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Adaptation to Climate Change, Grain Food Security, and Economic Growth in China:
A Multi-Regional General Equilibrium Analysis

Huang Delin, Li Xinxing, Chenggang Wang, li Ximing, Cai Songfeng, Li Xiangyang

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1. Background

In fifty to one hundred years, weather conditions will remain a principal factor affecting China's agricultural production and Chinese farmers' livelihood. Climate change's implications for grain food security is and will in many years remain a highly important research area among China's researchers and policy makers.

Recognizing the significance of climate change research, Chinese government has included in the National Key Basic Research Initiatives (973 Initiatives) a research project (grant number: 2010CB951500), entitled “The Impact of Climate Change on China’s Grain Production System and Adaptation Mechanisms.” Launched in 2010, the project contains four major components: 1) simulative forecasting of temporal dynamics of China’s staple grain production under climate change scenarios; 2) simulative forecasting of spatial patterns of China’s staple grain production under climate change scenarios; 3) system evaluation and policy analysis of climate change’s impact on China’s staple grain production; and 4) climate change’s impact on the spatial distribution of China’s grain food production and adaptation mechanism.

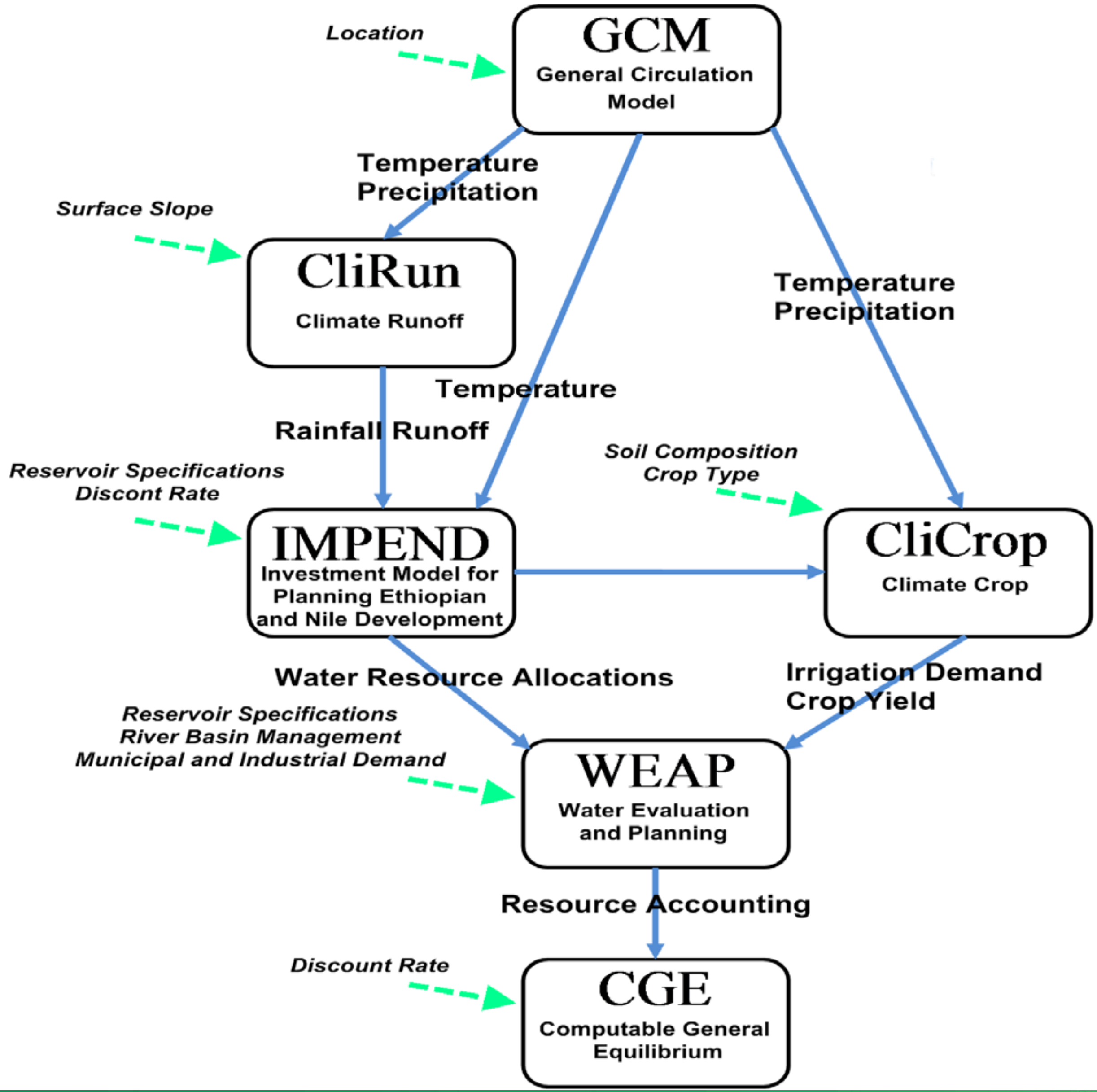
It is not difficult for us to study the economics policies and strategies of food security

The difficult is how to resolve the two Adaptation

Adaptation to Climate Change, Grain Food Security, and Economic Growth in China:

Food production to adapt to climate change

Sherman Robinson (IFPRI), Economics of Climate Change Adaptation: Ethiopia


Location
GCM
General Circulation Model
Temperature
Precipitation
Surface Slope
CliRun
Climate Runoff
Temperature
Precipitation
Temperature
Rainfall Runoff
Reservoir Specifications
Discont Rate
Soil Composition
Crop Type
IMPEND
Investment Model for Planning Ethiopian and Nile Development
CliCrop
Climate Crop
Water Resource Allocations
Irrigation Demand
Crop Yield
Reservoir Specifications
River Basin Management
Municipal and Industrial Demand
WEAP
Water Evaluation and Planning
Resource Accounting
Discount Rate
CGE
Computable General Equilibrium

Ye et al. (2012)

Table 1. Changes in climatic conditions under two emissions scenarios

Year	A2 Scenario①			B2 Scenario		
	Temperature increase/℃	Precipitation increase/%	CO_2/(μmol/L) Carbon dioxide	Temperature increase/℃	Precipitation increase/%	CO_2 /(μmol/L) Carbon dioxide
2020	1.4	3.3	440	0.9	3.7	429
2050	2.6	7.0	559	1.5	7.0	492

Note：①A2 and B2 were published by IPCC as the Special Report on Emissions Scenarios (SRES). The “A2”is high emissions Scenario， “B2” is medium-low emissions Scenario.

Table 2. Yield projections of China's three staple grains (unit: kilograms)

	A2 Scenario			B2 Scenario		
Year	Rice	Wheat	Maize	Rice	Wheat	Maize
2009	6585.3	4739	5258.5	6585.3	4739	5258.5
2015	6994.6	4700.5	5305.2	6986.7	4737.6	5320.3
2020	7047.8	4667.3	5394.4	7173.4	4686.8	5468.4
2025	7100.9	4634.1	5483.5	7360.1	4636.1	5616.4
2030	7239.6	4765	5550	7308.9	4733.8	5602.8
2035	7378.4	4895.9	5616.5	7257.7	4831.6	5589.1
2040	7521.1	5032.3	5684.2	7207	4932.5	5575.6
2045	7668.1	5174.4	5753.2	7156.9	5036.5	5562.1
2050	7815	5316.5	5822.1	7106.8	5140.5	5548.5

Note: The results account for the fertilization effect of CO2.

2.Methodology and Data Sources

China’s Multi-Regional Computable General Equilibrium database contains 176 sectors. The database was derived from the 2007 national and provincial input-output table and regional trade data, covering 31 provinces and autonomous regions. Some data variables were constructed with a top-down approach, dividing proportionally the national values into individual regions. Other variables were constructed with a bottom-up approach, combining the regional CGE models to obtain the national values with the weighted average of regional variables.

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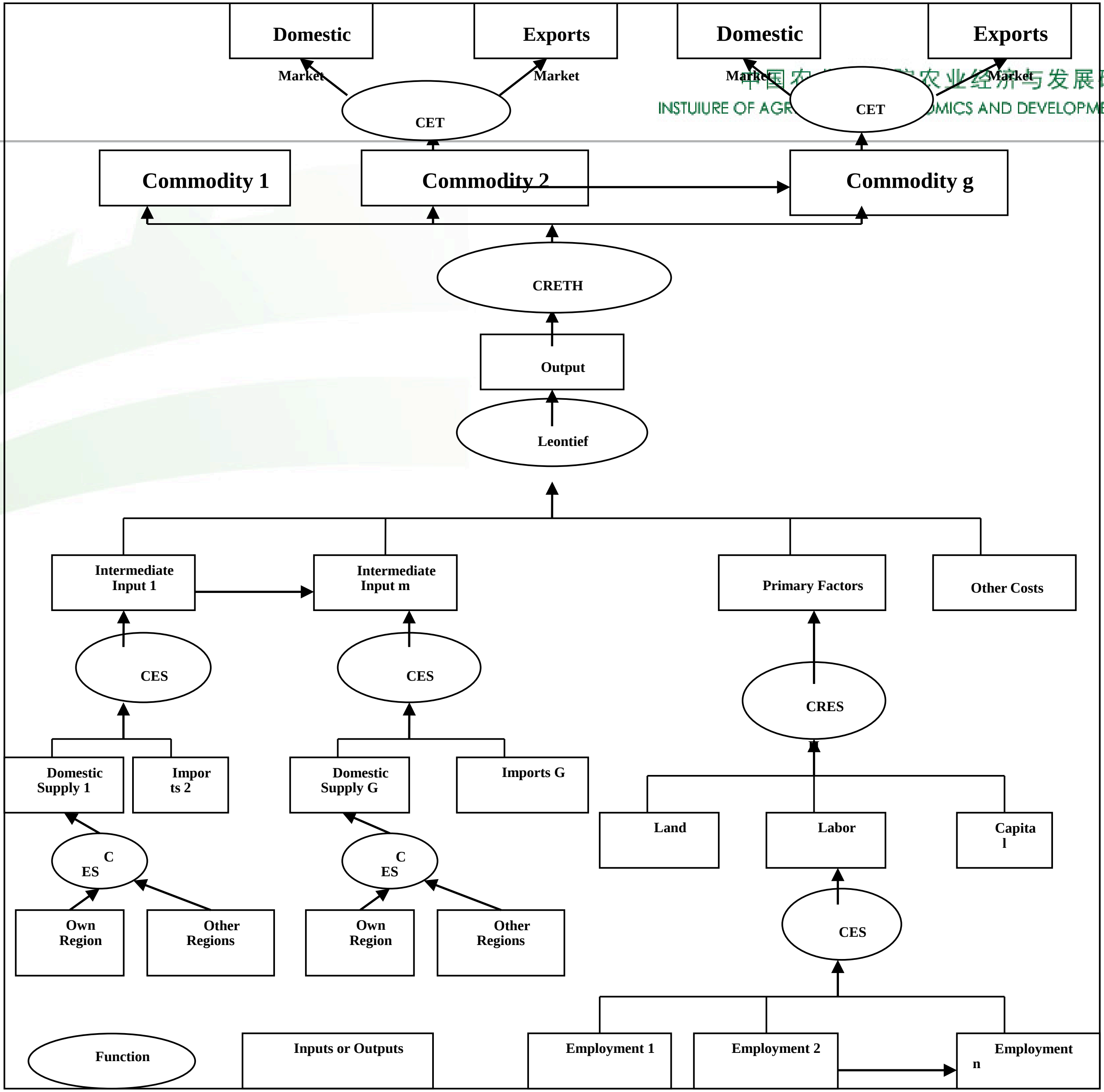
2.1 Structure



2.2Database

		Demand Matrix					
		1	2	3	4	5	6
		Production	Investment	Household Consumption	Exports	Government Purchases	Inventory
	Dimension	I	I	1	1	1	1
Intermediate Input	C´S	V1BAS	V2BAS	V3BAS	V4BAS	V5BAS	V6BAS
Distributional Input	C´S´N	V1MAR	V2MAR	V3MAR	V4MAR	V5MAR	V6MAR
Indirect Tax	C´S	V1TAX	V2TAX	V3TAX	V4TAX	V5TAX	V6TAX
Labor	M	V1LAB	C =	Number of products			
Capital	1	V1CAP	I =	Number of sectors			
Land	1	V1LND	S =	2（Domestically produced or imported）			
Production Tax	1	V1PTX	O =	Number of employment types			
Other Input	1	V1OCT	M =	Number of distributional inputs			

	Production Matrix			Tariff Vector
Dimension	I		Dimension	1
C	MAKE		C	V0TAR

Figure 2. Multi-Regional CGE model input-output table

2.3The schematic illustration of the MRCGE database

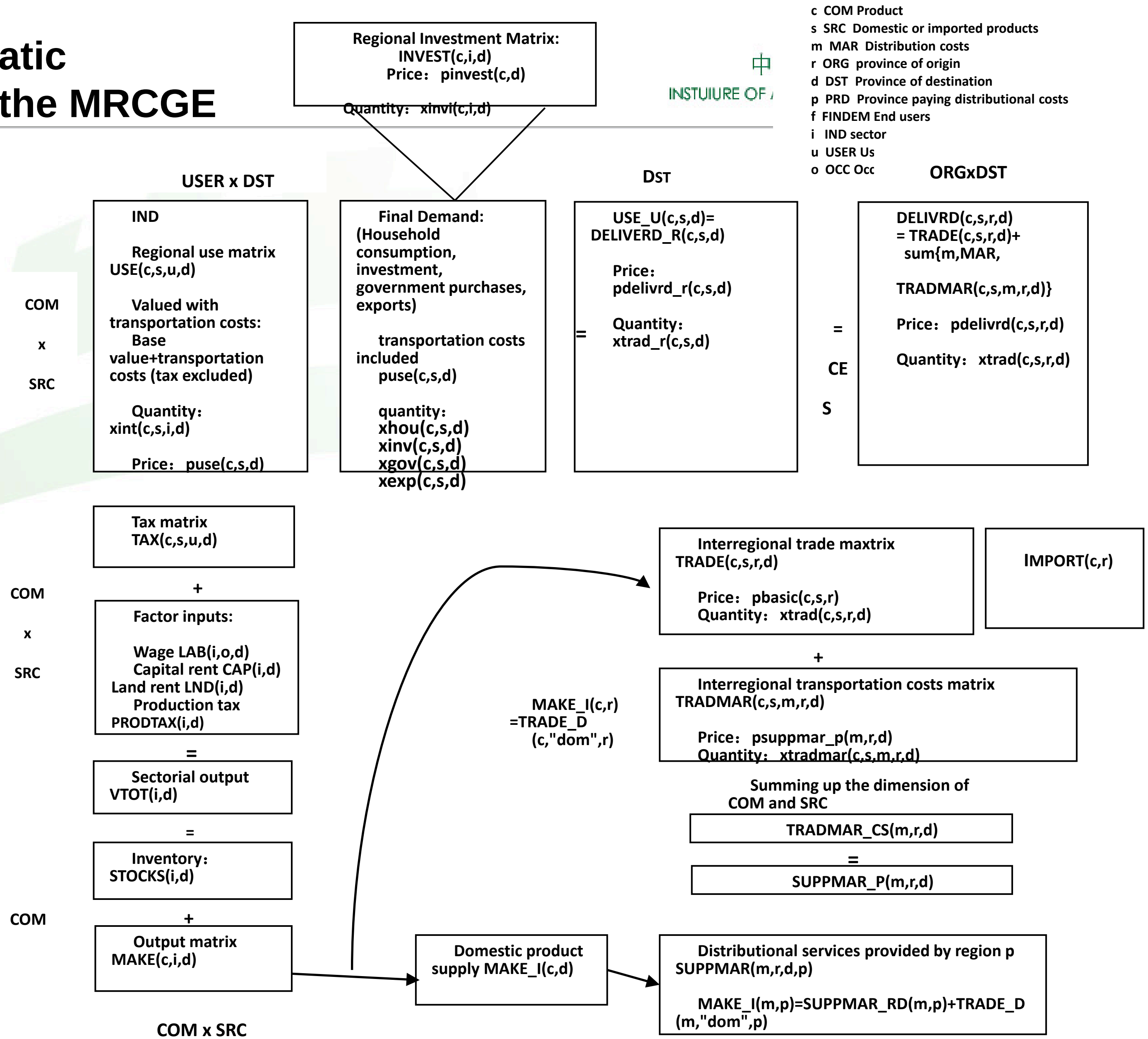


Figure3. The schematic illustration of the MRCGE database

3 Simulation schemes

3.1 Principles of policy simulation

The sectorial production function is assumed to be the Leontief for all regions, implying output is determined by the minimum input. The inputs include primary factors and intermediate inputs, returns to scales is assumed to be constant, and no substituation is allowed between intermediate inputs. The input bundle used in simulation is expressed as

$$xprim(i,d) = xtot(i,d) * atot(i,d) * aprim(i,d)$$

where *atot(i,d)* is the technological parameter of all inputs in sector i of region d, *aprim(i,d)* is the technological parameter of primary inputs in sector i of region d, *xtot(i,d)* is the output of sector i of region d, *xprim(i,d)* is the bundle of primary factors. The simulation was conducted with respect to changes in the technological parameter of all inputs, *atot(i,d)*. When that parameter decreases, ceteris paribus, the output in sector i will increase.

3.2.Policy simulation schemes

Simulation scheme 1: Under the A2 (high emissions) scenario, in 2030 the production of rice, wheat, and corn will be 9.94%, 0.55%, and 5.54% higher than the production under the baseline scenario. In 2050, they will be 18.67%, 12.19%, and 10.72% higher.

Simulation scheme 2: Under the B2 (medium-low emissions) scenario, in 2030, the production of rice, wheat, and corn will be 10.99%, -0.11%, and 6.55% higher than the production under the baseline scenario. In 2050, they will be 7.92%, 8.47%, and 5.51% higher.

Table 3. Production change under climate change scenarios

	A2 scenario			B2 scenario		
Year	Rice	Wheat	Corn	Rice	Wheat	Corn
2030	9.94%	0.55%	5.54%	2.91%	2.91%	6.57%
2050	18.67%	12.19%	10.72%	10.87%	10.87%	24.02%

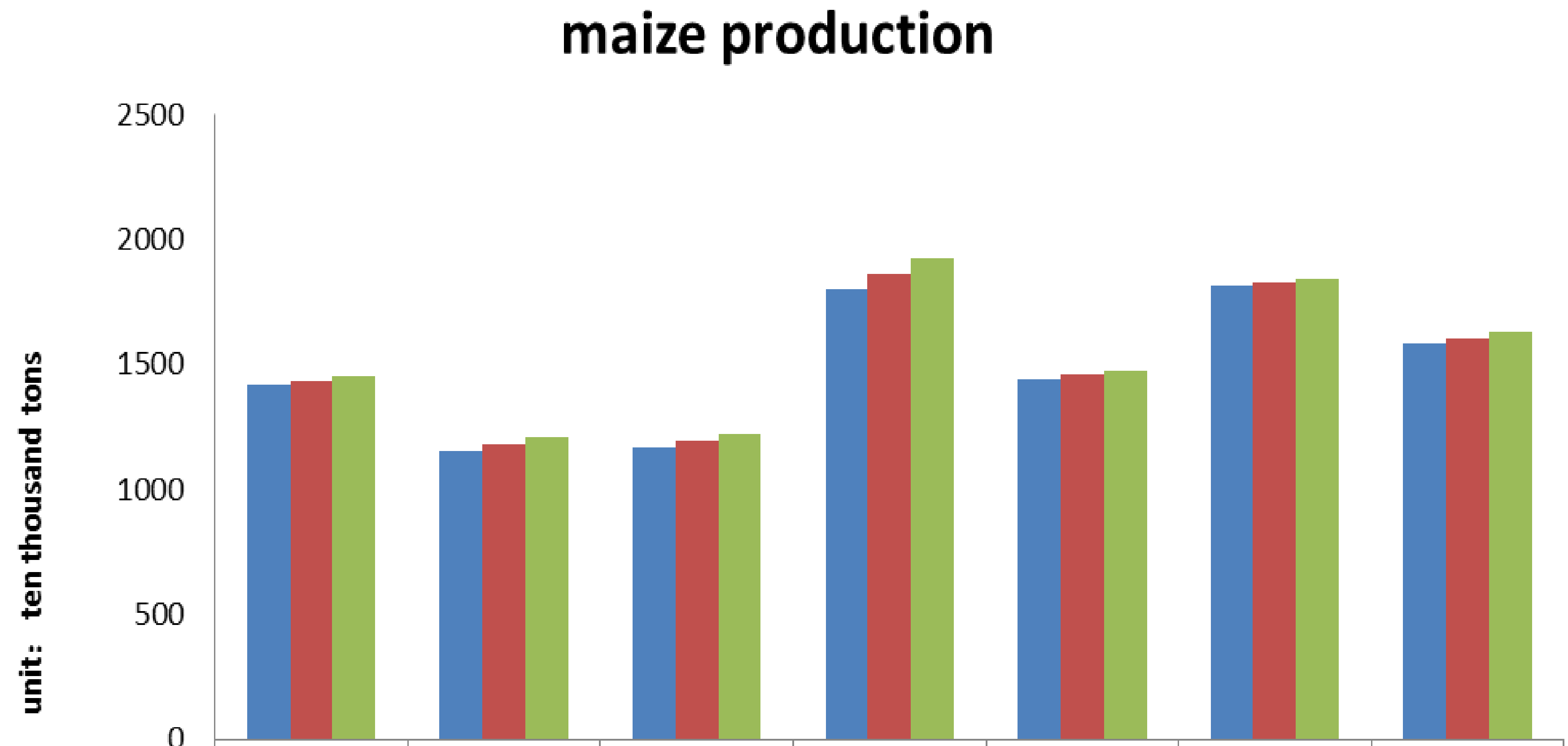
Note: The results account for the fertilization effect of carb

4.Simulation results

4.1 Future trends of grain food production

Under the A2 (high emissions) climate change scenario,

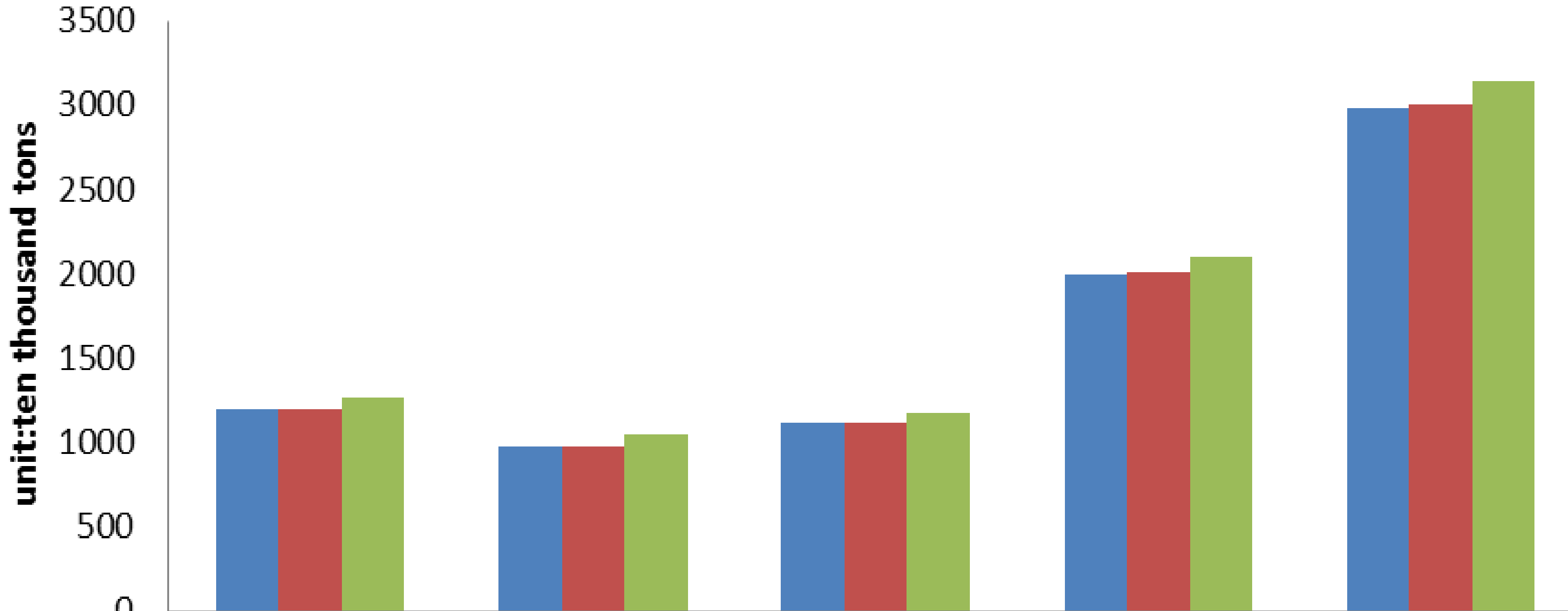
Forecasts of grain food production under A2 climate change scenario



	Hebei	Neimenggu	Liaoning	Jilin	Heilongjiang	Shandong	Henan
Maize 2007	1421.8	1155.3	1167.8	1800	1442	1816.5	1582.5
Maize 2030	1436.59	1179.21	1193.37	1860.84	1460.03	1829.22	1604.66
Maize 2050	1455.07	1206.25	1221.17	1926.36	1478.05	1845.2	1631.24

Forecasts of grain food production under A2 climate change scenario

wheat production



	Hebei	Jiangsu	Anhui	Shandong	Henan
Wheat 2007	1193.7	973.8	1111.3	1995.6	2980.2
Wheat 2030	1200.5	979.93	1121.3	2004.98	3005.53
Wheat 2050	1265.56	1042.26	1174.53	2103.36	3144.41

Forecasts of grain food production under A2 climate change scenario

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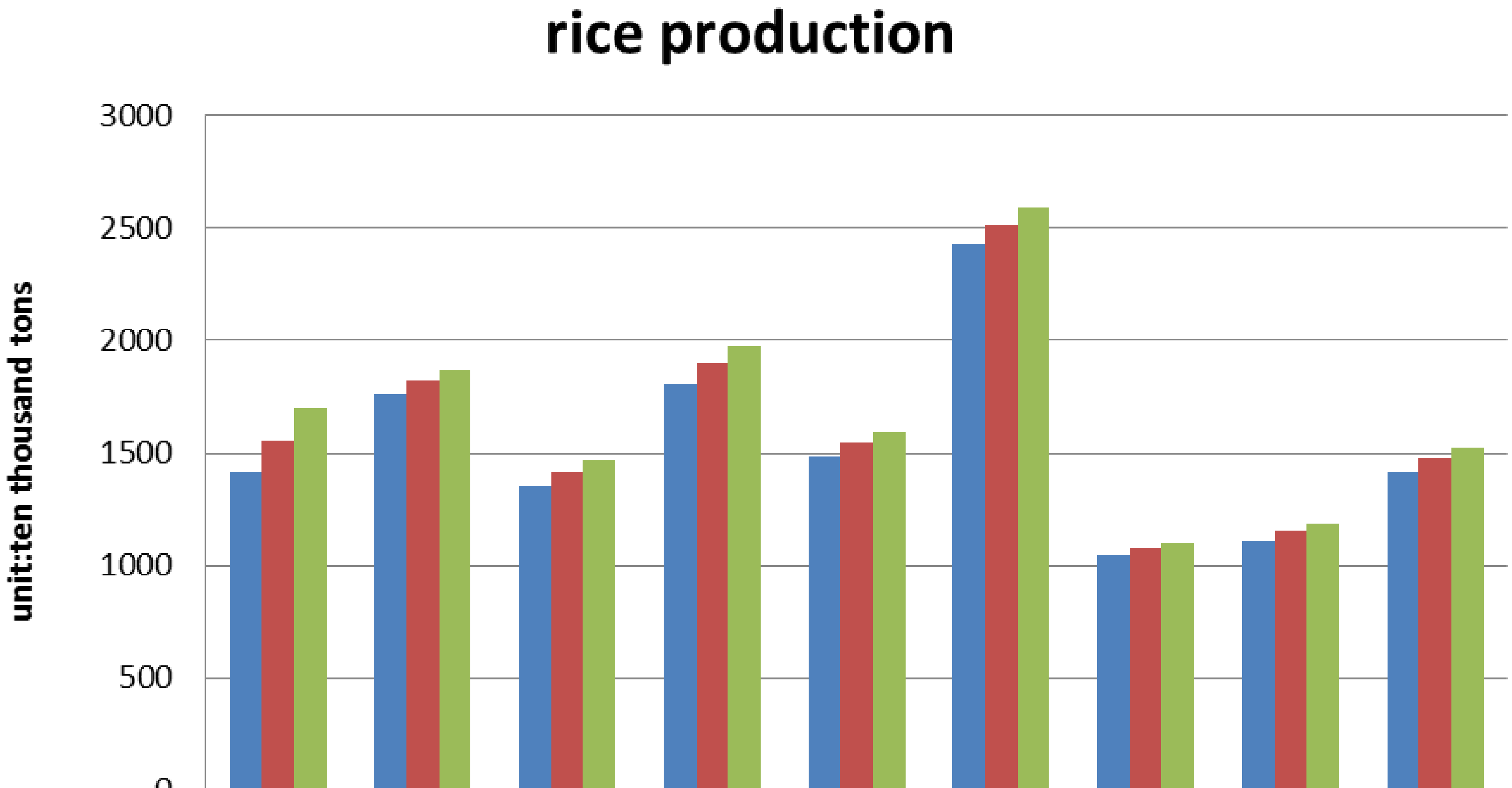
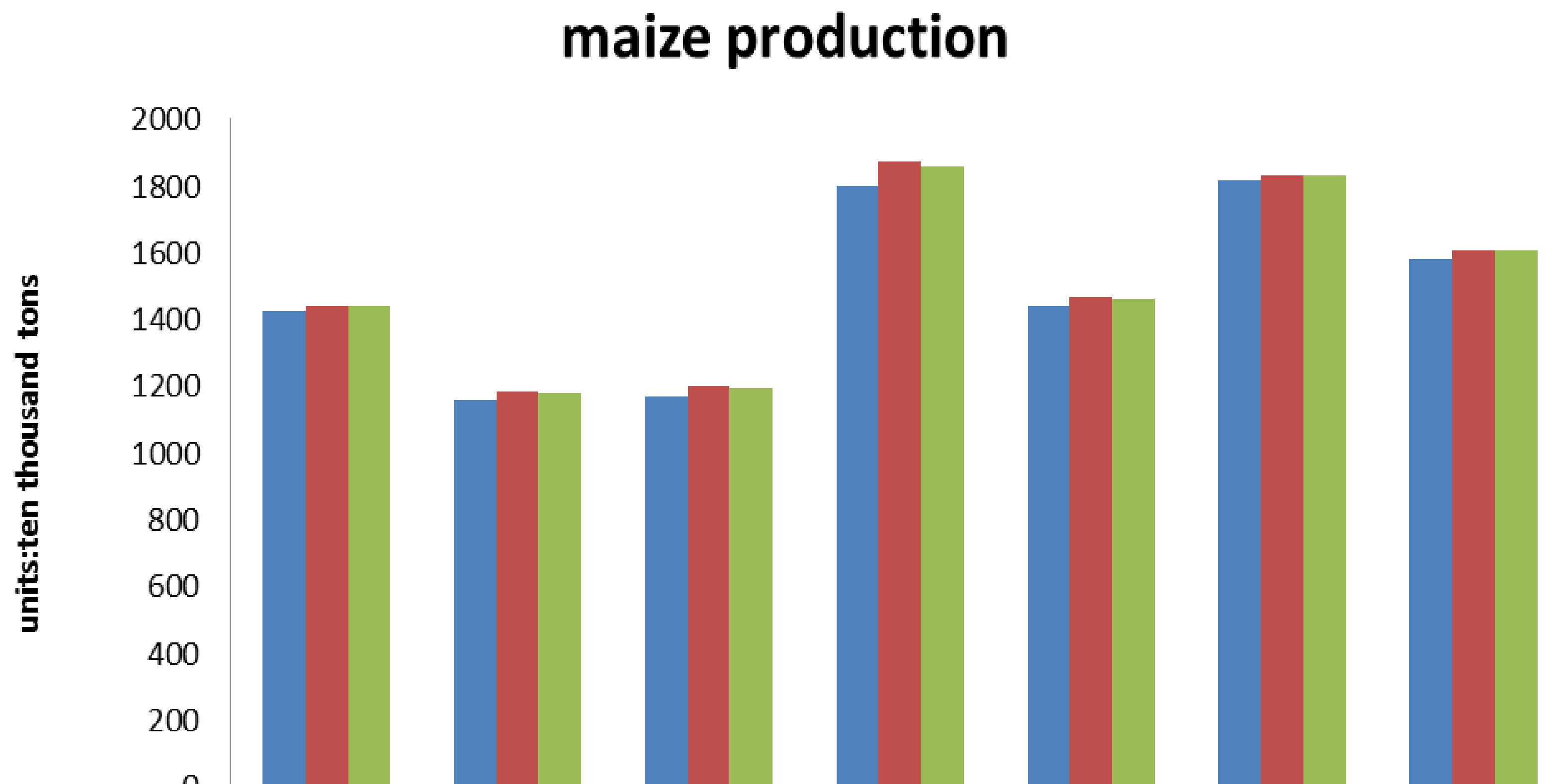


	Heilongjiang	Jiangsu	Anhui	Jiangxi	Hubei	Hunan	Guangdong	Guangxi	Sichuan
Rice 2007	1417.9	1761.1	1356.4	1806.4	1485.9	2425.7	1046.1	1112.5	1419.7
Rice 2030	1555.58	1823.27	1413.64	1896.72	1545.48	2517.63	1079.26	1152.44	1476.77
Rice 2050	1701.62	1872.58	1466.27	1978.37	1595.86	2591.86	1104.79	1184.15	1525.75

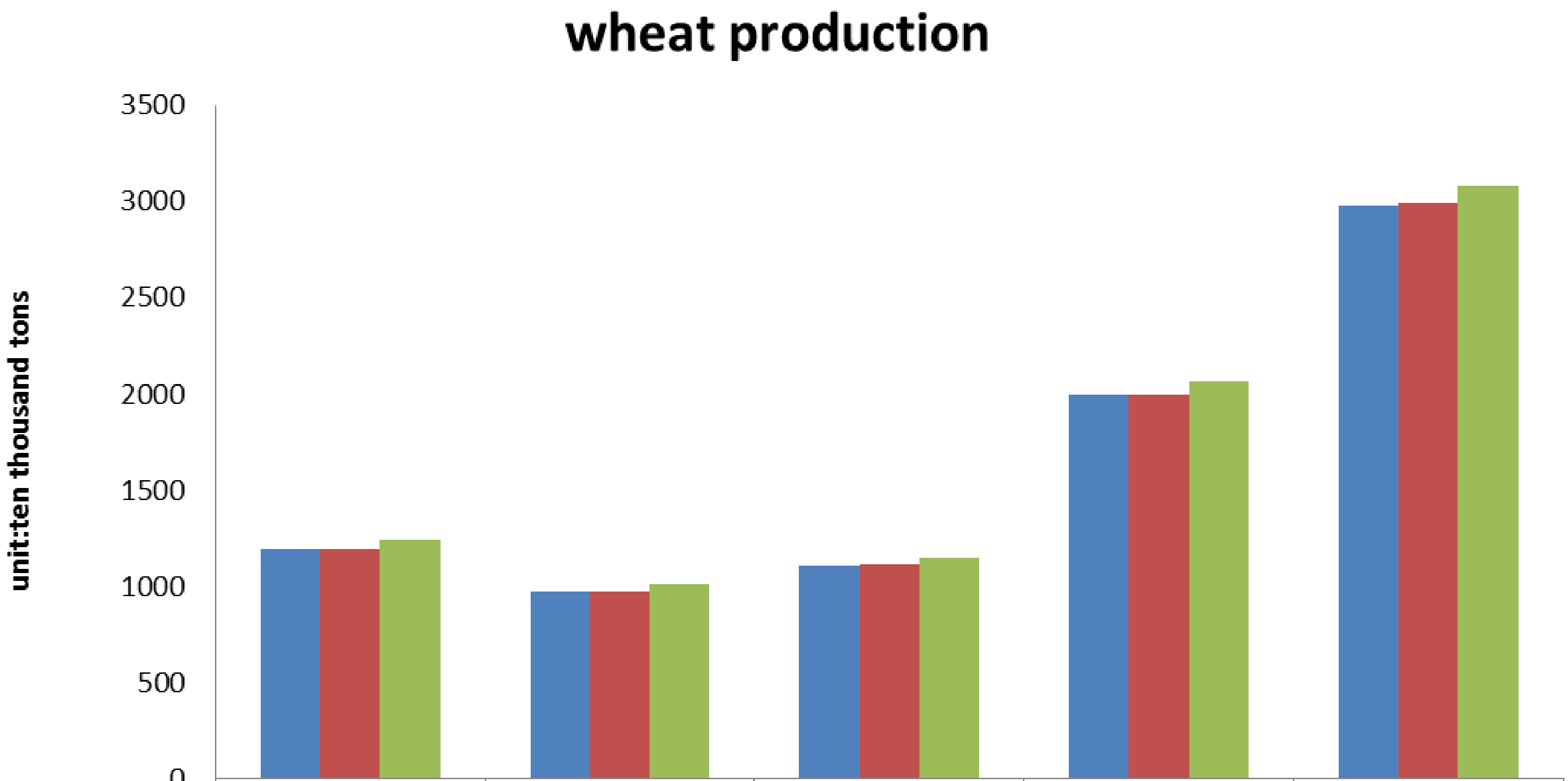
Under the B2 (medium-low emissions) climate change scenario,

Forecasts of grain food production under B2 climate change scenario



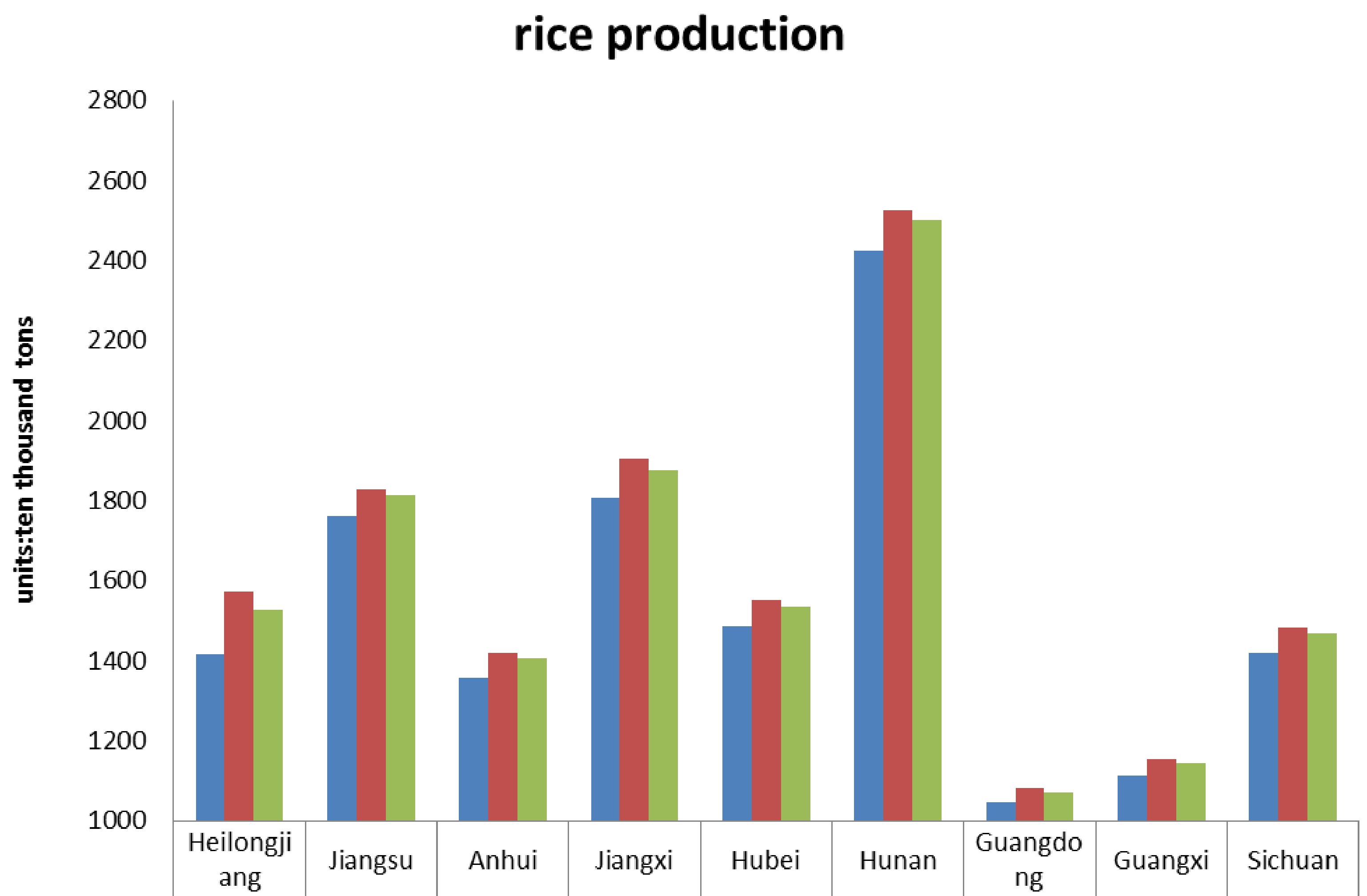
	Hebei	Neimenggu	Liaoning	Jilin	Heilongjiang	Shandong	Henan
Maize 2007	1421.8	1155.3	1167.8	1800	1442	1816.5	1582.5
Maize 2030	1439.15	1183.49	1198.16	1872.54	1463.05	1831.21	1607.98
Maize 2050	1438.29	1179.79	1192.91	1859.76	1459.45	1830.85	1606.71

Forecasts of grain food production under B2 climate change scenario



	Hebei	Jiangsu	Anhui	Shandong	Henan
Wheat 2007	1193.7	973.8	1111.3	1995.6	2980.2
Wheat 2030	1197.76	977.21	1119.63	2000.59	3001.06
Wheat 2050	1241.45	1018.59	1150.86	2067.84	3086

Forecasts of grain food production under B2 climate change scenario



	Heilongjiang	Jiangsu	Anhui	Jiangxi	Hubei	Hunan	Guangdong	Guangxi	Sichuan
Rice 2007	1417.9	1761.1	1356.4	1806.4	1485.9	2425.7	1046.1	1112.5	1419.7
Rice 2030	1572.31	1829.25	1419.34	1906.29	1551.43	2526.85	1082.5	1156.44	1482.59
Rice 2050	1527.79	1813.58	1406.72	1879.2	1536.72	2501.87	1073.19	1145.88	1467.69

4.2 Future trends of grain food price

Price of maize (per 50kg)

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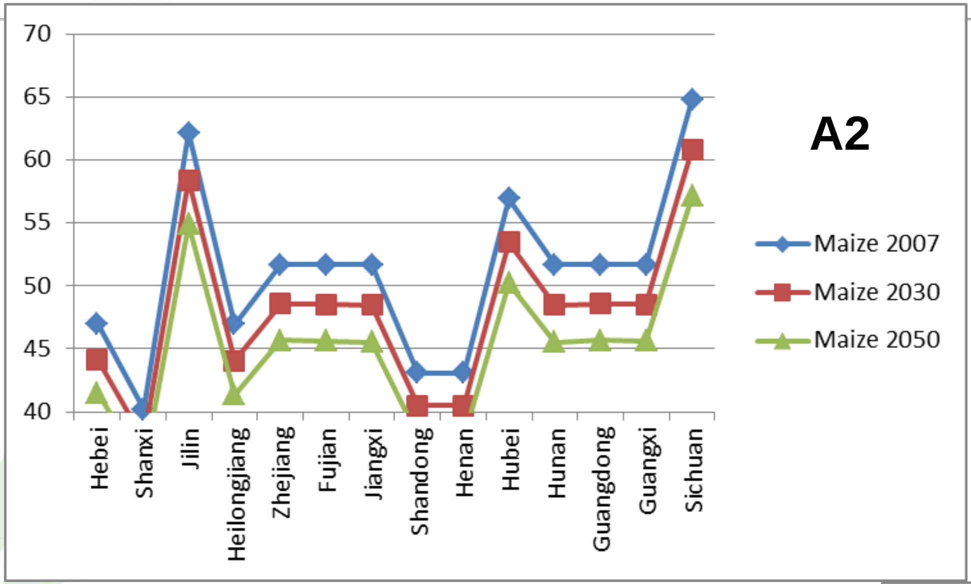
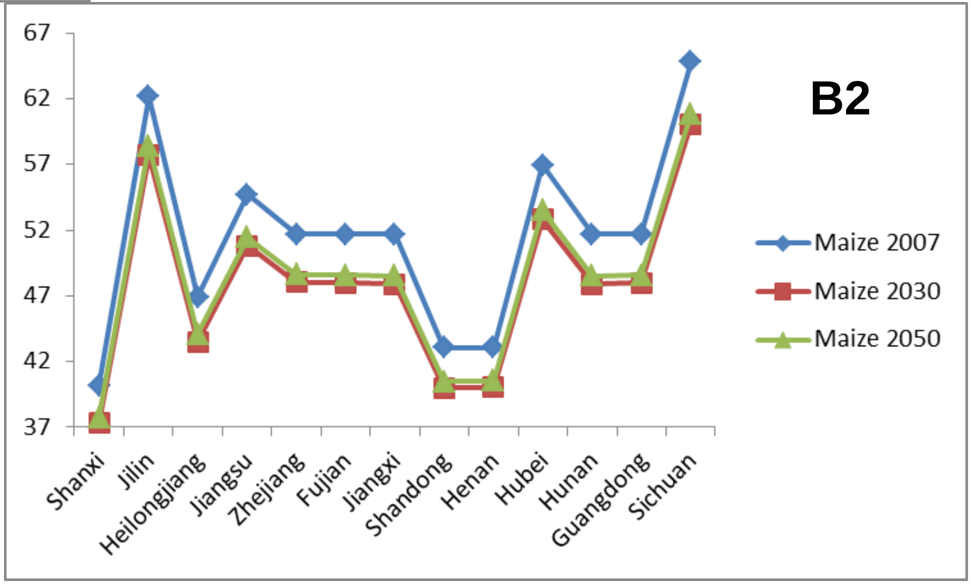
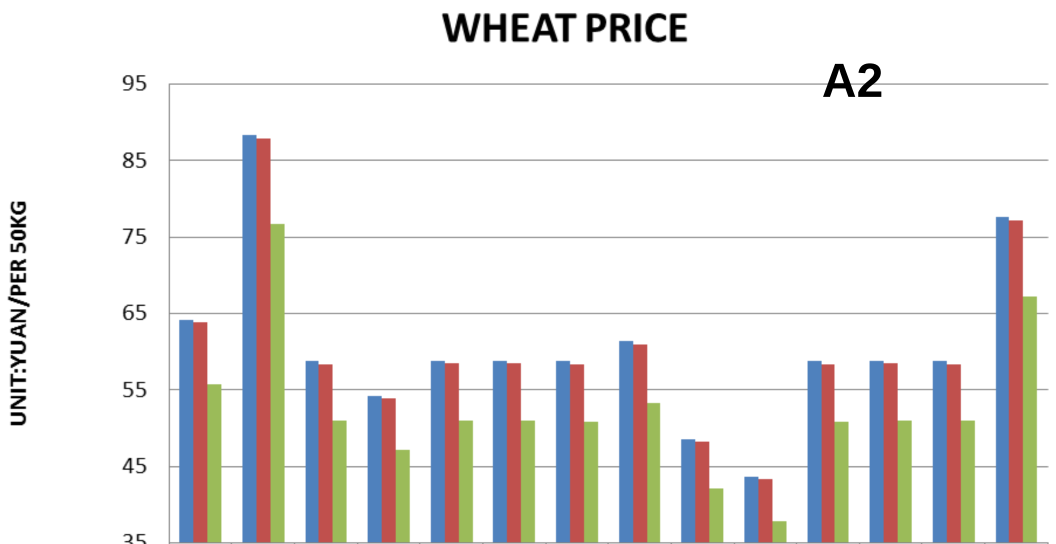
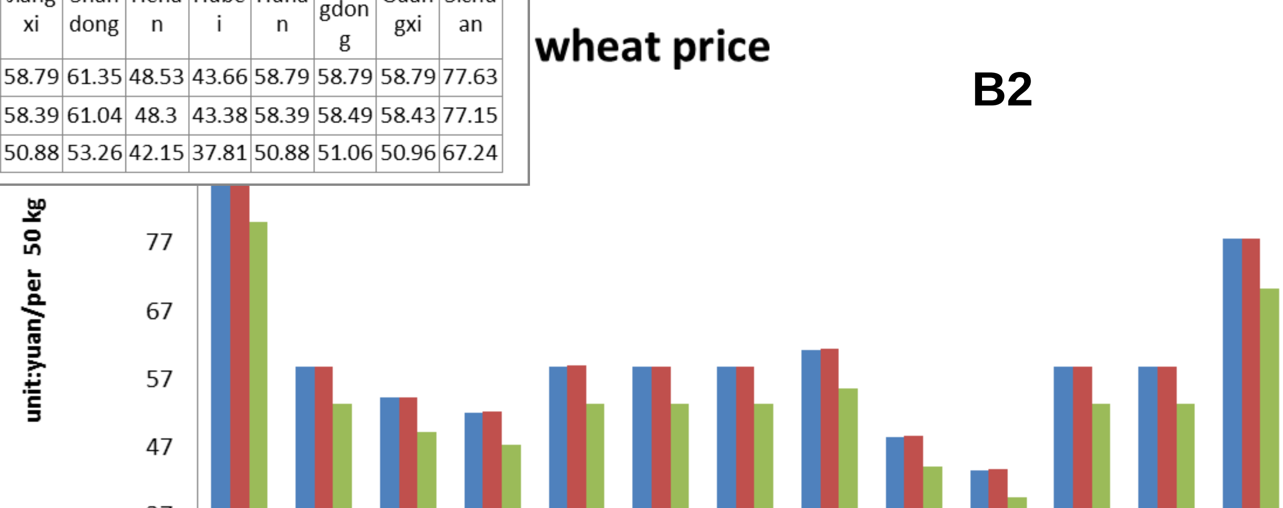


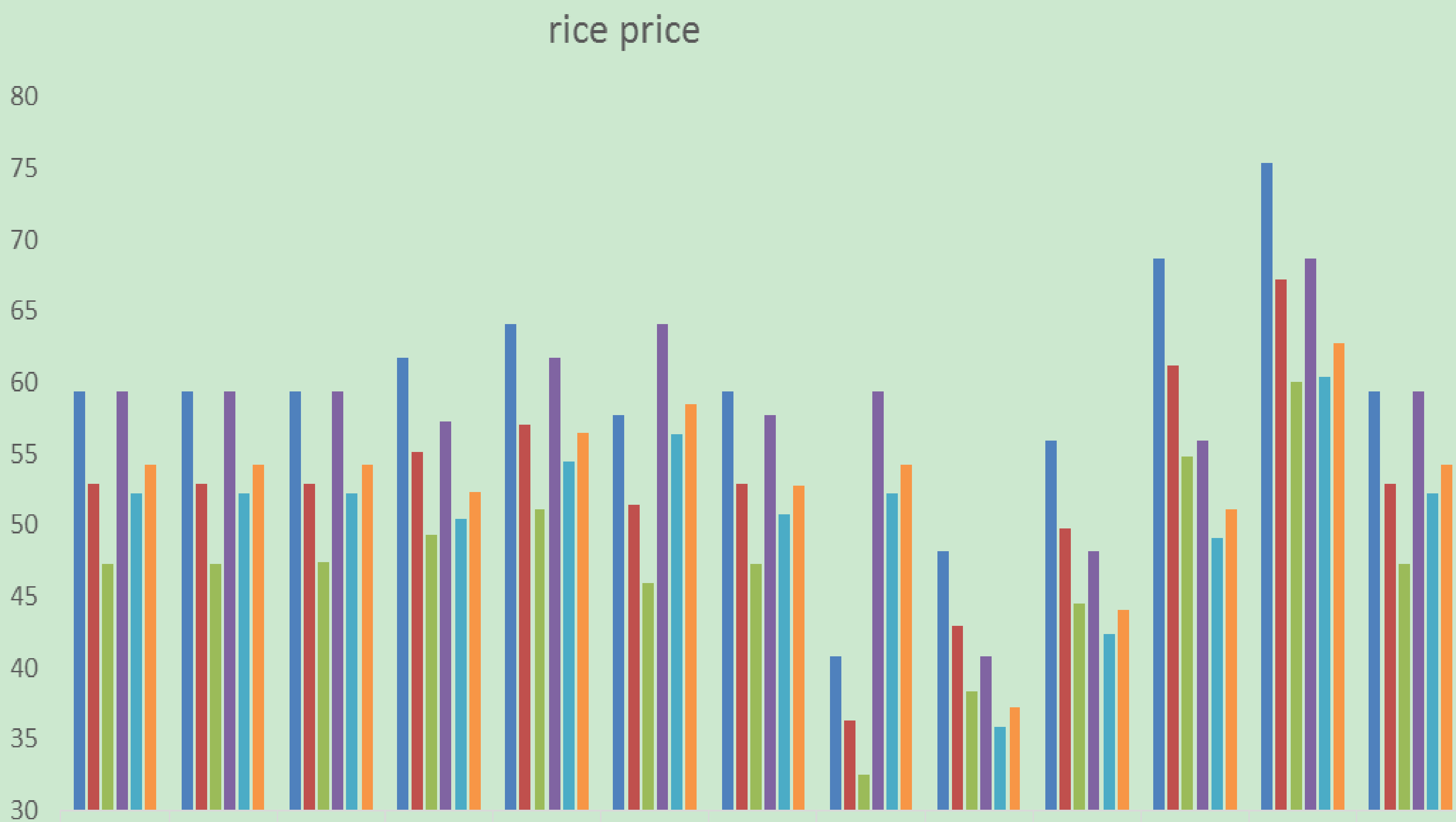




	Hebei	Shanxi	Jilin	Heilongjiang	Zhejiang	Fujian	Jiangxi	Shandong	Henan	Hubei	Hunan	Guangdong	Guangxi	Sichuan
Wheat 2007	64.24	88.36	58.79	54.28	58.79	58.79	58.79	61.35	48.53	43.66	58.79	58.79	58.79	77.63
Wheat 2030	63.91	87.87	58.43	53.93	58.5	58.47	58.39	61.04	48.3	43.38	58.39	58.49	58.43	77.15
Wheat 2050	55.78	76.67	51.04	47.15	51.08	51.02	50.88	53.26	42.15	37.81	50.88	51.06	50.96	67.24



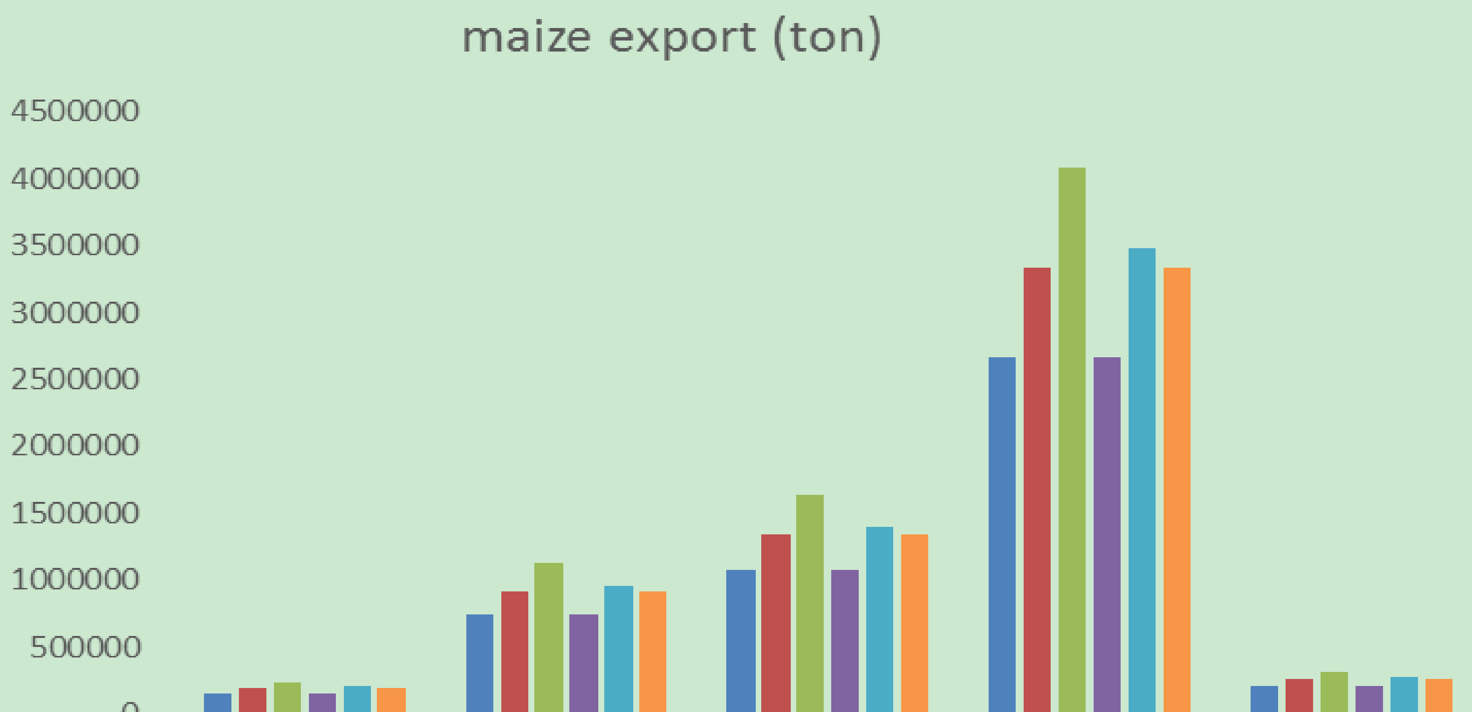
	Shanxi	Jilin	Heilongjiang	Jiangsu	Zhejiang	Fujian	Jiangxi	Shandong	Henan	Hubei	Hunan	Guangdong	Sichuan
Wheat 2007	88.36	58.79	54.28	52.06	58.79	58.79	58.79	61.35	48.53	43.66	58.79	58.79	77.63
Wheat 2030	88.51	58.84	54.31	52.17	58.94	58.9	58.81	61.48	48.66	43.7	58.81	58.92	77.72
Wheat 2050	80.2	53.39	49.31	47.28	53.39	53.37	53.32	55.69	44.07	39.6	53.32	53.39	70.41



	Hebei	Jilin	Heilongjiang	Zhejiang	Fujian	Jiangxi	Shandong	Henan	Hubei	Hunan	Guangdong	Guangxi	Sichuan
A2-- RICE price 2007	59.36	59.36	59.36	61.8	64.04	57.77	59.36	40.77	48.23	55.95	68.65	75.43	59.36
A2-- RICE price 2030	52.95	52.91	52.93	55.12	57.09	51.43	52.93	36.36	42.96	49.8	61.23	67.2	52.89
A2-- RICE price 2050	47.36	47.33	47.37	49.33	51.06	45.95	47.34	32.53	38.39	44.48	54.79	60.09	47.27
B2--Rice price 2007	59.36	59.36	59.36	57.26	61.8	64.04	57.77	59.36	40.77	48.23	55.95	68.65	59.36
B2--Rice price 2030	52.25	52.23	52.25	50.41	54.42	56.35	50.76	52.26	35.9	42.41	49.15	60.45	52.21
B2--Rice price 2050	54.23	54.22	54.23	52.33	56.5	58.52	52.74	54.23	37.26	44.04	51.07	62.75	54.22

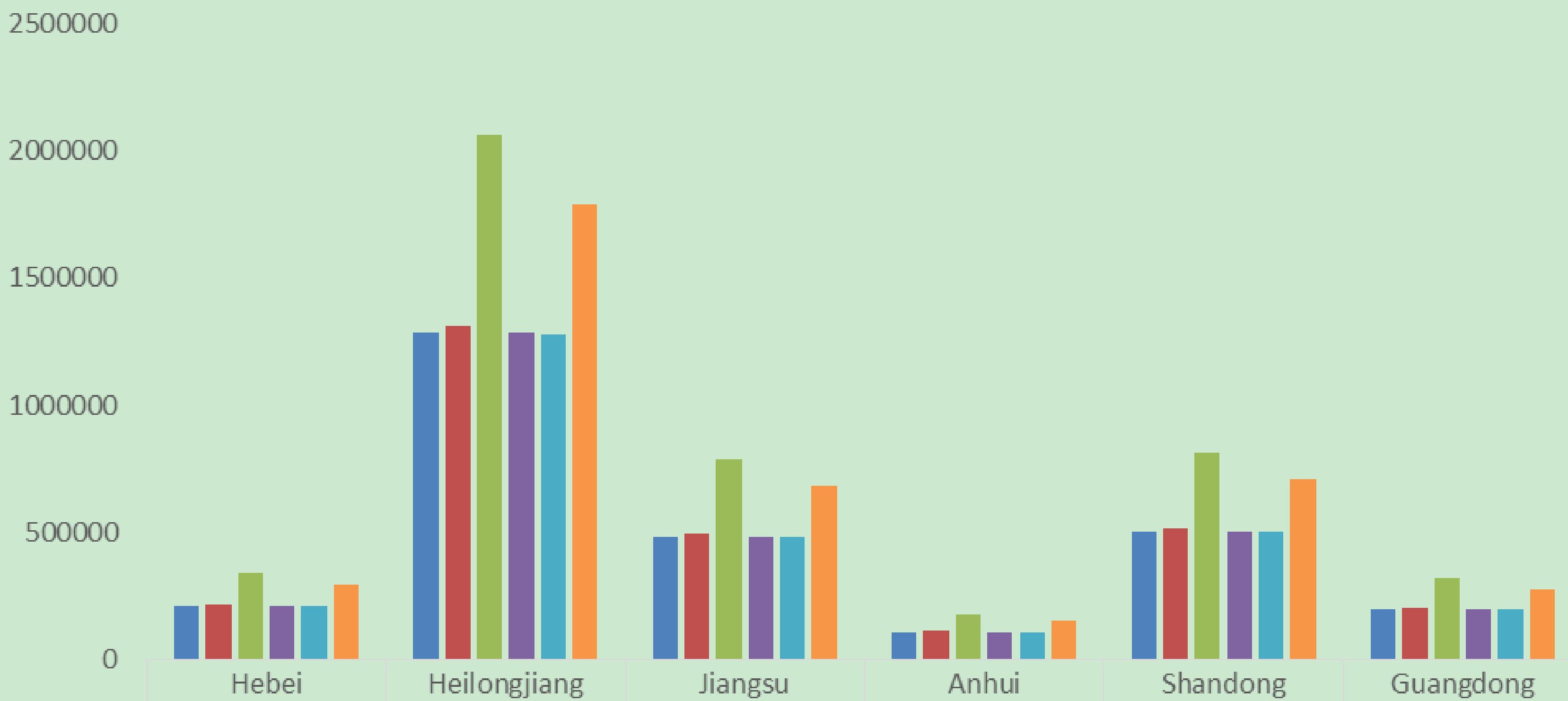
4.3 Future trends of grain exports

EXPORT (tons)

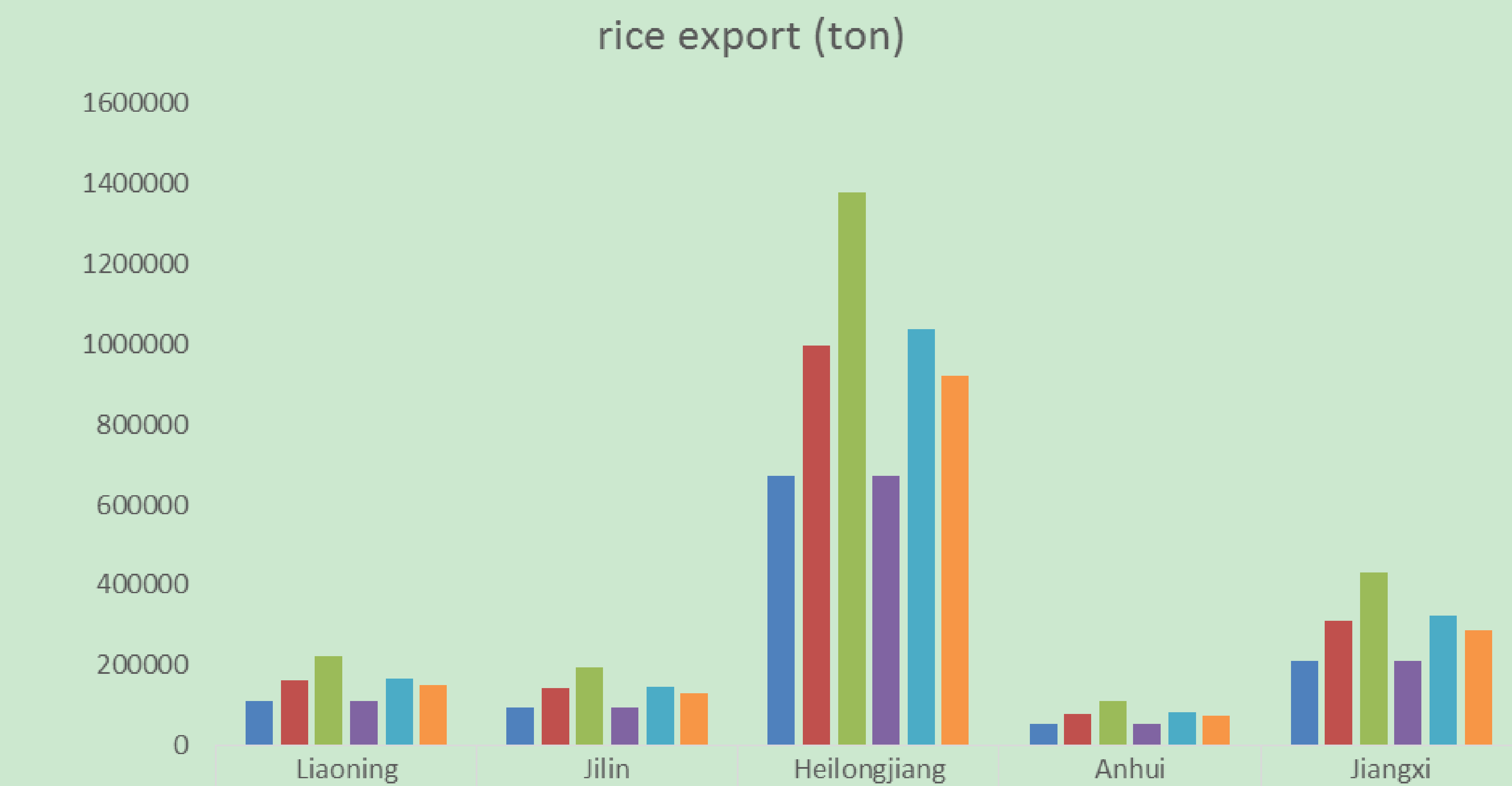


	Hebei	Neimenggu	Liaoning	Jilin	Heilongjiang
A2--Maize 2007	157764	735758	1076334	2666670	209492
A2--Maize 2030	196826.37	921610.47	1344125.9	3339470.84	262409.68
A2--Maize 2050	240227.24	1127843.44	1639364.32	4080271.77	320627.51
B2--Maize 2007	157764	735758	1076334	2666670	209492
B2--Maize 2030	204793.45	959428.43	1398696.03	3476537.68	273198.52
B2--Maize 2050	196747.48	920580.41	1341865.6	3333070.83	261885.95

wheat export(ton)



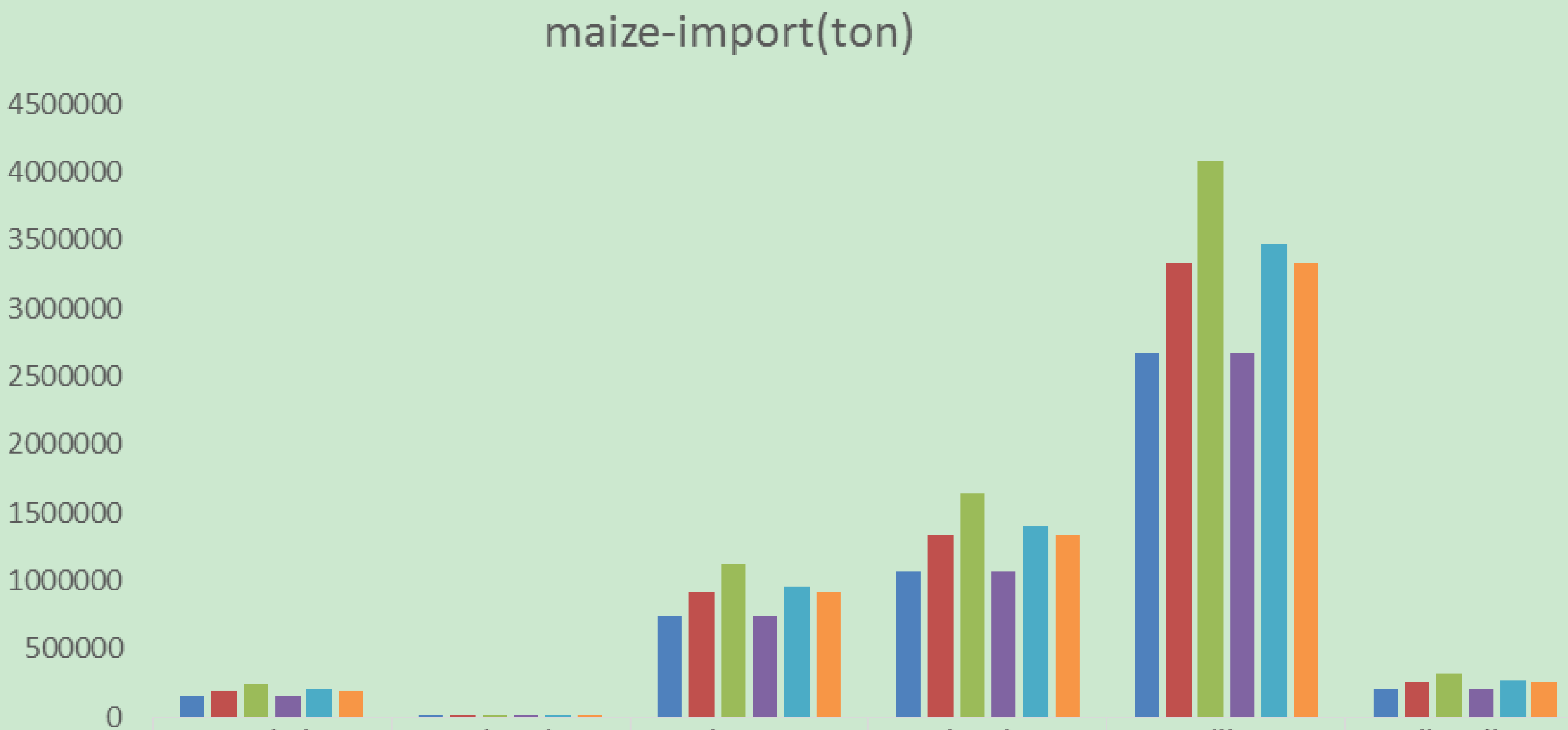
	Hebei	Heilongjiang	Jiangsu	Anhui	Shandong	Guangdong
A2--Wheat 2007	213141	1285169	485552	111462	504916	201821
A2--Wheat 2030	217275.94	1311386.45	495165.93	113958.75	514761.86	205796.87
A2--Wheat 2050	342133.93	2057555.57	786060.13	180044.57	813823.61	319543.19
B2--Wheat 2007	213141	1285169	485552	111462	504916	201821
B2--Wheat 2030	211414.56	1276558.37	481521.92	110904.69	500725.2	200448.62
B2--Wheat 2050	297800.61	1791140.04	682103.45	156124.82	707488.3	279017.53



	Liaoning	Jilin	Heilongjiang	Anhui	Jiangxi
A2--Rice 2007	109298	95343	670234	54689	209858
A2--Rice 2030	161520.58	141365.07	995699.63	80852.22	311261.39
A2--Rice 2050	222858.62	195472.22	1378470.27	111849.94	430670.59
B2--Rice 2007	109298	95343	670234	54689	209858
B2--Rice 2030	168100.32	147190.52	1036986.04	84128.09	324020.75
B2--Rice 2050	149410.37	130705.72	920432.35	74858.3	287442.5

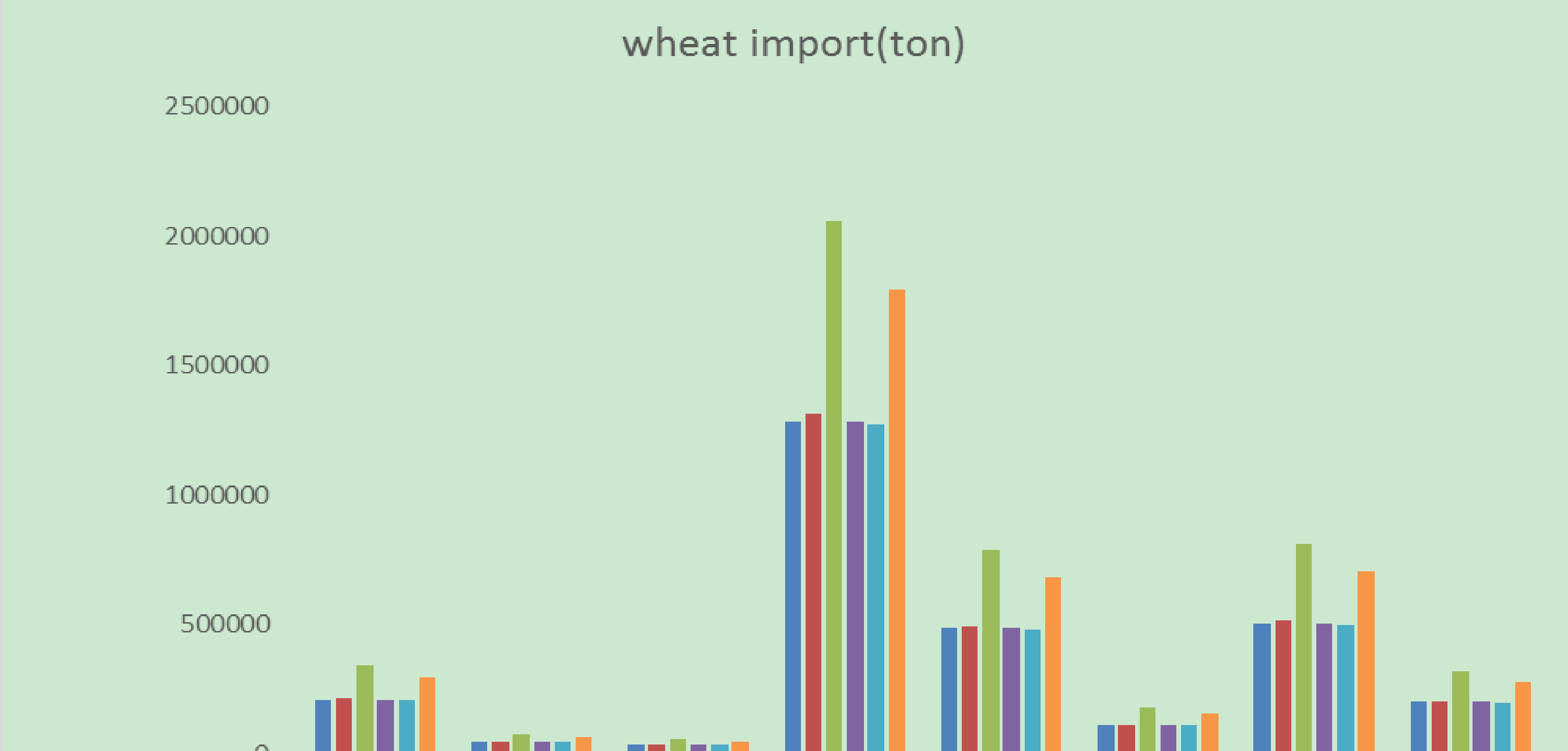
4.4 Future trends of grain imports

IMPORT (UNIT :tons)



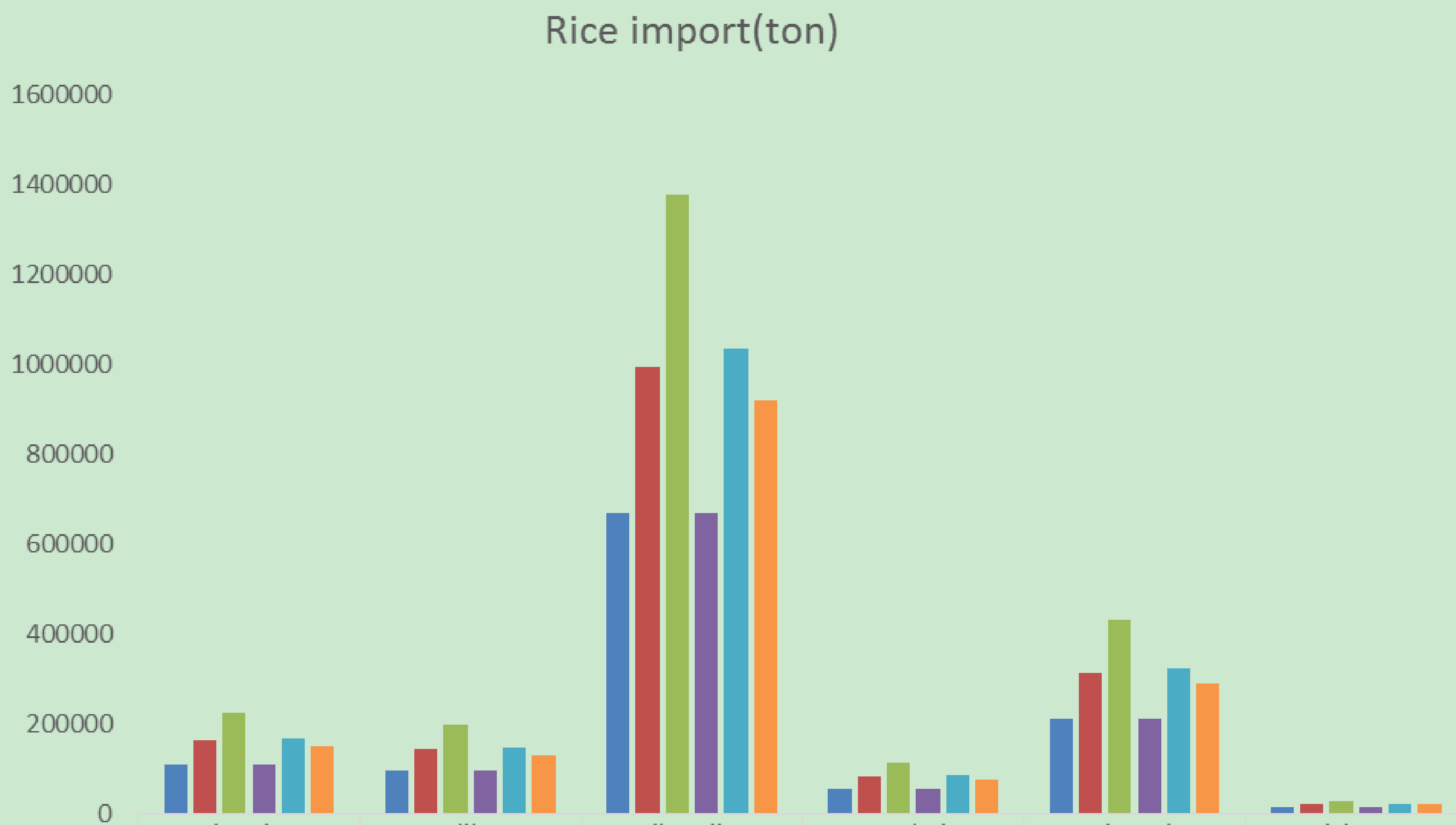
	Hebei	Shanxi	Neimenggu	Liaoning	Jilin	Heilongjiang
A2--Maize 2007	157764	10486	735758	1076334	2666670	209492
A2--Maize 2030	196826.37	13035.15	921610.47	1344125.9	3339470.84	262409.68
A2--Maize 2050	240227.24	15853.78	1127843.44	1639364.32	4080271.77	320627.51
B2--Maize 2007	157764	10486	735758	1076334	2666670	209492
B2--Maize 2030	204793.45	13553.16	959428.43	1398696.03	3476537.68	273198.52
B2--Maize 2050	196747.48	13024.66	920580.41	1341865.6	3333070.83	261885.95

IMPORT (UNIT :tons)



	Hebei	Neimenggu	Liaoning	Heilongjiang	Jiangsu	Anhui	Shandong	Guangdong
A2--Wheat 2007	213141	48847	36275	1285169	485552	111462	504916	201821
A2--Wheat 2030	217275.94	49994.9	36982.36	1311386.45	495165.93	113958.75	514761.86	205796.87
A2--Wheat 2050	342133.93	78697.4	57804.21	2057555.57	786060.13	180044.57	813823.61	319543.19
B2--Wheat 2007	213141	48847	36275	1285169	485552	111462	504916	201821
B2--Wheat 2030	211414.56	48690.69	36006.57	1276558.37	481521.92	110904.69	500725.2	200448.62
B2--Wheat 2050	297800.61	68327.18	50400.49	1791140.04	682103.45	156124.82	707488.3	279017.53

IMPORT (UNIT :tons)



	Liaoning	Jilin	Heilongjiang	Anhui	Jiangxi	Sichuan
A2--Rice 2007	109298	95343	670234	54689	209858	14106
A2--Rice 2030	161520.58	141365.07	995699.63	80852.22	311261.39	20878.29
A2--Rice 2050	222858.62	195472.22	1378470.27	111849.94	430670.59	28863.7
B2--Rice 2007	109298	95343	670234	54689	209858	14106
B2--Rice 2030	168100.32	147190.52	1036986.04	84128.09	324020.75	21730.29
B2--Rice 2050	149410.37	130705.72	920432.35	74858.3	287442.5	19305.47

4.5Future trends of household grain consumption

Consumption（unit: ten thousand tons）

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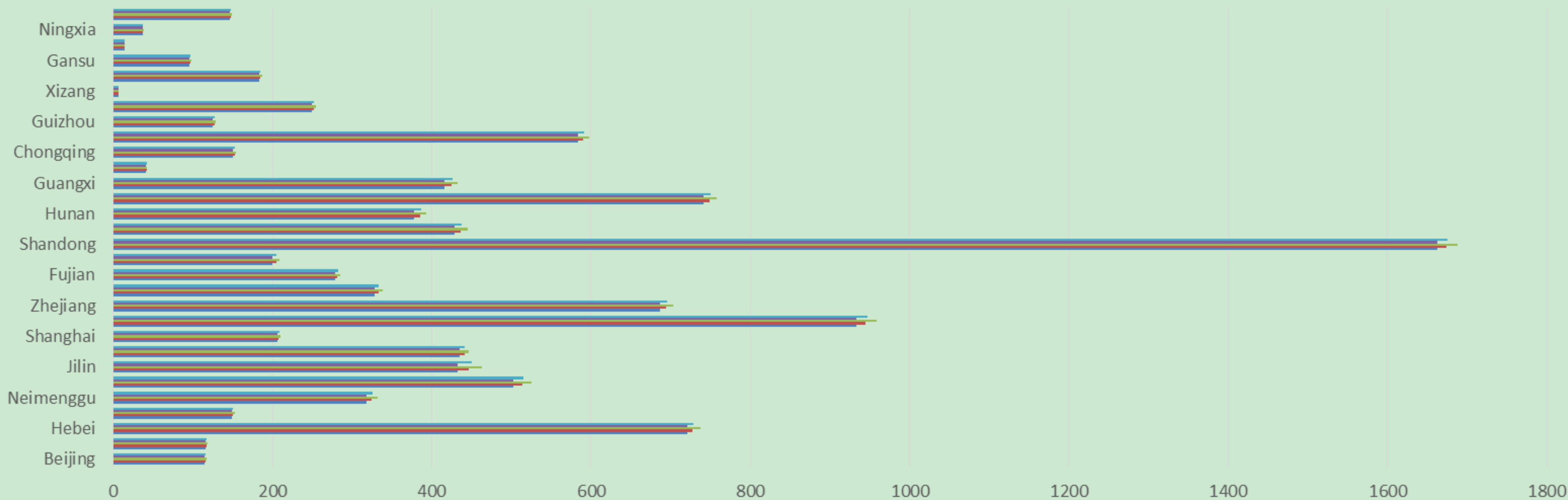
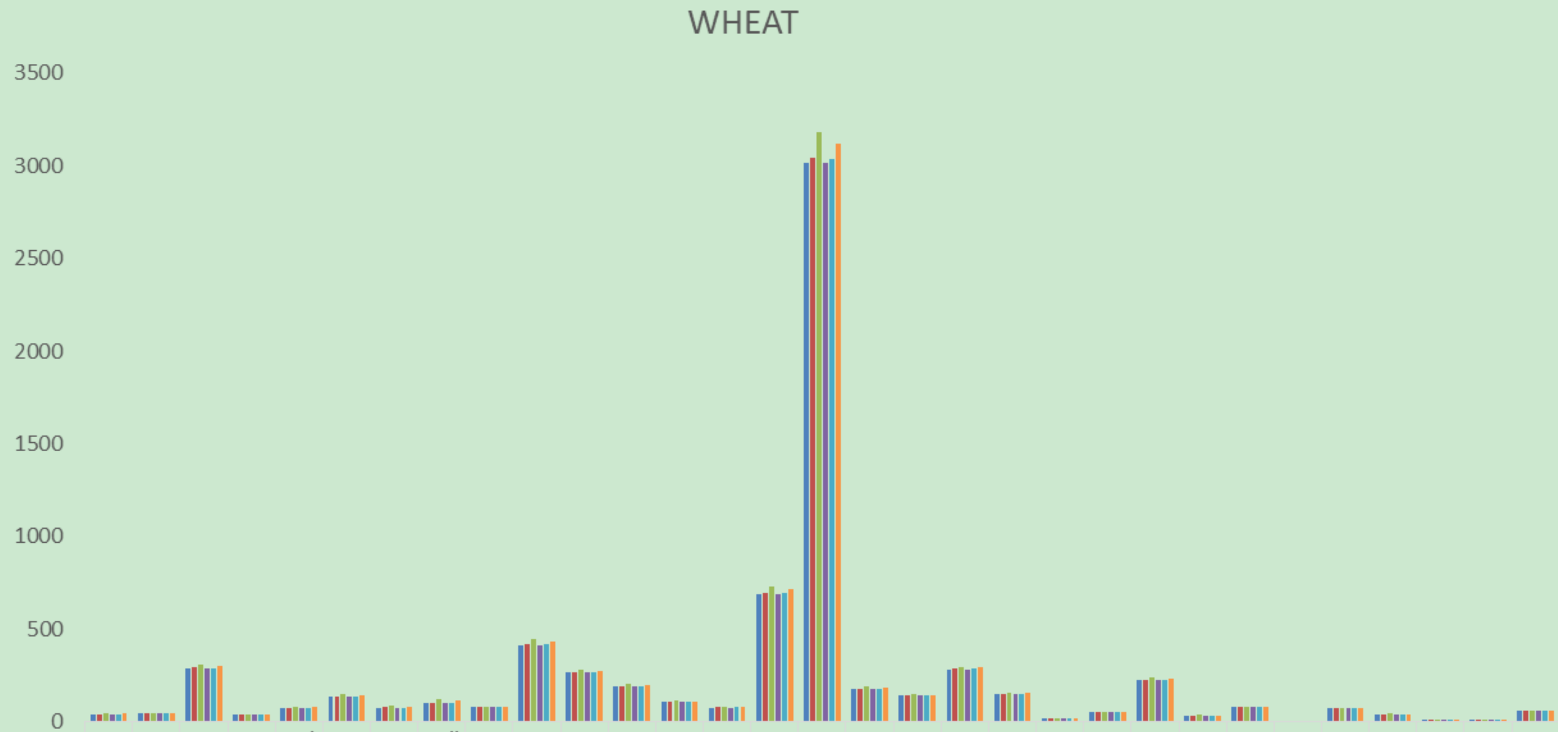
MAIZE



	Beijing	Tianjin	Hebei	Shanxi	Neimenggu	Liaoning	Jilin	Heilongjiang	Shanghai	Jiangsu	Zhejiang	Anhui	Fujian	Jiangxi	Shandong	Hubei	Hunan	Guangdong	Guangxi	Hainan	Chongqing	Sichuan	Guizhou	Yunnan	Xizang	Shaanxi	Gansu	Qinghai	Ningxia	Xinjiang
B2--Maize 2030	116.4	117.1	729.2	150.9	326.3	515.6	449.8	441.8	208.4	947.2	696.1	333.5	282.5	205.2	1676	437.9	386.8	750.6	425.8	42.03	152.8	591.5	127.6	252.6	6.53	185.3	97.15	14.13	37.78	147.7
B2--Maize 2007	114.8	115.9	720.4	149.1	318.5	502.5	432.4	435.4	206.4	932.7	686.9	328	278.3	200.5	1662	429.2	377.9	740.9	416.5	41.4	150.9	584.3	125.2	249.1	6.47	183.2	95.91	14.03	37.35	147.2
A2--Maize 2050	117.6	118.1	737.2	152.6	332.5	525.5	462.7	446.3	209.8	958.8	702.6	338.8	285.5	208.6	1689	444.9	393.4	757.5	432.6	42.46	154.3	597.4	129.2	255.2	6.59	187.2	98.29	14.27	38.19	148.5
A2--Maize 2030	116.1	116.9	727.9	150.7	325.1	513.5	447	440.8	208.1	945.2	694.8	332.9	281.9	204.6	1674	436.7	385.7	749.2	424.5	41.93	152.6	590.6	127.2	252.1	6.52	185	96.97	14.12	37.72	147.6
A2--Maize 2007	114.8	115.9	720.4	149.1	318.5	502.5	432.4	435.4	206.4	932.7	686.9	328	278.3	200.5	1662	429.2	377.9	740.9	416.5	41.4	150.9	584.3	125.2	249.1	6.47	183.2	95.91	14.03	37.35	147.2

Consumption（unit: ten thousand tons）



	Beijing	Tianjin	Hebei	Shanxi	Neimenggu	Liaoning	Jilin	Heilongjiang	Shanghai	Jiangsu	Zhejiang	Anhui	Fujian	Jiangxi	Shandong	Henan	Hubei	Hunan	Guangdong	Guangxi	Hainan	Chongqing	Sichuan	Guizhou	Yunnan	Xizang	Shaanxi	Gansu	Qinghai	Ningxia	Xinjiang
A2--Wheat 2007	42	44	290	40	76	137	77	101	80	415	266	192	107	77	690	301	179	140	284	151	16	51	227	34	78	4.3	71	42	9.7	11	61
A2--Wheat 2030	42	44	292	41	77	138	78	103	80	417	266	194	108	78	694	303	180	142	286	152	16	52	229	34	79	4.3	71	42	9.7	11	61
A2--Wheat 2050	45	47	307	42	81	151	87	121	84	444	279	203	113	83	728	317	188	150	298	160	17	54	238	36	82	4.5	74	44	10	12	64
B2--Wheat 2007	42	44	290	40	76	137	77	101	80	415	266	192	107	77	690	301	179	140	284	151	16	51	227	34	78	4.3	71	42	9.7	11	61
B2--Wheat 2030	42	44	291	41	77	138	77	102	80	416	266	194	107	78	692	303	180	142	285	152	16	52	228	34	79	4.3	71	42	9.7	11	61
B2--Wheat 2050	44	46	302	42	79	146	83	114	83	434	275	199	111	81	715	312	185	146	293	157	16	53	234	35	81	4.4	73	43	10	12	63

Consumption（unit: ten thousand tons）

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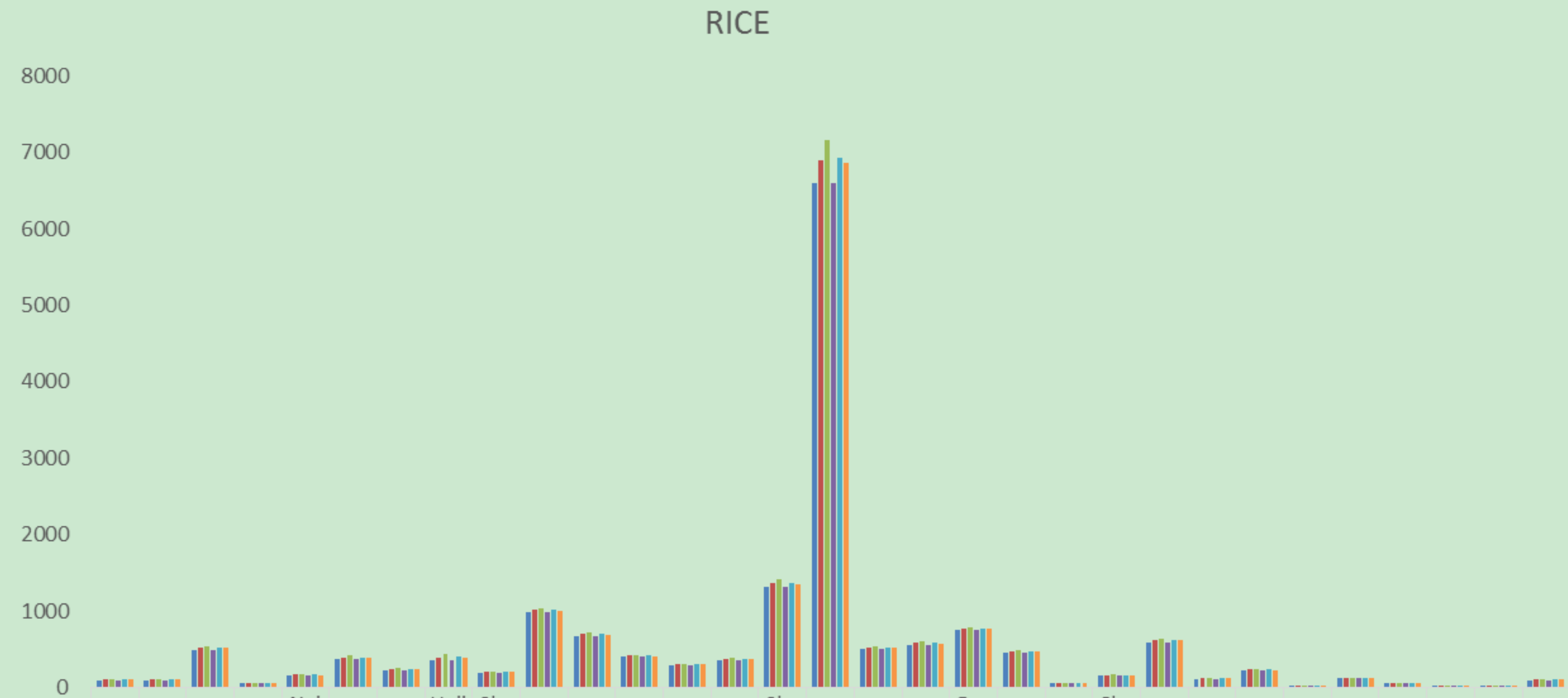

	Beijing	Tianjin	Hebei	Shanxi	Neimenggu	Liaoning	Jilin	Heilongjiang	Shanghai	Jiangsu	Zhejiang	Anhui	Fujian	Jiangxi	Shandong	Henan
A2--Rice 2007	95.4	96.2	492	58.1	156	363	223	358	192	975	671	395	290	352	1307	6600
A2--Rice 2030	99.3	101	516	60.7	164	388	238	393	199	1010	695	412	299	370	1362	6895
A2--Rice 2050	102	105	538	62.9	170	413	253	429	204	1037	714	427	306	385	1410	7155
B2--Rice 2007	95.4	96.2	492	58.1	156	363	223	358	192	975	671	395	290	352	1307	6600
B2--Rice 2030	99.6	102	518	60.9	164	391	240	397	199	1013	697	414	300	371	1368	6925
B2--Rice 2050	98.6	100	513	60.4	163	383	235	386	197	1004	691	410	298	366	1355	6855

	Hubei	Hunan	Guangdong	Guangxi	Hainan	Chongqing	Sichuan	Guizhou	Yunnan	Xizang	Shaanxi	Gansu	Qinghai	Ningxia	Xinjiang
A2--Rice 2007	501	556	743	453	48.7	155	591	113	222	5.64	114	58.6	12.5	22.1	92.8
A2--Rice 2030	521	578	766	470	50.2	161	614	118	230	5.82	119	61	12.9	23	98.8
A2--Rice 2050	538	595	784	483	51.3	165	635	121	236	5.98	123	63.1	13.3	23.7	105
B2--Rice 2007	501	556	743	453	48.7	155	591	113	222	5.64	114	58.6	12.5	22.1	92.8
B2--Rice 2030	523	580	769	471	50.3	161	617	118	231	5.84	119	61.2	12.9	23	99.5
B2--Rice 2050	518	574	762	467	49.9	160	611	117	229	5.81	118	60.8	12.8	22.8	97.8

4.6 Future trends of economic growth

Macroeconomic indicators

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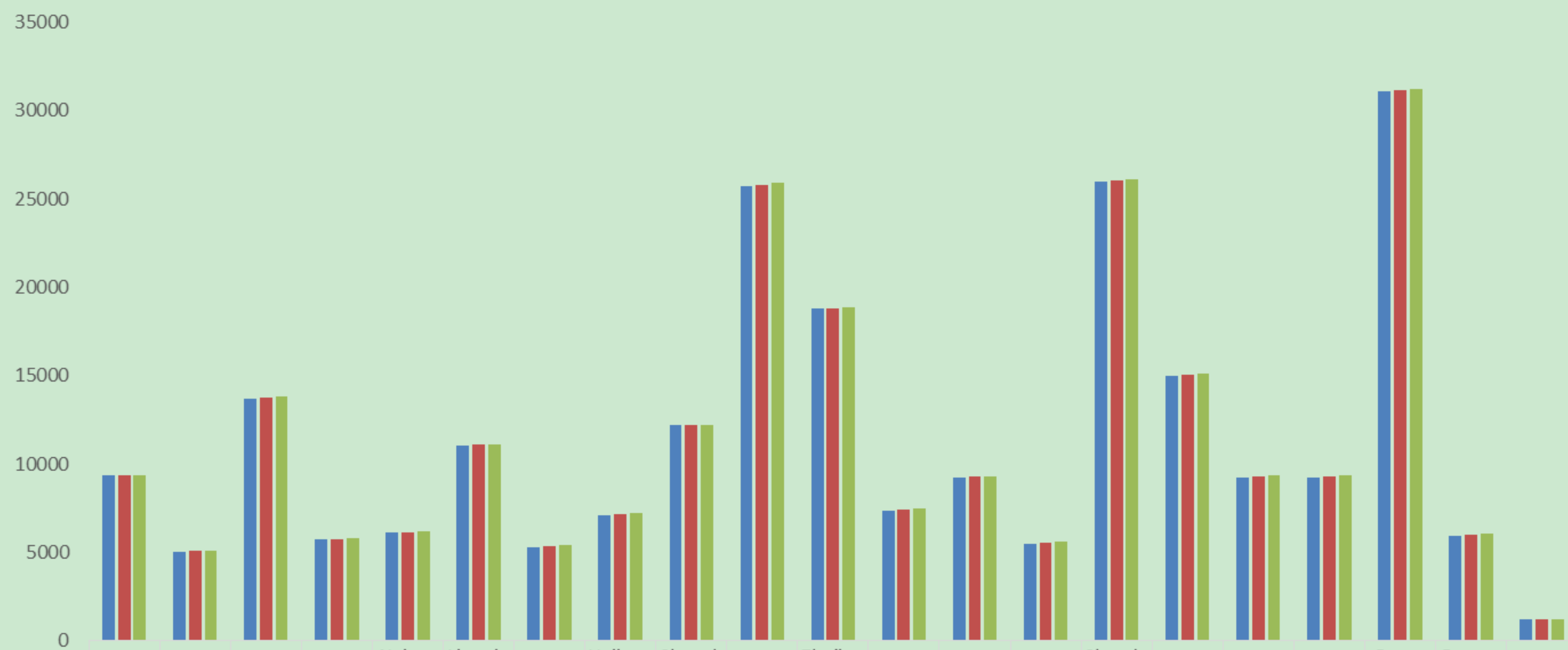
图表标题

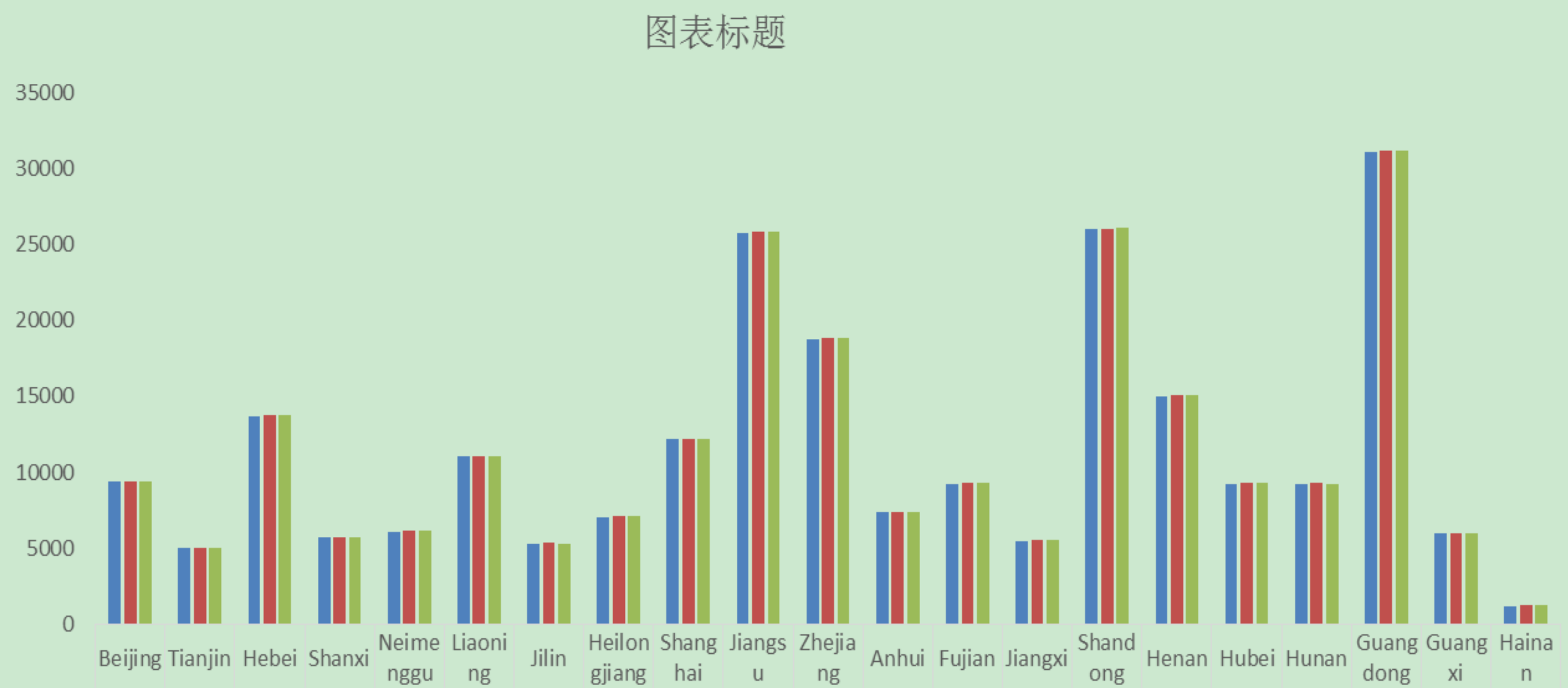


	Beijing	Tianjin	Hebei	Shanxi	Neimenggu	Liaoning	Jilin	Heilongjiang	Shanghai	Jiangsu
A2--Real GDP 2007	9353.32	5050.4	13709.5	5733.35	6091.12	11023.5	5284.69	7065	12188.9	25741.2
A2--Real GDP 2030	9359.87	5055.45	13746.5	5751.12	6120.36	11068.7	5332.78	7134.94	12197.4	25808.1
A2--Real GDP 2050	9366.41	5061.01	13805.5	5774.06	6153.25	11112.8	5380.34	7206.3	12207.1	25885.3

	Zhejiang	Anhui	Fujian	Jiangxi	Shandong	Henan	Hubei	Hunan	Guangdong	Guangxi	Hainan
A2--Real GDP 2007	18780.4	7364.18	9249.13	5500.25	25965.9	15012.5	9230.68	9200	31084.4	5955.65	1223.28
A2--Real GDP 2030	18814.2	7407.63	9271.33	5547.55	26023	15042.5	9288.83	9272.68	31134.1	5998.53	1227.19
A2--Real GDP 2050	18849.9	7465.81	9291.68	5591	26116.5	15090.5	9349.76	9338.92	31183.9	6039.62	1230.74

A2--Real GDP 2007 A2--Real GDP 2030 A2--Real GDP 2050

Macroeconomic indicators



	Beijing	Tianjin	Hebei	Shanxi	Neimenggu	Liaoning	Jilin	Heilongjiang	Shanghai	Jiangsu	Zhejiang	Anhui	Fujian	Jiangxi	Shandong	Henan	Hubei	Hunan	Guangdong	Guangxi	Hainan
B2--Real GDP 2007	9353.3	5050.4	13710	5733.4	6091.1	11023	5284.7	7065	12189	25741	18780	7364.2	9249.1	5500.3	25966	15012	9230.7	9200	31084	5955.7	1223.3
B2--Real GDP 2030	9360.8	5056	13751	5753.4	6125.2	11075	5340.7	7144.8	12199	25813	18820	7412.1	9273.2	5552.5	26028	15047	9295.3	9281	31140	6003.9	1227.7
B2--Real GDP 2050	9358.9	5055.5	13762	5754.6	6122.2	11065	5330.1	7128.6	12197	25808	18810	7413.5	9266.7	5538.8	26046	15053	9285.1	9259.8	31128	5992.6	1226.5

B2--Real GDP 2007 B2--Real GDP 2030 B2--Real GDP 2050

5.Concluding remarks and policy recommendations

Climate change will increase grain production, strengthening economic growth.

Climate change will increase grain production, bringing in more economic growth to major grain producing regions.

Yield growth differs in magnitude under different climate change scenarios.

Since many uncertainties remain in future economic and environmental conditions, grain food security should continue to be watched closely.