

Supporting Information

Water resources conservation and nitrogen pollution reduction under global food trade and agricultural intensification

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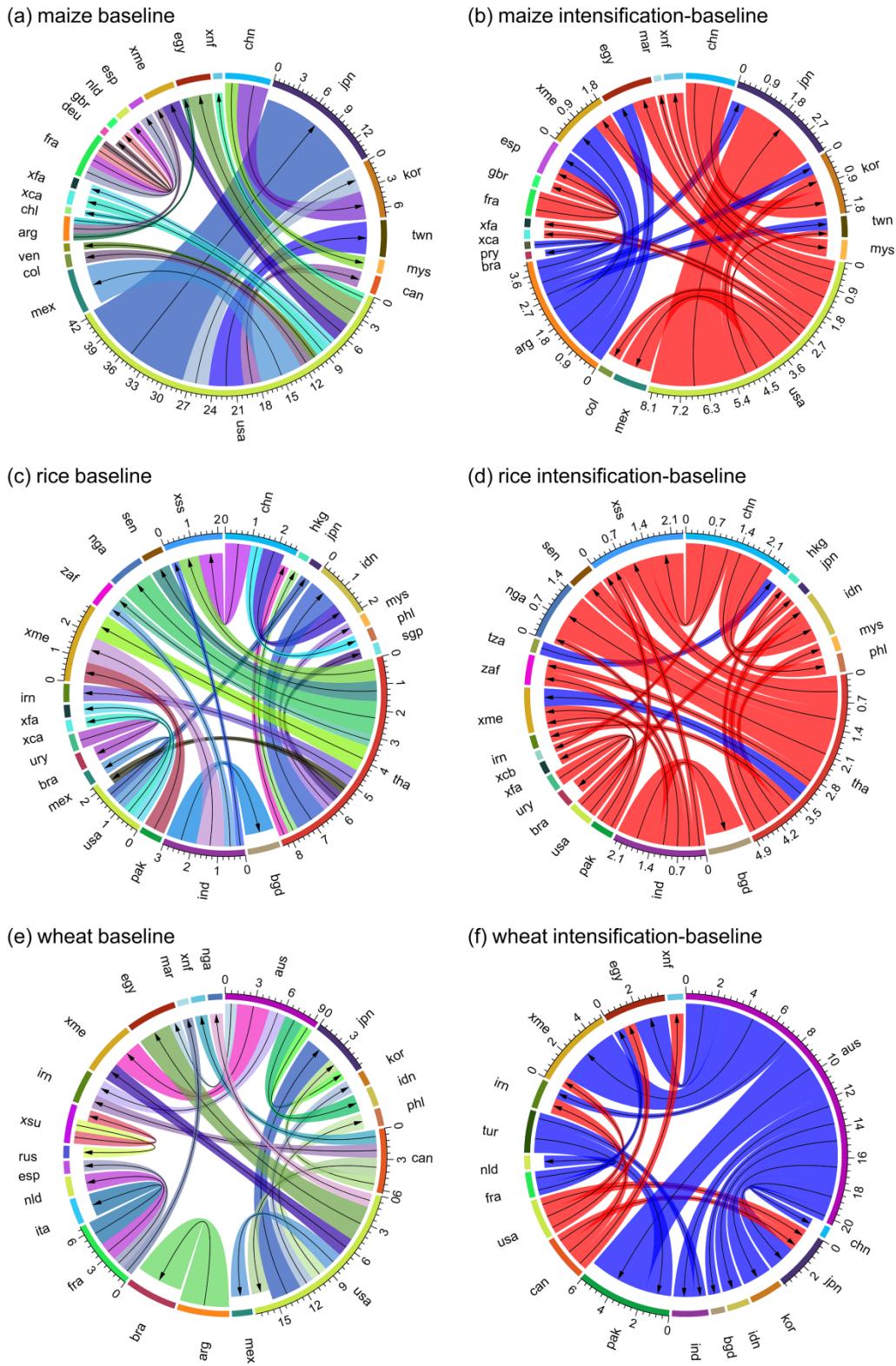


Fig. S1. Food export volume for maize, rice and wheat under baseline and differences between intensification and baseline scenarios. Unit: Tg y^{-1} . Arrows point to food importing countries; blue beams represent increases in export volume in subplots b, d, and f, while red beams represent decreases in export volume; the links with volumes less than 1% of the global total are disregarded; numbers outside arcs show total trade volume for major trading countries. Regions are defined in Tables S1 and S2.

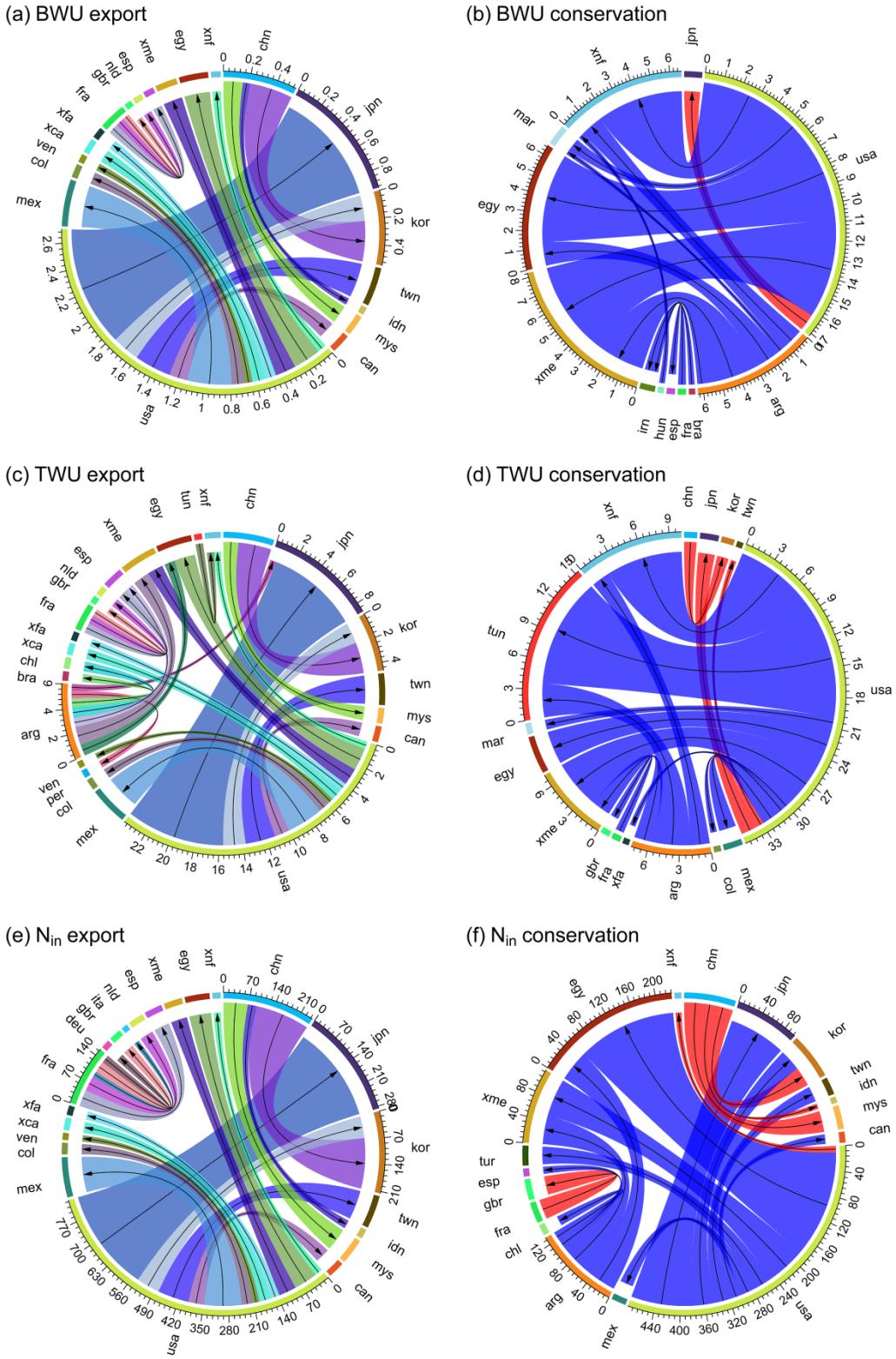


Fig. S2. Gross virtual resource export to importing countries and resource conservation through trade in maize under the baseline scenario. BW: blue water ($\text{km}^3 \text{y}^{-1}$); TWU: total water use ($\text{km}^3 \text{y}^{-1}$); N_{in} : nitrogen inputs (Gg N y^{-1}). Arrows point to food importing countries; blue beams represent resource conservation in subplots b, d, and f, while red beams represent increases in resource consumption; the links with volumes less than 1% of the global total are disregarded; numbers outside arcs show total volume of export and conservation for major trading countries. Regions are defined in Tables S1 and S2.

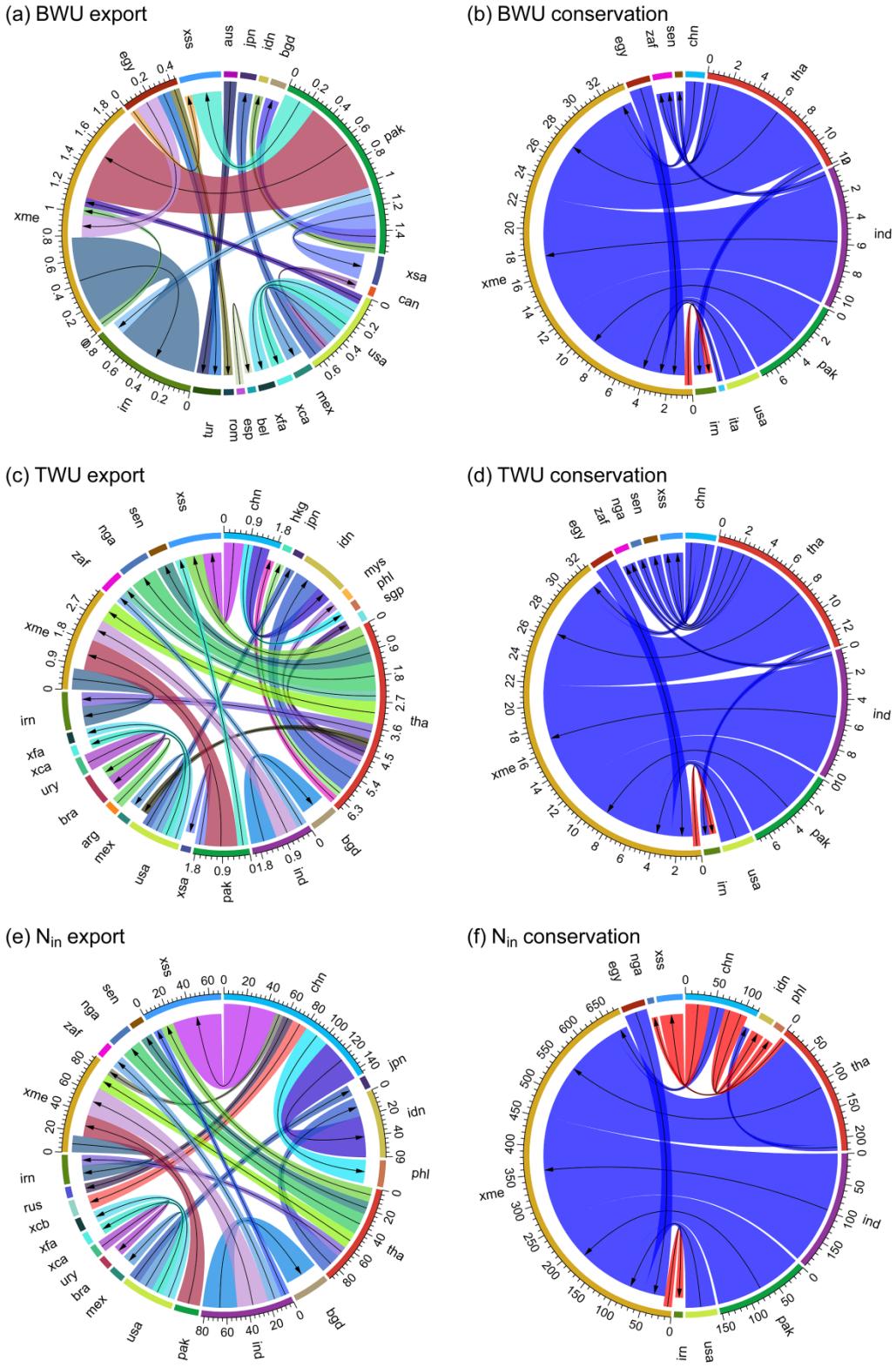


Fig. S3. Gross virtual resource export to importing countries and resource conservation through trade in rice under the baseline scenario. BW: blue water ($\text{km}^3 \text{y}^{-1}$); TWU: total water use ($\text{km}^3 \text{y}^{-1}$); N_{in} : nitrogen inputs (Gg N y^{-1}). Arrows point to food importing countries; blue beams represent resource conservation in subplots b, d, and f, while red beams represent increases in resource consumption; the links with volumes less than 1% of the global total are disregarded; numbers outside arcs show total volume of export and conservation for major trading countries. Regions are defined in Tables S1 and S2.

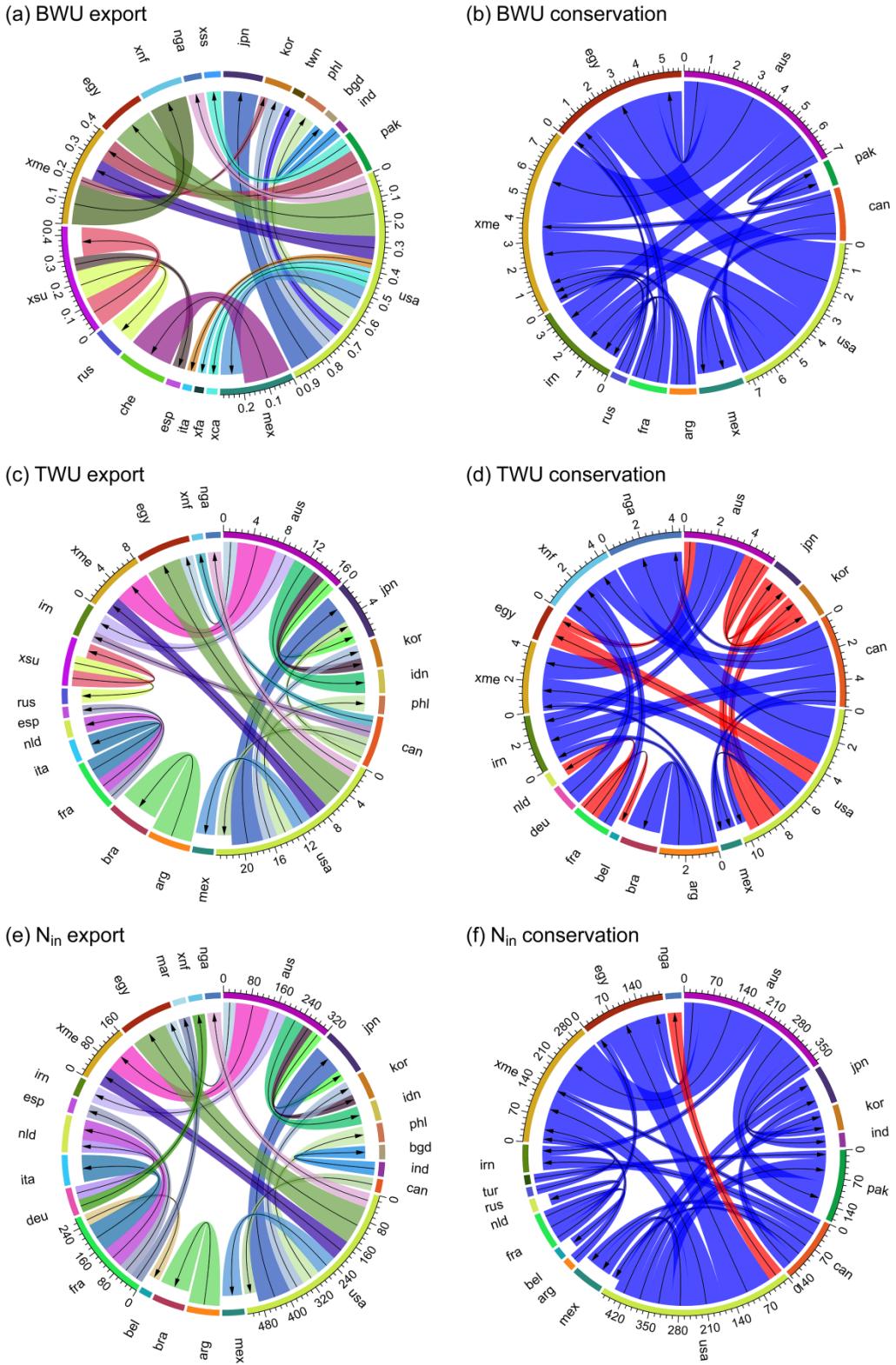


Fig. S4. Gross virtual resource export to importing countries and resource conservation through trade in wheat under the baseline scenario. BW: blue water ($\text{km}^3 \text{y}^{-1}$); TWU: total water use ($\text{km}^3 \text{y}^{-1}$); N_{in} : nitrogen inputs (Gg N y^{-1}). Arrows point to food importing countries; blue beams represent resource conservation in subplots b, d, and f, while red beams represent increases in resource consumption; the links with volumes less than 1% of the global total are disregarded; numbers outside arcs show total volume of export and conservation for major trading countries. Regions are defined in Tables S1 and S2.

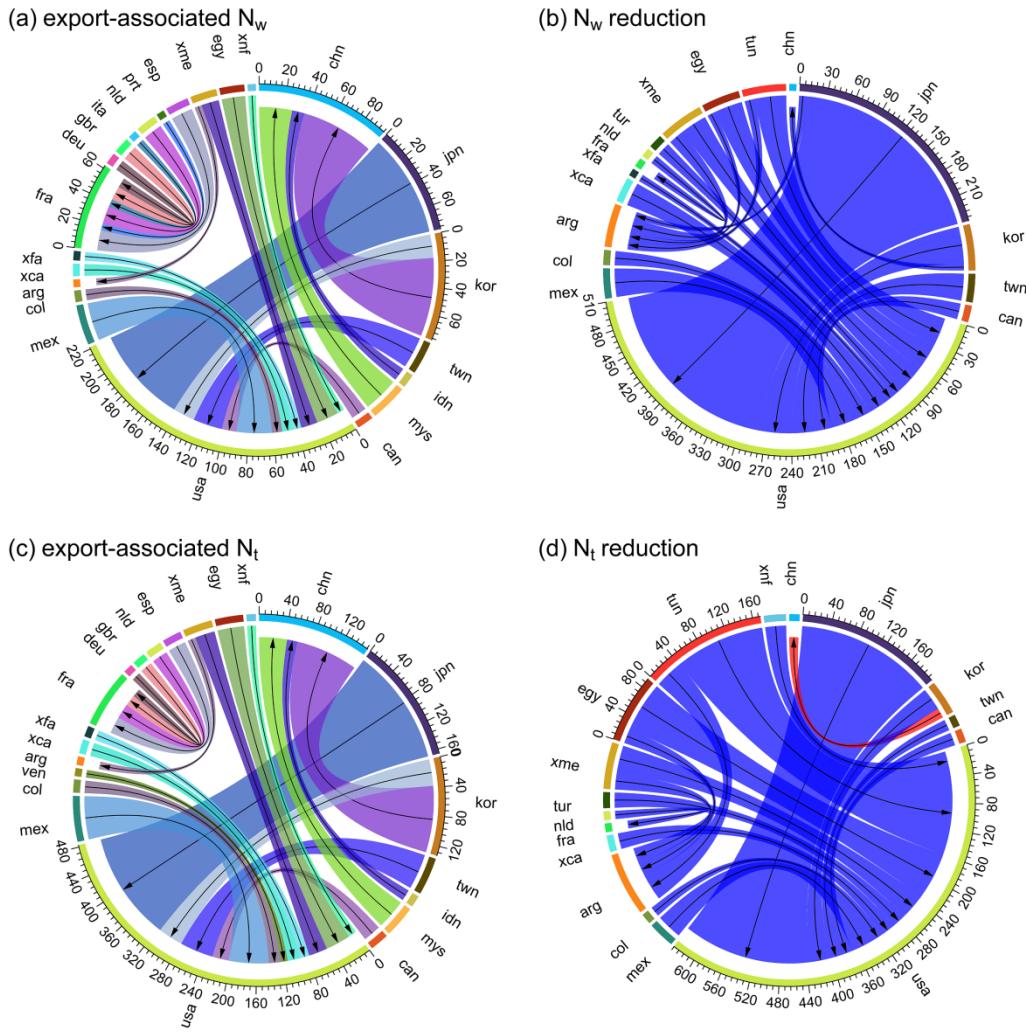


Fig. S5. Export-associated nitrogen (N) losses in exporting countries and N loss reduction through trade in maize under the baseline scenario. N_w : N losses to water (Gg N y^{-1}); N_t : N losses to the total environment (Gg N y^{-1}). Arrows point to food exporting countries; blue beams represent N loss reduction in subplots b and d, while red beams represent N loss increases; the links with volumes less than 1% of the global total are disregarded; numbers outside arcs show total volume of exported-associated N losses and N loss reduction for major trading countries. Regions are defined in Tables S1 and S2.

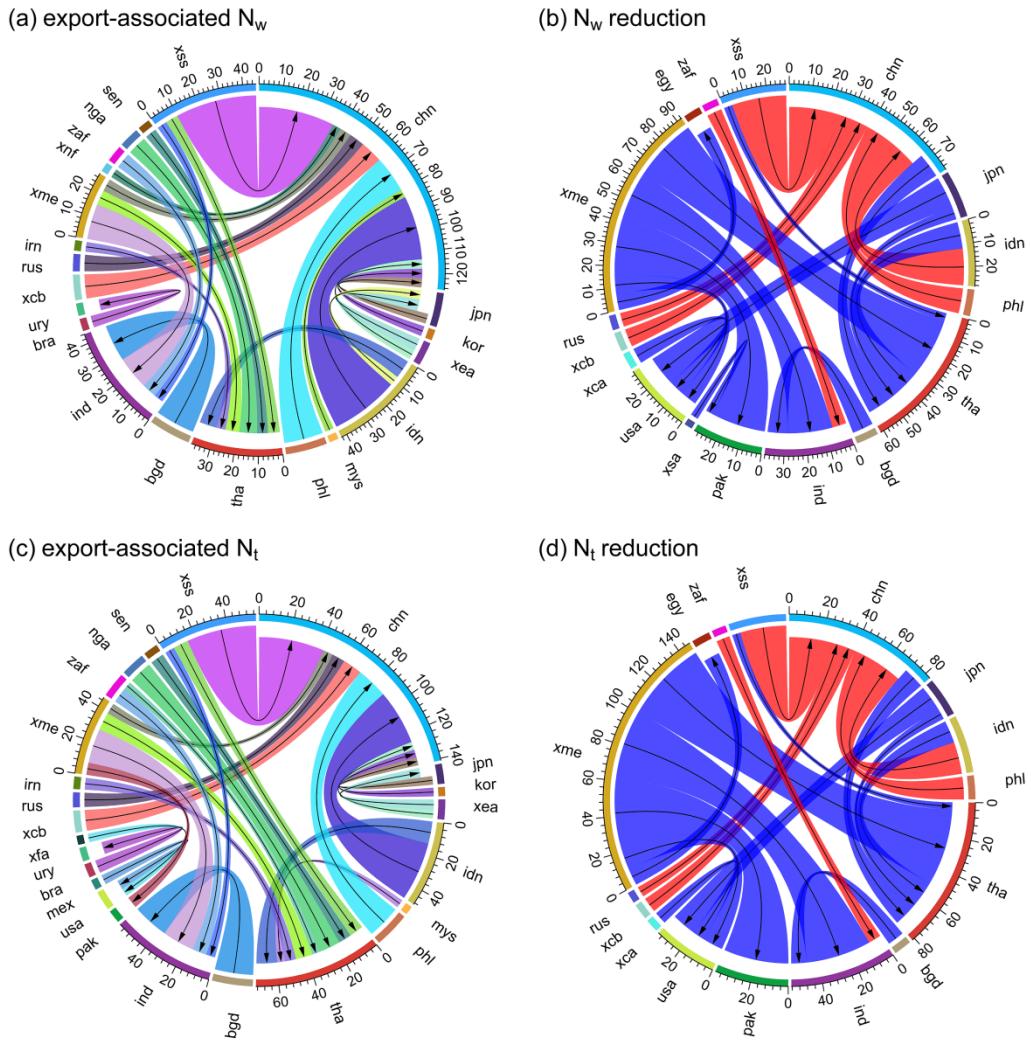


Fig. S6. Export-associated nitrogen (N) losses in exporting countries and N loss reduction through trade in rice under the baseline scenario. N_w : N losses to water (Gg N y^{-1}); N_t : N losses to the total environment (Gg N y^{-1}). Arrows point to food exporting countries; blue beams represent N loss reduction in subplots b and d, while red beams represent N loss increases; the links with volumes less than 1% of the global total are disregarded; numbers outside arcs show total volume of exported-associated N losses and N loss reduction for major trading countries. Regions are defined in Tables S1 and S2.

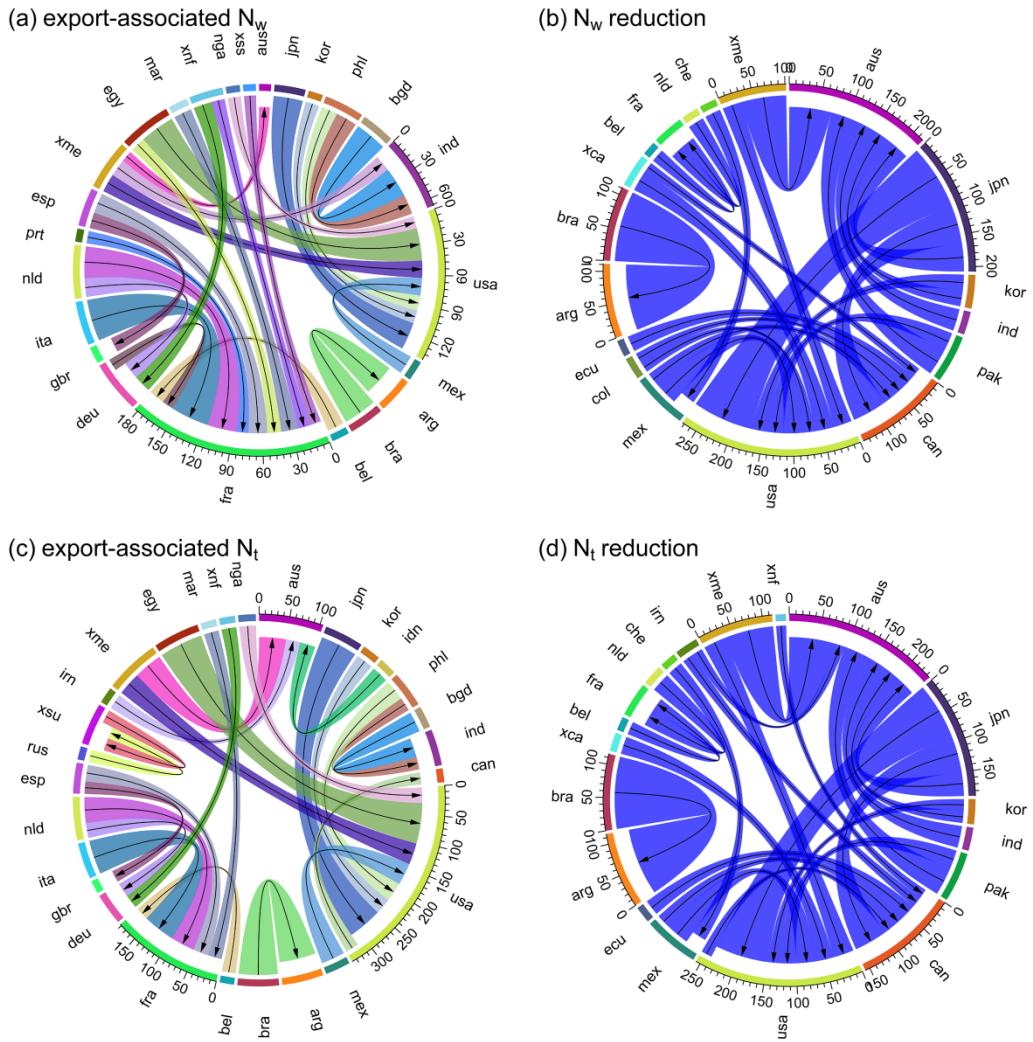


Fig. S7. Export-associated nitrogen (N) losses in exporting countries and N loss reduction through trade in wheat under the baseline scenario. N_w : N losses to water (Gg N y^{-1}); N_t : N losses to the total environment (Gg N y^{-1}). Arrows point to food exporting countries; blue beams represent N loss reduction in subplots b and d, while red beams represent N loss increases; the links with volumes less than 1% of the global total are disregarded; numbers outside arcs show total volume of exported-associated N losses and N loss reduction for major trading countries. Regions are defined in Tables S1 and S2.

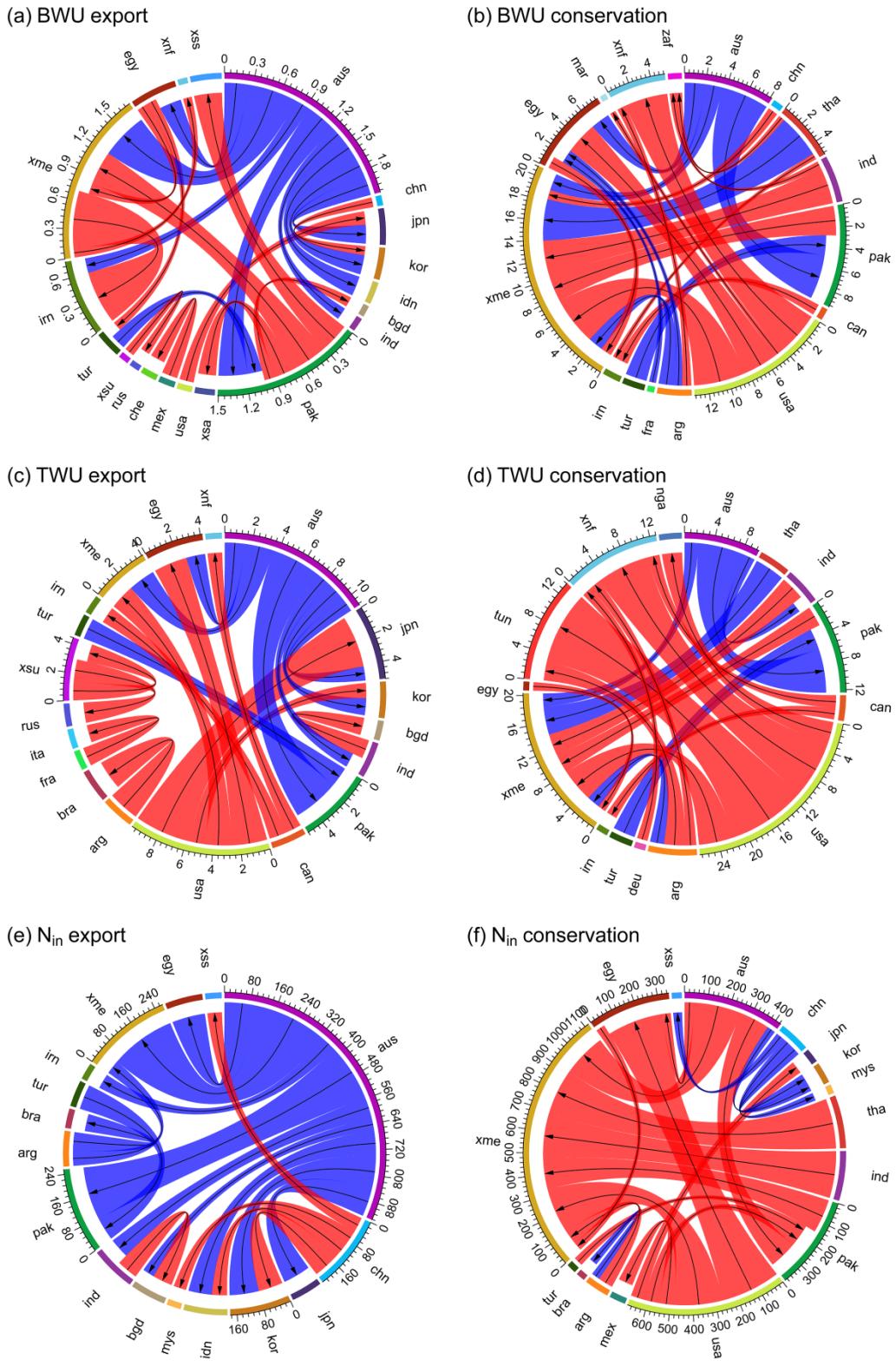


Fig. S8. Differences of gross virtual resource export to importing countries and resource conservation through trade in the three crops between intensification and baseline scenarios. BW: blue water ($\text{km}^3 \text{ y}^{-1}$); TWU: total water use ($\text{km}^3 \text{ y}^{-1}$); N_{in} : nitrogen inputs (Gg N y^{-1}). Arrows point to food importing countries; blue beams represent increases in gross virtual resource export and red beams show decreases in gross virtual resource export in subplots a, c, and e; blue beams represent increases in resource conservation and red beams show decreases in resource conservation in subplots b, d, and f; the links with volumes less than 1% of the global total are disregarded; numbers outside arcs show total volume of export and conservation for major trading countries. Regions are defined in Tables S1 and S2.

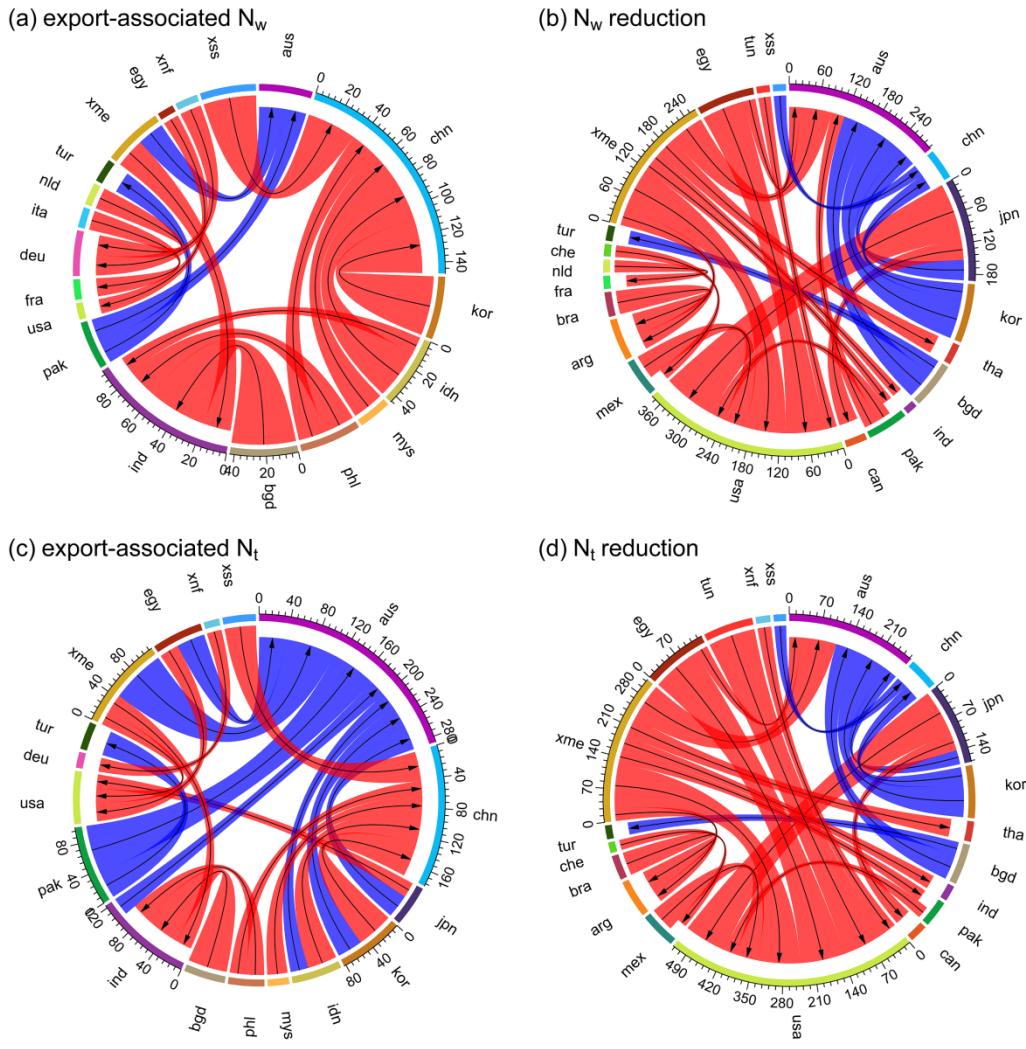


Fig. S9. Differences of export-associated nitrogen (N) losses in exporting countries and N loss reduction through trade in the three crops between intensification and baseline scenarios. N_w : N losses to water ($Gg N y^{-1}$); N_t : N losses to the total environment ($Gg N y^{-1}$). Arrows point to food exporting countries; blue beams represent increases in export-associated N losses and red beams show decreases in export-associated N losses in subplots a and c; blue beams represent increases in N loss reduction and red beams show decreases in N loss reduction in subplots b and d; the links with volumes less than 1% of global total are disregarded; numbers outside arcs show total volume of export-associated N losses and N loss reduction for major trading countries. Regions are defined in Tables S1 and S2.

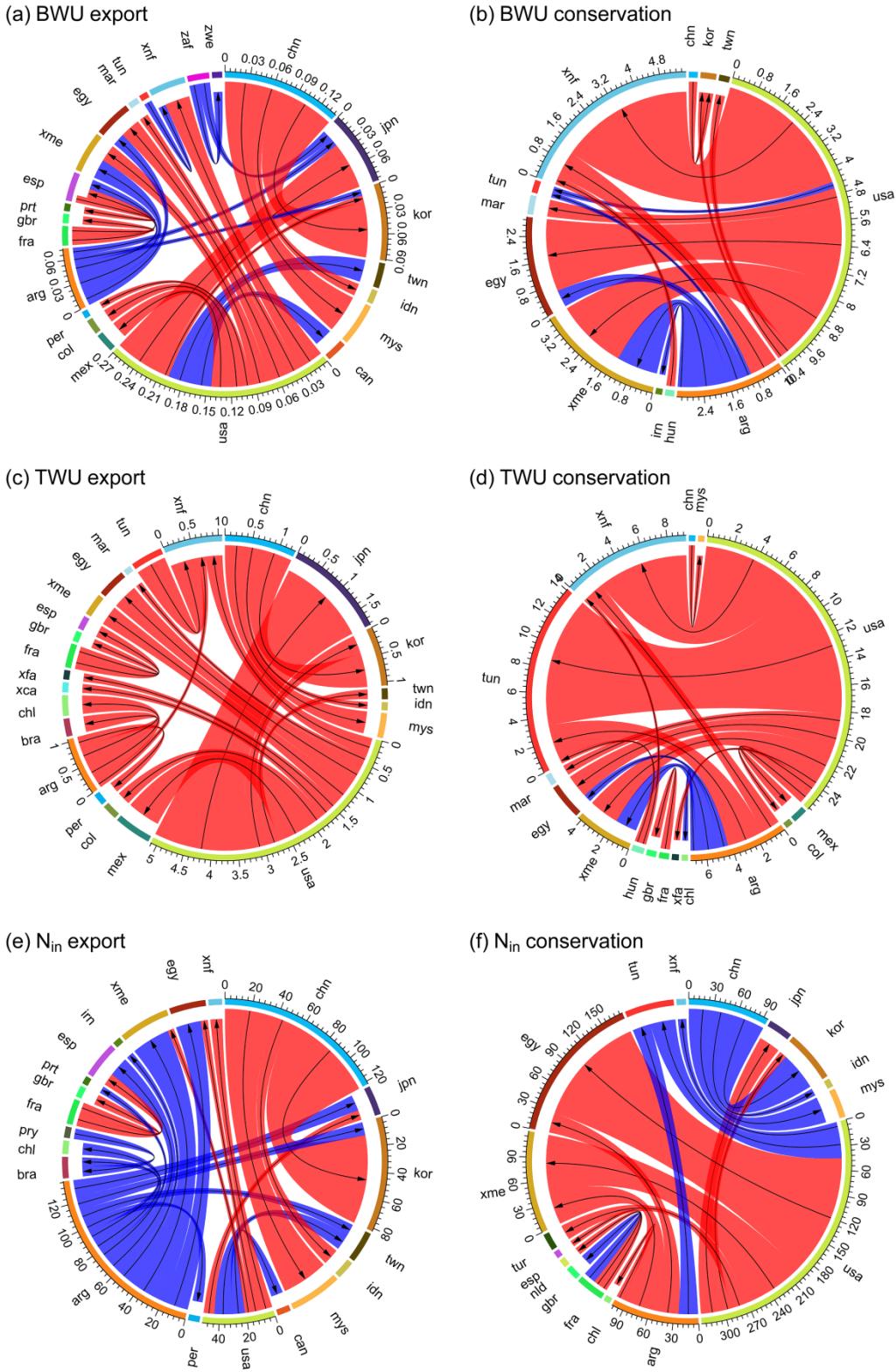


Fig. S10. Differences of gross virtual resource export to importing countries and resource conservation through trade in maize between intensification and baseline scenarios. BW: blue water ($\text{km}^3 \text{y}^{-1}$); TWU: total water use ($\text{km}^3 \text{y}^{-1}$); N_{in} : nitrogen inputs (Gg N y^{-1}). Arrows point to food importing countries; blue beams represent increases in gross virtual resource export and red beams show decreases in gross virtual resource export in subplots a, c, and e; blue beams represent increases in resource conservation and red beams show decreases in resource conservation in subplots b, d, and f; the links with volumes less than 1% of the global total are disregarded; numbers outside arcs show total volume of export and conservation for major trading countries. Regions are defined in Tables S1 and S2.

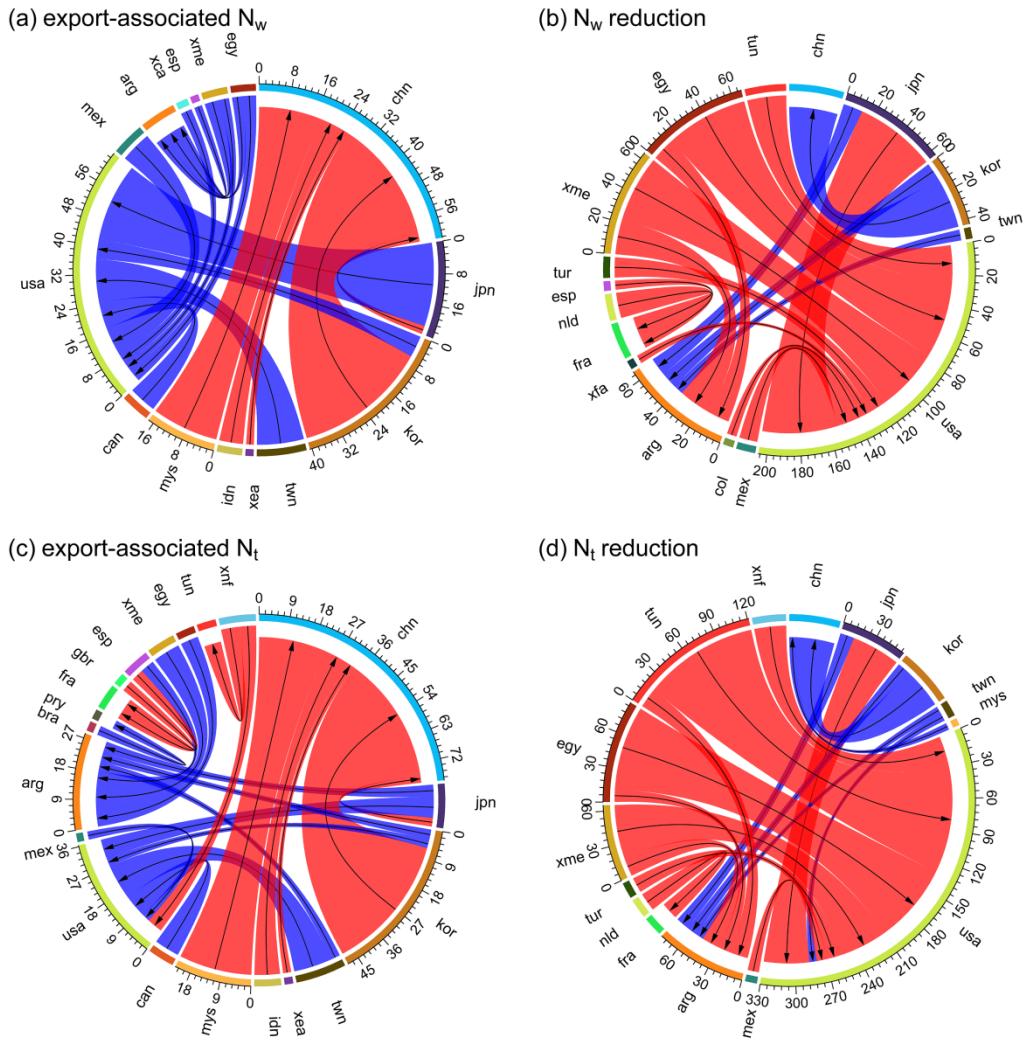


Fig. S11. Differences of export-associated nitrogen (N) losses in exporting countries and N loss reduction through trade in maize between intensification and baseline scenarios. N_w : N losses to water (Gg N y^{-1}); N_t : N losses to the total environment (Gg N y^{-1}). Arrows point to food exporting countries; blue beams represent increases in export-associated N losses and red beams show decreases in export-associated N losses in subplots a and c; blue beams represent increases in N loss reduction and red beams show decreases in N loss reduction in subplots b and d; the links with volumes less than 1% of global total are disregarded; numbers outside arcs show total volume of export-associated N losses and N loss reduction for major trading countries. Regions are defined in Tables S1 and S2.

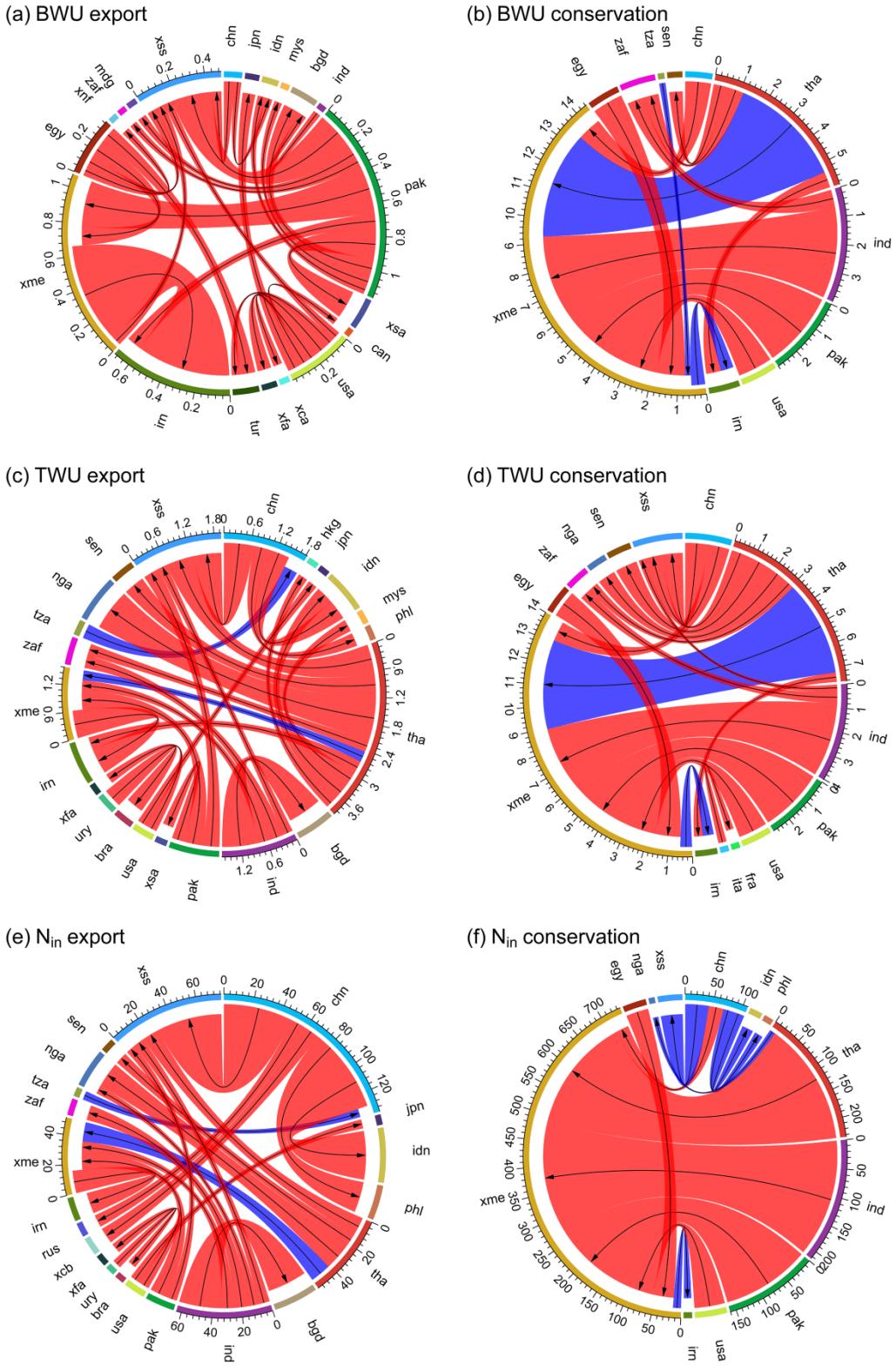


Fig. S12. Differences of gross virtual resource export to importing countries and resource conservation through trade in rice between intensification and baseline scenarios. BW: blue water ($\text{km}^3 \text{ y}^{-1}$); TWU: total water use ($\text{km}^3 \text{ y}^{-1}$); N_{in}: nitrogen inputs (Gg N y^{-1}). Arrows point to food importing countries; blue beams represent increases in gross virtual resource export and red beams show decreases in gross virtual resource export in subplots a, c, and e; blue beams represent increases in resource conservation and red beams show decreases in resource conservation in subplots b, d, and f; the links with volumes less than 1% of the global total are disregarded; numbers outside arcs show total volume of export and conservation for major trading countries. Regions are defined in Tables S1 and S2.

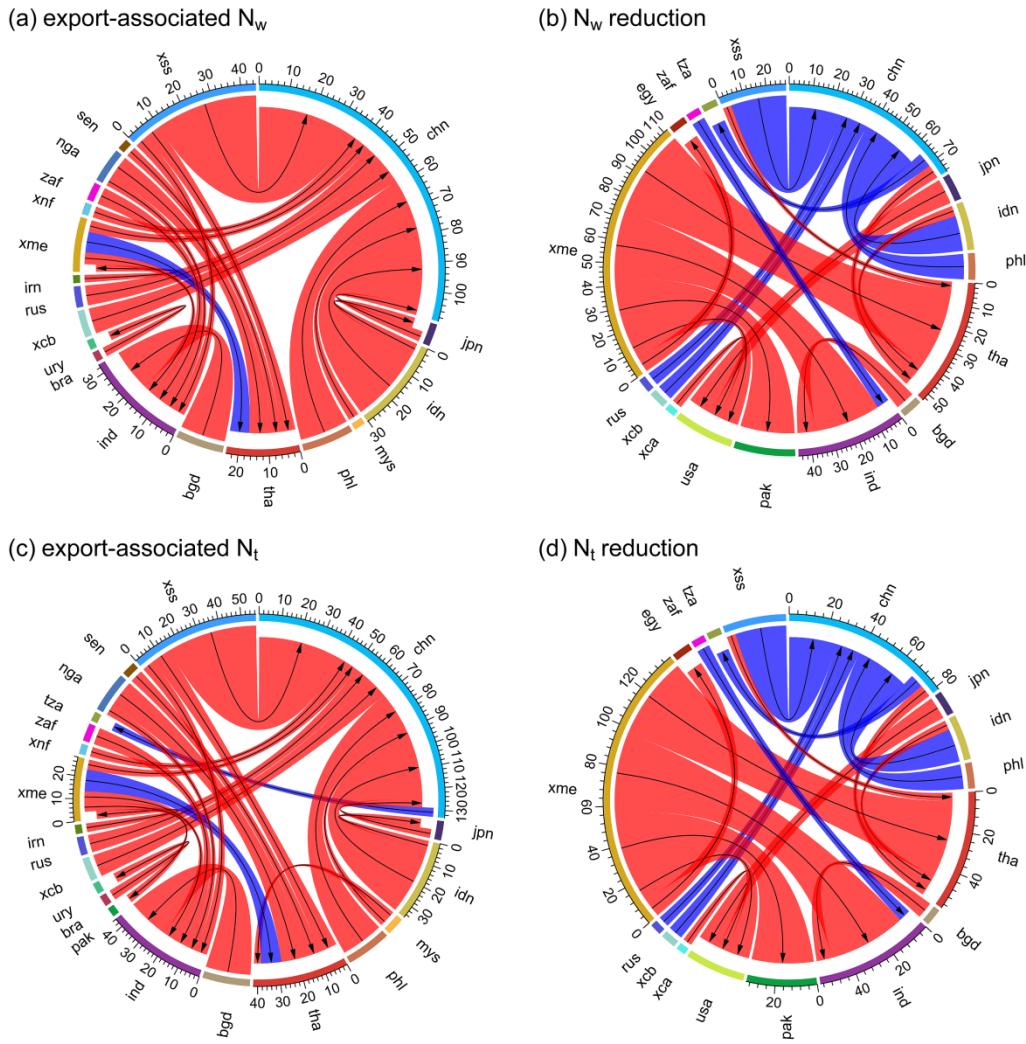


Fig. S13. Differences of export-associated nitrogen (N) losses in exporting countries and N loss reduction through trade in rice between intensification and baseline scenarios. N_w : N losses to water (Gg N y^{-1}); N_t : N losses to the total environment (Gg N y^{-1}). Arrows point to food exporting countries; blue beams represent increases in export-associated N losses and red beams show decreases in export-associated N losses in subplots a and c; blue beams represent increases in N loss reduction and red beams show decreases in N loss reduction in subplots b and d; the links with volumes less than 1% of global total are disregarded; numbers outside arcs show total volume of export-associated N losses and N loss reduction for major trading countries. Regions are defined in Tables S1 and S2.

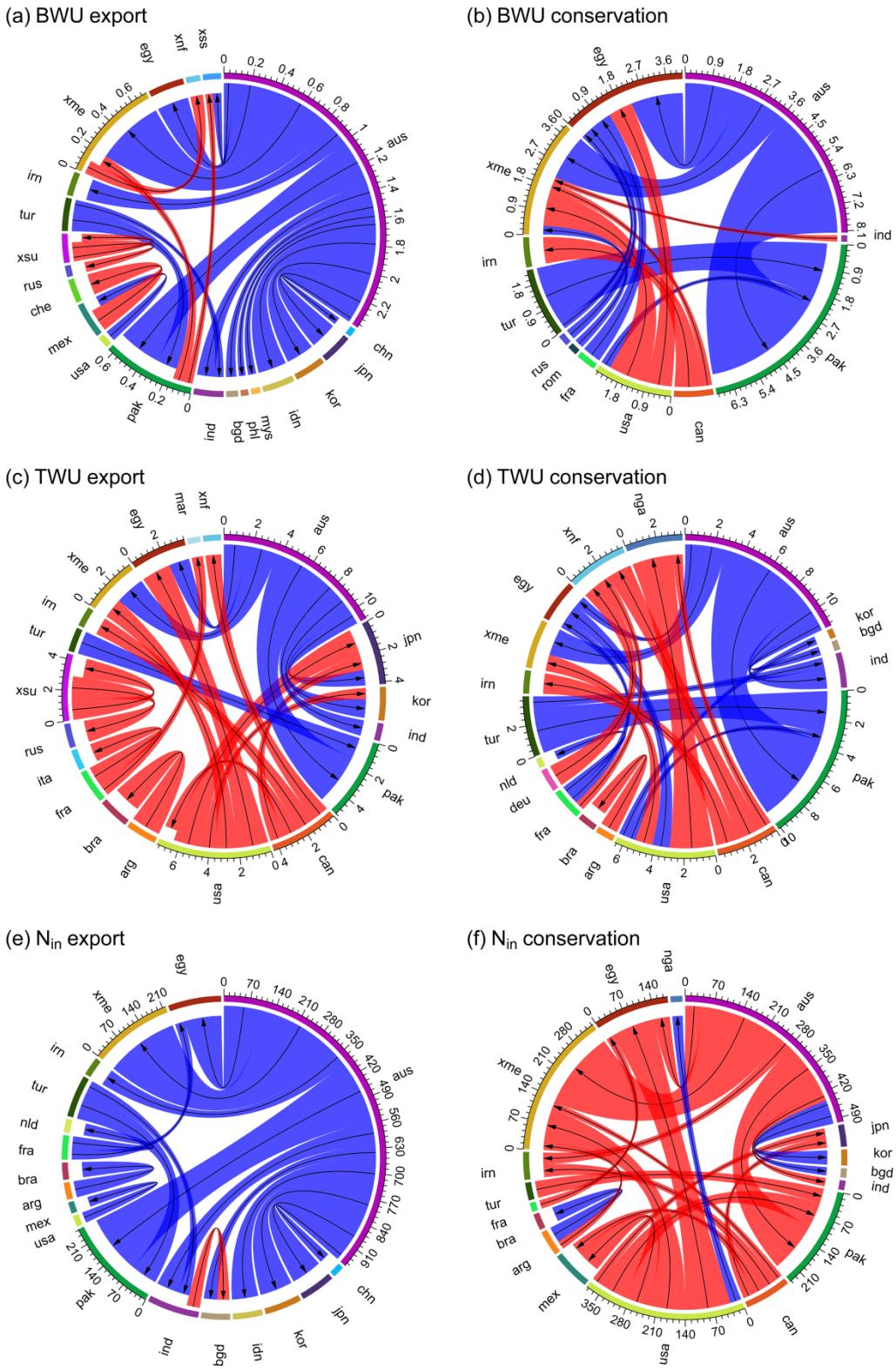


Fig. S14. Differences of gross virtual resource export to importing countries and resource conservation through trade in wheat between intensification and baseline scenarios. BW: blue water ($\text{km}^3 \text{y}^{-1}$); TWU: total water use ($\text{km}^3 \text{y}^{-1}$); N_{in} : nitrogen inputs (Gg N y^{-1}). Arrows point to food importing countries; blue beams represent increases in gross virtual resource export and red beams show decreases in gross virtual resource export in subplots a, c, and e; blue beams represent increases in resource conservation and red beams show decreases in resource conservation in subplots b, d, and f; the links with volumes less than 1% of the global total are disregarded; numbers outside arcs show total volume of export and conservation for major trading countries. Regions are defined in Tables S1 and S2.

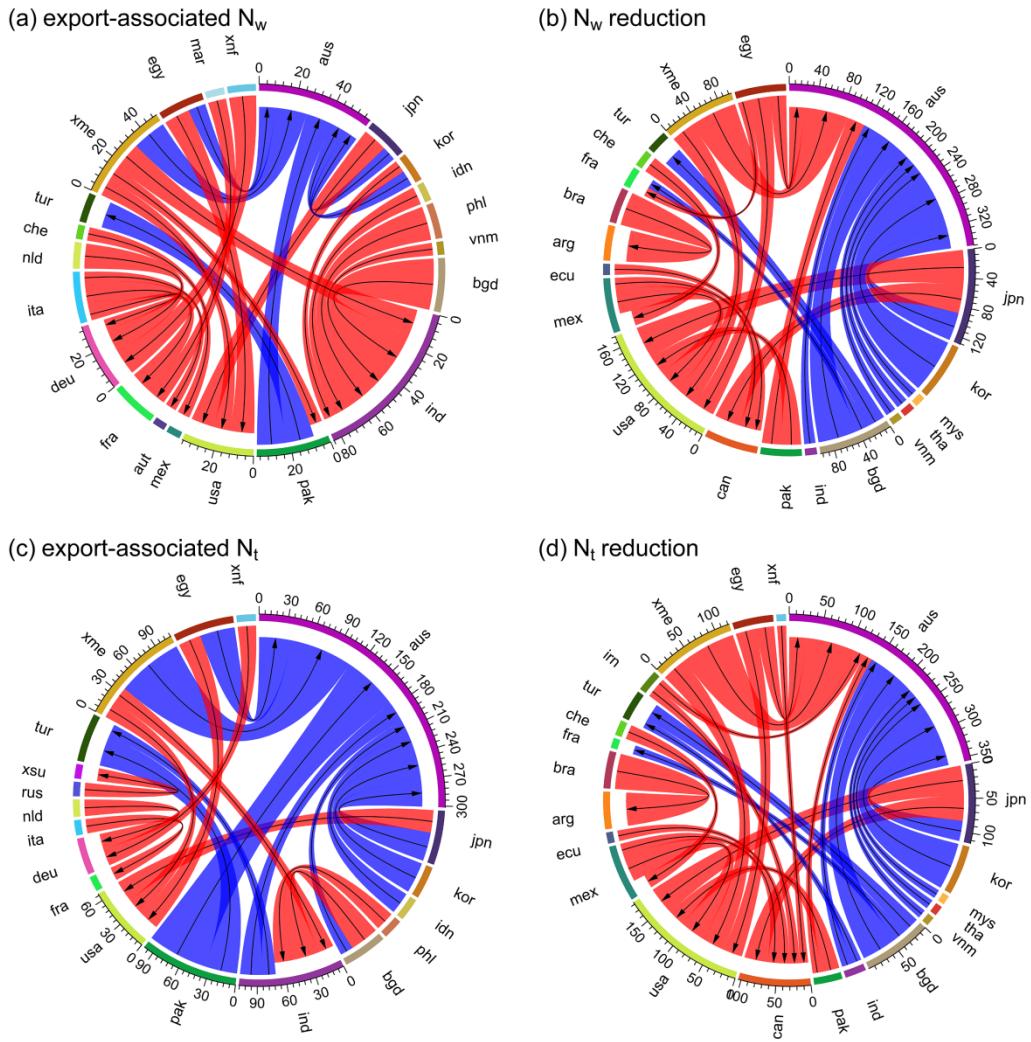


Fig. S15. Differences of export-associated nitrogen (N) losses in exporting countries and N loss reduction through trade in wheat between intensification and baseline scenarios. N_w : N losses to water (Gg N y^{-1}); N_t : N losses to the total environment (Gg N y^{-1}). Arrows point to food exporting countries; blue beams represent increases in export-associated N losses and red beams show decreases in export-associated N losses in subplots a and c; blue beams represent increases in N loss reduction and red beams show decreases in N loss reduction in subplots b and d; the links with volumes less than 1% of global total are disregarded; numbers outside arcs show total volume of export-associated N losses and N loss reduction for major trading countries. Regions are defined in Tables S1 and S2.

Table S1. Description of the 96 regions in the GTAP model.

Num.	Abb.	Name	Num.	Abb.	Name
1	aus	Australia	49	irl	Ireland
2	nzl	New Zealand	50	ita	Italy
3	xoc	Rest of Oceania	51	lux	Luxembourg
4	chn	China	52	nld	Netherlands
5	hkg	Hong Kong	53	prt	Portugal
6	jpn	Japan	54	esp	Spain
7	kor	SouthKorea	55	swe	Sweden
8	twn	Taiwan	56	che	Switzerland
9	xea	Rest of East Asia	57	xef	Rest of European Free Trade Area
10	khm	Cambodia	58	xer	Rest of Europe
11	idn	Indonesia	59	alb	Albania
12	mys	Malaysia	60	bgr	Bulgaria
13	pfl	Philippines	61	hrv	Croatia
14	sgp	Singapore	62	cyp	Cyprus
15	tha	Thailand	63	cze	Czech Republic
16	vnm	Vietnam	64	hun	Hungary
17	xse	Rest of Southeast Asia	65	mlt	Malta
18	bgd	Bangladesh	66	pol	Poland
19	ind	India	67	rom	Romania
20	pak	Pakistan	68	svk	Slovakia
21	lka	Sri Lanka	69	svn	Slovenia
22	xsa	Rest of South Asia	70	est	Estonia
23	can	Canada	71	lva	Latvia
24	usa	United States of America	72	ltu	Lithuania
25	mex	Mexico	73	rus	Russian Federation
26	xna	Rest of North America	74	xsu	Rest of Former Soviet Union
27	bol	Bolivia	75	tur	Turkey
28	col	Colombia	76	irn	Iran
29	ecu	Ecuador	77	xme	Rest of Middle East
30	per	Peru	78	egy	Egypt
31	ven	Venezuela	79	mar	Morocco
32	arg	Argentina	80	tun	Tunisia
33	bra	Brazil	81	xnf	Rest of North Africa
34	chl	Chile	82	bwa	Botswana
35	pry	Paraguay	83	zaf	South Africa
36	ury	Uruguay	84	xsc	Rest of South African Customs Union
37	xsm	Rest of South America	85	mwj	Malawi
38	xca	Rest of Central America	86	mus	Mauritius
39	xfa	Rest of Free Trade Area of the Americas	87	moz	Mozambique
40	xcb	Rest of the Caribbean	88	tza	Tanzania
41	aut	Austria	89	zmb	Zambia
42	bel	Belgium	90	zwe	Zimbabwe
43	dnk	Denmark	91	xsd	Rest of Southern African Development Community
44	fin	Finland	92	mdg	Madagascar
45	fra	France	93	nga	Nigeria
46	deu	Germany	94	sen	Senegal
47	gbr	United Kingdom	95	uga	Uganda
48	grc	Greece	96	xss	Rest of Sub-Saharan Africa

Table S2. Definition of regions in the GTAP model.

Name	Countries
Rest of Oceania	American Samoa, Cook Islands, French Polynesia, Fiji, Federated States of Micronesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, Norfolk Islands, Northern Mariana Islands, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis & Futuna
Rest of East Asia	Democratic People's Republic of Korea, Macau, Mongolia
Rest of Southeast Asia	Brunei Darussalam, Lao People's Democratic Republic, Myanmar, Timor-Leste
Rest of South Asia	Afghanistan, Bhutan, Maldives, Nepal
Rest of North America	Bermuda, Greenland, Saint Pierre & Miquelon
Rest of South America	Falkland Islands, French Guiana, Guyana, Suriname
Rest of Central America	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama
Rest of Free Trade Area of the Americas	Antigua & Barbuda, Bahamas, Barbados, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Puerto Rico, Saint Kitts & Nevis, Saint Lucia, Saint Vincent & the Grenadines, Trinidad & Tobago, USA Virgin Islands
Rest of the Caribbean	Anguilla, Aruba, Cayman Islands, Cuba, Guadeloupe, Martinique, Montserrat, Netherlands Antilles, Turks & Caicos, UK Virgin Islands
Rest of European Free Trade Area	Iceland, Liechtenstein, Norway
Rest of Europe	Andorra, Bosnia & Herzegovina, Faroe Islands, Gibraltar, Macedonia, Monaco, San Marino, Serbia & Montenegro
Rest of Former Soviet Union	Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Ukraine, Uzbekistan
Rest of Middle East	Bahrain, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestinian Territory, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, Yemen
Rest of North Africa	Algeria, Libya
Rest of South African Customs Union	Lesotho, Namibia, Swaziland
Rest of Southern African Development Community	Angola, The Democratic Republic of Congo, Seychelles
Rest of Sub-Saharan Africa	Benin, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Mali, Mauritania, Mayotte, Niger, Reunion, Rwanda, Saint Helena, Sao Tome & Principe, Sierra Leone, Somalia, Sudan, Togo

Table S3. Resource use intensities and nitrogen loss intensities for maize under the baseline and intensification scenarios. BWUI: blue water use intensity; TWUI: total water use intensity; $N_{in}I$: nitrogen input intensity; N_wI : water nitrogen loss intensity; N_tI : total nitrogen loss intensity; --: no information.

	BWUI ($m^3 t^{-1}$)		TWUI ($m^3 t^{-1}$)		$N_{in}I$ ($kg N t^{-1}$)		N_wI ($kg N t^{-1}$)		N_tI ($kg N t^{-1}$)	
	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification
aus	688.0	289.0	1609.5	664.4	9.3	15.3	1.0	1.2	4.5	4.3
nzl	47.5	49.2	502.3	503.3	29.3	26.9	14.1	12.8	19.7	18.7
xoc	0.0	1.4	1869.9	610.1	2.0	16.4	25.4	10.1	31.8	13.5
chn	87.4	91.0	725.6	727.2	39.4	27.6	15.6	8.7	24.9	18.3
hkg	--	--	--	--	--	--	--	--	--	--
jpn	0.8	1.3	440.6	419.1	26.3	29.8	21.1	23.9	24.9	28.0
kor	0.0	0.0	402.0	400.0	30.7	33.7	17.6	22.7	21.1	26.4
twn	0.0	0.0	425.5	404.2	25.6	30.2	12.0	16.5	15.0	20.3
xea	0.3	0.2	612.7	435.0	19.8	20.7	13.4	13.4	16.6	16.0
khm	0.0	0.0	1369.7	799.9	11.2	22.9	10.3	13.8	16.6	20.1
idn	14.4	22.1	826.5	651.0	24.6	28.8	19.6	20.1	27.0	28.9
mys	0.0	2.8	941.1	635.0	18.2	26.2	18.9	17.1	24.7	23.8
phl	0.0	0.1	793.0	620.6	19.2	25.5	15.9	18.9	22.3	26.5
sgp	--	--	--	--	--	--	--	--	--	--
tha	0.0	0.2	809.1	695.9	19.7	25.1	7.7	11.1	15.0	20.0
vnm	0.8	1.6	686.3	654.2	31.3	35.9	15.9	22.0	22.4	29.9
xse	22.7	47.6	1072.0	749.4	21.1	33.8	25.0	21.2	35.1	33.5
bgd	0.0	0.0	911.0	711.9	28.0	33.6	35.6	35.7	44.0	43.8
ind	18.6	24.1	1000.0	811.1	20.4	25.7	9.3	10.4	17.0	19.5
pak	186.5	181.2	624.9	582.5	18.9	17.4	2.9	2.9	6.4	6.6
lka	0.0	6.3	1418.9	780.2	12.9	24.2	13.2	13.3	19.3	19.2
xsa	534.0	312.5	1599.9	927.9	14.3	22.1	12.4	12.1	17.8	17.6
can	5.9	16.3	476.4	473.9	27.0	29.6	13.2	16.6	19.8	23.2
usa	63.7	74.3	562.4	546.8	19.6	23.8	5.3	8.5	11.4	14.8
mex	65.6	56.8	900.5	717.2	23.7	27.4	11.2	13.2	18.1	20.9
xna	--	--	--	--	--	--	--	--	--	--
bol	30.4	20.3	2910.0	977.5	6.6	18.2	2.8	2.1	11.4	8.4
col	1.8	2.5	1000.2	668.8	18.1	26.0	15.5	17.3	20.6	23.3
ecu	59.4	60.6	816.9	718.3	26.6	28.5	27.2	31.2	35.7	40.6
per	95.0	81.5	803.8	659.4	20.6	21.6	9.7	7.8	17.0	15.5
ven	17.7	16.0	773.6	627.6	22.5	27.3	5.8	8.9	11.6	16.2
arg	5.9	13.0	1140.3	545.7	7.8	16.3	4.2	3.8	8.7	7.9
bra	0.5	7.2	1046.0	717.4	19.1	24.8	11.8	11.9	18.4	19.1
chl	345.9	348.8	486.2	486.7	29.0	25.4	10.3	7.8	16.1	14.0
pry	0.3	16.6	2859.9	1008.5	9.4	23.5	15.9	11.0	23.0	16.9
ury	12.6	15.5	1099.5	525.0	9.7	17.2	7.6	6.1	12.2	10.4
xsm	0.0	1.7	967.4	606.7	19.3	24.3	15.7	13.7	22.5	20.5
xca	0.7	1.4	830.6	613.3	21.4	31.0	20.8	26.9	24.9	31.4
xfa	5.0	10.0	1049.0	649.0	15.8	22.1	11.6	11.2	16.7	16.9
xcb	0.6	0.4	705.6	483.7	10.1	15.3	5.7	5.5	10.4	10.3
aut	0.1	1.8	450.1	451.1	21.5	22.5	7.8	9.8	13.4	15.3
bel	1.0	5.8	499.1	493.4	34.4	27.8	20.4	13.7	26.1	19.6
dnk	18.4	13.1	1049.8	619.3	0.0	8.4	1.8	1.7	9.8	7.8
fin	1.0	8.7	533.8	526.9	3.2	5.1	5.2	4.9	15.6	15.2

Table S3. Continued.

	BWUI ($\text{m}^3 \text{t}^{-1}$)		TWUI ($\text{m}^3 \text{t}^{-1}$)		N _{in} I (kg N t^{-1})		N _w I (kg N t^{-1})		N _I (kg N t^{-1})	
	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification
fra	43.1	49.4	471.2	456.0	26.0	27.9	9.2	11.1	14.2	16.4
deu	0.9	5.1	499.8	499.8	23.6	22.8	10.3	9.4	16.8	15.9
gbr	0.0	2.8	1170.7	607.1	0.0	8.3	3.8	2.2	11.3	6.8
grc	311.4	296.3	555.8	521.9	24.4	23.2	5.6	5.2	10.9	11.1
irl	0.0	0.0	999.7	742.3	0.0	5.3	6.8	5.0	14.2	11.3
ita	84.6	85.9	436.5	425.5	23.6	25.8	7.1	9.8	11.4	14.5
lux	0.0	12.2	491.7	491.5	40.4	32.9	20.7	13.8	25.5	18.5
nld	1.9	5.2	619.9	511.5	22.6	17.4	15.2	6.7	21.8	13.3
prt	367.9	257.3	698.1	480.9	17.7	18.8	5.0	3.7	9.1	7.8
esp	279.0	269.7	566.8	532.3	26.0	21.6	7.4	4.3	12.1	9.5
swe	5.9	3.3	1294.9	612.1	0.0	9.2	0.9	0.5	8.1	4.8
che	0.1	0.4	464.9	450.0	23.5	25.6	16.9	17.6	20.9	21.8
xef	--	--	--	--	--	--	--	--	--	--
xer	2.6	20.1	656.8	508.9	10.9	18.3	2.6	3.8	8.3	10.3
alb	366.8	302.2	958.8	772.6	22.9	28.6	4.6	7.2	12.0	16.7
bgr	56.6	92.9	1932.3	1195.6	9.7	28.0	3.7	4.3	23.6	23.1
hrv	0.6	22.5	948.8	821.6	24.9	32.1	7.5	11.1	16.5	22.0
cyp	837.7	373.9	1962.5	748.4	0.1	24.5	1.4	2.1	21.5	16.9
cze	0.0	3.7	501.6	499.5	15.3	18.5	3.3	5.6	9.9	12.0
hun	1.1	16.3	524.5	495.5	14.2	18.1	1.5	2.7	8.2	9.6
mlt	--	--	--	--	--	--	--	--	--	--
pol	1.8	7.4	526.6	513.6	16.2	15.4	6.3	4.5	13.5	11.6
rom	18.4	43.2	1096.0	892.5	14.8	23.0	3.9	4.7	16.3	18.7
svk	5.9	12.2	545.2	502.6	12.0	16.8	1.9	3.7	7.6	9.8
svn	1.3	5.2	450.7	451.3	27.0	28.0	12.6	15.7	17.6	20.8
est	8.5	14.7	893.5	632.4	2.4	9.1	2.4	2.2	9.5	8.1
lva	2.2	19.8	1294.9	1050.4	13.4	19.9	4.0	4.3	17.3	16.9
ltu	1.8	13.8	1335.7	1007.9	8.9	17.3	2.7	3.2	14.8	14.8
rus	87.1	99.2	1470.2	1125.4	6.4	17.8	3.0	3.4	19.6	18.1
xsu	278.3	238.9	1496.4	1142.5	12.4	20.6	2.4	2.6	18.2	16.9
tur	348.9	360.3	1198.8	1084.1	67.1	41.9	28.1	11.8	45.5	29.1
irn	1626.1	1344.3	2060.1	1694.3	24.2	19.4	3.6	1.2	12.3	9.9
xme	2193.3	1689.2	2643.4	2030.8	45.6	18.4	17.2	1.9	27.0	10.4
egy	1603.1	1172.5	1624.0	1187.7	70.9	32.3	14.7	0.4	33.2	13.6
mar	1551.2	781.0	2649.6	1296.9	18.6	22.8	1.6	1.3	18.1	13.0
tun	0.0	648.6	27602.9	3336.9	1.4	100.7	85.9	39.7	309.7	92.5
xnf	4556.2	1224.3	7955.8	2009.0	10.1	25.1	6.4	3.1	38.5	17.7
bwa	6.4	135.4	3117.6	1385.3	17.4	29.5	0.5	0.7	15.2	13.8
zaf	31.0	95.5	1702.0	1192.9	29.6	38.5	4.4	5.1	18.4	21.8
xsc	18.4	42.9	1954.2	1015.5	14.9	22.6	10.3	7.5	19.0	15.8
mwi	0.1	8.4	2049.8	783.9	9.2	20.6	3.8	2.9	10.0	9.8
mus	--	--	--	--	--	--	--	--	--	--
moz	2.8	7.7	2867.7	807.8	2.2	18.6	9.3	4.8	17.6	10.5
tza	24.5	51.5	2368.8	973.2	7.3	27.1	7.8	9.0	21.5	20.1
zmb	1.0	15.0	1712.8	765.1	8.2	20.2	4.7	3.8	12.3	11.5
zwe	12.1	46.0	1553.6	840.6	17.5	25.9	5.3	4.1	12.9	13.0

Table S3. Continued.

	BWUI ($\text{m}^3 \text{t}^{-1}$)		TWUI ($\text{m}^3 \text{t}^{-1}$)		N _{inI} (kg N t^{-1})		N _{wI} (kg N t^{-1})		N _I (kg N t^{-1})	
	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification
xsd	0.1	2.0	2080.3	681.9	2.0	16.9	4.3	2.9	13.1	9.4
mdg	0.0	3.6	2517.8	827.9	5.4	21.7	37.0	14.8	44.8	19.8
nga	0.5	2.6	1182.2	680.2	10.8	18.0	4.8	3.9	11.4	10.5
sen	3.8	5.4	1165.9	749.5	12.9	18.2	4.2	4.9	10.4	11.1
uga	0.0	6.4	1416.6	789.2	9.2	17.8	3.6	3.5	11.4	10.8
xss	54.4	59.0	1560.1	827.3	13.1	21.5	5.3	4.8	13.1	12.8

Table S4. Resource use intensities and nitrogen loss intensities for rice under the baseline and intensification scenarios. BWUI: blue water use intensity; TWUI: total water use intensity; $N_{in}I$: nitrogen input intensity; N_wI : water nitrogen loss intensity; N_tI : total nitrogen loss intensity; --: no information.

	BWUI ($m^3 t^{-1}$)		TWUI ($m^3 t^{-1}$)		$N_{in}I$ ($kg N t^{-1}$)		N_wI ($kg N t^{-1}$)		N_tI ($kg N t^{-1}$)	
	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification
aus	1867.9	838.6	3210.6	1435.9	6.9	13.5	0.5	0.4	6.1	4.4
nzl	--	--	--	--	--	--	--	--	--	--
xoc	0.0	0.4	2251.6	1005.7	0.3	23.6	23.1	21.9	27.6	25.4
chn	61.5	61.6	695.0	693.3	49.0	36.5	35.6	25.2	42.3	32.2
hkg	--	--	--	--	--	--	--	--	--	--
jpn	7.1	6.7	637.8	635.0	42.7	35.5	38.8	31.8	44.8	37.8
kor	7.9	8.3	622.5	623.1	48.5	41.6	35.4	31.6	40.3	36.6
twn	0.7	1.0	695.2	612.7	26.5	28.1	13.6	13.6	17.4	18.0
xea	0.3	0.3	706.2	640.1	27.4	25.7	16.5	16.7	21.8	21.0
khm	16.2	16.5	1214.6	781.1	10.6	18.3	7.5	8.9	11.4	12.8
idn	1.3	1.2	717.8	603.0	20.8	24.7	16.0	17.8	20.7	22.9
mys	3.5	2.9	818.7	652.6	18.0	22.6	11.2	13.0	15.1	17.3
phl	0.4	0.4	1002.4	721.6	14.0	20.8	12.1	14.3	15.9	18.4
sgp	--	--	--	--	--	--	--	--	--	--
tha	2.1	2.7	786.7	679.5	15.5	19.8	6.4	8.9	10.7	13.7
vnm	0.0	0.0	689.4	657.4	27.8	29.4	18.6	19.8	24.0	25.6
xse	0.2	0.1	1206.6	789.9	10.0	24.2	17.8	22.9	21.9	26.6
bgd	0.0	0.0	711.8	671.2	27.1	29.3	22.6	24.2	27.4	29.6
ind	43.6	42.7	758.6	722.9	27.3	27.3	14.5	15.2	19.5	20.7
pak	945.1	923.3	1391.9	1359.4	26.3	17.9	3.0	1.0	9.0	6.2
lka	22.1	21.9	655.7	613.3	23.4	27.0	11.3	14.2	15.2	18.7
xsa	123.9	98.8	962.1	765.2	17.5	24.0	17.8	20.3	21.6	24.3
can	--	--	--	--	--	--	--	--	--	--
usa	285.3	280.1	782.7	767.4	25.7	28.6	6.0	11.1	11.2	17.0
mex	582.4	429.9	1485.0	1068.0	16.1	18.1	6.8	6.6	12.1	11.3
xna	--	--	--	--	--	--	--	--	--	--
bol	11.6	7.4	2516.1	929.4	0.9	13.2	3.0	2.6	8.4	6.0
col	17.9	15.1	745.7	612.6	18.7	23.1	13.9	15.4	17.4	19.4
ecu	5.7	5.5	740.5	615.0	15.6	20.0	17.2	17.2	21.4	22.0
per	363.3	303.8	889.4	735.4	16.1	17.4	9.6	8.9	14.5	13.7
ven	45.1	44.6	585.9	578.4	24.4	27.1	7.1	10.3	11.7	15.4
arg	126.6	80.0	1598.4	956.8	10.4	17.0	9.8	8.8	14.2	13.4
bra	23.1	21.1	1047.7	722.4	12.6	18.9	6.9	8.1	10.9	12.4
chl	621.0	586.6	889.0	839.5	18.1	20.7	4.3	5.8	9.8	12.7
pry	77.2	37.2	1798.8	898.7	7.9	17.8	6.6	5.1	10.2	8.5
ury	61.1	49.7	945.7	767.2	17.3	20.5	8.1	8.5	12.4	13.5
xsm	0.0	0.0	883.5	659.7	15.8	22.3	8.8	12.3	12.0	15.6
xca	14.2	10.6	795.2	627.7	23.0	26.3	22.5	22.2	27.6	27.4
xfa	63.0	54.7	681.6	582.8	17.4	20.9	4.3	6.1	7.9	10.6
xcb	0.0	5.4	789.0	732.6	22.0	25.3	8.1	11.4	13.6	17.8
aut	--	--	--	--	--	--	--	--	--	--
bel	60.4	31.8	1867.4	982.3	0.1	8.8	1.5	0.8	8.9	6.0
dnk	--	--	--	--	--	--	--	--	--	--
fin	--	--	--	--	--	--	--	--	--	--

Table S4. Continued.

	BWUI ($\text{m}^3 \text{t}^{-1}$)		TWUI ($\text{m}^3 \text{t}^{-1}$)		N _{in} I (kg N t^{-1})		N _w I (kg N t^{-1})		N _I (kg N t^{-1})	
	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification
fra	940.1	336.2	2801.7	1003.3	0.1	11.6	8.0	2.3	14.8	5.9
deu	62.8	29.6	1979.6	955.0	0.1	9.6	5.0	2.5	13.1	7.8
gbr	--	--	--	--	--	--	--	--	--	--
grc	466.0	430.2	849.0	783.4	17.5	20.1	1.7	4.1	7.0	10.5
irl	--	--	--	--	--	--	--	--	--	--
ita	175.6	155.4	763.4	676.4	22.0	23.2	6.5	7.8	11.7	13.0
lux	--	--	--	--	--	--	--	--	--	--
nld	--	--	--	--	--	--	--	--	--	--
prt	838.6	420.9	1694.2	845.2	4.9	12.3	6.0	2.9	12.3	7.4
esp	862.2	507.3	1486.7	875.2	9.4	13.3	1.6	0.9	7.0	5.1
swe	--	--	--	--	--	--	--	--	--	--
che	--	--	--	--	--	--	--	--	--	--
xef	--	--	--	--	--	--	--	--	--	--
xer	232.2	219.7	732.8	688.7	13.6	16.3	2.6	4.0	9.0	11.5
alb	285.2	260.7	712.9	651.6	14.1	19.8	1.3	3.9	5.5	9.9
bgr	174.0	176.5	726.6	721.8	24.7	22.7	8.3	7.3	16.0	16.0
hrv	--	--	--	--	--	--	--	--	--	--
cyp	--	--	--	--	--	--	--	--	--	--
cze	--	--	--	--	--	--	--	--	--	--
hun	66.7	69.2	731.8	733.8	18.5	17.6	5.0	5.0	14.1	14.2
mlt	--	--	--	--	--	--	--	--	--	--
pol	7.4	6.2	912.1	763.7	8.5	9.8	3.7	1.3	10.2	8.1
rom	264.6	226.9	994.0	842.6	8.4	10.7	1.2	1.2	8.6	8.6
svk	0.0	0.0	782.1	724.5	5.2	9.4	3.6	4.7	11.0	13.3
svn	270.6	107.4	2586.0	1082.3	0.1	12.6	27.6	9.9	34.4	14.1
est	--	--	--	--	--	--	--	--	--	--
lva	--	--	--	--	--	--	--	--	--	--
ltu	--	--	--	--	--	--	--	--	--	--
rus	501.2	355.2	1461.8	1016.6	6.0	9.1	4.3	2.0	12.8	8.7
xsu	1004.1	887.9	1359.3	1200.8	18.2	17.1	3.0	1.4	9.9	8.5
tur	933.1	612.9	1473.9	968.3	10.0	14.4	1.3	1.0	6.4	5.8
irn	1498.3	1249.0	1816.7	1514.2	17.1	14.9	2.4	0.8	9.0	7.2
xme	9550.5	9144.7	9925.8	9504.2	211.0	3.5	34.9	2.5	56.2	16.4
egy	916.9	907.7	940.5	931.1	28.9	22.5	0.9	0.4	10.4	8.7
mar	2611.0	1002.8	3348.7	1285.6	0.4	11.1	0.8	0.4	7.3	3.8
tun	--	--	--	--	--	--	--	--	--	--
xnf	0.0	363.1	2402.7	1817.6	19.9	17.3	10.6	8.5	38.7	30.9
bwa	1867.3	830.3	3609.5	1594.4	6.9	13.5	0.3	0.2	4.0	3.5
zaf	1602.6	1230.2	1989.0	1524.8	14.5	16.3	0.0	0.1	3.2	3.7
xsc	923.4	321.8	3472.5	1206.2	4.5	13.9	6.7	3.6	11.5	6.7
mwi	11.3	12.4	1260.5	746.9	12.3	19.4	3.9	4.9	7.0	8.7
mus	--	--	--	--	--	--	--	--	--	--
moz	17.1	8.6	2718.2	852.9	1.1	15.0	4.3	3.9	9.2	6.9
tza	217.7	112.5	2540.2	968.3	1.8	17.8	7.4	6.3	16.0	12.2
zmb	356.3	139.2	2544.3	965.6	1.6	14.4	3.3	3.3	9.2	7.4
zwe	410.5	175.7	2607.3	1110.0	7.1	17.3	6.3	4.6	10.4	8.5

Table S4. Continued.

	BWUI ($\text{m}^3 \text{t}^{-1}$)		TWUI ($\text{m}^3 \text{t}^{-1}$)		N _{in} I (kg N t^{-1})		N _w I (kg N t^{-1})		N _t I (kg N t^{-1})	
	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification
xsd	45.8	25.5	1176.1	654.3	2.2	12.4	3.5	4.7	9.5	9.3
mdg	180.7	81.8	1925.2	888.3	5.4	17.7	21.5	14.7	26.4	18.3
nga	2.2	16.5	1430.2	763.0	7.2	16.7	4.5	5.6	9.5	10.0
sen	773.7	455.5	2216.4	1290.5	10.7	16.4	6.0	5.9	10.1	9.4
uga	0.0	0.7	1186.6	643.2	3.9	12.2	2.5	2.1	8.2	6.9
xss	188.4	107.9	1696.5	897.7	6.4	17.2	11.0	10.7	16.1	14.8

Table S5. Resource use intensities and nitrogen loss intensities for wheat under the baseline and intensification scenarios. BWUI: blue water use intensity; TWUI: total water use intensity; $N_{in}I$: nitrogen input intensity; N_wI : water nitrogen loss intensity; N_tI : total nitrogen loss intensity; --: no information.

	BWUI ($m^3 t^{-1}$)		TWUI ($m^3 t^{-1}$)		$N_{in}I$ ($kg N t^{-1}$)		N_wI ($kg N t^{-1}$)		N_tI ($kg N t^{-1}$)	
	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification
aus	8.7	71.4	1633.9	972.3	30.6	41.1	3.2	3.7	15.0	15.6
nzl	0.0	3.1	764.6	554.0	40.4	40.8	21.8	17.3	28.1	23.5
xoc	0.0	1.8	3323.7	1080.5	0.1	32.5	56.1	21.3	67.5	26.3
chn	177.7	179.0	972.0	958.8	50.8	44.2	17.4	13.7	27.1	24.7
hkg	--	--	--	--	--	--	--	--	--	--
jpn	0.7	0.2	1023.4	738.7	47.9	47.3	41.8	30.9	49.6	38.5
kor	8.7	11.1	658.7	659.0	55.8	61.5	26.2	35.6	33.2	44.3
twn	--	--	--	--	--	--	--	--	--	--
xea	4.5	18.6	1396.4	974.6	14.0	22.8	7.5	3.9	18.0	11.7
khm	0.0	0.0	1353.7	1282.0	78.2	72.9	57.3	52.2	65.9	60.7
idn	--	--	--	--	--	--	--	--	--	--
mys	0.0	1.6	966.4	935.8	45.4	56.8	19.3	30.2	25.3	37.0
phl	--	--	--	--	--	--	--	--	--	--
sgp	--	--	--	--	--	--	--	--	--	--
tha	0.0	0.3	1190.0	1123.2	60.9	63.4	43.9	46.6	51.4	54.1
vnm	0.0	0.0	922.8	916.0	57.5	63.4	30.6	37.9	37.8	45.8
xse	6.3	4.0	2003.0	1119.1	11.2	35.0	45.7	35.1	55.0	41.3
bgd	0.0	0.0	1522.3	1499.8	61.8	67.4	56.9	65.4	67.2	75.9
ind	117.9	122.4	1770.3	1748.2	100.4	47.0	73.6	29.1	86.6	41.6
pak	1177.6	1163.9	2490.1	2448.6	192.1	31.6	81.1	7.0	96.9	22.2
lka	--	--	--	--	--	--	--	--	--	--
xsa	896.8	531.5	2655.5	1435.4	28.0	36.6	15.8	9.4	28.4	19.7
can	3.6	18.8	1085.1	877.7	19.8	26.2	1.6	1.7	11.6	11.3
usa	50.1	68.8	1406.4	1081.9	31.8	35.6	8.9	6.7	20.5	18.0
mex	685.9	571.0	1757.3	1475.2	54.6	29.1	27.0	7.8	38.6	16.7
xna	--	--	--	--	--	--	--	--	--	--
bol	0.0	18.5	3494.6	1118.4	2.4	26.3	10.2	4.5	21.6	9.4
col	0.0	0.0	1087.3	836.9	30.2	41.9	34.6	34.8	40.4	40.7
ecu	3.1	1.7	2502.9	1237.1	3.5	32.3	89.9	58.2	101.7	64.9
per	0.0	8.9	1203.1	767.8	19.2	28.3	13.0	10.2	19.4	15.9
ven	0.0	25.5	1534.2	1335.3	32.2	31.2	18.4	13.6	27.7	23.1
arg	1.3	5.3	1131.2	724.3	18.5	26.9	6.2	5.7	13.4	12.5
bra	0.2	1.0	1577.3	932.4	17.1	32.9	28.1	18.0	36.1	24.4
chl	330.7	197.8	1066.5	605.2	48.4	44.9	55.5	32.2	65.0	40.1
pry	0.0	0.4	2231.6	1075.1	14.8	32.4	41.0	16.2	48.7	21.0
ury	0.0	0.2	1042.1	905.8	28.4	38.7	15.3	19.5	22.9	29.0
xsm	--	--	--	--	--	--	--	--	--	--
xca	0.0	0.7	1888.0	1110.4	34.1	54.5	47.8	47.7	53.2	51.8
xfa	--	--	--	--	--	--	--	--	--	--
xcb	--	--	--	--	--	--	--	--	--	--
aut	0.1	4.3	845.2	630.1	39.8	39.0	19.8	12.1	27.9	21.5
bel	0.0	7.3	657.8	577.9	60.8	58.1	35.7	28.2	43.3	37.8
dnk	6.0	8.9	843.2	527.3	41.1	36.7	21.6	8.4	31.1	17.7
fin	0.0	2.9	792.9	651.6	41.4	39.1	27.4	20.5	42.8	34.9

Table S5. Continued.

	BWUI ($\text{m}^3 \text{t}^{-1}$)		TWUI ($\text{m}^3 \text{t}^{-1}$)		N _{inI} (kg N t^{-1})		N _{wI} (kg N t^{-1})		N _I (kg N t^{-1})	
	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification
fra	1.8	13.2	1180.5	644.0	34.2	36.1	15.4	9.9	23.1	16.6
deu	0.1	6.0	802.1	598.2	40.1	39.5	17.6	10.3	25.8	19.3
gbr	0.1	3.6	896.7	535.4	36.6	34.7	17.9	9.0	25.9	16.5
grc	13.3	19.9	992.9	580.6	31.8	32.5	13.8	6.7	21.5	13.5
irl	0.0	2.4	1086.4	565.5	47.6	40.9	32.0	15.2	39.7	21.0
ita	17.3	31.2	1080.3	652.3	39.1	42.8	17.2	11.8	26.4	21.8
lux	0.0	22.1	1218.1	652.1	54.3	42.3	27.8	11.4	34.5	18.4
nld	0.0	4.9	750.7	572.7	50.7	44.2	28.6	16.1	39.0	26.0
prt	115.9	117.7	1405.9	873.5	45.3	57.9	15.1	16.7	29.8	31.7
esp	19.8	29.4	820.9	574.2	30.7	33.6	6.3	4.0	13.6	11.8
swe	0.0	5.1	727.1	511.9	60.5	49.8	41.9	21.4	52.1	32.6
che	0.0	0.1	2090.7	878.7	88.0	48.1	116.2	51.1	124.4	56.4
xef	0.0	5.2	1056.3	545.1	94.2	53.2	107.3	41.7	123.6	54.3
xer	0.0	12.5	1535.8	788.6	24.7	31.0	11.1	6.5	21.5	14.5
alb	13.8	12.6	1114.4	558.4	40.0	36.7	31.9	15.2	38.1	20.6
bgr	3.3	15.3	1162.1	704.3	27.8	30.5	10.2	5.0	20.8	13.8
hrv	0.2	11.4	1545.9	846.4	37.5	40.6	20.8	16.8	28.6	23.5
cyp	1748.8	565.7	3321.4	1071.9	0.1	24.9	1.7	0.4	17.7	7.4
cze	0.0	2.9	862.5	596.8	37.0	35.9	16.4	7.4	24.6	16.0
hun	1.2	12.2	975.8	710.5	26.9	30.7	6.7	3.9	17.1	13.9
mlt	--	--	--	--	--	--	--	--	--	--
pol	0.2	6.6	988.4	614.3	33.1	34.5	16.5	8.0	27.0	17.2
rom	22.6	28.0	1602.4	836.6	18.2	25.9	7.0	3.6	18.4	11.7
svk	2.2	8.7	1203.8	663.7	31.8	32.2	18.3	6.8	28.1	14.6
svn	0.5	5.9	1364.3	841.1	50.1	48.7	38.3	28.3	45.8	35.6
est	0.0	4.1	1412.1	591.1	31.1	30.4	19.4	5.0	30.5	12.3
lva	0.0	6.3	2216.3	728.6	7.1	27.5	8.1	5.2	22.4	12.4
ltu	0.0	4.2	1863.3	691.0	15.3	27.3	10.3	4.1	22.3	11.1
rus	9.9	21.8	1523.0	962.7	10.4	25.0	3.4	3.7	16.4	14.7
xsu	99.4	85.5	1710.5	1045.8	15.3	24.9	3.3	2.2	17.9	14.1
tur	92.5	85.0	1514.7	867.8	39.1	40.7	14.4	8.3	26.2	19.0
irn	810.2	577.6	2239.3	1474.3	46.2	39.7	9.6	3.8	24.3	16.3
xme	1166.5	785.4	2271.5	1496.9	75.9	33.6	24.5	4.3	38.7	15.1
egy	964.2	935.7	1018.3	988.1	66.7	41.2	12.9	0.5	23.4	10.8
mar	181.0	144.2	1573.0	855.6	25.6	37.7	4.2	3.7	19.9	16.2
tun	72.7	90.9	1540.2	979.4	38.5	44.3	7.6	6.9	21.8	20.3
xnf	124.2	138.1	2437.1	1104.2	27.1	40.5	5.9	3.1	23.2	16.9
bwa	535.1	287.0	2713.9	1273.0	16.9	33.3	1.5	3.8	9.5	10.0
zaf	193.2	174.6	1366.4	904.2	31.1	37.0	7.0	6.0	17.1	16.7
xsc	49.9	45.9	1681.6	796.7	18.0	27.7	4.8	3.0	11.6	9.0
mwi	0.0	16.1	3938.1	1279.0	19.3	43.9	13.9	13.7	22.8	21.1
mus	--	--	--	--	--	--	--	--	--	--
moz	0.0	1.6	2852.3	1177.8	3.1	32.4	68.7	40.0	85.2	47.8
tza	0.0	8.0	2362.5	962.6	2.4	25.6	8.9	6.5	20.7	12.7
zmb	81.5	34.1	3002.7	1118.6	5.0	32.1	56.0	29.9	73.0	37.6
zwe	--	--	--	--	--	--	--	--	--	--

Table S5. Continued.

	BWUI ($\text{m}^3 \text{t}^{-1}$)		TWUI ($\text{m}^3 \text{t}^{-1}$)		N _{in} I (kg N t^{-1})		N _w I (kg N t^{-1})		N _t I (kg N t^{-1})	
	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification	baseline	intensification
xsd	7.2	4.6	2966.6	1073.5	0.3	28.1	18.2	13.0	30.7	18.8
mdg	0.0	6.6	3907.3	1311.0	3.7	43.4	148.1	68.3	167.4	75.5
nga	68.2	30.7	3997.5	1590.8	4.5	27.7	7.6	9.3	16.2	13.5
sen	0.0	13.2	2758.3	1783.4	2.2	14.4	2.3	2.0	14.0	9.5
uga	0.0	4.8	3062.1	1112.7	0.9	23.3	6.6	3.5	17.3	8.8
xss	74.2	61.1	1477.3	916.4	23.5	37.3	8.0	11.4	15.4	18.3