water

Supplementary Materials

A. Precipitation during the planting year 2016 to 2018

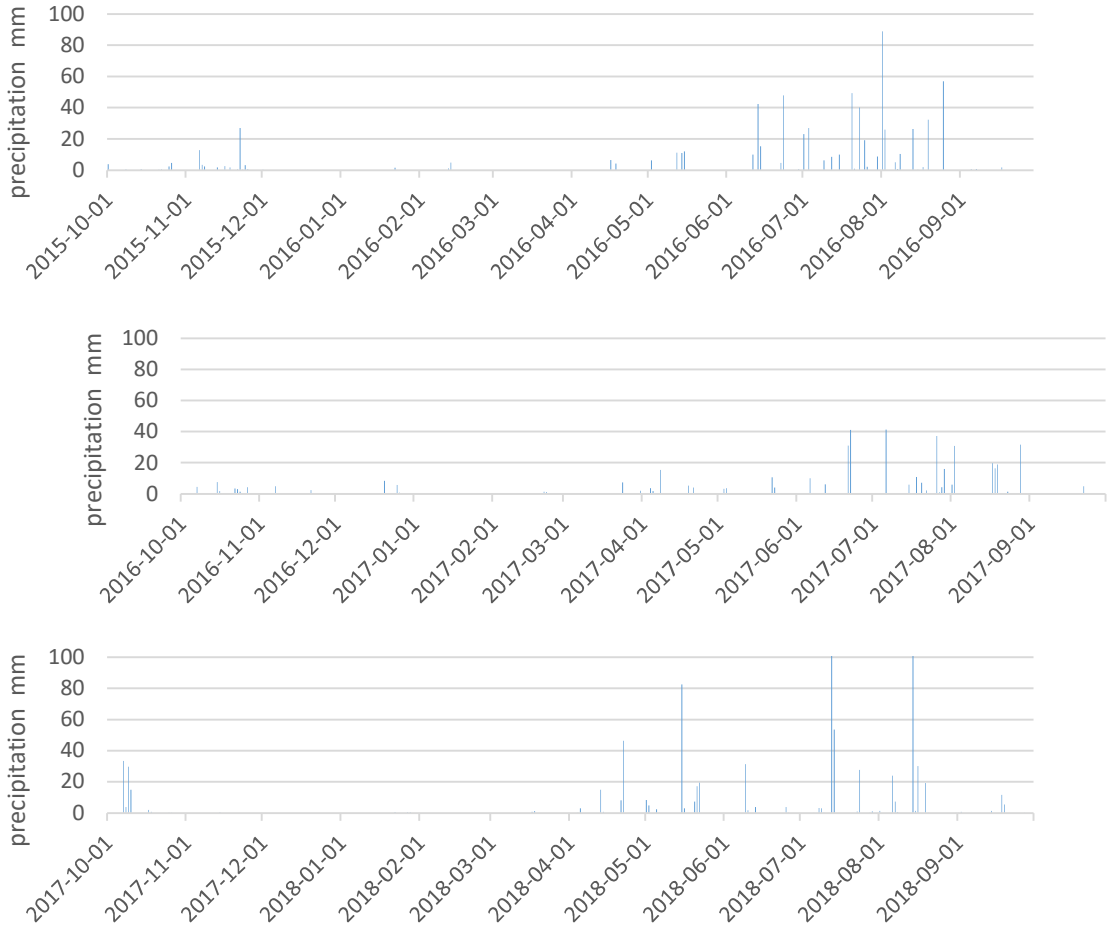

Figure A1. Precipitation during the planting year 2016 to 2018.

Note: The planting year 2016, which annual rainfall amount was 692 mm, belongs an average rainfall year according to the North China Plain climate. The planting year 2017, which annual rainfall amount was 459 mm, belongs to a drought year with little rain. The planting year 2018, which annual rainfall amount was 813mm with several heavy rainfall events (115.4mm on July 13 and 158.9mm on August 14, which could not be displayed due to the limitation of the vertical axis, so it is marked), belongs to a rainy year.

B. The specific calculation methods of the crop water consumption in different kinds of cropping systems

The crops' water consumption numerically equals each crop's water requirement, which also consistent with the evapotranspiration of the crop in the field, and it was influenced by climate. Here we use CROPWAT 8.0 to calculate single crop's evapotranspiration. Then we added the crop's evapotranspiration together as for the system's crop water consumption.

In CROPWAT 8.0, we need crop information as showed in below table B1.

Table B1. The length of crop development stages and crop coefficients.

Crop	Planting year	Sowing date	Initial stage (days)	Rapid Development stage (days)	Mid stage (days)	Late stage (days)	K_c ini	K_c mid	K_c end
Winter wheat	2016	10/15	30	137	42	30	0.58	1.17	0.25
	2017	10/12	30	137	39	29	0.52	1.17	0.25
	2018	10/13	30	139	39	29	0.55	1.15	0.25
Summer maize	2016	6/20	17	31	35	25	029	1.20	0.35
	2017	6/9	18	31	37	26	0.3	1.18	0.35
	2018	6/12	17	31	37	26	0.25	1.18	0.35
Spring maize Ⅰ	2016	4/9	23	37	44	30	0.34	1.2	0.35
Spring maize Ⅱ	2016	4/15	21	36	42	29	0.34	1.2	0.35
	2017	4/4	22	36	43	30	0.35	1.2	0.35
	2018	4/7	21	36	42	29	0.3	1.19	0.35
Spring maize Ⅲ	2016	5/17	20	35	40	29	0.28	1.18	0.35
	2017	5/19	19	34	39	28	0.25	1.19	0.35
	2018	5/24	18	32	37	26	0.25	1.18	0.35
Rye	2016	9/24	29	128	48	16	0.4	1.05	0.99
	2017	10/1	30	130	49	18	0.52	1.04	1
	2018	9/30	30	126	30	10	0.5	1.07	1.02
Spinach	2016	9/24	40	100	35	16	0.44	1	0.91
	2017	10/1	40	98	30	14	0.53	1	0.9
	2018	9/30	40	99	30	15	0.5	1.01	0.96
Vetch	2016	9/24	38	98	45	10	0.44	1.15	0.91
	2017	10/1	40	102	53	13	0.53	1.15	0.9
	2018	9/30	40	102	53	13	0.5	1.16	0.91
Potato	2016	3/15	19	24	40	24	0.1	1.15	0.76
	2017	2/28	20	25	40	25	0.1	1.15	0.75
	2018	3/6	20	25	40	25	0.1	1.15	0.75
Pea	2016	3/15	14	24	32	15	0.37	1.15	0.3
	2017	2/28	15	25	34	16	0.4	1.15	0.3
	2018	3/7	15	25	35	17	0.4	1.16	0.3
Soybean	2016	5/17	22	27	50	25	0.3	1.13	0.48
	2017	5/19	21	26	48	25	0.25	1.14	0.48
	2018	5/24	20	25	45	23	0.25	1.13	0.48

Note: Spring maize Ⅰ represents the maize planted in vetch–spring maize plots in the 2016 planting year, the sowing date was April 9. Its sowing date in the 2017 and 2018 planting years was the same as spring maize Ⅲ. Spring maize Ⅱ is the maize of the potato/spring maize cropping system, the sowing date was usually earlier than the other spring maize. Spring maize Ⅲ represents the maize in other cropping systems, they had the same sowing date in the middle of May. Kc ini、Kc mid were calibrated by the wind speed, the humidity and the plant height of actual field situation. The calibration method and the process are shown in FAO 56. The vetch's growth stage length and the crop coefficient were not showed in FAO 56, we used bean's information as the substitution. Potatoes were planted with plastic mulching. Kc ini=0.1, according to FAO 56, and Kc mid and Kc end were reduced by 10–30%, here we used 15%.

There are four kinds of cropping systems: mono-cropping, rotation cropping, relay cropping and intercropping system in this study.They have different crop characteristics. It is necessary to calculate the system's crop water consumption respectively. The water consumption of the mono-cropping system was the water requirement of the spring maize. The water consumption of the rotation cropping system (including winter wheat-summer maize system) was the sum of the water requirement of the preceding crop and the successive crop. In terms of the relay cropping

system and the intercropping system, the evapotranspiration of the preceding crops was adjusted according to the planting density (as compared with the mono-culturing density), and then added the evapotranspiration of the spring maize (all cropping systems in this study had the same maize density and were consistent with local farmers), so as to acquire the system's crop water demand. The reason why we have to do this adjustment was because in relay cropping and inter-cropping systems, crops (like potatoes, peas and soybeans) do not reach the requirement of "large-area" which FAO 56 asked for due to the space left for the following maize. Thus, the evapotranspiration of these crops was adjusted according to the difference of actual density in relay cropping system (or inter-cropping system) and the density in mono-culture, so as to calculate the corresponding crop evapotranspiration. The planting density of mono-cropping potato was calculated according to row spacing of 60 cm and plant spacing of 30 cm, which was the twice of the planting density in this study. The planting density of mono-cropping pea was calculated according to the row spacing of 30 cm and the plant spacing of 8 cm, which was twice of that in this study. The planting density of mono-cropping soybeans was 200,000-240,000 plants/ ha, which about twice of this study.

At the same time, in our field experiment, soybean growing was seriously affected by the shade of maize, the evapotranspiration of the soybean was lower than that of the non-shade soybean, and it was estimated that the evapotranspiration was reduced by 50% according to the plant height, the leaf extension and the pod setting. So, in conclusion, the adjustment coefficient of potato and pea was 0.5, soybean was 0.25.

For the amount of green water and the blue water of different kinds of cropping systems: the mono-cropping system was as same as the spring maize's; the rotation cropping system's was calculated by adding the preceding crop's and the successive crop's, respectively. For the relay cropping and intercropping system, the evapotranspiration of the system should be calculated first by the method mentioned in last paragraph, then compared the system's evapotranspiration with the effective rainfall of the corresponding ten-day period, then the green water amount of the ten-day was obtained. The sum of the green water of each ten-day period was the total amount of the green water. Finally, the amount of the blue water was the difference of the evapotranspiration of the system and the green water of the system. The detailed calculation process is shown in below tables (from B2 to B4). The unit of this part need to be transformed to m^3/ha.

Table B2. The calculation of the water requirement of the Potato/Maize system.

Date	The order of ten-day	Mono-potato ET_c mm/dec	Relay-potato ET_c mm/dec	Maize ET_c mm/dec	Effective rainfall mm/dec	System ET_c mm/dec	Green water mm/dec	Blue water mm/dec
2016/3	1	1.5	0.75		0	0.75	0	0.75
2016/3	2	3.9	1.95		0	1.95	0	1.95
2016/4	3	10.4	5.2		0	5.2	0	5.2
2016/4	4	22.4	11.2	6.4	10	17.6	10	7.6
2016/4	5	48.9	24.45	14.6	0	39.05	0	39.05
2016/5	6	49.3	24.65	15.2	6	39.85	6	33.85
2016/5	7	54.2	27.1	28	28.4	55.1	28.4	26.7
2016/5	8	60.2	30.1	44.8	0	74.9	0	74.9
2016/6	9	53.2	26.6	53	0	79.6	0	79.6
2016/6	10	51.6	25.8	63.9	45.6	89.7	45.6	44.1
2016/6	11	43.8	21.9	70.3	39.5	92.2	39.5	52.7
2016/7	12			38	41	38	38	0
2016/7	13			41.7	45.8	41.7	41.7	0
2016/7	14			50.2	46.7	50.2	46.7	3.5
2016/8	15			22.8	54.7	22.8	22.8	0
2016/8	16			12.5	43.1	12.5	12.5	0
2016 planting year						661.1	291.20	369.90
2017/2	1	0.2	0.1		0.3	0.1	0.1	0.00
2017/3	2	2.4	1.2		0	1.2	0	1.20
2017/3	3	2.6	1.3		0	1.3	0	1.30
2017/3	4	10.2	5.1		9.2	5.1	5.1	0.00
2017/4	5	21.8	10.9	4.9	18.8	15.8	15.8	0.00
2017/4	6	41.6	20.8	12.1	5.8	32.9	5.8	27.10
2017/4	7	57.7	28.85	19	4	47.85	4	43.85
2017/5	8	57.4	28.7	29.7	6.7	58.4	6.7	51.70
2017/5	9	72.9	36.45	53.3	0	89.75	0	89.75
2017/5	10	72.3	36.15	73.1	13.6	109.25	13.6	95.65
2017/6	11	52.1	26.05	67.5	9.5	93.55	9.5	84.05
2017/6	12	30.3	15.15	67	6	82.15	6	76.15
2017/6	13			55.9	47.2	55.9	47.2	8.70
2017/7	14			58.8	33.3	58.8	33.3	25.50
2017/7	15			59.5	21.2	59.5	21.2	38.30
2017/7	16			19.6	43.2	19.6	19.6	0.00
2017/8	17			22.7	30.4	22.7	22.7	0.00
2017/8	18			2.9	40.5	2.9	2.9	0.00
2017 planting year						756.75	213.50	543.25
2018/3	1	1	0.5		0	0.5	0	0.50
2018/3	2	2.5	1.25		1.9	1.25	1.25	0
2018/3	3	6.8	3.4		0	3.4	0	3.4
2018/4	4	23.5	11.75	5.3	3	17.05	3	14.05
2018/4	5	45.8	22.9	12.7	14.3	35.6	14.3	21.3
2018/4	6	44.4	22.2	11.8	40.1	34	34	0
2018/5	7	50.9	25.45	22.8	14.5	48.25	14.5	33.75
2018/5	8	37	18.5	24.1	50.9	42.6	42.6	0
2018/5	9	65.4	32.7	59.9	30.2	92.6	30.2	62.4
2018/6	10	63.1	31.55	73.2	27.8	104.75	27.8	76.95
2018/6	11	43.8	21.9	60.1	3.7	82	3.7	78.3
2018/6	12	15.8	7.9	76.6	3.7	84.5	3.7	80.8
2018/7	13			53.2	6.2	53.2	6.2	47
2018/7	14			49	58.6	49	49	0
2018/7	15			52.6	25.4	52.6	25.4	27.2
2018/8	16			24.6	27.8	24.6	24.6	0
2018/8	17			5.9	62.6	5.9	5.9	0
2018 planting year						731.8	286.15	445.65

Table B3. The calculation of the water requirement of the Pea/Maize system.

Date	The order of ten-day	Mono-pea ET_c mm/dec	Relay-pea ET_c mm/dec	Maize ET_c mm/dec	Effective rainfall mm/dec	System ET_c mm/dec	Green water mm/dec	Blue water mm/dec
2016/3	1	5.6	2.8		0	2.8	0	2.8
2016/3	2	15.2	7.6		0	7.6	0	7.6
2016/4	3	26.1	13.05		0	13.05	0	13.05
2016/4	4	31.3	15.65		10	15.65	10	5.65
2016/4	5	51.7	25.85		0	25.85	0	25.85
2016/5	6	49.1	24.55		6	24.55	6	18.55
2016/5	7	54.1	27.05	6	28.4	33.05	28.4	4.65
2016/5	8	49.1	24.55	13.9	0	38.45	0	38.45
2016/6	9	13.7	6.85	15	0	21.85	0	21.85
2016/6	10			28.7	45.6	28.7	28.7	0
2016/6	11			47.2	39.5	47.2	39.5	7.7
2016/7	12			34.1	41	34.1	34.1	0
2016/7	13			41	45.8	41	41	0
2016/7	14			55.9	46.7	55.9	46.7	9.2
2016/8	15			34.8	54.7	34.8	34.8	0
2016/8	16			30.7	43.1	30.7	30.7	0
2016/8	17			46.4	41.3	46.4	41.3	5.1
2016/9	18			25.5	1.3	25.5	1.3	24.2
2016/9	19			8.6	1.3	8.6	1.3	7.3
	2016 planting year					535.75	343.80	191.95
2017/2	1	0.9	0.45		0.3	0.45	0.3	0.15
2017/3	2	9.8	4.9		0	4.9	0	4.9
2017/3	3	11.6	5.8		0	5.8	0	5.8
2017/3	4	18.8	9.4		9.2	9.4	9.2	0.2
2017/4	5	28	14		18.8	14	14	0
2017/4	6	41.9	20.95		5.8	20.95	5.8	15.15
2017/4	7	57.5	28.75		4	28.75	4	24.75
2017/5	8	57.2	28.6		6.7	28.6	6.7	21.9
2017/5	9	60.2	30.1	3.3	0	33.4	0	33.4
2017/5	10	21.2	10.6	15.7	13.6	26.3	13.6	12.7
2017/6	11			15	9.5	15	9.5	5.5
2017/6	12			28.7	6	28.7	6	22.7
2017/6	13			37.7	47.2	37.7	37.7	0
2017/7	14			52.8	33.3	52.8	33.3	19.5
2017/7	15			62.3	21.2	62.3	21.2	41.1
2017/7	16			27.7	43.2	27.7	27.7	0
2017/8	17			54	30.4	54	30.4	23.6
2017/8	18			40.2	40.5	40.2	40.2	0
2017/8	19			28.9	27.8	28.9	27.8	1.1
2017/9	20			19.2	0	19.2	0	19.2
2017/9	21			7.5	0	7.5	0	7.5
	2017 planting year					546.55	287.40	259.15
2018/3	1	3.4	1.7		0	1.7	0	1.70
2018/3	2	10.1	5.05		1.9	5.05	1.9	3.15
2018/3	3	21.3	10.65		0	10.65	0	10.65
2018/4	4	34.8	17.4		3	17.4	3	14.4
2018/4	5	50.6	25.3		14.3	25.3	14.3	11
2018/4	6	44.6	22.3		40.1	22.3	22.3	0
2018/5	7	51.2	25.6		14.5	25.6	14.5	11.1
2018/5	8	37.2	18.6		50.9	18.6	18.6	0
2018/5	9	46.7	23.35	10.9	30.2	34.25	30.2	4.05
2018/6	10	17.5	8.75	14.4	27.8	23.15	23.15	0
2018/6	11			20	3.7	20	3.7	16.3
2018/6	12			44.7	3.7	44.7	3.7	41
2018/7	13			43.3	6.2	43.3	6.2	37.1
2018/7	14			52.2	58.6	52.2	52.2	0
2018/7	15			73.2	25.4	73.2	25.4	47.8
2018/8	16			52.3	27.8	52.3	27.8	24.5
2018/8	17			46.7	62.6	46.7	46.7	0
2018/8	18			42.8	0.2	42.8	0.2	42.6
2018/9	19			25.9	0.7	25.9	0.7	25.2
2018/9	20			4.2	5	4.2	4.2	0
	2018 planting year					589.3	298.75	290.55

Table B4. The calculation of the water requirement of the Soybean||Maize system.

Date	The order of ten-day	Mono-soybean ET_c mm/dec	Relay-soybean ET_c mm/dec	Maize ET_c mm/dec	Effective rainfall mm/dec	System ET_c mm/dec	Green water mm/dec	Blue water mm/dec
2016/5	1	6.4	1.6	6	28.4	7.6	7.6	0
2016/5	2	14.9	3.725	13.9	0	17.625	0	17.625
2016/6	3	14.8	3.7	15	0	18.7	0	18.7
2016/6	4	28.9	7.225	28.7	45.6	35.925	35.925	0
2016/6	5	50	12.5	47.2	39.5	59.7	39.5	20.2
2016/7	6	34.8	8.7	34.1	41	42.8	41	1.8
2016/7	7	38.5	9.625	41	45.8	50.625	45.8	4.825
2016/7	8	52.6	13.15	55.9	46.7	69.05	46.7	22.35
2016/8	9	32.7	8.175	34.8	54.7	42.975	42.975	0
2016/8	10	29	7.25	30.7	43.1	37.95	37.95	0
2016/8	11	49	12.25	46.4	41.3	58.65	41.3	17.35
2016/9	12	30	7.5	25.5	1.3	33	1.3	31.7
2016/9	13	12	3	8.6	1.3	11.6	1.3	10.3
	2016 planting year					486.2	341.35	144.85
2017/5	1	3.3	0.825	3.3	0	4.125	0	4.125
2017/5	2	15.7	3.925	15.7	13.6	19.625	13.6	6.025
2017/6	3	13.8	3.45	15	9.5	18.45	9.5	8.95
2017/6	4	28.2	7.05	28.7	6	35.75	6	29.75
2017/6	5	40.2	10.05	37.7	47.2	47.75	47.2	0.55
2017/7	6	53.8	13.45	52.8	33.3	66.25	33.3	32.95
2017/7	7	58.5	14.625	62.3	21.2	76.925	21.2	55.725
2017/7	8	26.1	6.525	27.7	43.2	34.225	34.225	0
2017/8	9	50.7	12.675	54	30.4	66.675	30.4	36.275
2017/8	10	38	9.5	40.2	40.5	49.7	40.5	9.2
2017/8	11	30.5	7.625	28.9	27.8	36.525	27.8	8.725
2017/9	12	23	5.75	19.2	0	24.95	0	24.95
2017/9	13	10.7	2.675	7.5	0	10.175	0	10.175
	2017 planting year					491.125	263.73	227.40
2018/5	1	10.9	2.725	10.9	30.2	13.625	13.625	0
2018/6	2	14.4	3.6	14.4	27.8	18	18	0
2018/6	3	18.1	4.525	20	3.7	24.525	3.7	20.825
2018/6	4	45.7	11.425	44.7	3.7	56.125	3.7	52.425
2018/7	5	45.6	11.4	43.3	6.2	54.7	6.2	48.5
2018/7	6	49.1	12.275	52.2	58.6	64.475	58.6	5.875
2018/7	7	68.8	17.2	73.2	25.4	90.4	25.4	65
2018/8	8	49.1	12.275	52.3	27.8	64.575	27.8	36.775
2018/8	9	44.2	11.05	46.7	62.6	57.75	57.75	0
2018/8	10	45.5	11.375	42.8	0.2	54.175	0.2	53.975
2018/9	11	31.9	7.975	25.9	0.7	33.875	0.7	33.175
2018/9	12	6.2	1.55	4.2	5	5.75	5	0.75
	2018 planting year					537.975	220.68	317.30

C. Agricultural materials water consumption

The water consumption of the input materials was converted by using relevant parameters in the life cycle assessment database. All the raw data of agricultural materials input obtained from the experimental records as shown in Table C1. The water consumption parameters of the inputs and its resources are shown in Table C2.

Table C1. The input of agricultural capital goods in different cropping systems.

Systems	Nitrogen $CO(NH_2)_2$ kg/ha	Potassium K_2SO_4 kg/ha	Phosphate $(NH_4)_2 \cdot HPO_4$ kg/ha	Phosphate $Ca(H_2PO_4)_2$ kg/ha	Herbicide kg/ha	Chemicals Pesticide kg/ha	Bactericide kg/ha	Electricity kW • h/ha	Diesel kg/ha	Plastic mulching kg/ha	Seeds Crops kg/ha	Seeds Maize kg/ha
Winter wheat-summer maize	973	630	408	-	1.00	0.12	0.6	2777	242	-	300	27
Mono-spring maize	583	180	163	-	0.50	0.06	0.3	717	156	-	-	27
Rye-spring maize	583	180	313	-	0.50	0.06	0.3	2133	242	-	112.5	27
Spinach-spring maize	869	300	261	-	0.50	0.06	0.3	1867	207	-	75	27
Vetch-spring maize	583	180	163	151	0.50	0.06	0.3	2283	264	-	60	27
Potato/spring maize	583	800	163	-	0.00	3.06	0.9	2500	143	119	1775	27
Pea/spring maize	583	180	163	-	0.00	0.36	0.3	2050	143	-	60	27
Soybean‖spring maize	583	180	163	-	0.00	0.09	0.3	717	156	-	20	27

Table C2. The water consumption parameters of the agricultural means of production.

Items		Database	Unit	Parameters
Nitrogen	$CO(NH_2)_2$	CLCD-China-ECER 0.8.1	kg/kg	192.01
Potassium	K_2SO_4	CLCD-China-ECER 0.8.1	kg/kg	51.83
Phosphate	$(NH_4)_2 \cdot HPO_4$	CLCD-China-ECER 0.8.1	kg/kg	143.52
Phosphate	$Ca(H_2PO_4)_2$	CLCD-China-ECER 0.8.1	kg/kg	71.59
Chemicals	Herbicide	Ecoinvent 2.2	kg/kg	23000
	Pesticide	Ecoinvent 2.2	kg/kg	220000
	Bactericide	Ecoinvent 2.2	kg/kg	160000
Electricity	Power (the North China Plain)	CLCD-China-ECER 0.8.1	kg/kW • h	3.57
Diesel	Diesel	CLCD-China-ECER 0.8.1	kg/kg	6.11
Plastic Mulching	Plastic film	Ecoinvent 3.1.0	kg/kg	0.0026
Seeds	Wheat	Ecoinvent 3.1.0	kg/kg	0.36
	Rye	Ecoinvent 3.1.0	kg/kg	0.184
	Spinach	Ecoinvent 3.1.0	kg/kg	0.0087
	Potato	Ecoinvent 3.1.0	kg/kg	0.114
	Pea	Ecoinvent 3.1.0	kg/kg	0.085
	Soybean	Ecoinvent 3.1.0	kg/kg	0.062
	Maize	Ecoinvent 3.1.0	kg/kg	0.0059

Note: Vetch seed parameter was not in the database. According to the calculation results of other crop seeds, the water consumption of the seed production only account for less than 1% of the total agricultural material water footprint, the error of missing data can be ignored.

D. Grey water

The critical dilution volume method is usually used to calculate the grey water demand：

$$GW = \frac{L_p}{C_{max} - C_{nat}} \quad (1)$$

$$L_p = F_N \cdot \left(l_\alpha + l_\beta\right) \quad (2)$$

where GW (m^3/ha) is the grey water demand, L_p (kg) is the amount of pollutants that go into the natural water body caused by each hectare of cultivated land, C_{max} (kg/m^3) is the concentration of the maximum pollutant that the water body can afford and C_{max}(Nitrogen) =3.1 mg/L; C_{nat} (kg/m^3) is the natural concentration of the pollutant in water, C_{nat}(Nitrogen)=1.5mg/L. F_N (kg/ha) is the annual nitrogen requirement of the cropping system, l_α is the total nitrogen coefficient of the fertilizer lost in the form of underground leaching, l_β is the total nitrogen coefficient of the fertilizer lost in the form of surface runoff, see Table D1.

Table D1. Total nitrogen loss rates of different cropping systems.

Systems	Annual nitrogen requirement	l_α (%)	l_β (%)
Winter wheat-summer maize	525	1.393	0.95
Mono-spring maize	300	0.767	0.563
Rye-spring maize	327	1.534	0.95
Spinach-spring maize	450	1.534	0.95
Vetch-spring maize	300	1.534	0.95
Potato/spring maize	330	1.534	0.95
Pea/spring maize	330	1.534	0.95
Soybean‖spring maize	300	1.534	0.95

Note: The annual nitrogen requirement refers to the nitrogen element amount, which is differ from nitrogen fertilizer amount. But it can be converted from nitrogen fertilizer. l_α and l_β were cited from the China first national pollution source survey.

E. Results showed in table form.

Results were showed in below table (From E1 to E4) in order to display the result in number form.

Table E1. The total water consumption and its composition of multiple cropping systems.

Systems	Crop water demand	Fallow period soil evaporation	Agricultural materials water consumption	Grey water	Total
	m^3/ha	m^3/ha	m^3/ha	m^3/ha	m^3/ha
		2016 planting year			
Winter wheat-summer maize	8150	98	435	7688	16371
Mono-spring maize	3878	1182	221	2494	7775
Rye-spring maize	7451	103	248	5077	12879
Spinach-spring maize	6135	265	301	6986	13686
Vetch-spring maize	7311	208	238	4658	12415
Potato/spring maize	6611	1149	1004	5123	13887
Pea/spring maize	5354	1002	280	5123	11759
Soybean||spring maize	4862	1182	216	2494	8754
		2017 planting year			
Winter wheat-summer maize	8056	94	435	7688	16273
Mono-spring maize	3929	1179	221	2494	7823
Rye-spring maize	7883	94	248	5077	13302
Spinach-spring maize	5902	339	301	6986	13527
Vetch-spring maize	7034	194	238	4658	12124
Potato/spring maize	7570	915	1004	5123	14612
Pea/spring maize	5465	766	280	5123	11634
Soybean||spring maize	4910	1179	216	2494	8799
		2018 planting year			
Winter wheat-summer maize	8901	87	435	7688	17111
Mono-spring maize	4306	1285	221	2494	8306
Rye-spring maize	7269	310	248	5077	12903
Spinach-spring maize	6647	376	301	6986	14309
Vetch-spring maize	7933	240	238	4658	13069
Potato/spring maize	7318	1072	1004	5123	14517
Pea/spring maize	5893	923	280	5123	12219
Soybean||spring maize	5380	1285	216	2494	9375
		3-year average			
Winter wheat-summer maize	8369	93	435	7688	16585
Mono-spring maize	4038	1215	221	2494	7968
Rye-spring maize	7534	169	248	5077	13028
Spinach-spring maize	6228	326	301	6986	13841
Vetch-spring maize	7426	214	238	4658	12536
Potato/spring maize	7166	1045	1004	5123	14339
Pea/spring maize	5571	897	280	5123	11871
Soybean||spring maize	5051	1215	216	2494	8976

Table E2. The infield water consumption and its composition of multiple cropping systems.

Systems	Green water mm	Blue water mm	Fallow period soil evaporation mm	Total mm
2016 planting year				
Winter wheat-summer maize	268.4	546.6	9.8	824.8
Mono-spring maize	306.0	81.8	118.2	506.0
Rye-spring maize	343.7	401.4	10.3	755.4
Spinach-spring maize	333.6	279.9	26.5	640.0
Vetch-spring maize	318.7	412.4	20.8	751.9
Potato/spring maize	291.2	369.9	114.9	776.0
Potato/spring maize (Modified)	369.6	217.9	100.2	687.7
Pea/spring maize	343.5	192.0	100.2	635.6
Soybean||spring maize	341.4	144.9	118.2	604.4
2017 planting year				
Winter wheat-summer maize	296.1	509.5	9.4	815.0
Mono-spring maize	247.3	145.6	117.9	510.8
Rye-spring maize	326.4	461.9	9.4	797.7
Spinach-spring maize	295.6	294.6	33.9	624.1
Vetch-spring maize	321.8	381.6	19.4	722.8
Potato/spring maize	213.7	543.3	91.5	848.5
Pea/spring maize	287.3	259.2	76.6	623.1
Soybean||spring maize	263.6	227.4	117.9	609.0
2018 planting year				
Winter wheat-summer maize	319.8	570.3	8.7	898.8
Mono-spring maize	196.2	234.4	128.5	559.1
Rye-spring maize	221.2	505.7	31.0	757.9
Spinach-spring maize	211.1	453.6	37.6	702.3
Vetch-spring maize	241.4	551.9	24.0	817.3
Potato/spring maize	286.1	445.7	107.2	838.9
Pea/spring maize	298.7	290.6	92.3	681.6
Soybean||spring maize	220.7	317.3	128.5	666.5
3-year average				
Winter wheat-summer maize	294.8	542.1	9.3	846.2
Mono-spring maize	249.8	153.9	121.5	525.3
Rye-spring maize	297.1	456.3	16.9	770.3
Spinach-spring maize	280.1	342.7	32.6	655.4
Vetch-spring maize	294.0	448.6	21.4	764.0
Potato/spring maize	263.6	453.0	104.5	821.1
Pea/spring maize	309.8	247.3	89.7	646.7
Soybean||spring maize	275.2	229.9	121.5	626.6
Winter wheat-summer maize	294.8	542.1	9.3	846.2

Table E3. The crop's water requirement and its composition.

Crops	ETc mm	From Rainfall mm	From Irrigation mm
	2016 planting year		
Winter wheat	502.7	71.1	431.6
Summer maize	312.3	197.3	115
Spring maize Ⅰ	480.6	290.6	190
Spring maize Ⅱ	461.4	285.8	175.6
Spring maizeⅢ	387.8	306	81.8
Rye	357.3	37.7	319.6
Spinach	225.7	27.6	198.1
Vetch	250.5	28.1	222.4
Potato	399.4	129.4	270
Pea	295.2	43.6	251.6
Soybean	393.7	301	92.7
	2017 planting year		
Winter wheat	471.1	97.2	373.9
Summer maize	334.5	198.9	135.6
Spring maizeI	-	-	-
Spring maizeII	546.2	194.7	351.5
Spring maizeIII	392.9	247.3	145.6
Rye	395.4	79.1	316.3
Spinach	197.3	48.3	149
Vetch	310.5	74.5	236
Potato	421.5	73.6	347.9
Pea	307.2	58.1	249.1
Soybean	392.5	245.9	146.6
	2018 planting year		
Winter wheat	502.5	152.7	349.8
Summer maize	387.6	167.1	220.5
Spring maizeI	-	-	-
Spring maizeII	531.7	241.1	290.6
Spring maizeIII	430.6	196.2	234.4
Rye	296.3	25	271.3
Spinach	234.1	14.9	219.2
Vetch	362.7	45.2	317.5
Potato	400.1	174.4	225.7
Pea	317.4	155	162.4
Soybean	429.5	192.6	236.9

Note: Spring maize Ⅰ represents the maize planted in vetch–spring maize plots in the 2016 planting year, the sowing date was April 9. Its sowing date in the 2017 and 2018 planting years was the same as spring maize Ⅲ. Spring maize Ⅱ is the maize of the potato/spring maize cropping system, the sowing date was usually earlier than the other spring maize. Spring maize Ⅲ represents the maize in other cropping systems, they had the same sowing date in the middle of May.

Table E4. The feeding population of the cropping system and its water consumption of a single person.

Systems	Total supply of population person/year	Blue water (3-year average) m^3/ha	Unit cost m^3/person
Winter wheat-summer maize	116	5421	143
Mono-spring maize	57	1539	139
Rye-spring maize	58	4563	226
Spinach-spring maize	84	3427	164
Vetch-spring maize	60	4486	211
Potato/spring maize	81	4530	177
Pea/spring maize	70	2473	169
Soybean‖spring maize	56	2299	160

Note: In the soybean-spring maize cropping system, soybeans were treated as the green manure, which did not have contribution to the yield. The maize yield had been slightly affected as well.