



**Supplementary Fig. 1** Maize cultivation and spatial distribution of 91 experimental sites in 12 counties in Henan province for maize production in China from 2008 to 2009.

**Supplementary Table 1.** N rate, grain yield, reactive N losses (Nr losses), environment cost, fertilizer cost, yield benefit, economic benefit and net benefit with different N treatment over 91 sites in 12 counties in Henan province for maize production in China from 2008 to 2009.

County	Year	Site	Treatment	N rate (kg N/ha)	Grain yield (t/ha)	Nr losses (kg N/ha)			Environment cost (\$/ha)				Fertilizer N cost \$/ha	Yield benefit \$/ha	Economic benefit \$/ha	Net benefit \$/ha	
						N <sub>2</sub> O emission	N leaching	NH <sub>3</sub> volatilization	Total	Global warming	Eutrophication	Soil acidification					Total
Hebi	2008	1	N0	0	9.4	0.5	4	1	6	5	1	2	9	0	3383	3383	3374
	2008	1	N1	120	9.8	1.0	14	30	45	11	11	56	78	85	3533	3448	3370
	2008	1	N2	240	10.0	1.9	43	59	103	22	26	110	157	171	3602	3432	3275
	2008	1	N3	360	9.9	3.9	132	88	223	43	56	164	263	256	3543	3287	3024
	2008	1	N4	480	9.3	7.8	219	117	343	87	86	217	390	341	3361	3020	2630
	2008	2	N0	0	6.5	0.5	4	1	6	5	1	2	9	0	2332	2332	2322
	2008	2	N1	120	8.1	1.0	14	30	45	11	11	56	78	85	2895	2809	2731
	2008	2	N2	240	8.5	1.9	43	59	103	22	26	110	157	171	3039	2868	2711
	2008	2	N3	360	8.5	3.9	132	88	223	43	56	164	263	256	3043	2787	2524
	2008	2	N4	480	7.6	7.8	219	117	343	87	86	217	390	341	2741	2400	2010

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2008	3	N0	0	8.1	0.5	4	1	6	5	1	2	9	0	2905	2905	2896
2008	3	N1	120	8.9	1.0	14	30	45	11	11	56	78	85	3202	3116	3038
2008	3	N2	240	9.4	1.9	43	59	103	22	26	110	157	171	3373	3203	3046
2008	3	N3	360	9.4	3.9	132	88	223	43	56	164	263	256	3388	3132	2869
2008	3	N4	480	9.1	7.8	219	117	343	87	86	217	390	341	3276	2935	2545
2008	4	N0	0	9.1	0.5	4	1	6	5	1	2	9	0	3286	3286	3277
2008	4	N1	120	10.2	1.0	14	30	45	11	11	56	78	85	3665	3580	3502
2008	4	N2	240	10.5	1.9	43	59	103	22	26	110	157	171	3759	3589	3431
2008	4	N3	360	10.9	3.9	132	88	223	43	56	164	263	256	3916	3661	3398
2008	4	N4	480	10.5	7.8	219	117	343	87	86	217	390	341	3788	3447	3057
2009	5	N0	0	6.7	0.5	4	1	6	5	1	2	9	0	2416	2416	2407
2009	5	N1	120	7.4	1.0	14	30	45	11	11	56	78	85	2665	2580	2502
2009	5	N2	240	8.6	1.9	43	59	103	22	26	110	157	171	3105	2935	2778
2009	5	N3	360	8.1	3.9	132	88	223	43	56	164	263	256	2913	2657	2394
2009	5	N4	480	8.0	7.8	219	117	343	87	86	217	390	341	2867	2526	2136
2009	6	N0	0	8.8	0.5	4	1	6	5	1	2	9	0	3151	3151	3142
2009	6	N1	120	9.7	1.0	14	30	45	11	11	56	78	85	3484	3399	3321

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2009	6	N2	240	10.5	1.9	43	59	103	22	26	110	157	171	3762	3592	3435
2009	6	N3	360	10.2	3.9	132	88	223	43	56	164	263	256	3655	3399	3136
2009	6	N4	480	9.9	7.8	219	117	343	87	86	217	390	341	3562	3221	2831
2009	7	N0	0	8.0	0.5	4	1	6	5	1	2	9	0	2887	2887	2878
2009	7	N1	120	9.3	1.0	14	30	45	11	11	56	78	85	3337	3252	3174
2009	7	N2	240	10.0	1.9	43	59	103	22	26	110	157	171	3596	3426	3269
2009	7	N3	360	9.7	3.9	132	88	223	43	56	164	263	256	3500	3245	2982
2009	7	N4	480	9.5	7.8	219	117	343	87	86	217	390	341	3405	3064	2674
2009	8	N0	0	7.7	0.5	4	1	6	5	1	2	9	0	2772	2772	2762
2009	8	N1	120	8.6	1.0	14	30	45	11	11	56	78	85	3086	3001	2923
2009	8	N2	240	10.3	1.9	43	59	103	22	26	110	157	171	3711	3541	3384
2009	8	N3	360	10.0	3.9	132	88	223	43	56	164	263	256	3611	3356	3093
2009	8	N4	480	9.4	7.8	219	117	343	87	86	217	390	341	3372	3031	2641
2009	9	N0	0	7.5	0.5	4	1	6	5	1	2	9	0	2689	2689	2680
2009	9	N1	120	9.0	1.0	14	30	45	11	11	56	78	85	3249	3163	3085
2009	9	N2	240	9.8	1.9	43	59	103	22	26	110	157	171	3515	3344	3187
2009	9	N3	360	9.7	3.9	132	88	223	43	56	164	263	256	3496	3241	2978

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	2009	9	N4	480	9.1	7.8	219	117	343	87	86	217	390	341	3275	2934	2544
	2009	10	N0	0	7.3	0.5	4	1	6	5	1	2	9	0	2636	2636	2627
	2009	10	N1	120	8.3	1.0	14	30	45	11	11	56	78	85	2983	2897	2819
	2009	10	N2	240	9.8	1.9	43	59	103	22	26	110	157	171	3515	3345	3188
	2009	10	N3	360	9.7	3.9	132	88	223	43	56	164	263	256	3488	3233	2970
	2009	10	N4	480	9.1	7.8	219	117	343	87	86	217	390	341	3289	2948	2558
	2009	11	N0	0	7.1	0.5	4	1	6	5	1	2	9	0	2564	2564	2555
	2009	11	N1	120	9.2	1.0	14	30	45	11	11	56	78	85	3310	3225	3147
	2009	11	N2	240	9.3	1.9	43	59	103	22	26	110	157	171	3358	3187	3030
	2009	11	N3	360	9.1	3.9	132	88	223	43	56	164	263	256	3283	3028	2765
	2009	11	N4	480	8.9	7.8	219	117	343	87	86	217	390	341	3198	2857	2467
Jiaozuo	2008	1	N0	0	9.3	0.5	4	1	6	5	1	2	9	0	3347	3347	3338
	2008	1	N1	120	9.7	1.0	14	30	45	11	11	56	78	85	3491	3406	3328
	2008	1	N2	240	10.2	1.9	43	59	103	22	26	110	157	171	3650	3479	3322
	2008	1	N3	360	9.4	3.9	132	88	223	43	56	164	263	256	3361	3106	2843
	2008	1	N4	480	8.8	7.8	219	117	343	87	86	217	390	341	3175	2834	2444
	2008	2	N0	0	9.7	0.5	4	1	6	5	1	2	9	0	3484	3484	3475

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2008	2	N1	120	10.5	1.0	14	30	45	11	11	56	78	85	3771	3686	3608
2008	2	N2	240	11.2	1.9	43	59	103	22	26	110	157	171	4017	3846	3689
2008	2	N3	360	10.8	3.9	132	88	223	43	56	164	263	256	3887	3631	3369
2008	2	N4	480	10.6	7.8	219	117	343	87	86	217	390	341	3796	3455	3065
2008	3	N0	0	8.0	0.5	4	1	6	5	1	2	9	0	2891	2891	2882
2008	3	N1	120	10.4	1.0	14	30	45	11	11	56	78	85	3732	3647	3569
2008	3	N2	240	10.9	1.9	43	59	103	22	26	110	157	171	3920	3750	3592
2008	3	N3	360	11.4	3.9	132	88	223	43	56	164	263	256	4101	3845	3582
2008	3	N4	480	9.5	7.8	219	117	343	87	86	217	390	341	3399	3058	2668
2009	4	N0	0	7.8	0.5	4	1	6	5	1	2	9	0	2804	2804	2795
2009	4	N1	120	8.4	1.0	14	30	45	11	11	56	78	85	3025	2940	2862
2009	4	N2	240	9.0	1.9	43	59	103	22	26	110	157	171	3225	3054	2897
2009	4	N3	360	8.3	3.9	132	88	223	43	56	164	263	256	2979	2724	2461
2009	4	N4	480	8.2	7.8	219	117	343	87	86	217	390	341	2952	2611	2221
2009	5	N0	0	8.3	0.5	4	1	6	5	1	2	9	0	2966	2966	2957
2009	5	N1	120	9.1	1.0	14	30	45	11	11	56	78	85	3288	3203	3125
2009	5	N2	240	8.6	1.9	43	59	103	22	26	110	157	171	3088	2917	2760

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2009	5	N3	360	8.4	3.9	132	88	223	43	56	164	263	256	3004	2748	2485
2009	5	N4	480	7.9	7.8	219	117	343	87	86	217	390	341	2850	2509	2119
2009	6	N0	0	8.5	0.5	4	1	6	5	1	2	9	0	3060	3060	3051
2009	6	N1	120	9.9	1.0	14	30	45	11	11	56	78	85	3553	3467	3390
2009	6	N2	240	9.1	1.9	43	59	103	22	26	110	157	171	3273	3103	2946
2009	6	N3	360	8.8	3.9	132	88	223	43	56	164	263	256	3154	2899	2636
2009	6	N4	480	8.3	7.8	219	117	343	87	86	217	390	341	2991	2650	2260
2009	7	N0	0	7.1	0.5	4	1	6	5	1	2	9	0	2564	2564	2555
2009	7	N1	120	8.8	1.0	14	30	45	11	11	56	78	85	3169	3084	3006
2009	7	N2	240	8.6	1.9	43	59	103	22	26	110	157	171	3106	2936	2778
2009	7	N3	360	8.0	3.9	132	88	223	43	56	164	263	256	2859	2603	2340
2009	7	N4	480	7.6	7.8	219	117	343	87	86	217	390	341	2749	2408	2018
2008	8	N0	0	10.8	0.5	4	1	6	5	1	2	9	0	3887	3887	3877
2008	8	N1	105	11.5	0.9	12	27	39	10	10	49	69	75	4150	4076	4007
2008	8	N2	210	11.9	1.6	32	52	85	18	21	96	136	149	4278	4129	3993
2008	8	N3	315	11.9	3.0	86	77	166	33	42	143	218	224	4294	4070	3852
2008	8	N4	420	11.3	5.5	163	102	271	61	68	190	320	298	4058	3760	3440

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2008	9	N0	0	8.1	0.5	4	1	6	5	1	2	9	0	2924	2924	2915
2008	9	N1	105	9.1	0.9	12	27	39	10	10	49	69	75	3287	3213	3144
2008	9	N2	210	9.8	1.6	32	52	85	18	21	96	136	149	3515	3366	3230
2008	9	N3	315	10.4	3.0	86	77	166	33	42	143	218	224	3727	3503	3285
2008	9	N4	420	9.4	5.5	163	102	271	61	68	190	320	298	3371	3073	2753
2008	10	N0	0	7.7	0.5	4	1	6	5	1	2	9	0	2784	2784	2775
2008	10	N1	105	9.4	0.9	12	27	39	10	10	49	69	75	3367	3293	3224
2008	10	N2	210	9.9	1.6	32	52	85	18	21	96	136	149	3563	3414	3278
2008	10	N3	315	10.2	3.0	86	77	166	33	42	143	218	224	3683	3459	3241
2008	10	N4	420	9.6	5.5	163	102	271	61	68	190	320	298	3447	3149	2829
2009	11	N0	0	3.2	0.5	4	1	6	5	1	2	9	0	1151	1151	1142
2009	11	N1	105	4.9	0.9	12	27	39	10	10	49	69	75	1753	1678	1609
2009	11	N2	210	6.3	1.6	32	52	85	18	21	96	136	149	2262	2113	1977
2009	11	N3	315	5.2	3.0	86	77	166	33	42	143	218	224	1867	1643	1425
2009	11	N4	420	4.8	5.5	163	102	271	61	68	190	320	298	1734	1436	1116
2009	12	N0	0	3.4	0.5	4	1	6	5	1	2	9	0	1212	1212	1203
2009	12	N1	105	5.3	0.9	12	27	39	10	10	49	69	75	1894	1819	1750

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	2009	12	N2	210	6.9	1.6	32	52	85	18	21	96	136	149	2491	2341	2206
	2009	12	N3	315	6.3	3.0	86	77	166	33	42	143	218	224	2278	2055	1836
	2009	12	N4	420	5.1	5.5	163	102	271	61	68	190	320	298	1834	1536	1216
Kaifeng	2008	1	N0	0	6.0	0.5	4	1	6	5	1	2	9	0	2158	2158	2149
	2008	1	N1	120	7.1	1.0	14	30	45	11	11	56	78	85	2553	2468	2390
	2008	1	N2	240	9.6	1.9	43	59	103	22	26	110	157	171	3453	3282	3125
	2008	1	N3	360	8.7	3.9	132	88	223	43	56	164	263	256	3131	2875	2612
	2008	1	N4	480	7.9	7.8	219	117	343	87	86	217	390	341	2846	2505	2115
	2008	2	N0	0	7.9	0.5	4	1	6	5	1	2	9	0	2858	2858	2848
	2008	2	N1	120	9.4	1.0	14	30	45	11	11	56	78	85	3381	3295	3218
	2008	2	N2	240	9.5	1.9	43	59	103	22	26	110	157	171	3412	3242	3084
	2008	2	N3	360	8.8	3.9	132	88	223	43	56	164	263	256	3181	2925	2662
	2008	2	N4	480	8.8	7.8	219	117	343	87	86	217	390	341	3160	2819	2429
	2008	3	N0	0	6.4	0.5	4	1	6	5	1	2	9	0	2312	2312	2303
	2008	3	N1	120	8.1	1.0	14	30	45	11	11	56	78	85	2904	2819	2741
	2008	3	N2	240	8.4	1.9	43	59	103	22	26	110	157	171	3033	2862	2705
	2008	3	N3	360	8.4	3.9	132	88	223	43	56	164	263	256	3020	2765	2502

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2008	3	N4	480	8.0	7.8	219	117	343	87	86	217	390	341	2880	2539	2149
2008	4	N0	0	7.7	0.5	4	1	6	5	1	2	9	0	2767	2767	2758
2008	4	N1	120	8.5	1.0	14	30	45	11	11	56	78	85	3043	2958	2880
2008	4	N2	240	9.2	1.9	43	59	103	22	26	110	157	171	3303	3132	2975
2008	4	N3	360	8.8	3.9	132	88	223	43	56	164	263	256	3145	2890	2627
2008	4	N4	480	8.5	7.8	219	117	343	87	86	217	390	341	3064	2723	2333
2008	5	N0	0	7.0	0.5	4	1	6	5	1	2	9	0	2516	2516	2507
2008	5	N1	105	7.4	0.9	12	27	39	10	10	49	69	75	2667	2592	2523
2008	5	N2	210	8.3	1.6	32	52	85	18	21	96	136	149	2974	2825	2689
2008	5	N3	315	7.7	3.0	86	77	166	33	42	143	218	224	2765	2541	2323
2008	5	N4	420	7.6	5.5	163	102	271	61	68	190	320	298	2728	2430	2110
2008	6	N0	0	7.3	0.5	4	1	6	5	1	2	9	0	2630	2630	2620
2008	6	N1	105	7.9	0.9	12	27	39	10	10	49	69	75	2856	2781	2712
2008	6	N2	210	8.6	1.6	32	52	85	18	21	96	136	149	3081	2932	2796
2008	6	N3	315	8.0	3.0	86	77	166	33	42	143	218	224	2885	2661	2443
2008	6	N4	420	7.5	5.5	163	102	271	61	68	190	320	298	2707	2409	2089
2008	7	N0	0	5.8	0.5	4	1	6	5	1	2	9	0	2075	2075	2066

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2008	7	N1	105	6.5	0.9	12	27	39	10	10	49	69	75	2332	2258	2189
2008	7	N2	210	7.8	1.6	32	52	85	18	21	96	136	149	2791	2642	2506
2008	7	N3	315	7.7	3.0	86	77	166	33	42	143	218	224	2764	2540	2322
2008	7	N4	420	7.2	5.5	163	102	271	61	68	190	320	298	2598	2300	1980
2009	8	N0	0	8.4	0.5	4	1	6	5	1	2	9	0	3027	3027	3018
2009	8	N1	105	9.4	0.9	12	27	39	10	10	49	69	75	3377	3302	3233
2009	8	N2	210	9.0	1.6	32	52	85	18	21	96	136	149	3236	3086	2951
2009	8	N3	315	8.9	3.0	86	77	166	33	42	143	218	224	3199	2976	2757
2009	8	N4	420	8.8	5.5	163	102	271	61	68	190	320	298	3170	2871	2552
2009	9	N0	0	5.4	0.5	4	1	6	5	1	2	9	0	1943	1943	1934
2009	9	N1	105	6.6	0.9	12	27	39	10	10	49	69	75	2363	2289	2220
2009	9	N2	210	7.2	1.6	32	52	85	18	21	96	136	149	2570	2421	2286
2009	9	N3	315	6.2	3.0	86	77	166	33	42	143	218	224	2220	1996	1778
2009	9	N4	420	6.5	5.5	163	102	271	61	68	190	320	298	2340	2041	1722
2009	10	N0	0	8.2	0.5	4	1	6	5	1	2	9	0	2939	2939	2930
2009	10	N1	105	9.0	0.9	12	27	39	10	10	49	69	75	3227	3152	3083
2009	10	N2	210	9.7	1.6	32	52	85	18	21	96	136	149	3472	3323	3187

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	2009	10	N3	315	9.0	3.0	86	77	166	33	42	143	218	224	3234	3010	2792
	2009	10	N4	420	8.9	5.5	163	102	271	61	68	190	320	298	3184	2886	2566
Luoyang	2009	1	N0	0	6.8	0.5	4	1	6	5	1	2	9	0	2451	2451	2441
	2009	1	N1	120	7.3	1.0	14	30	45	11	11	56	78	85	2640	2555	2477
	2009	1	N2	240	8.5	1.9	43	59	103	22	26	110	157	171	3042	2872	2715
	2009	1	N3	360	8.0	3.9	132	88	223	43	56	164	263	256	2867	2611	2348
	2009	1	N4	480	7.6	7.8	219	117	343	87	86	217	390	341	2748	2407	2017
	2009	2	N0	0	5.5	0.5	4	1	6	5	1	2	9	0	1983	1983	1974
	2009	2	N1	120	6.3	1.0	14	30	45	11	11	56	78	85	2252	2167	2089
	2009	2	N2	240	6.7	1.9	43	59	103	22	26	110	157	171	2406	2236	2079
	2009	2	N3	360	6.3	3.9	132	88	223	43	56	164	263	256	2279	2023	1760
	2009	2	N4	480	6.2	7.8	219	117	343	87	86	217	390	341	2221	1880	1490
	2009	3	N0	0	4.6	0.5	4	1	6	5	1	2	9	0	1645	1645	1636
	2009	3	N1	120	6.1	1.0	14	30	45	11	11	56	78	85	2185	2099	2022
	2009	3	N2	240	6.2	1.9	43	59	103	22	26	110	157	171	2212	2042	1884
	2009	3	N3	360	6.1	3.9	132	88	223	43	56	164	263	256	2203	1947	1684
	2009	3	N4	480	6.0	7.8	219	117	343	87	86	217	390	341	2144	1803	1413

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2008	4	N0	0	7.5	0.5	4	1	6	5	1	2	9	0	2687	2687	2678
2008	4	N1	120	8.8	1.0	14	30	45	11	11	56	78	85	3154	3069	2991
2008	4	N2	240	9.7	1.9	43	59	103	22	26	110	157	171	3469	3298	3141
2008	4	N3	360	9.6	3.9	132	88	223	43	56	164	263	256	3445	3189	2926
2008	4	N4	480	9.4	7.8	219	117	343	87	86	217	390	341	3395	3054	2664
2008	5	N0	0	6.7	0.5	4	1	6	5	1	2	9	0	2396	2396	2387
2008	5	N1	120	7.5	1.0	14	30	45	11	11	56	78	85	2711	2626	2548
2008	5	N2	240	8.4	1.9	43	59	103	22	26	110	157	171	3023	2852	2695
2008	5	N3	360	8.3	3.9	132	88	223	43	56	164	263	256	2993	2737	2474
2008	5	N4	480	8.0	7.8	219	117	343	87	86	217	390	341	2888	2547	2157
2008	6	N0	0	6.9	0.5	4	1	6	5	1	2	9	0	2489	2489	2480
2008	6	N1	120	7.9	1.0	14	30	45	11	11	56	78	85	2828	2743	2665
2008	6	N2	240	8.8	1.9	43	59	103	22	26	110	157	171	3166	2996	2839
2008	6	N3	360	8.7	3.9	132	88	223	43	56	164	263	256	3115	2859	2596
2008	6	N4	480	8.4	7.8	219	117	343	87	86	217	390	341	3008	2667	2277
2008	7	N0	0	7.6	0.5	4	1	6	5	1	2	9	0	2720	2720	2711
2008	7	N1	120	8.8	1.0	14	30	45	11	11	56	78	85	3145	3060	2982

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2008	7	N2	240	9.8	1.9	43	59	103	22	26	110	157	171	3520	3349	3192
2008	7	N3	360	10.1	3.9	132	88	223	43	56	164	263	256	3619	3363	3100
2008	7	N4	480	9.5	7.8	219	117	343	87	86	217	390	341	3427	3086	2696
2008	8	N0	0	5.2	0.5	4	1	6	5	1	2	9	0	1857	1857	1848
2008	8	N1	120	6.1	1.0	14	30	45	11	11	56	78	85	2211	2125	2047
2008	8	N2	240	6.7	1.9	43	59	103	22	26	110	157	171	2414	2244	2087
2008	8	N3	360	6.5	3.9	132	88	223	43	56	164	263	256	2346	2090	1827
2008	8	N4	480	6.3	7.8	219	117	343	87	86	217	390	341	2280	1939	1549
2009	9	N0	0	7.0	0.5	4	1	6	5	1	2	9	0	2534	2534	2525
2009	9	N1	120	8.1	1.0	14	30	45	11	11	56	78	85	2897	2811	2733
2009	9	N2	240	8.8	1.9	43	59	103	22	26	110	157	171	3157	2987	2830
2009	9	N3	360	8.4	3.9	132	88	223	43	56	164	263	256	3004	2748	2485
2009	9	N4	480	7.9	7.8	219	117	343	87	86	217	390	341	2846	2505	2115
2009	10	N0	0	6.9	0.5	4	1	6	5	1	2	9	0	2465	2465	2456
2009	10	N1	120	8.0	1.0	14	30	45	11	11	56	78	85	2861	2776	2698
2009	10	N2	240	8.4	1.9	43	59	103	22	26	110	157	171	3020	2849	2692
2009	10	N3	360	8.6	3.9	132	88	223	43	56	164	263	256	3076	2821	2558

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2009	10	N4	480	7.7	7.8	219	117	343	87	86	217	390	341	2783	2442	2052
2009	11	N0	0	5.6	0.5	4	1	6	5	1	2	9	0	2022	2022	2013
2009	11	N1	120	6.3	1.0	14	30	45	11	11	56	78	85	2253	2167	2089
2009	11	N2	240	6.9	1.9	43	59	103	22	26	110	157	171	2483	2313	2156
2009	11	N3	360	6.6	3.9	132	88	223	43	56	164	263	256	2366	2111	1848
2009	11	N4	480	6.0	7.8	219	117	343	87	86	217	390	341	2142	1801	1411
2009	12	N0	0	4.7	0.5	4	1	6	5	1	2	9	0	1690	1690	1680
2009	12	N1	120	5.5	1.0	14	30	45	11	11	56	78	85	1992	1907	1829
2009	12	N2	240	6.0	1.9	43	59	103	22	26	110	157	171	2157	1986	1829
2009	12	N3	360	5.4	3.9	132	88	223	43	56	164	263	256	1935	1680	1417
2009	12	N4	480	4.8	7.8	219	117	343	87	86	217	390	341	1721	1380	990
2009	13	N0	0	6.6	0.5	4	1	6	5	1	2	9	0	2364	2364	2355
2009	13	N1	90	7.1	0.8	10	23	34	9	8	43	60	64	2554	2490	2430
2009	13	N2	180	7.9	1.4	24	45	70	15	17	83	116	128	2844	2717	2601
2009	13	N3	270	7.1	2.3	56	66	125	26	31	123	180	192	2560	2368	2188
2009	13	N4	360	6.7	3.9	123	88	215	43	54	164	261	256	2411	2155	1894
2009	14	N0	0	7.4	0.5	4	1	6	5	1	2	9	0	2666	2666	2657

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2009	14	N1	90	7.7	0.8	10	23	34	9	8	43	60	64	2779	2715	2655
2009	14	N2	180	7.8	1.4	24	45	70	15	17	83	116	128	2813	2685	2569
2009	14	N3	270	8.1	2.3	56	66	125	26	31	123	180	192	2910	2718	2538
2009	14	N4	360	7.5	3.9	123	88	215	43	54	164	261	256	2708	2452	2191
2009	15	N0	0	8.0	0.5	4	1	6	5	1	2	9	0	2869	2869	2860
2009	15	N1	90	8.5	0.8	10	23	34	9	8	43	60	64	3058	2994	2933
2009	15	N2	180	8.9	1.4	24	45	70	15	17	83	116	128	3201	3073	2958
2009	15	N3	270	8.6	2.3	56	66	125	26	31	123	180	192	3108	2917	2737
2009	15	N4	360	8.4	3.9	123	88	215	43	54	164	261	256	3021	2766	2505
2009	16	N0	0	6.7	0.5	4	1	6	5	1	2	9	0	2398	2398	2389
2009	16	N1	90	7.3	0.8	10	23	34	9	8	43	60	64	2627	2563	2503
2009	16	N2	180	7.8	1.4	24	45	70	15	17	83	116	128	2812	2684	2568
2009	16	N3	270	7.4	2.3	56	66	125	26	31	123	180	192	2656	2464	2284
2009	16	N4	360	6.8	3.9	123	88	215	43	54	164	261	256	2450	2194	1933
2009	17	N0	0	7.0	0.5	4	1	6	5	1	2	9	0	2515	2515	2506
2009	17	N1	90	7.8	0.8	10	23	34	9	8	43	60	64	2794	2730	2670
2009	17	N2	180	8.4	1.4	24	45	70	15	17	83	116	128	3007	2879	2764

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	2009	17	N3	270	9.5	2.3	56	66	125	26	31	123	180	192	3414	3222	3042
	2009	17	N4	360	7.4	3.9	123	88	215	43	54	164	261	256	2649	2393	2133
	2009	18	N0	0	8.0	0.5	4	1	6	5	1	2	9	0	2882	2882	2873
	2009	18	N1	90	8.4	0.8	10	23	34	9	8	43	60	64	3020	2956	2896
	2009	18	N2	180	8.6	1.4	24	45	70	15	17	83	116	128	3088	2960	2845
	2009	18	N3	270	8.3	2.3	56	66	125	26	31	123	180	192	2985	2793	2613
	2009	18	N4	360	8.0	3.9	123	88	215	43	54	164	261	256	2860	2604	2344
Nanyang	2009	1	N0	0	6.3	0.5	4	1	6	5	1	2	9	0	2262	2262	2253
	2009	1	N1	120	7.1	1.0	14	30	45	11	11	56	78	85	2567	2481	2403
	2009	1	N2	240	7.5	1.9	43	59	103	22	26	110	157	171	2701	2531	2374
	2009	1	N3	360	7.4	3.9	132	88	223	43	56	164	263	256	2660	2404	2141
	2009	1	N4	480	6.8	7.8	219	117	343	87	86	217	390	341	2428	2087	1697
	2009	2	N0	0	6.2	0.5	4	1	6	5	1	2	9	0	2246	2246	2236
	2009	2	N1	120	7.2	1.0	14	30	45	11	11	56	78	85	2573	2488	2410
	2009	2	N2	240	6.7	1.9	43	59	103	22	26	110	157	171	2403	2233	2075
	2009	2	N3	360	6.7	3.9	132	88	223	43	56	164	263	256	2422	2166	1903
	2009	2	N4	480	6.6	7.8	219	117	343	87	86	217	390	341	2369	2028	1638

	2009	3	N0	0	5.4	0.5	4	1	6	5	1	2	9	0	1957	1957	1948
	2009	3	N1	120	7.2	1.0	14	30	45	11	11	56	78	85	2586	2501	2423
	2009	3	N2	240	7.4	1.9	43	59	103	22	26	110	157	171	2663	2492	2335
	2009	3	N3	360	7.1	3.9	132	88	223	43	56	164	263	256	2559	2303	2040
	2009	3	N4	480	7.1	7.8	219	117	343	87	86	217	390	341	2559	2218	1828
Pingdingshan	2009	1	N0	0	3.7	0.5	4	1	6	5	1	2	9	0	1325	1325	1316
	2009	1	N1	120	4.4	1.0	14	30	45	11	11	56	78	85	1583	1498	1420
	2009	1	N2	240	6.2	1.9	43	59	103	22	26	110	157	171	2239	2068	1911
	2009	1	N3	360	5.5	3.9	132	88	223	43	56	164	263	256	1967	1711	1448
	2009	1	N4	480	5.0	7.8	219	117	343	87	86	217	390	341	1785	1444	1054
	2009	2	N0	0	3.8	0.5	4	1	6	5	1	2	9	0	1366	1366	1357
	2009	2	N1	120	4.5	1.0	14	30	45	11	11	56	78	85	1632	1547	1469
	2009	2	N2	240	6.4	1.9	43	59	103	22	26	110	157	171	2308	2137	1980
	2009	2	N3	360	5.6	3.9	132	88	223	43	56	164	263	256	2027	1772	1509
	2009	2	N4	480	5.1	7.8	219	117	343	87	86	217	390	341	1841	1500	1110
	2009	3	N0	0	4.8	0.5	4	1	6	5	1	2	9	0	1723	1723	1713
	2009	3	N1	120	5.7	1.0	14	30	45	11	11	56	78	85	2058	1973	1895

	2009	3	N2	240	8.1	1.9	43	59	103	22	26	110	157	171	2910	2740	2583
	2009	3	N3	360	7.1	3.9	132	88	223	43	56	164	263	256	2557	2301	2038
	2009	3	N4	480	6.5	7.8	219	117	343	87	86	217	390	341	2321	1980	1590
	2009	4	N0	0	3.2	0.5	4	1	6	5	1	2	9	0	1138	1138	1129
	2009	4	N1	120	3.8	1.0	14	30	45	11	11	56	78	85	1360	1275	1197
	2009	4	N2	240	5.4	1.9	43	59	103	22	26	110	157	171	1923	1753	1596
	2009	4	N3	360	4.7	3.9	132	88	223	43	56	164	263	256	1690	1434	1171
	2009	4	N4	480	4.3	7.8	219	117	343	87	86	217	390	341	1534	1193	803
Shanmenxia	2009	1	N0	0	4.5	0.5	4	1	6	5	1	2	9	0	1609	1609	1599
	2009	1	N1	120	5.9	1.0	14	30	45	11	11	56	78	85	2127	2042	1964
	2009	1	N2	240	6.7	1.9	43	59	103	22	26	110	157	171	2418	2247	2090
	2009	1	N3	360	6.3	3.9	132	88	223	43	56	164	263	256	2256	2000	1737
	2009	1	N4	480	6.0	7.8	219	117	343	87	86	217	390	341	2172	1831	1441
	2009	2	N0	0	5.6	0.5	4	1	6	5	1	2	9	0	2016	2016	2007
	2009	2	N1	120	6.0	1.0	14	30	45	11	11	56	78	85	2142	2057	1979
	2009	2	N2	240	7.3	1.9	43	59	103	22	26	110	157	171	2636	2466	2309
	2009	2	N3	360	6.8	3.9	132	88	223	43	56	164	263	256	2433	2177	1914

	2009	2	N4	480	6.3	7.8	219	117	343	87	86	217	390	341	2259	1918	1528
	2009	3	N0	0	4.3	0.5	4	1	6	5	1	2	9	0	1528	1528	1519
	2009	3	N1	120	5.5	1.0	14	30	45	11	11	56	78	85	1992	1907	1829
	2009	3	N2	240	6.7	1.9	43	59	103	22	26	110	157	171	2391	2220	2063
	2009	3	N3	360	6.0	3.9	132	88	223	43	56	164	263	256	2172	1916	1654
	2009	3	N4	480	5.8	7.8	219	117	343	87	86	217	390	341	2097	1756	1366
	2009	4	N0	0	6.1	0.5	4	1	6	5	1	2	9	0	2175	2175	2166
	2009	4	N1	120	6.3	1.0	14	30	45	11	11	56	78	85	2271	2186	2108
	2009	4	N2	240	7.4	1.9	43	59	103	22	26	110	157	171	2660	2490	2333
	2009	4	N3	360	7.2	3.9	132	88	223	43	56	164	263	256	2570	2315	2052
	2009	4	N4	480	6.7	7.8	219	117	343	87	86	217	390	341	2418	2077	1687
Shangqiu	2009	1	N0	0	6.8	0.5	4	1	6	5	1	2	9	0	2428	2428	2418
	2009	1	N1	120	7.8	1.0	14	30	45	11	11	56	78	85	2797	2712	2634
	2009	1	N2	240	8.8	1.9	43	59	103	22	26	110	157	171	3165	2995	2838
	2009	1	N3	360	8.4	3.9	132	88	223	43	56	164	263	256	3014	2758	2495
	2009	1	N4	480	8.5	7.8	219	117	343	87	86	217	390	341	3039	2698	2308
	2009	2	N0	0	5.9	0.5	4	1	6	5	1	2	9	0	2111	2111	2102

	2009	2	N1	120	8.2	1.0	14	30	45	11	11	56	78	85	2934	2849	2771
	2009	2	N2	240	8.7	1.9	43	59	103	22	26	110	157	171	3122	2951	2794
	2009	2	N3	360	8.4	3.9	132	88	223	43	56	164	263	256	3006	2750	2487
	2009	2	N4	480	7.7	7.8	219	117	343	87	86	217	390	341	2751	2410	2020
	2009	3	N0	0	6.7	0.5	4	1	6	5	1	2	9	0	2391	2391	2381
	2009	3	N1	120	8.3	1.0	14	30	45	11	11	56	78	85	2980	2894	2816
	2009	3	N2	240	8.8	1.9	43	59	103	22	26	110	157	171	3151	2981	2824
	2009	3	N3	360	9.2	3.9	132	88	223	43	56	164	263	256	3293	3037	2775
	2009	3	N4	480	9.0	7.8	219	117	343	87	86	217	390	341	3236	2895	2505
	2009	4	N0	0	6.3	0.5	4	1	6	5	1	2	9	0	2277	2277	2268
	2009	4	N1	120	8.2	1.0	14	30	45	11	11	56	78	85	2947	2862	2784
	2009	4	N2	240	8.5	1.9	43	59	103	22	26	110	157	171	3063	2893	2735
	2009	4	N3	360	9.0	3.9	132	88	223	43	56	164	263	256	3235	2980	2717
	2009	4	N4	480	8.4	7.8	219	117	343	87	86	217	390	341	3035	2694	2304
Xinxiang	2008	1	N0	0	6.8	0.5	4	1	6	5	1	2	9	0	2443	2443	2433
	2008	1	N1	120	7.3	1.0	14	30	45	11	11	56	78	85	2637	2552	2474
	2008	1	N2	240	7.8	1.9	43	59	103	22	26	110	157	171	2795	2624	2467

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2008	1	N3	360	7.1	3.9	132	88	223	43	56	164	263	256	2552	2297	2034
2008	1	N4	480	6.7	7.8	219	117	343	87	86	217	390	341	2403	2062	1672
2008	2	N0	0	6.4	0.5	4	1	6	5	1	2	9	0	2315	2315	2306
2008	2	N1	120	8.1	1.0	14	30	45	11	11	56	78	85	2919	2834	2756
2008	2	N2	240	8.7	1.9	43	59	103	22	26	110	157	171	3118	2948	2791
2008	2	N3	360	9.3	3.9	132	88	223	43	56	164	263	256	3354	3098	2835
2008	2	N4	480	9.3	7.8	219	117	343	87	86	217	390	341	3352	3011	2621
2009	3	N0	0	5.6	0.5	4	1	6	5	1	2	9	0	2025	2025	2016
2009	3	N1	120	6.5	1.0	14	30	45	11	11	56	78	85	2343	2258	2180
2009	3	N2	240	7.6	1.9	43	59	103	22	26	110	157	171	2723	2553	2395
2009	3	N3	360	7.1	3.9	132	88	223	43	56	164	263	256	2563	2308	2045
2009	3	N4	480	7.8	7.8	219	117	343	87	86	217	390	341	2792	2451	2061
2009	4	N0	0	7.1	0.5	4	1	6	5	1	2	9	0	2568	2568	2558
2009	4	N1	120	8.2	1.0	14	30	45	11	11	56	78	85	2956	2871	2793
2009	4	N2	240	9.2	1.9	43	59	103	22	26	110	157	171	3311	3141	2984
2009	4	N3	360	9.6	3.9	132	88	223	43	56	164	263	256	3451	3195	2932
2009	4	N4	480	9.1	7.8	219	117	343	87	86	217	390	341	3283	2942	2552

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	2009	5	N0	0	7.7	0.5	4	1	6	5	1	2	9	0	2761	2761	2751
	2009	5	N1	120	8.8	1.0	14	30	45	11	11	56	78	85	3177	3092	3014
	2009	5	N2	240	9.4	1.9	43	59	103	22	26	110	157	171	3374	3204	3046
	2009	5	N3	360	9.5	3.9	132	88	223	43	56	164	263	256	3413	3157	2894
	2009	5	N4	480	9.0	7.8	219	117	343	87	86	217	390	341	3225	2884	2494
Zhengzhou	2009	1	N0	0	6.1	0.5	4	1	6	5	1	2	9	0	2198	2198	2189
	2009	1	N1	120	7.5	1.0	14	30	45	11	11	56	78	85	2691	2606	2528
	2009	1	N2	240	7.9	1.9	43	59	103	22	26	110	157	171	2835	2664	2507
	2009	1	N3	360	7.3	3.9	132	88	223	43	56	164	263	256	2609	2353	2090
	2009	1	N4	480	7.5	7.8	219	117	343	87	86	217	390	341	2691	2350	1960
	2009	2	N0	0	6.1	0.5	4	1	6	5	1	2	9	0	2185	2185	2175
	2009	2	N1	120	6.7	1.0	14	30	45	11	11	56	78	85	2404	2318	2240
	2009	2	N2	240	7.0	1.9	43	59	103	22	26	110	157	171	2498	2328	2171
	2009	2	N3	360	6.9	3.9	132	88	223	43	56	164	263	256	2474	2218	1955
	2009	2	N4	480	6.7	7.8	219	117	343	87	86	217	390	341	2396	2055	1665
	2009	3	N0	0	6.1	0.5	4	1	6	5	1	2	9	0	2196	2196	2187
	2009	3	N1	120	7.3	1.0	14	30	45	11	11	56	78	85	2619	2534	2456

	2009	3	N2	240	7.7	1.9	43	59	103	22	26	110	157	171	2783	2612	2455
	2009	3	N3	360	7.6	3.9	132	88	223	43	56	164	263	256	2737	2482	2219
	2009	3	N4	480	7.4	7.8	219	117	343	87	86	217	390	341	2661	2320	1930
Zhoukou	2008	1	N0	0	6.8	0.5	4	1	6	5	1	2	9	0	2458	2458	2448
	2008	1	N1	60	7.1	0.7	8	16	24	8	6	29	43	43	2539	2496	2453
	2008	1	N2	120	8.5	1.0	14	30	45	11	11	56	78	85	3049	2964	2886
	2008	1	N3	180	9.1	1.4	24	45	70	15	17	83	116	128	3269	3141	3025
	2008	1	N4	240	8.3	1.9	43	59	103	22	26	110	157	171	2966	2796	2639
	2008	2	N0	0	6.3	0.5	4	1	6	5	1	2	9	0	2249	2249	2240
	2008	2	N1	120	8.5	1.0	14	30	45	11	11	56	78	85	3069	2984	2906
	2008	2	N2	240	8.8	1.9	43	59	103	22	26	110	157	171	3177	3006	2849
	2008	2	N3	360	8.6	3.9	132	88	223	43	56	164	263	256	3094	2838	2575
	2008	2	N4	480	8.7	7.8	219	117	343	87	86	217	390	341	3110	2768	2378
	2008	3	N0	0	6.0	0.5	4	1	6	5	1	2	9	0	2153	2153	2144
	2008	3	N1	120	8.8	1.0	14	30	45	11	11	56	78	85	3159	3074	2996
	2008	3	N2	240	9.0	1.9	43	59	103	22	26	110	157	171	3241	3071	2913
	2008	3	N3	360	8.5	3.9	132	88	223	43	56	164	263	256	3070	2814	2551



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2008	3	N4	480	8.8	7.8	219	117	343	87	86	217	390	341	3147	2806	2416
2008	4	N0	0	6.8	0.5	4	1	6	5	1	2	9	0	2434	2434	2425
2008	4	N1	120	8.6	1.0	14	30	45	11	11	56	78	85	3083	2997	2919
2008	4	N2	240	8.4	1.9	43	59	103	22	26	110	157	171	3005	2834	2677
2008	4	N3	360	8.3	3.9	132	88	223	43	56	164	263	256	2971	2715	2452
2008	4	N4	480	8.4	7.8	219	117	343	87	86	217	390	341	3028	2687	2297
2008	5	N0	0	7.5	0.5	4	1	6	5	1	2	9	0	2690	2690	2681
2008	5	N1	120	8.2	1.0	14	30	45	11	11	56	78	85	2960	2875	2797
2008	5	N2	240	8.3	1.9	43	59	103	22	26	110	157	171	2972	2802	2645
2008	5	N3	360	8.3	3.9	132	88	223	43	56	164	263	256	2989	2733	2471
2008	5	N4	480	8.2	7.8	219	117	343	87	86	217	390	341	2933	2592	2202
2009	6	N0	0	4.6	0.5	4	1	6	5	1	2	9	0	1667	1667	1657
2009	6	N1	120	5.9	1.0	14	30	45	11	11	56	78	85	2127	2042	1964
2009	6	N2	240	7.0	1.9	43	59	103	22	26	110	157	171	2510	2340	2183
2009	6	N3	360	6.5	3.9	132	88	223	43	56	164	263	256	2348	2093	1830
2009	6	N4	480	6.2	7.8	219	117	343	87	86	217	390	341	2211	1870	1480
2009	7	N0	0	4.1	0.5	4	1	6	5	1	2	9	0	1488	1488	1478

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2009	7	N1	120	5.5	1.0	14	30	45	11	11	56	78	85	1989	1904	1826
2009	7	N2	240	6.5	1.9	43	59	103	22	26	110	157	171	2333	2162	2005
2009	7	N3	360	6.2	3.9	132	88	223	43	56	164	263	256	2225	1969	1706
2009	7	N4	480	6.0	7.8	219	117	343	87	86	217	390	341	2162	1821	1431
2009	8	N0	0	4.4	0.5	4	1	6	5	1	2	9	0	1581	1581	1572
2009	8	N1	120	6.0	1.0	14	30	45	11	11	56	78	85	2164	2079	2001
2009	8	N2	240	6.5	1.9	43	59	103	22	26	110	157	171	2323	2153	1996
2009	8	N3	360	6.3	3.9	132	88	223	43	56	164	263	256	2260	2004	1741
2009	8	N4	480	6.2	7.8	219	117	343	87	86	217	390	341	2246	1905	1515
2009	9	N0	0	4.2	0.5	4	1	6	5	1	2	9	0	1521	1521	1512
2009	9	N1	120	6.4	1.0	14	30	45	11	11	56	78	85	2302	2217	2139
2009	9	N2	240	6.9	1.9	43	59	103	22	26	110	157	171	2483	2313	2156
2009	9	N3	360	6.7	3.9	132	88	223	43	56	164	263	256	2403	2147	1884
2009	9	N4	480	6.6	7.8	219	117	343	87	86	217	390	341	2372	2031	1641
2009	10	N0	0	8.6	0.5	4	1	6	5	1	2	9	0	3106	3106	3097
2009	10	N1	120	9.0	1.0	14	30	45	11	11	56	78	85	3238	3152	3074
2009	10	N2	240	9.8	1.9	43	59	103	22	26	110	157	171	3526	3356	3199

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	2009	10	N3	360	10.2	3.9	132	88	223	43	56	164	263	256	3674	3418	3155
	2009	10	N4	480	9.8	7.8	219	117	343	87	86	217	390	341	3528	3187	2797
Zhumadian	2008	1	N0	0	10.3	0.5	4	1	6	5	1	2	9	0	3706	3706	3697
	2008	1	N1	105	10.7	0.9	12	27	39	10	10	49	69	75	3847	3772	3703
	2008	1	N2	210	11.0	1.6	32	52	85	18	21	96	136	149	3943	3794	3659
	2008	1	N3	315	10.9	3.0	86	77	166	33	42	143	218	224	3904	3680	3462
	2008	1	N4	420	10.6	5.5	231	102	339	61	86	190	337	298	3815	3517	3179
	2009	2	N0	0	7.5	0.5	4	1	6	5	1	2	9	0	2679	2679	2669
	2009	2	N1	120	8.7	1.0	14	30	45	11	11	56	78	85	3128	3043	2965
	2009	2	N2	240	9.1	1.9	43	59	103	22	26	110	157	171	3263	3092	2935
	2009	2	N3	360	8.6	3.9	132	88	223	43	56	164	263	256	3101	2845	2582
	2009	2	N4	480	7.6	7.8	219	117	343	87	86	217	390	341	2748	2407	2017
	2008	3	N0	0	3.6	0.5	4	1	6	5	1	2	9	0	1283	1283	1274
	2008	3	N1	120	6.0	1.0	14	30	45	11	11	56	78	85	2168	2083	2005
	2008	3	N2	240	7.4	1.9	43	59	103	22	26	110	157	171	2664	2494	2337
	2008	3	N3	360	7.5	3.9	132	88	223	43	56	164	263	256	2709	2453	2191
	2008	3	N4	480	6.8	7.8	219	117	343	87	86	217	390	341	2445	2104	1714

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2008	4	N0	0	5.8	0.5	4	1	6	5	1	2	9	0	2098	2098	2089
2008	4	N1	120	7.6	1.0	14	30	45	11	11	56	78	85	2733	2648	2570
2008	4	N2	240	9.1	1.9	43	59	103	22	26	110	157	171	3255	3085	2927
2008	4	N3	360	9.1	3.9	132	88	223	43	56	164	263	256	3282	3026	2763
2008	4	N4	480	7.6	7.8	219	117	343	87	86	217	390	341	2742	2401	2011
2008	5	N0	0	5.1	0.5	4	1	6	5	1	2	9	0	1845	1845	1836
2008	5	N1	120	6.7	1.0	14	30	45	11	11	56	78	85	2400	2315	2237
2008	5	N2	240	9.3	1.9	43	59	103	22	26	110	157	171	3335	3164	3007
2008	5	N3	360	9.0	3.9	132	88	223	43	56	164	263	256	3243	2987	2724
2008	5	N4	480	7.6	7.8	219	117	343	87	86	217	390	341	2734	2393	2003
2008	6	N0	0	4.6	0.5	4	1	6	5	1	2	9	0	1666	1666	1657
2008	6	N1	120	6.1	1.0	14	30	45	11	11	56	78	85	2196	2111	2033
2008	6	N2	240	7.5	1.9	43	59	103	22	26	110	157	171	2703	2533	2376
2008	6	N3	360	7.7	3.9	132	88	223	43	56	164	263	256	2768	2512	2250
2008	6	N4	480	7.4	7.8	219	117	343	87	86	217	390	341	2674	2333	1943
2008	7	N0	0	4.3	0.5	4	1	6	5	1	2	9	0	1563	1563	1554
2008	7	N1	120	6.6	1.0	14	30	45	11	11	56	78	85	2355	2270	2192

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2008	7	N2	240	8.1	1.9	43	59	103	22	26	110	157	171	2907	2736	2579
2008	7	N3	360	8.1	3.9	132	88	223	43	56	164	263	256	2926	2671	2408
2008	7	N4	480	7.4	7.8	219	117	343	87	86	217	390	341	2671	2330	1940

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**Supplementary Table 2.** N rate (kg N/ha), control yield (Mg/ha), grain yield (Mg/ha), Nr losses intensity (kg N/Mg grain yield), economic benefit and net benefit (\$/ha) with agronomically, economically and agronomically optimal N rate over 91 sites in 12 counties in Henan province for maize production in China from 2008 to 2009. F, C and R indicate fluvo aquatic soil, cinnamon soil and red clay, respectively.

Country	Year	Site	Soil type	Control yield	Agronomically optimal N									Economically optimal N									Ecologically optimal N								
					N rate	Grain yield	Economic benefit	Net benefit	Nr losses intensity			N rate	Grain yield	Economic benefit	Net benefit	Nr losses intensity			N rate	Grain yield	Economic benefit	Net benefit	Nr losses intensity								
									Total	N <sub>2</sub> O emission	N leaching					NH <sub>3</sub> volatilization	Total	N <sub>2</sub> O emission					N leaching	NH <sub>3</sub> volatilization	Total	N <sub>2</sub> O emission	N leaching	NH <sub>3</sub> volatilization			
Hebi	2008	1	F	9.4	234	10.0	46	-100	10.0	0.19	4.0	5.8	142	9.9	79	0	5.4	0.11	1.7	3.6	71	9.7	59	23	2.9	0.07	0.9	1.9			
	2008	2	F	6.5	284	8.6	562	376	15.8	0.29	7.5	8.1	246	8.6	575	420	12.5	0.23	5.3	7.0	207	8.5	561	436	9.9	0.19	3.7	6.0			
	2008	3	F	8.1	320	9.5	268	50	18.2	0.33	9.6	8.3	247	9.4	294	138	11.5	0.21	4.9	6.5	174	9.2	268	167	7.4	0.14	2.5	4.7			
	2008	4	F	9.1	351	10.8	347	100	19.5	0.34	11.2	7.9	278	10.7	372	190	12.3	0.23	5.7	6.4	201	10.5	344	223	7.7	0.15	2.8	4.7			
	2009	5	F	6.7	319	8.3	354	136	20.4	0.37	10.7	9.3	255	8.3	377	215	13.7	0.25	5.9	7.5	192	8.1	355	241	9.4	0.18	3.4	5.9			
	2009	6	F	8.8	307	10.4	358	152	15.2	0.27	7.7	7.2	249	10.3	378	221	10.6	0.20	4.5	5.9	190	10.1	357	245	7.4	0.14	2.6	4.6			
	2009	7	F	8.0	310	10.0	481	272	16.1	0.29	8.2	7.6	261	9.9	498	331	11.9	0.22	5.2	6.4	210	9.8	479	352	8.7	0.17	3.3	5.3			

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	2009	8	F	7.7	318	10.1	623	406	16.9	0.30	8.8	7.7	277	10.0	637	456	13.0	0.24	6.0	6.8	230	9.9	619	476	9.8	0.18	3.9	5.7
	2009	9	F	7.5	305	9.9	646	442	15.8	0.29	7.9	7.5	268	9.8	659	487	12.5	0.23	5.6	6.7	226	9.7	643	504	9.7	0.18	3.8	5.7
	2009	10	F	7.3	332	9.7	607	378	19.2	0.34	10.5	8.4	286	9.6	623	435	14.4	0.26	6.8	7.3	235	9.5	603	457	10.6	0.20	4.3	6.1
	2009	11	F	7.1	300	9.6	662	462	15.8	0.29	7.8	7.7	264	9.5	675	506	12.6	0.23	5.6	6.8	224	9.4	660	522	9.9	0.19	3.9	5.9
Jiaozuo	2008	1	F	9.3	202	9.9	80	-41	8.2	0.16	3.0	5.0	138	9.9	102	26	5.2	0.11	1.6	3.5	84	9.7	87	43	3.3	0.08	1.0	2.2
	2008	2	F	9.7	295	11.0	273	77	13.2	0.24	6.5	6.5	230	11.0	297	154	8.9	0.17	3.5	5.2	168	10.8	275	179	6.0	0.12	2.0	3.9
	2008	3	F	8.0	278	11.3	986	805	11.6	0.21	5.4	6.0	255	11.3	994	832	10.0	0.19	4.3	5.5	229	11.2	984	842	8.6	0.16	3.4	5.0
	2008	4	F	10.8	242	12.0	237	88	8.8	0.16	3.6	5.0	190	11.9	257	145	6.3	0.12	2.2	3.9	144	11.8	242	161	4.6	0.09	1.5	3.1
	2008	5	F	8.1	257	9.8	501	333	11.8	0.22	5.1	6.5	238	9.8	505	352	10.5	0.20	4.3	6.0	196	9.7	489	369	8.1	0.15	2.9	5.0
	2008	6	F	7.7	280	10.2	685	505	13.0	0.24	6.1	6.7	248	10.2	697	542	10.7	0.20	4.5	6.0	216	10.1	685	555	8.8	0.17	3.4	5.3
	2009	7	F	7.8	263	8.7	142	-26	13.7	0.25	6.0	7.4	188	8.6	169	59	8.5	0.16	3.0	5.4	122	8.5	148	82	5.4	0.12	1.7	3.6
	2009	8	F	8.3	207	8.8	56	-68	9.5	0.18	3.5	5.8	132	8.7	83	11	5.6	0.12	1.8	3.8	73	8.6	67	30	3.3	0.09	1.0	2.2
	2009	9	F	8.5	219	9.4	168	34	9.6	0.18	3.7	5.7	167	9.4	186	90	6.8	0.13	2.3	4.4	120	9.2	172	107	4.9	0.10	1.5	3.3

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	2009 10	F	7.1	252	8.7	388	228	12.8	0.24	5.5	7.1	212	8.7	402	273	10.0	0.19	3.8	6.0	173	8.6	388	288	7.8	0.15	2.7	5.0
	2009 11	C	3.2	250	5.9	788	632	18.7	0.35	7.9	10.4	227	5.9	796	658	16.2	0.30	6.4	9.5	203	5.8	788	666	14.1	0.27	5.2	8.6
	2009 12	F	3.4	248	6.7	1018	857	16.3	0.30	6.9	9.1	230	6.7	1024	878	14.6	0.27	5.8	8.5	210	6.6	1016	886	13.0	0.25	4.9	7.8
Kaifeng	2008 1	F	6.0	301	9.0	862	661	16.9	0.31	8.4	8.2	272	9.0	873	696	14.1	0.26	6.4	7.4	238	8.9	859	711	11.6	0.22	4.7	6.6
	2008 2	F	7.9	271	9.5	351	183	13.3	0.24	6.0	7.0	222	9.4	369	238	9.8	0.18	3.8	5.8	177	9.3	354	254	7.4	0.14	2.5	4.7
	2008 3	F	6.4	307	8.6	568	362	18.3	0.33	9.3	8.7	264	8.6	584	415	14.0	0.26	6.2	7.5	218	8.4	567	434	10.7	0.20	4.1	6.4
	2008 4	F	7.7	291	9.0	263	71	15.8	0.29	7.6	7.9	226	8.9	287	147	10.6	0.20	4.2	6.2	165	8.8	266	171	7.2	0.14	2.4	4.7
	2008 5	F	7.0	252	8.0	170	13	14.0	0.26	6.0	7.7	187	7.9	193	83	9.3	0.18	3.3	5.9	130	7.7	175	103	6.3	0.13	2.0	4.2
	2008 6	F	7.3	220	8.4	221	88	10.9	0.21	4.2	6.5	175	8.3	238	136	8.1	0.16	2.8	5.2	134	8.2	225	150	6.1	0.13	1.9	4.1
	2008 7	R	5.8	292	7.7	469	279	18.8	0.34	9.1	9.3	248	7.6	485	331	14.3	0.27	6.0	8.0	202	7.5	469	348	10.9	0.21	4.0	6.7
	2009 8	F	8.4	233	9.2	112	-31	10.8	0.20	4.3	6.2	164	9.1	136	43	6.9	0.14	2.3	4.4	105	9.0	119	62	4.4	0.10	1.3	2.9
	2009 9	F	7.2	254	8.6	351	193	13.1	0.24	5.6	7.2	211	8.6	366	239	10.0	0.19	3.8	6.1	170	8.5	352	254	7.7	0.15	2.6	5.0
	2009 10	F	8.2	242	9.4	275	125	11.1	0.21	4.6	6.3	196	9.4	291	175	8.3	0.16	3.0	5.2	153	9.2	277	191	6.2	0.13	2.0	4.1

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Luoyang	2008	1	F	7.5	345	9.7	566	326	20.7	0.36	11.7	8.6	291	9.7	586	393	14.7	0.27	7.1	7.4	234	9.5	564	418	10.5	0.20	4.2	6.1
	2008	2	C	6.7	330	8.4	382	155	21.8	0.39	11.8	9.6	267	8.3	405	233	14.7	0.27	6.6	7.8	202	8.1	381	260	10.0	0.19	3.7	6.1
	2008	3	C	6.9	327	8.8	426	202	20.4	0.36	11.0	9.1	268	8.7	447	274	14.2	0.26	6.4	7.6	208	8.5	424	299	9.9	0.19	3.7	6.0
	2008	4	F	7.6	346	10.0	613	371	20.4	0.36	11.6	8.5	296	9.9	631	434	14.8	0.27	7.3	7.3	241	9.7	609	458	10.7	0.20	4.4	6.1
	2008	5	C	5.2	315	6.7	333	120	24.7	0.44	12.8	11.5	252	6.7	355	196	16.8	0.31	7.2	9.3	188	6.5	332	222	11.4	0.22	4.0	7.2
	2009	6	C	6.8	295	8.2	276	80	17.9	0.33	8.8	8.8	233	8.1	298	153	12.2	0.23	4.9	7.1	169	7.9	276	178	8.2	0.16	2.8	5.3
	2009	7	C	5.5	287	6.6	182	-7	21.0	0.38	10.0	10.6	210	6.5	211	84	13.1	0.25	4.9	7.9	141	6.3	189	110	8.4	0.17	2.7	5.6
	2009	8	C	4.6	310	6.4	429	219	25.3	0.46	12.9	11.9	258	6.3	447	282	18.3	0.34	8.0	10.0	203	6.2	426	305	13.2	0.25	4.9	8.1
	2009	9	C	7.0	282	8.6	375	191	15.5	0.28	7.3	8.0	233	8.6	392	247	11.5	0.22	4.6	6.7	184	8.5	374	267	8.5	0.16	3.0	5.4
	2009	10	C	6.9	288	8.5	396	206	16.4	0.30	7.9	8.3	238	8.5	414	266	12.0	0.23	4.9	6.9	189	8.3	397	285	8.9	0.17	3.2	5.6
	2009	11	F	5.6	261	6.8	228	61	17.4	0.32	7.7	9.4	203	6.7	248	126	12.2	0.23	4.5	7.5	148	6.6	230	147	8.5	0.17	2.7	5.6
	2009	12	C	4.7	241	5.8	242	91	17.7	0.33	7.3	10.1	191	5.8	259	146	13.0	0.25	4.6	8.1	145	5.7	244	163	9.6	0.20	3.1	6.4
	2009	13	C	7.9	183	8.9	230	121	8.0	0.16	2.8	5.1	150	8.9	242	156	6.4	0.13	2.1	4.2	121	8.8	233	165	5.1	0.11	1.6	3.4

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	2009 14	C	7.8	202	8.4	46	-76	9.7	0.19	3.6	6.0	125	8.3	74	4	5.7	0.12	1.8	3.8	65	8.1	57	23	3.2	0.09	1.0	2.1
	2009 15	C	8.9	209	9.7	153	25	8.7	0.17	3.3	5.3	157	9.7	171	80	6.2	0.12	2.0	4.0	112	9.6	157	95	4.4	0.10	1.3	3.0
	2009 16	C	7.8	186	8.8	230	119	8.3	0.16	2.9	5.2	152	8.8	242	155	6.5	0.13	2.1	4.3	122	8.7	233	165	5.2	0.11	1.6	3.5
	2009 17	R	8.4	206	10.1	485	364	8.2	0.16	3.0	5.0	181	10.1	494	389	7.0	0.14	2.4	4.4	160	10.0	487	396	6.1	0.12	2.0	4.0
	2009 18	R	8.6	173	9.1	61	-38	7.3	0.14	2.5	4.7	115	9.0	82	19	4.7	0.10	1.5	3.2	70	8.9	69	33	3.1	0.08	1.0	2.0
Nanyang	2009 1	R	6.3	268	7.5	253	80	16.4	0.30	7.4	8.7	210	7.5	274	147	11.4	0.22	4.3	6.9	156	7.3	255	167	8.1	0.16	2.6	5.3
	2009 2	R	6.2	265	6.9	56	-115	17.5	0.32	7.8	9.4	163	6.8	93	0	9.1	0.18	3.0	5.9	81	6.6	69	28	4.7	0.12	1.4	3.1
	2009 3	R	5.4	311	7.6	537	327	21.4	0.38	10.9	10.0	265	7.5	553	383	16.1	0.30	7.1	8.6	217	7.4	535	403	12.1	0.23	4.6	7.2
Pingdingshan	2009 1	C	3.7	299	5.7	526	327	26.1	0.47	12.9	12.7	257	5.7	541	377	20.2	0.37	8.8	11.1	211	5.6	523	396	15.5	0.29	5.8	9.3
	2009 2	C	3.8	299	5.9	545	345	25.4	0.46	12.5	12.4	257	5.9	560	396	19.6	0.36	8.5	10.7	212	5.7	543	415	15.1	0.29	5.7	9.1
	2009 3	F	4.8	299	7.5	744	545	20.1	0.36	9.9	9.8	266	7.4	756	585	16.4	0.30	7.3	8.8	229	7.3	742	600	13.2	0.25	5.3	7.7
	2009 4	C	3.2	299	4.9	417	219	30.4	0.55	15.0	14.8	248	4.9	436	280	22.3	0.41	9.4	12.5	196	4.7	417	300	16.6	0.32	6.0	10.3
Shanmenxia	2009 1	C	4.5	304	6.6	569	365	23.3	0.42	11.7	11.2	263	6.6	582	413	18.1	0.33	8.0	9.8	218	6.5	565	432	13.9	0.26	5.3	8.3

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	2009	2	R	5.6	285	6.9	268	80	19.9	0.36	9.4	10.1	224	6.9	290	153	13.6	0.26	5.3	8.0	164	6.7	270	176	9.4	0.19	3.1	6.1
	2009	3	R	4.3	305	6.4	573	369	24.2	0.44	12.2	11.6	264	6.4	587	417	18.8	0.35	8.4	10.1	219	6.3	570	436	14.4	0.27	5.6	8.6
	2009	4	C	6.1	306	7.2	174	-22	21.9	0.40	11.1	10.4	219	7.1	207	78	12.8	0.24	5.0	7.6	146	6.9	184	104	8.0	0.16	2.6	5.3
Shangqiu	2009	1	F	6.8	340	8.7	452	216	22.5	0.40	12.5	9.5	281	8.6	473	289	15.5	0.28	7.2	8.0	217	8.4	449	316	10.6	0.20	4.1	6.3
	2009	2	F	5.9	288	8.8	852	662	15.9	0.29	7.6	8.0	260	8.8	863	697	13.3	0.25	5.8	7.2	229	8.7	851	709	11.1	0.21	4.4	6.5
	2009	3	F	6.7	365	9.2	659	399	25.0	0.43	14.9	9.7	313	9.2	677	465	17.9	0.32	9.3	8.4	254	9.0	653	492	12.6	0.23	5.4	7.0
	2009	4	F	6.3	329	9.0	717	491	20.3	0.36	11.0	9.0	290	8.9	731	540	15.8	0.29	7.6	7.9	244	8.8	713	559	12.1	0.22	5.0	6.8
Xinxiang	2008	1	F	6.8	228	7.6	118	-23	12.6	0.24	5.0	7.4	162	7.5	141	49	8.2	0.16	2.7	5.3	106	7.4	124	68	5.4	0.12	1.6	3.6
	2008	2	F	6.4	414	9.4	766	457	30.1	0.56	18.8	10.7	359	9.3	784	530	23.7	0.41	13.9	9.4	288	9.1	754	564	15.4	0.28	7.4	7.7
	2009	3	C	5.6	443	7.6	398	58	40.8	0.82	25.9	14.1	343	7.5	435	196	26.4	0.47	14.9	11.1	236	7.2	393	246	14.0	0.26	5.7	8.1
	2009	4	F	7.1	364	9.5	566	306	24.3	0.42	14.5	9.4	305	9.4	588	383	16.6	0.30	8.4	7.9	242	9.2	563	411	11.4	0.21	4.7	6.5
	2009	5	C	7.7	311	9.5	437	227	17.1	0.31	8.8	8.0	259	9.5	456	291	12.3	0.23	5.4	6.7	204	9.3	436	313	8.9	0.17	3.3	5.4
Zhengzhou	2009	1	C	6.1	305	7.8	397	192	20.0	0.36	10.1	9.5	253	7.8	415	255	14.4	0.27	6.2	8.0	196	7.6	394	277	10.3	0.20	3.7	6.4

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	2009	2	C	6.1	300	7.0	110	-90	21.6	0.39	10.7	10.5	201	6.9	145	25	11.7	0.22	4.3	7.2	115	6.6	118	57	6.5	0.14	2.0	4.3
	2009	3	C	6.1	314	7.8	391	179	21.1	0.38	10.9	9.8	257	7.8	411	247	14.9	0.28	6.5	8.1	198	7.6	389	271	10.4	0.20	3.8	6.4
Zhoukou	2008	1	F	6.8	197	8.6	497	377	9.1	0.17	3.3	5.6	175	8.6	505	400	7.9	0.15	2.7	5.1	155	8.5	498	406	6.9	0.14	2.3	4.5
	2008	2	F	6.3	322	9.1	789	568	19.1	0.34	10.1	8.6	285	9.1	802	615	15.1	0.28	7.1	7.7	244	8.9	786	633	11.9	0.22	5.0	6.7
	2008	3	F	6.0	316	9.3	960	745	18.0	0.32	9.4	8.3	287	9.2	970	781	15.0	0.27	7.1	7.6	252	9.1	956	796	12.2	0.23	5.2	6.8
	2008	4	F	6.8	320	8.7	455	237	19.7	0.35	10.4	9.0	266	8.6	474	303	14.1	0.26	6.3	7.6	210	8.4	453	326	10.1	0.19	3.8	6.1
	2008	5	F	7.5	307	8.4	110	-97	18.8	0.34	9.6	8.9	205	8.3	147	24	10.0	0.19	3.7	6.1	116	8.0	119	57	5.4	0.12	1.7	3.6
	2009	6	F	4.6	303	6.8	572	369	22.5	0.41	11.3	10.8	261	6.8	587	420	17.4	0.32	7.7	9.4	217	6.7	570	438	13.4	0.25	5.2	8.0
	2009	7	F	4.1	324	6.5	608	387	27.2	0.49	14.5	12.2	281	6.4	623	439	20.8	0.38	9.7	10.7	231	6.3	604	460	15.6	0.29	6.3	9.1
	2009	8	F	4.4	324	6.6	568	346	26.7	0.48	14.2	12.0	279	6.6	584	402	20.1	0.37	9.4	10.4	227	6.4	564	424	14.9	0.28	5.9	8.7
	2009	9	F	4.2	321	7.1	805	587	24.2	0.43	12.8	11.0	285	7.1	819	632	19.3	0.35	9.2	9.8	245	7.0	803	649	15.3	0.29	6.4	8.6
	2009	10	F	8.6	404	10.0	202	-97	27.3	0.50	17.0	9.9	288	9.9	241	51	14.2	0.26	6.8	7.1	169	9.5	200	103	6.8	0.13	2.3	4.4
Zhumadian	2008	1	F	10.3	244	10.9	54	-97	9.7	0.18	4.0	5.5	151	10.8	87	4	5.3	0.11	1.7	3.5	79	10.6	67	28	2.8	0.07	0.9	1.9

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2008	2	R	3.6	328	7.7	1236	1011	23.5	0.42	12.7	10.4	302	7.6	1245	1044	20.0	0.36	9.9	9.7	271	7.5	1233	1057	16.7	0.31	7.6	8.8
2008	3	R	5.8	293	9.1	952	758	15.9	0.29	7.7	7.9	266	9.0	962	791	13.5	0.25	6.0	7.2	237	9.0	951	803	11.3	0.21	4.6	6.5
2008	4	R	5.1	309	9.0	1157	949	17.8	0.32	9.1	8.4	285	8.9	1166	979	15.3	0.28	7.2	7.8	256	8.8	1154	991	12.9	0.24	5.6	7.1
2008	5	F	4.6	370	7.7	852	587	30.9	0.53	18.7	11.7	327	7.7	866	642	23.4	0.42	12.6	10.4	275	7.5	845	666	17.1	0.31	7.9	8.9
2008	6	C	4.3	329	8.2	1165	938	22.1	0.39	11.9	9.7	302	8.2	1174	973	18.6	0.34	9.3	9.0	269	8.1	1161	987	15.3	0.28	6.9	8.1
2009	7	F	7.5	246	9.1	401	246	11.8	0.22	5.0	6.7	208	9.0	415	289	9.3	0.18	3.5	5.7	172	8.9	402	303	7.4	0.15	2.5	4.8

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