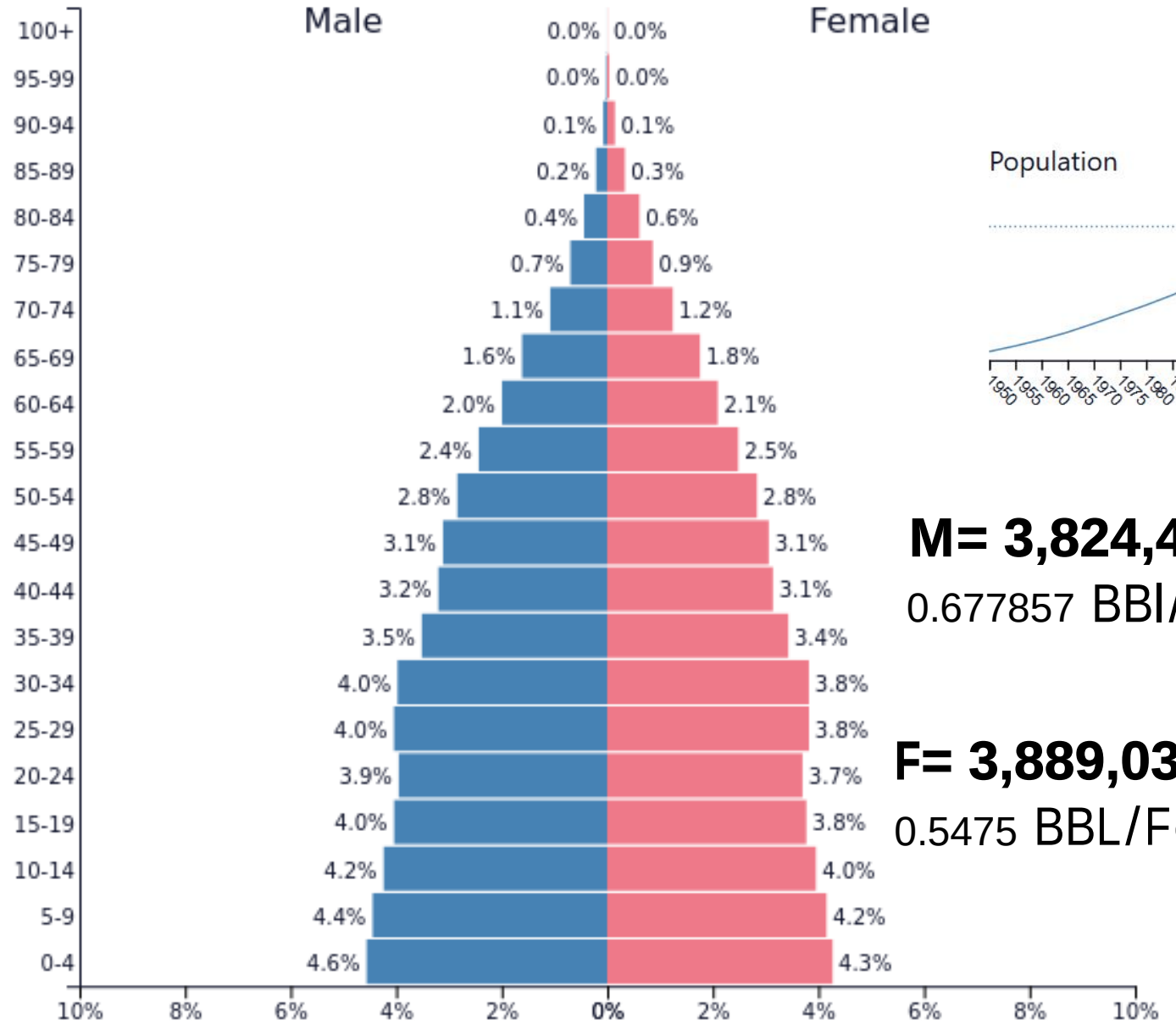
Patzec 2004

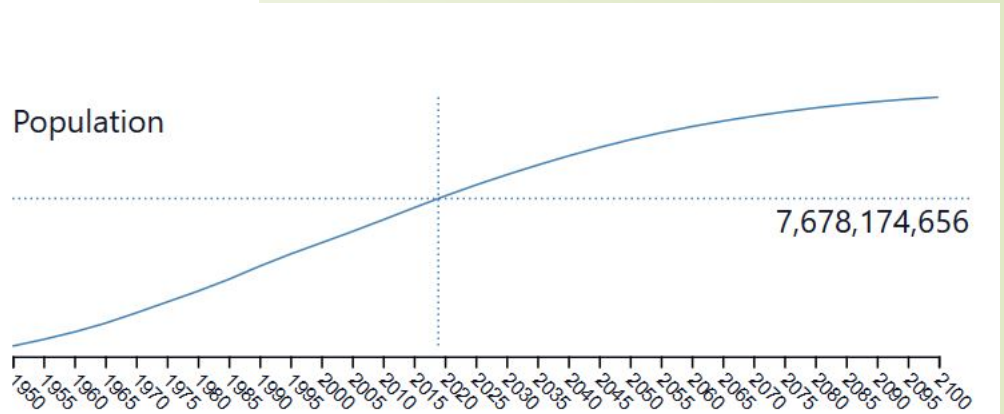
Calorific Needs Based on Gender and Age

Gender	Age (years)	Sedentary[b]	Moderately Active[c]	Active[d]
Child	2-3	1,000	1,000-1,400	1,000-1,400
Female	4-8	1,200	1,400-1,600	1,400-1,800
	9-13	1,600	1,600-2,000	1,800-2,200
	14-18	1,800	2,000	2,400
	19-30	2,000	2,000-2,200	2,400
	31-50	1,800	2,000	2,200
	51+	1,600	1,800	2,000-2,200
Male	4-8	1,400	1,400-1,600	1,600-2,000
	9-13	1,800	1,800-2,200	2,000-2,600
	14-18	2,200	2,400-2,800	2,800-3,200
	19-30	2,400	2,600-2,800	3,000
	31-50	2,200	2,400-2,600	2,800-3,000
	51+	2,000	2,200-2,400	2,400-2,800

Conversion Factor: 1 BBL=1,400,000 kcal

0.5475
0.677857





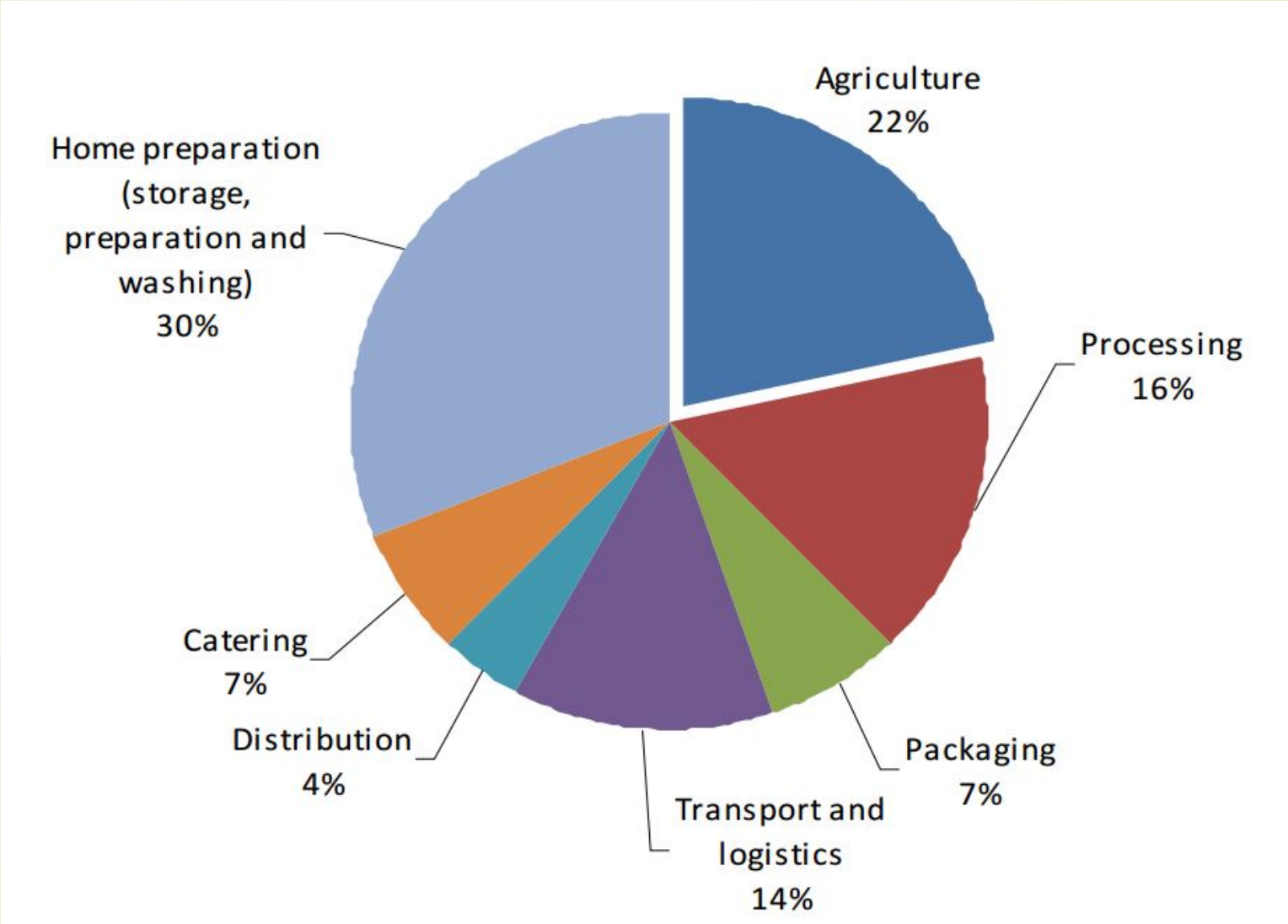
M= 3,824,434,000 ➔ 7.1 MMBBL/Day

0.677857 BBl/Male/Year

F= 3,889,035,000 ➔ 5.83 MMBBL/Day

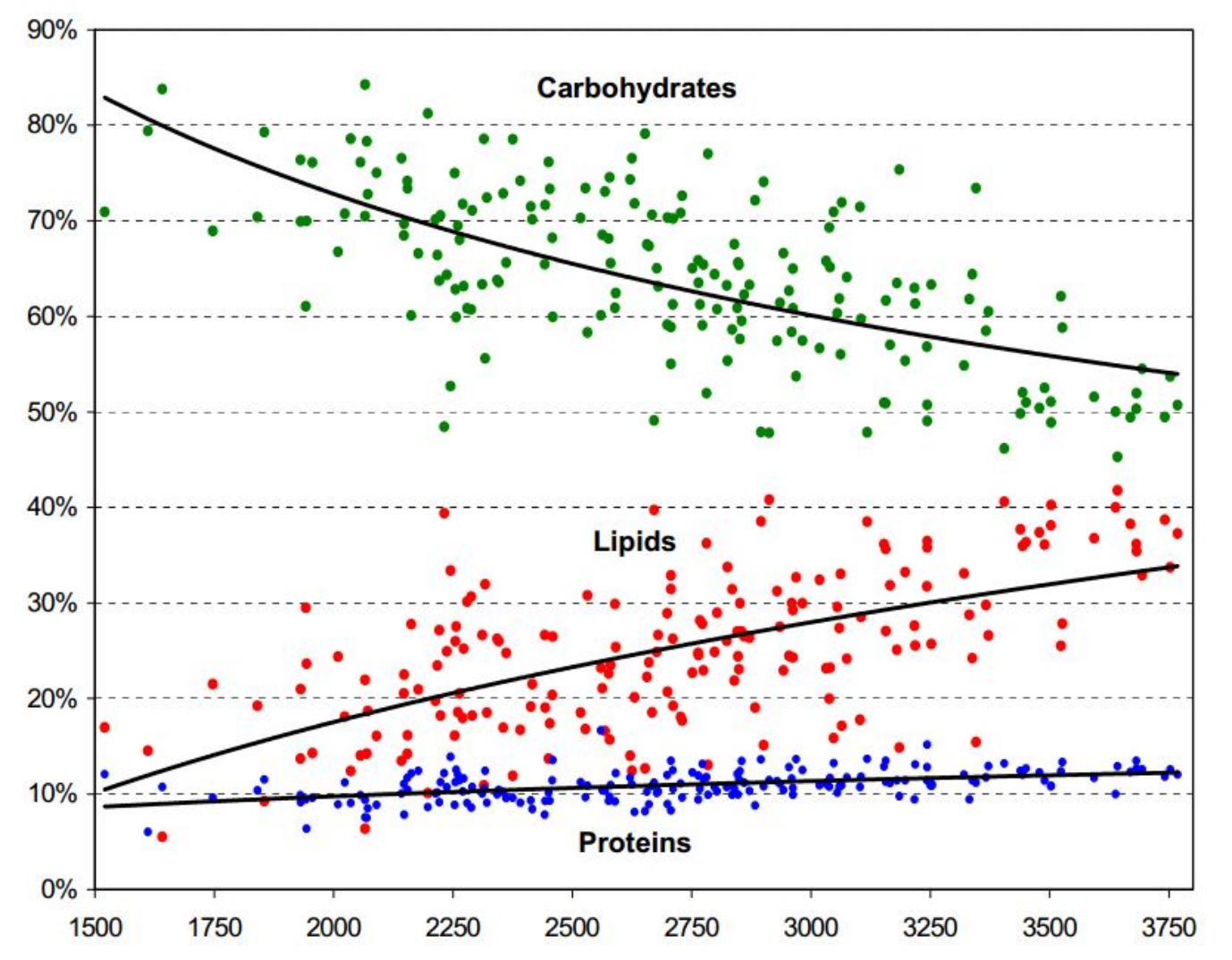
0.5475 BBL/Female/Day Calorific Needs

Energy Consumption of the Food System in the US



Source: Heller and Keoleian, 2000

Energy Intake Structure, Global Mean FAO Stat

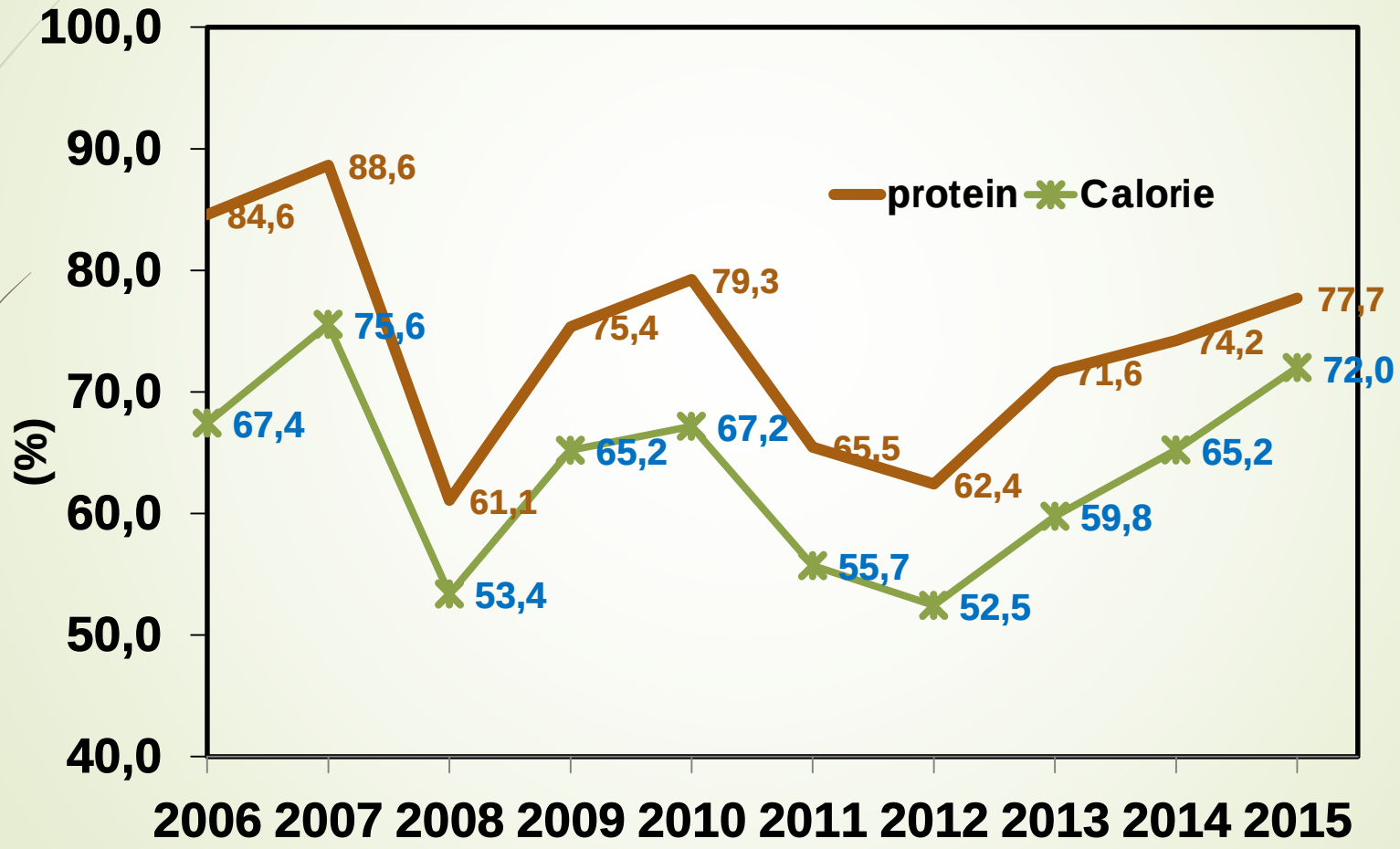


Kcal/person/day

Can you think of possible solutions?

- Conservation projects
- Restriction on land use
- Optimise efficient farming methods
- Crop improvement. Research into high-yield or resistant crops
- Develop less damaging pesticides and herbicides
- Use renewable energy
- Look for/develop alternatives to palm oil or soya (often labelled vegetable oil or fat) in food such as chocolate
- Advertise accurately where food comes from
- Buy food from countries closer to the UK to reduce food miles

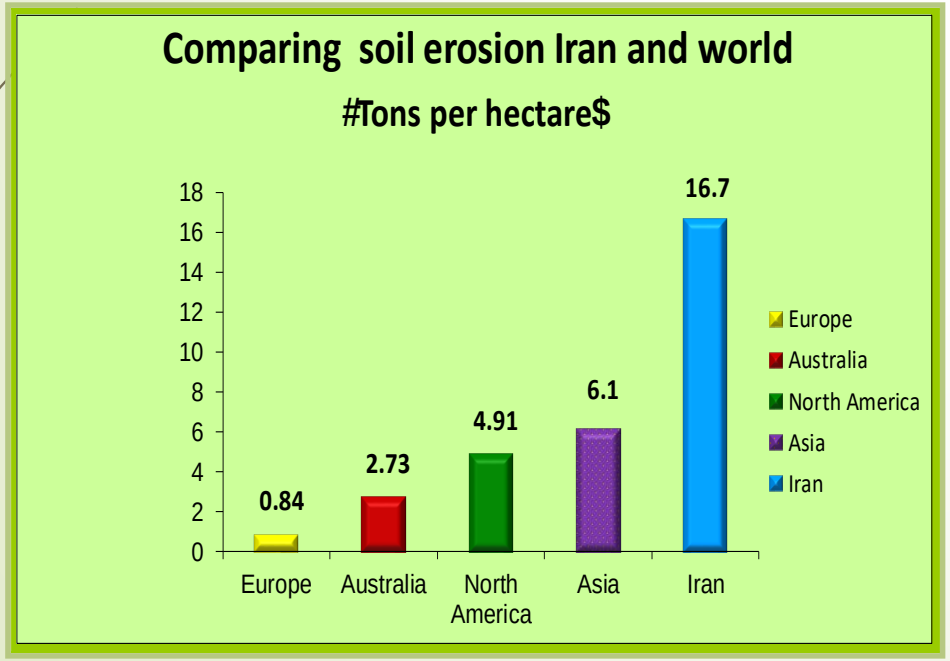
Temporal variation of Self-sufficiency in supply of Calorie (Energy) and Protein during 2006-2015



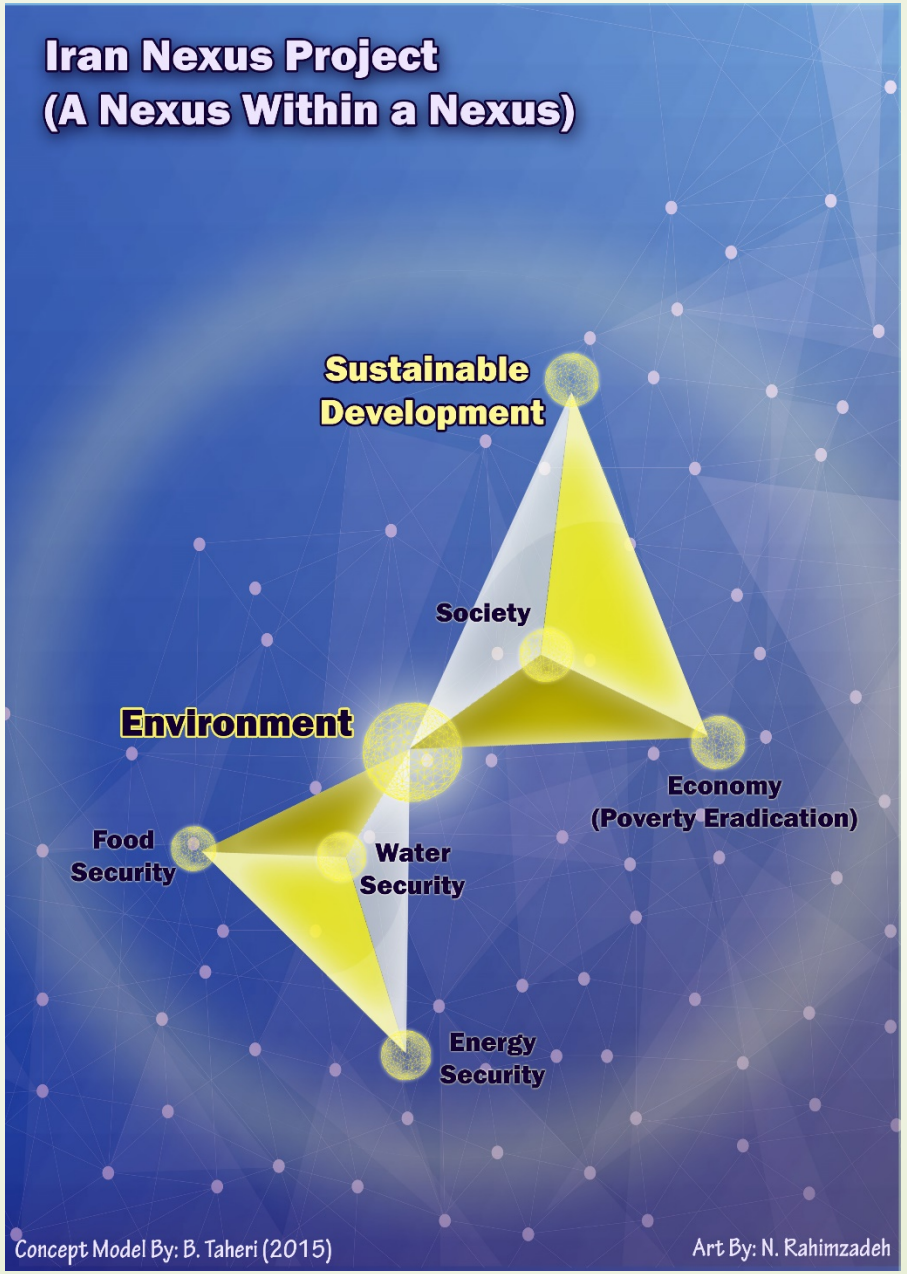
A. Keshavarz, D. Sanij)

1.Rates of soil erosion by water and wind;

- **Watershed area in the territory of water erosion: 125 m ha**
- **Water erosion average: 16.7 ton/ha/year**
- **economical losses from soil erosion: >10 billion dollars/year**



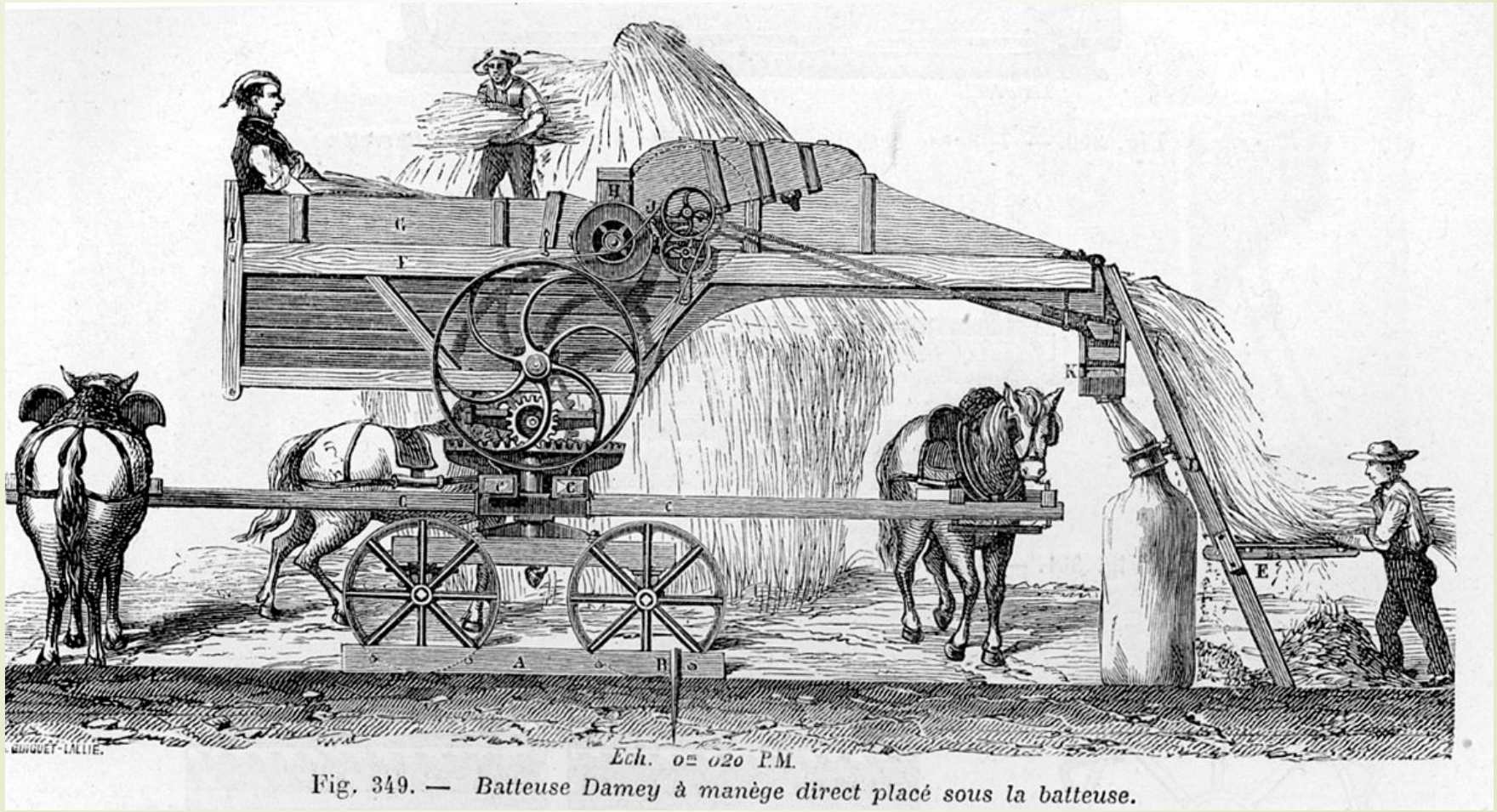
A 3-way Interaction, 7-Element NEXUS Model



Energy Productivity of Biomass

Items	Unit	Wheat	Barley
Energy input	MJ ha^{-1}	32493	25655
Energy output	MJ ha^{-1}	48517	49800
Energy use efficiency	–	1.49	1.94
Specific energy	MJ.kg^{-1}	17.80	15.14
Energy productivity	kg MJ^{-1}	0.056	0.066
Net energy	MJ ha^{-1}	16024	24145

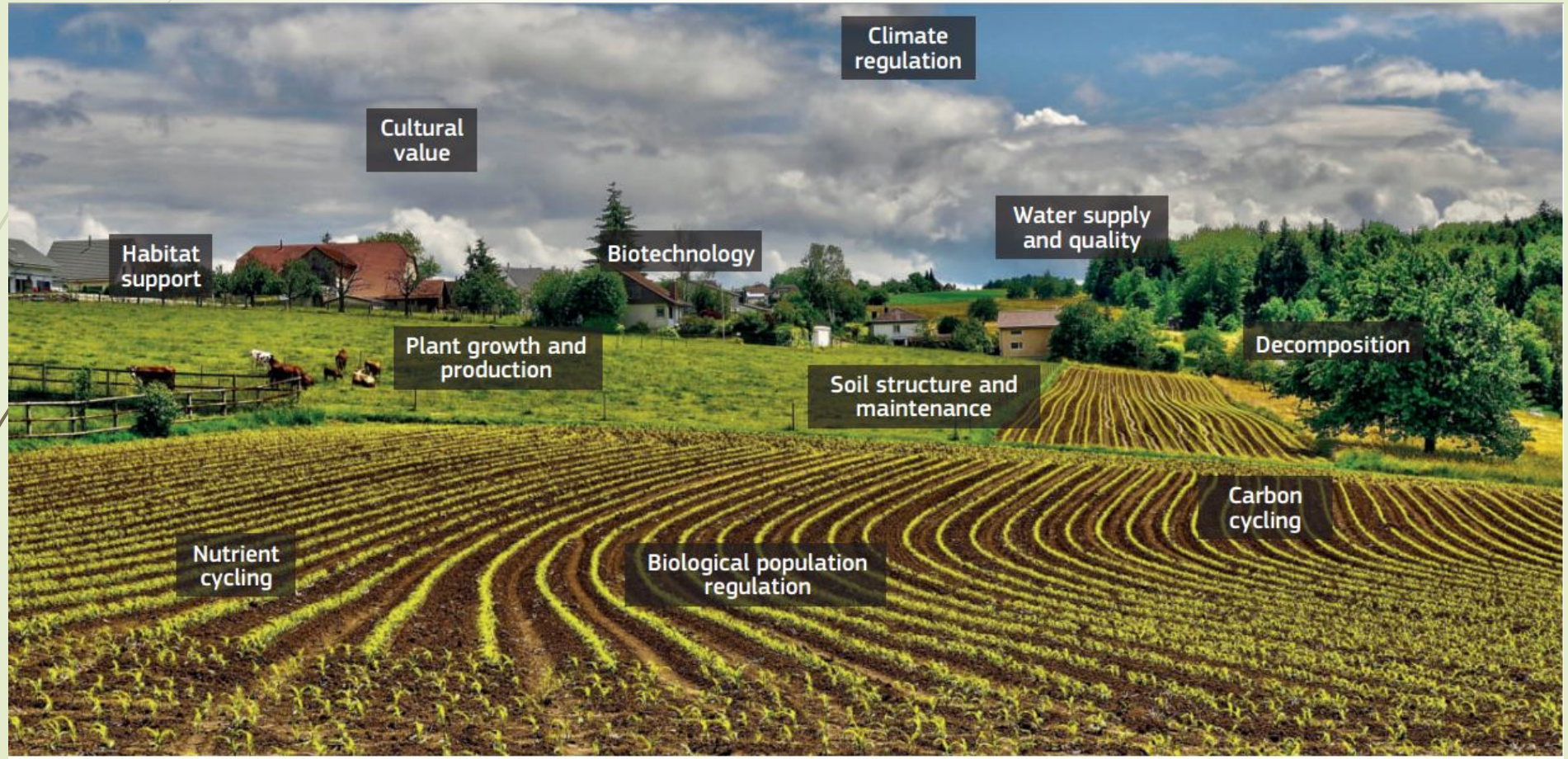
- Hand threshing was laborious, with a bushel of wheat taking about an hour. In the late 18th century, before threshing was mechanized, about one-quarter of agricultural labor was devoted to it.



Ech. 0m 020 P.M.

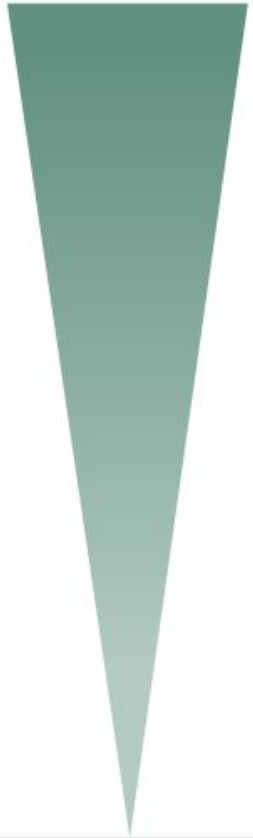
Fig. 349. — *Batteuse Damey à manège direct placé sous la batteuse.*

Vital Soil Ecoservices and Soil BioDiversity



The contribution of soil and its biota to the provision of ecosystem services in a mixed landscape. Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services, such as food and water; regulating services, such as pest and disease control; supporting services, such as habitat provision, that maintain the conditions for life on Earth; cultural services, such as the educational value of ecosystems. (JDE)

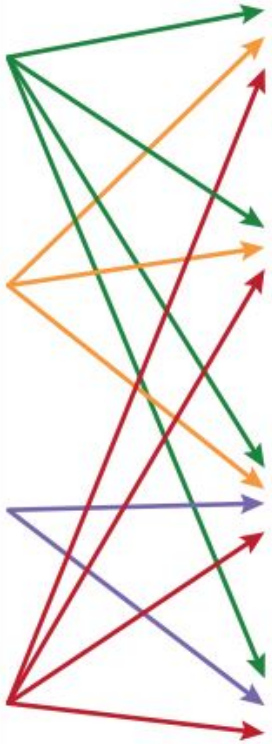
Distribution of Species within SBD

Organism size	Group	Known species	Estimated species	% described
	Vascular plants	350 700	400 000	88 %
	Macrofauna			
	Earthworms	7 000*	30 000*	23 %
	Ants	14 000	25 000 - 30 000	60 - 50 %
	Termites	2 700	3 100	87 %
	Mesofauna			
	Mites	40 000*	100 000	55 %
	Collembolans	8 500*	50 000	17 %
	Microfauna ad microorganisms			
	Nematodes	20 000 - 25 000*	1 000 000 - 10 000 000*	0.2 - 2.5 %
	Protists	21 000*	7 000 000 - 70 000 000*	0.03 - 0.3 %
	Fungi	97 000	1 500 000 - 5 100 000	1.9 - 6.5 %
	Bacteria	15 000	> 1 000 000	< 1.5 %

Known and estimated number of species of soil organisms and vascular plants organised according to size. Values of estimated diversity comply with the published literature, and are supported by expert judgement. Asterisks indicate numbers of species that live in the soil (updated from Barrios, Ecological Economics, 2007). [1,2]

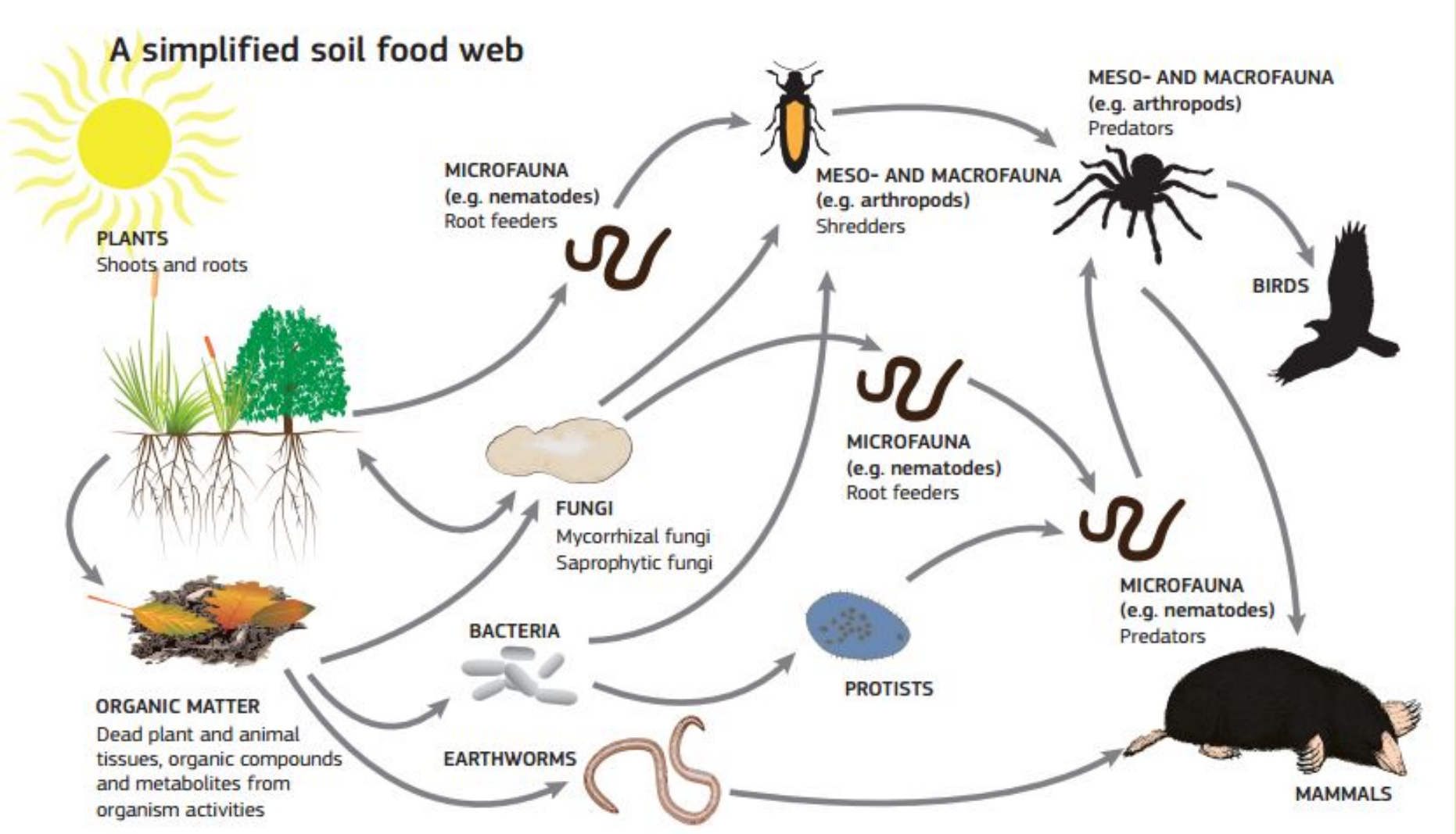
Ecosystem Services of SBD

ECOSYSTEM SERVICES	ECOSYSTEM FUNCTIONS	SOIL BIOTA
PROVISIONING Plant production (food) Biotechnology	Decomposition and carbon cycling	Macrofauna Mesofauna Microfauna Bacteria, fungi and archaea
REGULATING Climate regulation Atmospheric composition Hydrological services	Nutrient cycling	Microfauna Bacteria Mycorrhizal fungi Other microorganisms
SUPPORTING Habitat Biodiversity conservation	Soil structure and maintenance	Roots Earthworms Macroarthropods Fungi
CULTURAL Natural capital	Biological population regulation	Macrofauna Mesofauna Microfauna Bacteria and fungi

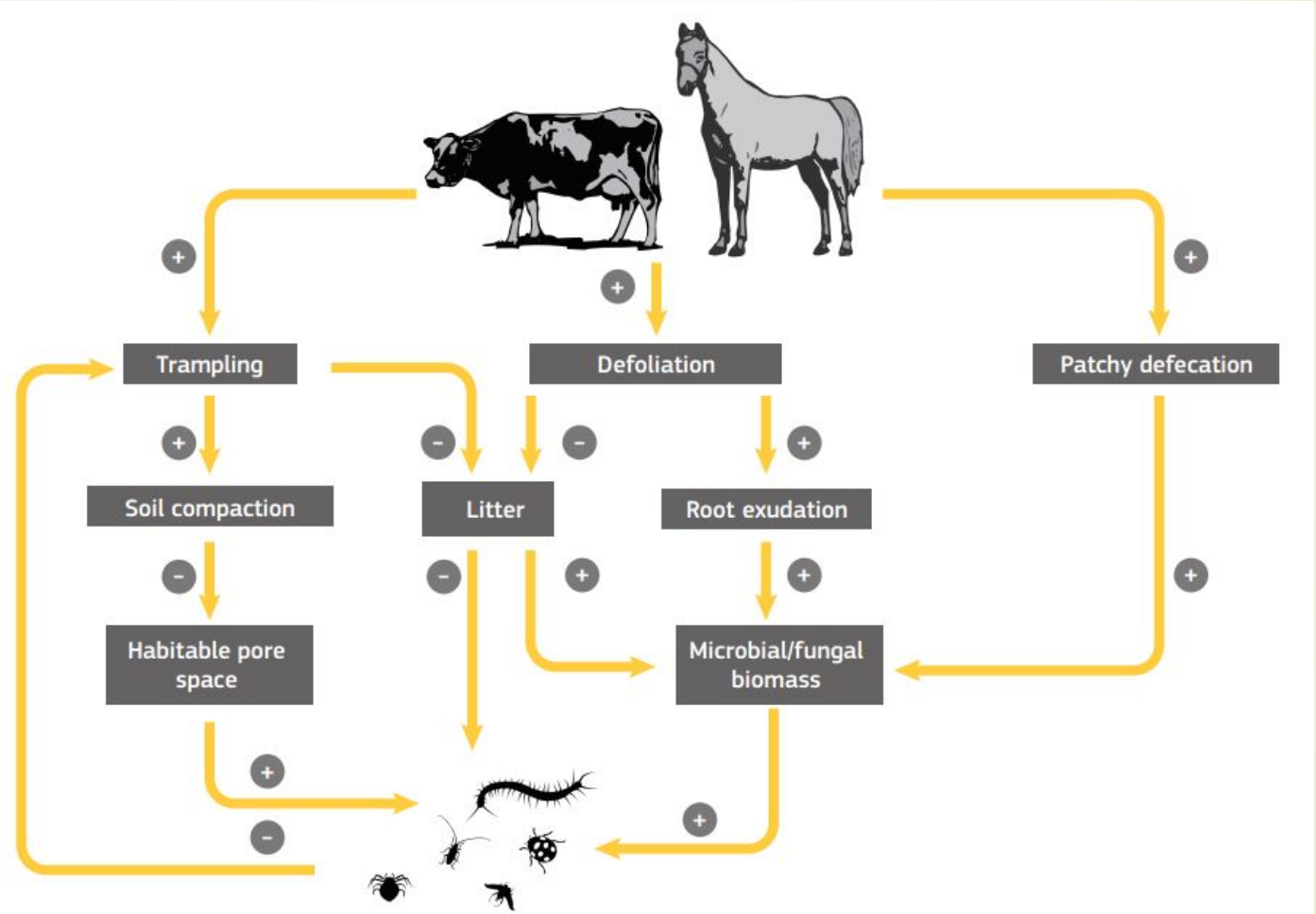


Soil-based ecosystem services, ecosystem functions and soil organisms that support them. The terms 'functions' and 'services' can be confusing. Usually, functions are considered as the biological processes underpinning and maintaining the ecosystem, while ecosystem services are defined as the direct and indirect contributions of an ecosystem to human well-being (derived from Brussaard, 2012). [119]

Soil Food Web

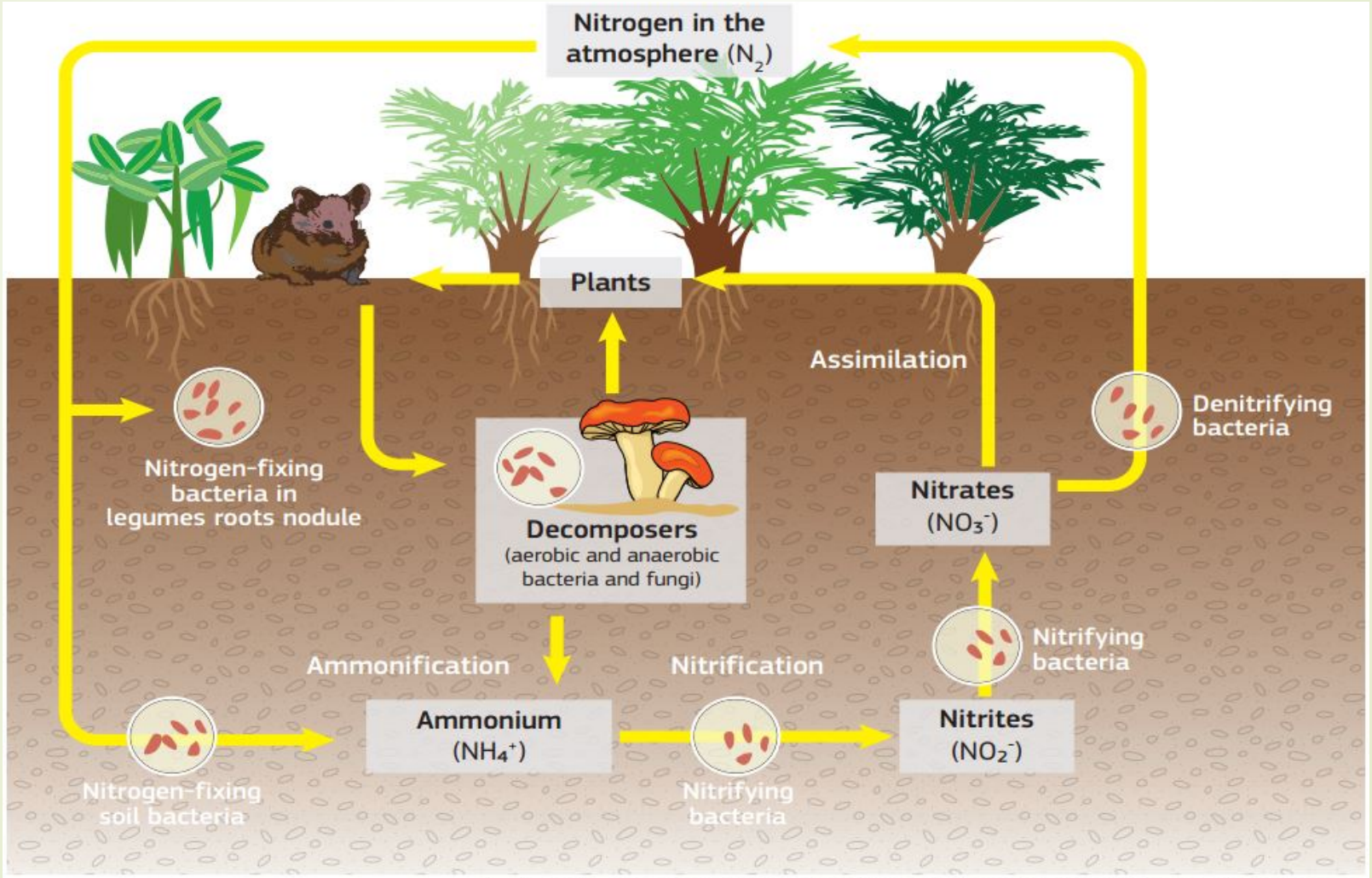


Schematic Links Between the Aboveground Grazing Mammals and Soil Microbes



Conceptual framework of the most important mechanisms through which livestock or other large grazing mammals can affect soil organisms. The arrows represent causal pathways, and the sign (+/−) for each arrow indicates the link between the box in which the arrow starts and the box in which the arrow ends. A pathway from top to bottom with only plus signs (+) indicates general positive effects of large grazers on soil organisms; the minus sign (−) indicates that effects are generally negative. (DVI, JRC)

Depiction of Nitrogen Cycle



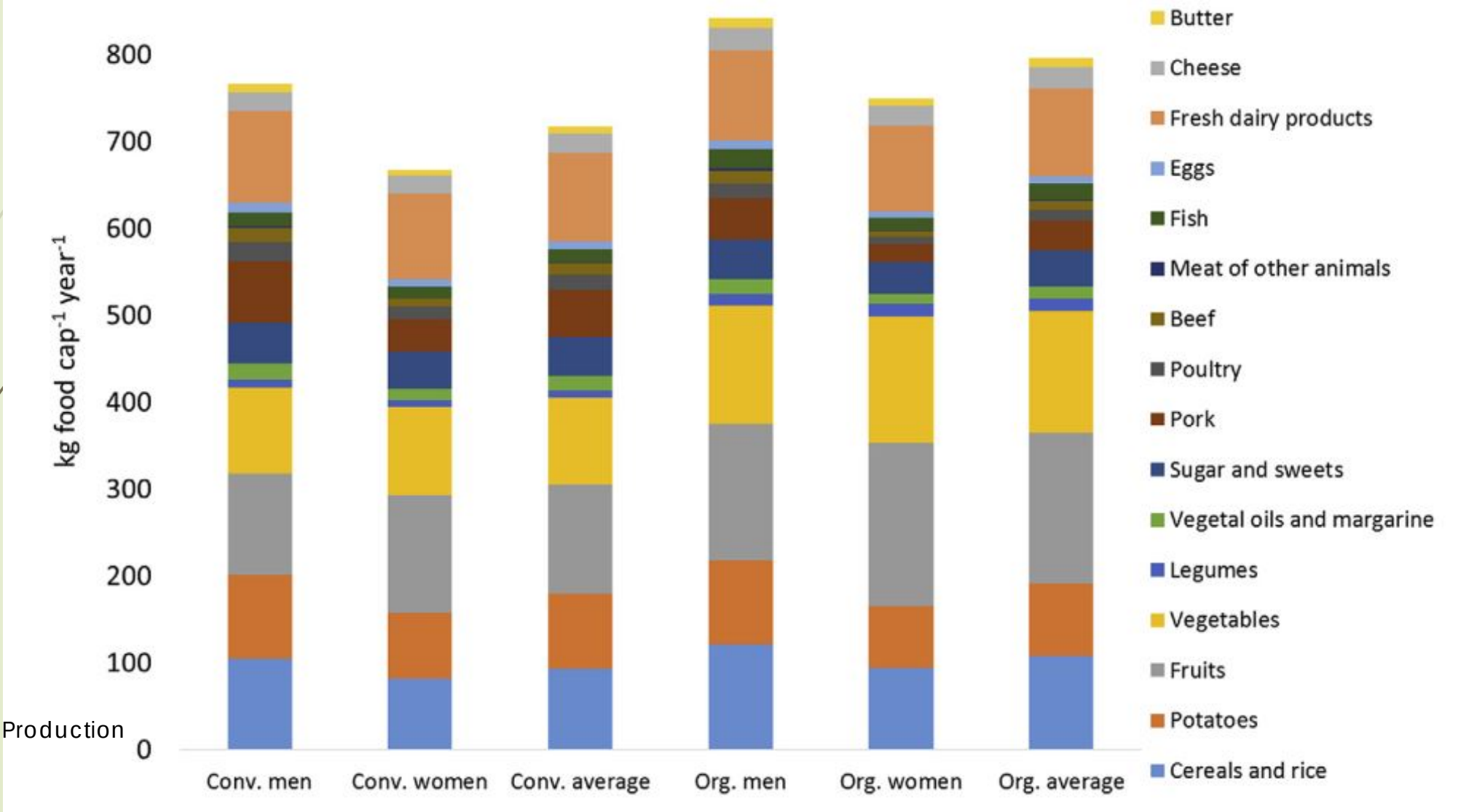
Schematic representation of the main flows of nitrogen (N) through the terrestrial environment. The importance of soil bacteria and fungi in the cycle is immediately recognised as being a key element, providing different forms of N compounds assimilable by higher organisms, such as plants. (JJB, FVI, NLA, NRCS)

Carbon footprints and land use of conventional and organic diets in Germany

Food categories	Carbon footprints (kg CO_2.eq. kg^{-1}) and the number of studies, n, on which the data are based (S7, S8)				Yield-correction factors between conventional and organic yields (dimensionless ratios) and the crops on which correction factors are based (S9)	Land use (m^2 kg^{-1}) and the number of studies, n, on which the data are based (S9, S10)			
	Conv.	n	Org.	n		Conv.	n	Org.	n [a]
Plant-based food products									
Cereals	0.54	7	0.50	7	1.27 (wheat)	1.40	2	1.78	2 + 73
Rice	1.46	1	2.00	1	1.06 (rice)	1.80	1	1.91	1 + 7
Potatoes	0.18	5	0.16	5	1.30 (potatoes)	0.23	2	0.30	2 + 21
Pomaceous fruits	0.21	1	0.16	1	1.31 (apples)	0.44	1	0.58	1 + 6
Stone fruits	0.61	1	0.22	1	1.22 (fruits)	0.44	1	0.54	1 + 14
Citrus fruits	0.12	2	0.06	2	1.22 (fruits)	0.50	1	0.61	1 + 14
Other fruits	0.11	2	0.11	2	1.22 (fruits)	0.44	1	0.54	1 + 14
Berries	0.36	3	0.36	3	1.41 (strawberries)	0.96	1	1.35	1 + 5
Nuts and seeds	1.50	1	1.50	1	1.41 (strawberries)	4.30	1	6.06	1 + 5
Fresh tomatoes and cucumbers	0.43	2	0.34	2	1.19 (tomatoes)	0.30	1	0.36	1 + 20
Other fresh vegetables	0.15	1	0.13	1	1.11 (carrots)	0.21	1	0.23	1 + 7
Processed tomatoes and cucumbers	1.13	1	1.13	1	1.19 (tomatoes)	0.30	1	0.36	1 + 20
Other processed vegetables	0.51	1	0.48	1	1.11 (carrots)	0.21	1	0.23	1 + 7
Legumes	0.32	3	0.35	3	1.12 (pulses)	0.36	1	0.40	1 + 39
Vegetal oils and margarine	1.95	1	1.95	1	1.23 (sunflower)	9.80	1	12.1	1 + 3
Sugar and sweets	2.50	1	2.50	1	0.95 (other root and tuber crops)	0.69	1	0.66	1 + 3
Animal-based food products									
Pork	3.42	5	3.96	5	n. a.	6.47	4	12.0	4
Poultry	3.76	3	5.11	3	n. a.	5.05	3	15.4	3
Beef	15.4	1	15.4	1	n. a.	39.8	3	66.3	3
Meat of other animals	17.5	1	10.1	1	n. a.	26.5	1	44.5	1
Fish	4.00	1	4.00	1	n. a.	3.30	1	4.13	1
Eggs	2.90	2	2.80	2	n. a.	4.03	2	10.1	2
Fresh dairy products	1.10 [b]	1	1.10 [b]	n. a. [b]	n. a.	1.60	10	2.24	10
Cheese	4.90 [b]	1	4.90 [b]	n. a. [b]	n. a.	7.12 [c]	n. a. [c]	9.97 [d]	n. a. [d]
Butter	7.20 [b]	1	7.20 [b]	n. a. [b]	n. a.	10.5 [e]	n. a. [e]	14.6 [d]	n. a. [d]

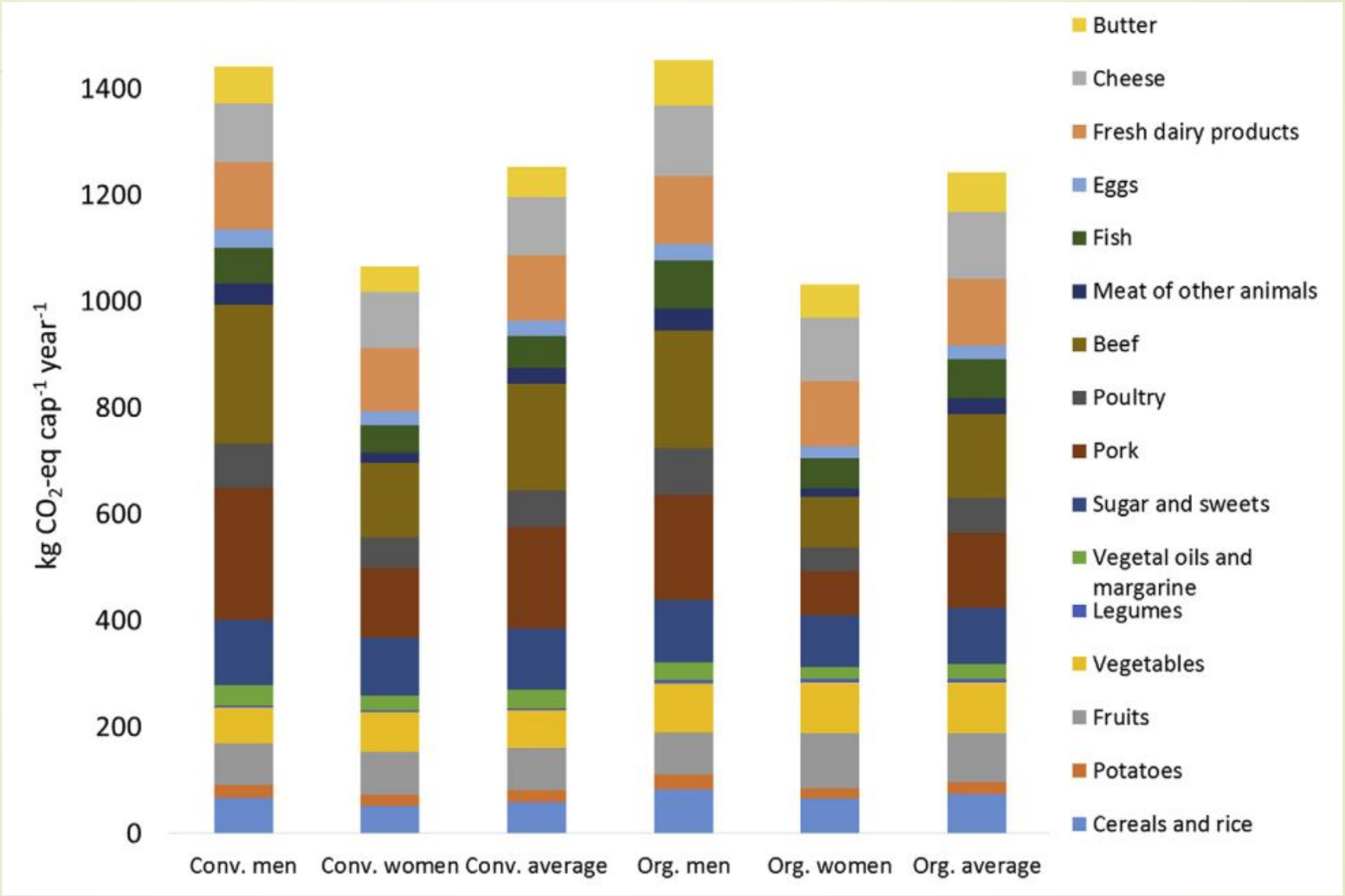
Maria Nordborg, et al,
Journal of Cleaner Production
May 2017

Food supply in conventional and organic diets in Germany



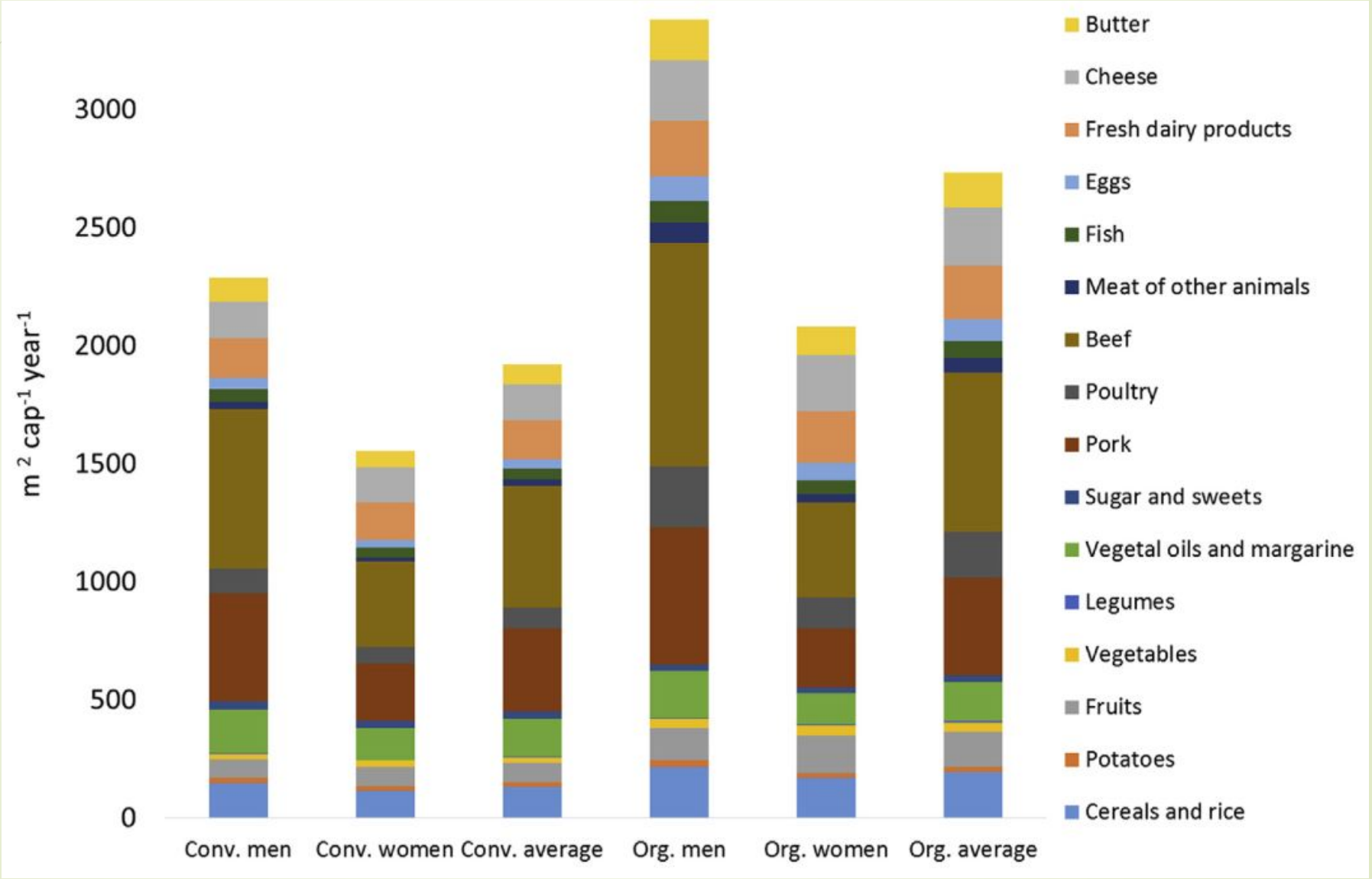
H. Treu et al.
Journal of Cleaner Production
161 (2017) 127e142

Carbon footprints in diets of conventional and organic consumers in Germany



Maria Nordborg, et al,
Journal of Cleaner Production
May 2017

Land use in diets of conventional and organic consumers in Germany



H. Treu et al.
Journal of Cleaner Production
161 (2017) 127e142

Average Conventional German Food Supply

Food categories	Food supply (kg cap^{-1} year^{-1})		Relative difference (basis = BMEL), %
	Average conventional diet of German citizens aged 18–80 years (this study)	National official statistics from the German Federal Ministry of Food and Agriculture: data for 2008 (BMEL, 2014)	
Plant-based food products			
Cereals and rice	93	89	4
Potatoes	86	64	34
Fruits, berries and nuts	126	121 [a]	5
Vegetables	100	92	9
Legumes	8	Not available	–
Vegetal oils and margarine	16	16	5
Sugar and sweets	45	48	−6
Animal-based food products			
Pork	54	54	−1
Poultry	18	18	−2
Beef	13	12	6
Meat of other animals	1	2	−33
Fish	14	16	−7
Eggs	10	13	−22
Fresh dairy products	102	86	18
Cheese	22	33	−35
Butter	8	11	−30
Total	717	675	6

Maria Nordborg, et al,
Journal of Cleaner Production
May 2017

Study	Country	Methods and data sources	Carbon footprint of diets (kg CO_2-eq cap^{-1} $year^{-1}$)		
			Average consumer	Men	Women
This study	Germany	Food consumption data from diet-history interviews collected within the NVS II (data from 2005 to 2007). Carbon footprint data from LCA studies. System boundaries are cradle-to-retail. Waste is included. Beverages, soups, and sauces are not included.	1250 [a]	1440 [a]	1065 [a]
Temme et al. (2014)	The Netherlands	Food consumption data from 24-h recalls collected within the Dutch National Food Consumption Survey (data from 2007 to 2010). LCA data from Blonk Consultants v. 2012. System boundaries are cradle-to-grave. Beverages, soups, and sauces are included (12% of total GHG emissions).	1550	1750	1350
Vieux et al. (2012)	France	Food consumption data from 7-days diet records collected within the French National Food Survey (data from 2006 to 2007). Carbon footprint data from LCA studies. System boundaries are cradle-to-retail. Beverages, soups, and sauces are included (7% of total GHG emissions).	1520	1725	1340
Aston et al. (2012)	United Kingdom	Food consumption data from 7-days diet records collected within the British National Diet and Nutrition Survey (data from 2000/2001). Carbon footprint data from LCA studies. System boundaries are not specified. Beverage inclusion not specfiied	1445	1670	1220
Berners-Lee et al. (2012)	United Kingdom	Self-reported food consumption data collected within the British National Diet and Nutrition Survey (data from 2010). Carbon footprint data from LCA studies. System boundaries are cradle-to-grave. Food waste is included. Beverages and soups are included, but their share of total GHG emissions is not specified.	2700	N/A	N/A
Saxe et al. (2013)	Denmark	Hypothetical average Danish diet. LCA data from the Danish LCA Food Database and other literature. System boundaries are cradle-to-retail. Waste and beverages included (15% of total GHG emissions).	1920	N/A	N/A
Hyland et al. (2016)	Ireland	Food consumption data from semi-weighted food diary on four consecutive days from the National Adult Nutrition Survey of Ireland (data from 2008 to 2010). LCA data from mostly US and UK meta-studies. System boundaries are cradle-to-household. Alcoholic and non-alcoholic beverages are included (16% of total GHG emissions).	2380	2865	1925
Tukker et al. (2011)	Europe	Five hypothetical European diet clusters based on data from food balance sheets (from 2003) assembled by the FAO, and data from the FAO yearbook. Food balance sheets refer to theoretical consumption availability and not actual food intake. Input/output analysis was used to calculate GHG emission using the E3IOT EE model. System boundaries are cradle-to-retail. Food waste is included.	2590	N/A	N/A
Meier and Christen (2012)	Germany	Food consumption data from the NVS II (data from 2005 to 2007). The data collection method is not specified. Representative carbon footprint data for German food production and consumption, complemented by data from the Danish LCA Food database and other data from e.g., GGELS and Leip et al. (2010). System boundaries are cradle-to-store. Beverages are not included.	1870	2200	1535
Meier and Christen (2013a)	Germany	Food consumption data from the NVS II (data from 2005 to 2007). The data collection method is not specified. LCA data from several databases (e.g. Leip et al., 2010; Danish LCA food database, CAPRI). Input/output analysis was used to calculate carbon footprints. System boundaries are cradle-to-retail. Beverages are not included. Emissions for land use change are included.	2050	2130	1980
Eberle and Fels (2016)	Germany	Food consumption based on data from "the German food basket" (data from 2011). The German food basket is based on official statistics and contains 79 different food products. LCA data from the database GEMIS (version 4.81). System boundaries are cradle-to-grave. Waste and out-of-home consumption is included. Beverages not included.	2750	N/A	N/A

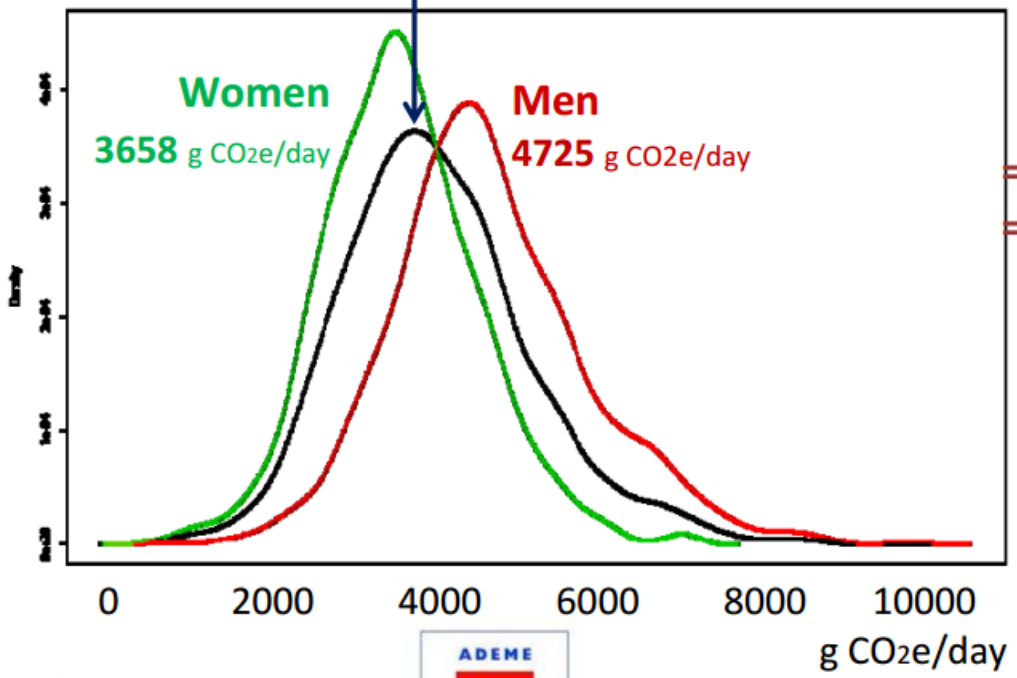
[a] Conventional diet.

Sample Daily Diet Carbon (CO2-eq) Calculated for France

AVERAGE

N=1918	Carbon Footprint
Average*(E-T)*	**4090 g CO2e/day/pers.** *(1175)*

DISTRIBUTION



⇒ **Coherent order of magnitude**

*Finland: **4800** g CO2e/day/pers Risku-Norja 2009*

*Sweden: **2557** g CO2e/day/pers Wallen 2004*

=> High inter-individual variability

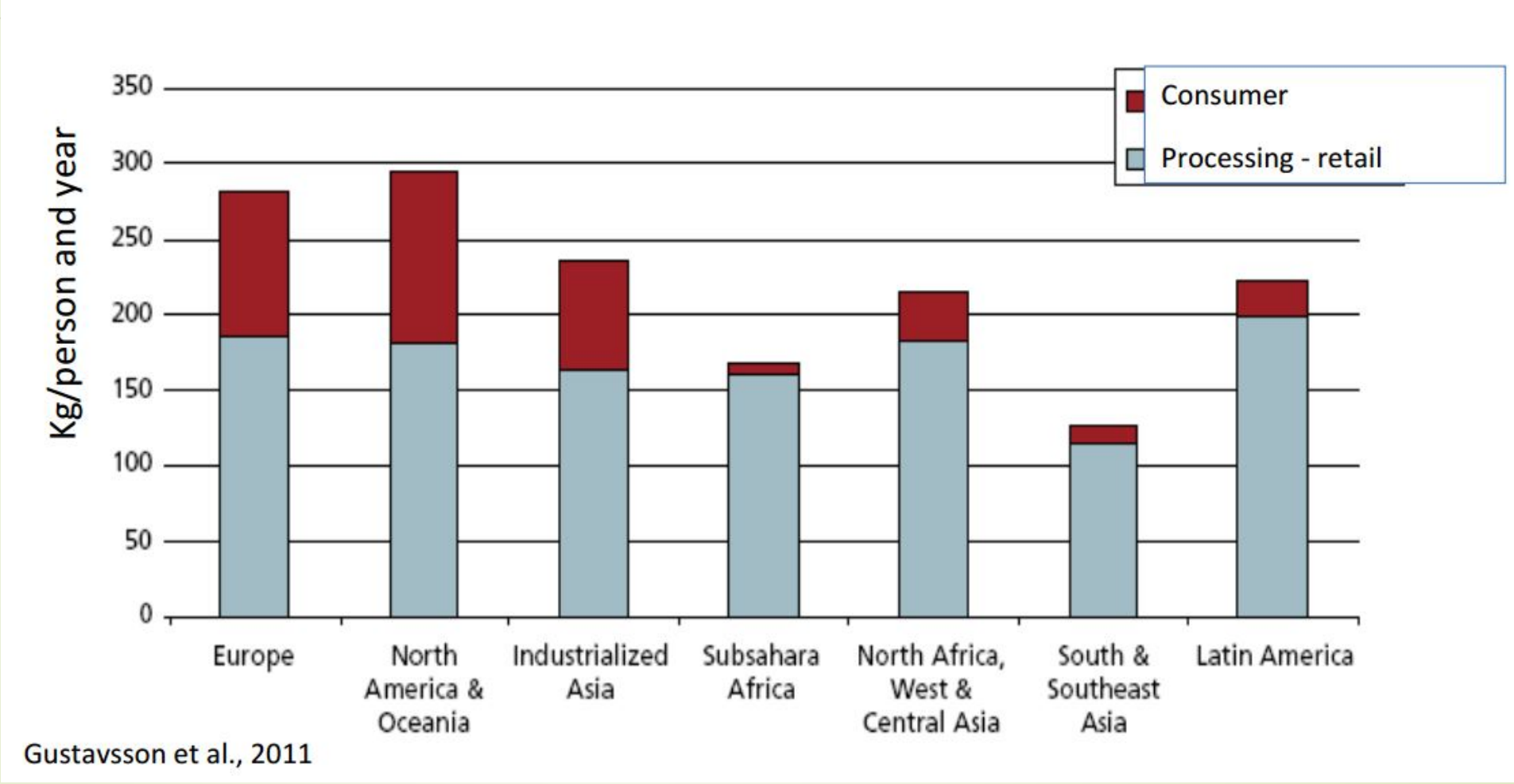
=> Women's CF < Men's CF (p<0.001)

INRA ADEME Agence de l'Environnement et de la Maîtrise de l'Energie

duALIne - Alimentation durable

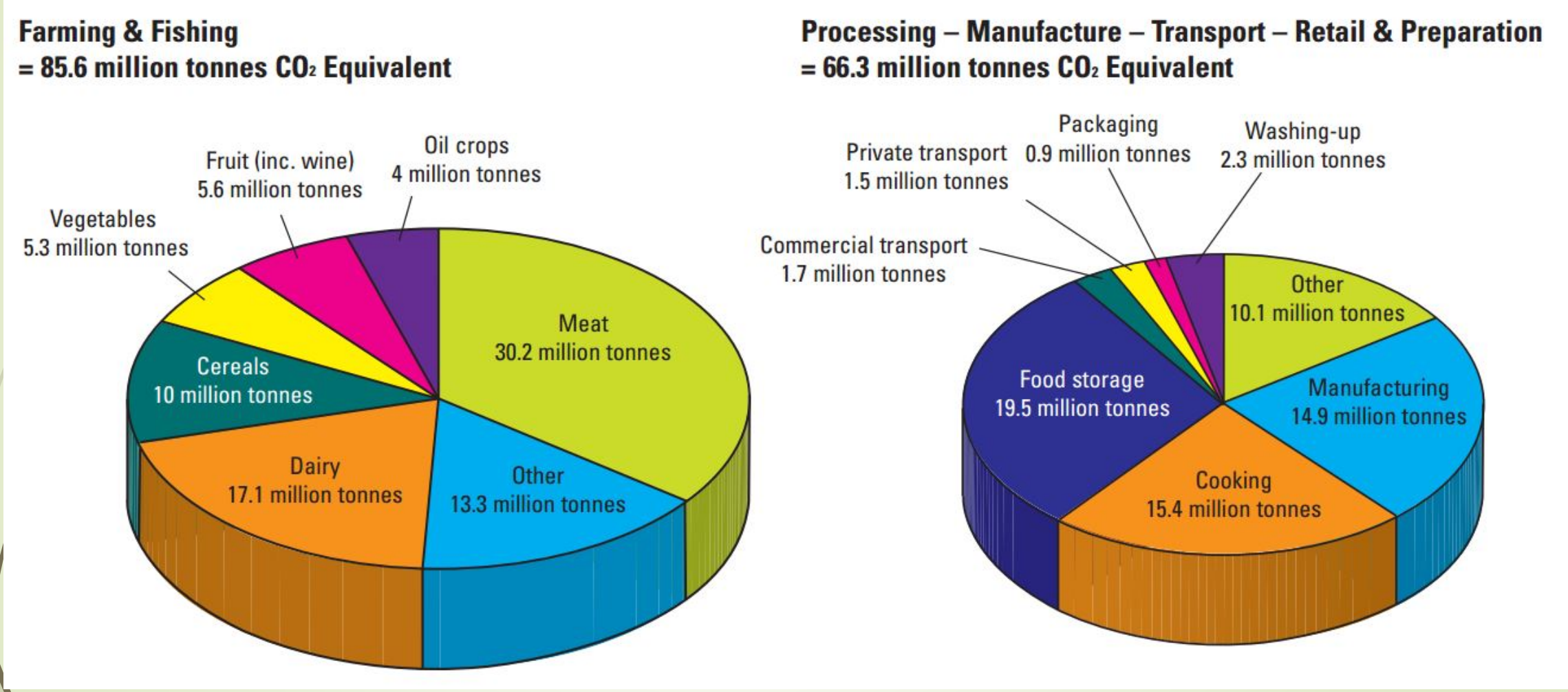
cirad

Regional Food Waste Kg/Person/Year



Gustavsson et al., 2011

The UK's Food Related Carbon Footprint (152 million tonnes CO2 equivalent)



Source: Audsley E, et al (2009). An assessment of greenhouse gas emissions from the UK food system and the scope for reduction by 2050. How low can we go? WWF UK and the Food Climate Research Network

Recommendations are generally aligned with the more healthy diet

- Eat less livestock related food, e.g.
  - Increased substitutes for butter and cheese
  - Low fat or soy milk
  - More starchy food like whole grain cereal or potatoes
  - More food with complex carbohydrates such as bread and pasta
  - More seasonal fruits
  - More locally produced foods
  - Lesser meat and more meat free days
    - Lesser carbon footprint
    - Lesser water pollution
    - Lesser air pollution
    - Lesser land use/land use change
- The case of animals in organic farming of small-holders is slightly different
- Etc. etc, you fill the blanks!

Priority Reasons for Organic Food Consumption in Germany

- Environmental Concerns
- Health Issues
- Avoiding Genetically Modified Food
- Better Animal Welfare
- Climate Change?
- Soil Preservation?

Comparison of Land Use of Diets

Results for land use of diets from this study and comparable studies.

Study	Country	Methods and data sources	Land use of diets (m^2 cap^{-1} $year^{-1}$)		
			Average consumer	Men	Women
This study	Germany	Food consumption data from diet-history interviews collected within the NVS II (2005–2007). Carbon footprint data from LCA studies. System boundaries are cradle-to-retail.	1920 [a]	2290 [a]	1550 [a]
Arnoult et al. (2010)	England and Wales	Hypothetical diets (household food consumption data). Land use assessed with the Land Use Allocation Model (LUAM).	2000	N/A	N/A
Temme et al. (2013)	The Netherlands	Food consumption data from 24-h recalls on two non-consecutive days from the Dutch Food Consumption Survey (2003). Data on land use were derived from the Dutch Food Composition table (data from 2006). Land use was only assessed for women.	N/A	N/A	1350
Meier and Christen (2012)	Germany	Food consumption data from the NVS II (data from 2005 to 2007). Data collection method not specified. System boundaries are cradle-to-store.	2010	2360	1650
Meier and Christen (2013a)	Germany	Food consumption data from the NVS II (data from 2005 to 2007). Data collection method not specified. Land-use data from LCA studies, e.g., Leip et al. (2010), Danish LCA food database and CAPRI. System boundaries are cradle-to-store.	2100	2210	1985
Eberle and Fels (2016)	Germany	Food consumption data from the "German food basket" (data from 2011). The German food basket is based on official statistics and contains 79 different food products. Land-use data from the database GEMIS (version 4.81). System boundaries are cradle-to-grave. Food waste and out-of-home consumption included.	2675	N/A	N/A

[a] Conventional diet.

Thanks Much
For Patiently Listening! ☺