

International Comparisons of Agriculture Industry—What China can Learn from Others

Yueyun(Bill) Chen

Department of Business Administration, University of the West, Los Angeles, USA

Email address:

billchen@uwest.edu

To cite this article:

Yueyun(Bill) Chen. International Comparisons of Agriculture Industry—What China can Learn from Others. *International Journal of Agricultural Economics*. Vol. 1 No. 2, 2016, pp. 45-56. doi: 10.11648/j.ijae.20160102.15

Received: July 11, 2016; **Accepted:** July 20, 2016; **Published:** July 29, 2016

Abstract: Agriculture is an important industry in all economies since it provides basic needs and feeds people. With the improvements of its productivity and increasing globalization, the shares of the total outputs (or GDPs) and employments from the agriculture industry have been increasingly less in many countries, including both developed and developing countries. How to stabilize and improve this important industry during its economic structure change is a challenging issue to many countries. This paper compares the agriculture industry in different countries and focuses on how developing countries like China can learn from other developed countries on strengthening and improving their own agriculture industry.

Keywords: Agriculture Industry, Economic Structure, Economic Growth, Total Factor Productivity

1. Introduction

In the past several years China's economy has slowed down significantly. In 2015, its annual growth was 6.9%, much lower than the annual growth rate of 8-10% in the previous decades. Its service industry has surpassed the industrial industry in terms of the total outputs ([5], [6]). In 2015, the service industry shared 50.5% of its total GDP; that was 40.5% for the industrial industry and 9% for the agriculture industry.

As many developed countries have experienced, the service industry will be increasingly important and the agriculture industry become less significant when an economy advances ([14], [15], [30], [31]). Agriculture's shares of the GDP and employment in China will further be decreased in coming decades.

Agriculture is still an important industry in all economies since it provides basic needs and feeds people ([1], [11], [13]). China has a huge population of more than 1.35 billion people. Maintaining a strong agriculture industry will be crucial to China's future—the stability of the economy and society and its independence of food supply.

How to stabilize and improve this important industry

during its economic structure change is a challenging issue to many countries ([22], [23], [24], [25], [26], [27]). This paper compares the agriculture industry in different countries and focuses on how developing countries like China can learn from other developed countries on strengthening and improving their own agriculture industry.

The US agriculture sector only employs 1.6% of total labor but it produces necessary food not only providing to its own people but also exporting to other countries ([5], [6]). China currently has about 30% of labor working in the agriculture and related sectors, but it still needs to import huge amounts of agricultural products each year. Therefore, China has large potential to improve its agriculture industry's productivity. Lessons and experiences from developed countries like the US will be very useful to China.

2. Comparisons of China with Others - Economic Structure

Table 1 provides basic information for six countries-China, US, Japan, Germany, India and South Korea on its population, GDP, arable land, fresh water, trade, etc.

Table 1. Comparisons of China with other countries in terms of population, GDP, land, water, and trade (2013).

	China	US	Japan
Total Population	1,357,380,000	316,497,531	127,338,621
% of World Population	18.92%	4.41%	1.77%
Total GDP (US\$)	9,490,602,600,148	16,768,053,000,000	4,919,563,108,372
GDP per capita (US\$)	6,991.85	52,980.04	38,633.71
% of World GDP	12.47%	22.03%	6.46%
Total Land (sq.km)	9,388,211	9,147,420	364,560
Total Arable Land (hectares)	105,720,000	151,837,000	4,237,000
Arable Land per capita	0.08	0.48	0.03
Total Fresh Water (billion cubic meters)	554.1	478.4	90.04
Total Trade (million US \$)	4,693,141	5,002,218	1,855,906
% of the World Trade	12%	13%	5%
% of Trade/GDP	43.91%	30.13%	35.14%

Table 1. Continued.

	Germany	India	South Korea
Total Population	80,645,605	1,279,498,874	50,219,669
% of World Population	1.12%	17.83%	0.70%
Total GDP (US\$)	3,730,260,571,357	1,861,801,615,478	1,305,604,961,393
GDP per capita (US\$)	46,254.98	1,455.10	25,997.88
% of World GDP	4.90%	1.72%	2.45%
Total Land (sq.km)	348,540	2,973,190	97,466
Total Arable Land (hectares)	11,876,000	157,000,000	1,495,800
Arable Land per capita	0.15	0.12	0.03
Total Fresh Water (billion cubic meters)	32.3	761	25.47
Total Trade (million US \$)	3,244,603	1,054,824	1,292,923
% of the World Trade	8%	3%	3%
% of Trade/GDP	85.32%	53.28%	102.77%

Table 2 compares China with other countries in terms of the economic structure. Except for India, the agriculture industry's shares of GDPs and employments are much higher in China than in the others.

Table 2. Comparisons of China with other countries in terms of economic structure (2013).

	China	US	Japan	Germany	India	South Korea
% of GDP in Agriculture (2013)	9.41	1.45	1.21	0.86	17.96	2.34
% of GDP in Industry (2013)	43.67	20.50	26.21	30.71	30.73	38.41
% of GDP in Service (2013)	46.92	78.05	72.58	68.43	51.31	59.25
Total labor force (2010)	781,054,640	157,632,611	66,740,831	41,936,673	471,277,041	24,955,811
% of labor force in Agriculture (2010)	36.70	1.60	3.70	1.60	51.10	6.60
% of Labor in Industry (2010)	28.70	17.20	25.60	28.40	22.30	17.00
% of labor in Service (2010)	34.60	81.20	69.70	70.00	26.60	76.40

**Figure 1.** Changes of the Economic Structure from 1970-2012.

Figure 1 is the changes of the economic structure from 1970 to 2012 in South Asia, East Asia, European Union, and US. It is clear that even in South Asia and East Asia, the agriculture's share of the GDP shrank significantly.

3. Agriculture Industry Comparisons

Table 3 gives the total agriculture outputs in different levels of countries from 1965-2012. China's share of the world agriculture output was about 10-12% in 1960s, 1970s, and 1980s. Since 2000, its relevant share has increased to 20% or above.

Table 3. Gross Agricultural Production (smoothed using Hodrick-Prescott filter, $\lambda=6$) (1961-2012).

Income Class	1965	1970	1980	1990	1995	2000	2005
Low income	40,602,262	45,896,512	55,056,180	67,762,629	73,266,522	86,041,408	105,407,910
Lower-middle-income	128,309,419	147,987,423	192,354,097	274,525,110	326,922,450	371,480,413	434,604,454
Middle-income-upper	198,534,185	231,210,327	321,129,896	460,949,019	571,733,763	688,825,832	817,787,314
Middle-income-upper (no China)	112,537,262	129,916,684	178,606,972	231,472,765	265,691,498	307,511,480	364,373,275
China	85,996,923	101,293,643	142,522,924	229,476,254	306,042,265	381,314,351	453,414,040
High-income	328,005,377	359,674,545	433,398,633	472,232,612	501,827,245	535,275,039	546,232,304
Transition economies	149,221,437	174,152,449	198,859,496	210,185,673	163,466,633	148,792,007	161,389,431
World	844,672,679	958,921,256	1,200,798,302	1,485,655,044	1,637,216,612	1,830,414,699	2,065,421,413
China's %	0.1	0.11	0.12	0.15	0.19	0.21	0.22

Table 3. Continued.

Income Class	2006	2007	2008	2009	2010	2011	2012
Low income	110,227,395	115,178,814	120,261,480	125,277,418	130,064,823	134,341,010	138,229,532
Lower-middle-income	452,048,554	469,113,837	485,192,860	500,773,821	517,154,334	533,813,426	550,046,695
Middle-income-upper	846,790,923	876,412,492	905,715,164	934,222,758	963,209,238	992,510,009	1,021,668,479
Middle-income-upper (no China)	376,086,169	387,400,256	398,059,115	408,444,302	419,697,450	431,538,185	443,659,861
China	470,704,754	489,012,235	507,656,050	525,778,456	543,511,788	560,971,824	578,008,617
High-income	548,750,850	552,120,981	555,884,508	559,179,326	561,722,162	564,056,578	566,811,318
Transition economies	162,671,830	164,218,990	166,392,234	168,578,896	171,127,561	174,841,496	178,838,765
World	2,120,489,552	2,177,045,114	2,233,446,247	2,288,032,219	2,343,278,118	2,399,562,519	2,455,594,788
China's %	0.22	0.22	0.23	0.23	0.23	0.23	0.24

3.1. Agriculture Inputs (1965-2012)

In order to better understand the agriculture industry, one also needs to compare its inputs. Table 4 provides agriculture land information of different levels of economies. China's share of the world total agriculture land had been quite stable from 1965 to 2012, ranging between 13-14%. Compared with its output share, China's land productivity was above the world average since 2000. Using 13-14% of the world's agriculture land, China produced about 22-24% of the world's agriculture products.

Table 4. Agricultural Land.

Income Class	1965	1970	1980	1990	2000	2005	2006
Low income	101,057	108,684	114,026	135,336	152,040	174,139	174,888
Lower-middle-income	398,550	418,963	448,958	500,974	561,352	587,885	588,972
Middle-income-upper	435,536	462,557	506,852	537,719	573,611	594,259	598,642
Middle-income-upper (no China)	212,013	229,901	252,423	273,687	287,808	306,858	308,271
China	223,524	232,656	254,429	264,032	285,803	287,401	290,371
High-income	495,304	512,340	514,010	519,949	507,406	497,139	487,431
Transition economies	326,895	329,459	341,831	344,346	315,964	308,351	308,123
World	1,757,343	1,832,003	1,925,678	2,038,324	2,110,373	2,161,773	2,158,055
China's %	0.13	0.13	0.13	0.13	0.14	0.13	0.13

Table 4. Continued.

Income Class	2007	2008	2009	2010	2011	2012
Low income	176,259	183,757	184,062	190,350	192,013	196,355
Lower-middle-income	591,155	596,025	591,854	593,901	600,124	598,568
Middle-income-upper	597,308	605,166	610,505	618,567	625,160	629,397
Middle-income-upper (no China)	308,962	310,091	311,542	315,377	317,702	319,194
China	288,345	295,075	298,963	303,189	307,457	310,203
High-income	483,503	482,224	477,379	470,616	473,032	476,744
Transition economies	307,741	307,638	308,460	304,799	306,228	304,639
World	2,155,966	2,174,809	2,172,259	2,178,232	2,196,556	2,205,703
China's %	0.13	0.14	0.14	0.14	0.14	0.14

1000 Ha of Rainfed Cropland Equivalents (Rainfed Cropland, Irrigated Cropland and Pasturement Pasture, weighted by relative quality)

3.2. Irrigation Area

Table 5 is the irrigated area of the world. China had been around 20% of the world's total irrigated area, which is a little lower than 22-24% of the world's total output but higher than its agriculture land share (14%). Irrigation is essential for sustainable agriculture growth ([20], [29]).

Table 5. Irrigated Area.

Income Class	1965	1970	1980	1990	2000	2005	2006
Low income	5,263	5,994	8,426	11,632	15,042	16,290	16,541
Lower-middle-income	51,621	57,975	71,047	86,353	102,813	109,712	110,676
Middle-income-upper	51,559	57,794	71,236	81,745	93,810	99,268	100,641
Middle-income-upper (no China)	18,431	20,807	26,348	34,342	39,990	44,239	44,890
China	33,128	36,987	44,888	47,403	53,820	55,029	55,751
High-income	35,775	38,328	43,943	49,094	51,087	51,582	51,349
Transition economies	11,793	13,701	21,867	26,689	24,256	23,555	23,412
World	156,011	173,792	216,519	255,513	287,008	300,407	302,618
China's %	0.21	0.21	0.21	0.19	0.19	0.18	0.18

Table 5. Continued.

Income Class	2007	2008	2009	2010	2011	2012
Low income	16,629	16,711	16,822	16,983	17,085	17,151
Lower-middle-income	111,470	112,668	113,363	113,478	113,691	113,303
Middle-income-upper	102,151	104,806	106,242	107,981	109,737	110,810
Middle-income-upper (no China)	45,633	46,334	46,981	47,633	48,055	48,319
China	56,518	58,472	59,261	60,348	61,682	62,491
High-income	51,279	51,309	50,958	50,850	50,745	50,852
Transition economies	23,414	23,255	23,202	23,241	23,238	23,222
World	304,943	308,749	310,588	312,533	314,496	315,338
China's %	0.19	0.19	0.19	0.19	0.2	0.2

Area equipped for irrigation (1000 Ha)

3.3. Labor Inputs

Table 6 shows the labor inputs in the agriculture industry. China's share of the world's total agriculture labor had been 30% or more before 2006, and since then it had been decreasing over the years but still was 23% or higher. Since China's agriculture output share was about 24%, its labor productivity in the agriculture industry was only about the world average. In other words, China used the world's 23-24% of the labor to produce the similar percentage of the outputs.

Table 6. Agricultural Labor.

Income Class	1965	1970	1980	1990	2000	2005	2006
Low income	95,769	105,010	124,541	156,999	192,626	213,744	217,615
Lower-middle-income	238,514	255,721	303,247	362,201	415,210	442,288	447,739
Middle-income-upper	299,775	346,848	366,542	472,194	443,632	417,271	401,921
Middle-income-upper (no China)	65,815	68,738	75,322	83,054	83,202	82,852	82,515
China	233,960	278,110	291,220	389,140	360,430	334,419	319,406
High-income	50,829	43,161	34,892	26,780	19,051	16,265	15,788
Transition economies	52,662	50,185	42,889	38,782	37,145	32,104	31,242
World	737,550	800,925	872,111	1,056,956	1,107,664	1,121,671	1,114,305
China's %	0.32	0.35	0.33	0.37	0.33	0.3	0.29

Table 6. Continued.

Income Class	2007	2008	2009	2010	2011	2012
Low income	221,539	225,740	230,010	234,372	238,835	243,388
Lower-middle-income	452,635	457,808	462,887	467,870	472,745	477,490
Middle-income-upper	389,176	380,555	369,645	359,454	345,479	336,653
Middle-income-upper (no China)	81,866	81,325	80,745	80,144	79,539	78,923
China	307,310	299,230	288,900	279,310	265,940	257,730
High-income	15,259	14,781	14,337	13,910	13,486	13,086
Transition economies	30,090	29,400	29,533	28,612	28,627	28,317
World	1,108,699	1,108,284	1,106,411	1,104,218	1,099,172	1,098,933
China's %	0.28	0.27	0.26	0.25	0.24	0.23

(1000 persons economically active in agriculture, +15 yrs, male+female)

3.4. Farm Machinery

Table 7 presents information on farm machinery. China's share of the world's far machinery was lower than 20% before 2008 and was about 21-24% since then. Thus, China's farm machinery use was about the world average recently and was less than the average before 2008.

Table 7. Farm machinery.

Income Class	1965	1970	1980	1990	2000	2005	2006
Low income	64,808	86,550	120,661	164,552	283,950	428,605	453,818
Lower-middle-income	172,289	302,115	869,588	1,962,859	3,871,252	4,975,140	5,189,550
Middle-income-upper	996,345	1,372,784	3,411,437	6,162,405	9,180,079	10,496,932	11,000,370
Middle-income-upper (no China)	815,271	1,065,033	2,090,849	3,235,224	4,296,374	4,348,097	4,396,375
China	181,074	307,750	1,320,588	2,927,181	4,883,705	6,148,836	6,603,995
High-income	11,864,892	13,905,374	16,603,967	17,849,612	16,977,424	16,206,408	16,125,786
Transition economies	1,930,410	2,675,331	4,465,017	5,809,601	4,523,977	4,236,281	4,265,548
World	15,028,745	18,342,155	25,470,669	31,949,029	34,836,681	36,343,366	37,035,073
China's %	0.01	0.02	0.05	0.09	0.14	0.17	0.18

Table 7. Continued.

Income Class	2007	2008	2009	2010	2011	2012
Low income	477,217	504,482	543,967	579,559	621,378	669,461
Lower-middle-income	5,429,172	5,674,636	5,928,355	6,224,893	6,516,285	6,829,042
Middle-income-upper	11,579,246	12,921,280	13,642,156	14,352,049	15,098,626	15,726,335
Middle-income-upper (no China)	4,474,241	4,565,403	4,670,375	4,859,921	5,032,379	5,247,440
China	7,105,005	8,355,877	8,971,782	9,492,128	10,066,248	10,478,894
High-income	16,002,495	15,927,163	15,849,498	15,814,573	15,828,449	15,926,086
Transition economies	4,301,008	4,291,816	4,302,751	4,376,202	4,462,433	4,471,333
World	37,789,138	39,319,378	40,266,727	41,347,275	42,527,171	43,622,257
China's %	0.19	0.21	0.22	0.23	0.24	0.24

Number of 40 CV Tractor-Equivalents in Use Machinery Units (4w, 2w tractors, harvester-threshers, milking machines, aggregated by CV/machine weights)

3.5. Synthetic Fertilizer Consumption

Table 8 gives the data of the world's synthetic fertilizer consumption. China's use of synthetic fertilizers was quite low in 1960s and 1970s, compared with the world's average (also given its world's agriculture output share in the same time periods). During the 1990s, its share of the world synthetic fertilizer consumption matched its output share, but since 2000, its share was about 30%, so that China used and relied on synthetic fertilizers too much. Appropriate use of synthetic fertilizers can improve agriculture productivity and increase outputs ([19]) but overuse of that will have side effects. Lands may be polluted and/or destroyed.

Table 8. Synthetic Fertilizer Consumption.

Income Class	1965	1970	1980	1990	2000	2005	2006
Low income	367,017	758,395	1,735,983	2,486,901	2,703,733	2,805,854	2,845,196
Lower-middle-income	1,951,818	3,805,413	10,113,586	20,543,321	28,914,066	34,854,940	35,989,321
Middle-income-upper	4,259,853	8,283,844	26,657,747	40,579,984	54,369,232	68,803,117	72,463,830
Middle-income-upper (no China)	2,227,853	4,364,844	11,391,747	13,816,384	19,621,232	22,134,817	23,095,830
China	2,032,000	3,919,000	15,266,000	26,763,600	34,748,000	46,668,300	49,368,000
High-income	30,354,456	39,193,506	49,896,587	45,913,465	43,711,611	41,334,652	42,727,620
Transition economies	10,732,331	18,166,271	29,910,500	31,554,000	7,362,400	8,774,424	8,919,865
World	47,665,476	70,207,430	118,314,403	141,077,670	137,061,042	156,572,986	162,945,831
China's %	0.04	0.06	0.13	0.19	0.25	0.3	0.3

Table 8. Continued.

Income Class	2007	2008	2009	2010	2011	2012
Low income	3,055,291	2,599,391	2,826,193	3,348,757	3,669,205	3,787,163
Lower-middle-income	37,215,646	39,483,688	42,060,441	44,268,349	44,065,324	42,102,761
Middle-income-upper	76,276,511	70,053,666	70,980,389	74,425,089	78,552,369	81,029,366
Middle-income-upper (no China)	25,114,911	21,631,966	22,080,389	24,525,789	26,452,369	27,629,366
China	51,161,600	48,421,700	48,900,000	49,899,300	52,100,000	53,400,000
High-income	42,375,802	33,676,786	37,670,642	40,508,132	40,467,041	41,342,421
Transition economies	9,785,056	9,902,149	9,912,804	10,013,457	11,215,621	11,494,673
World	168,708,306	155,715,679	163,450,469	172,563,784	177,969,558	179,756,384
China's %	0.3	0.31	0.3	0.29	0.29	0.3

Tons of N, P₂O₅, and K₂O nutrients of fertilizer consumption

3.6. Agriculture Input Annual Growth

Table 9 shows the world's annual agriculture input growth. It was 3% in the 1960s and 2% in the 1970s, 1980s, and 1990s. Since then, it was only about 1%. China's agriculture input was more than the world average before 2006, but since then it was lower generally.

Table 9. Agricultural Input Growth.

Income Class	1965	1970	1980	1990	2000	2005	2006
Low income	0.015	0.032	0.018	0.013	0.017	0.025	0.032
Lower-middle-income	0.013	0.023	0.023	0.011	0.019	0.013	0.02
Middle-income-upper	0.033	0.024	0.025	0.037	0.014	0.022	0.011
Middle-income-upper (no China)	0.02	0.022	0.022	0.024	0.018	0.007	0.039
China	0.03	0.025	0.031	0.047	0.013	0.023	-0.003
High-income	0.016	0.009	-0.002	-0.001	-0.01	-0.017	0.002
Transition economies	0.051	0.036	0.023	0.001	-0.019	-0.007	-0.008
World	0.03	0.02	0.02	0.02	0.01	0.01	0.01

Table 9. Continued.

Income Class	2007	2008	2009	2010	2011	2012
Low income	0.026	0.027	0.02	0.032	0.026	0.02
Lower-middle-income	0.018	0.025	0.016	0.017	0.014	0.013
Middle-income-upper	0.015	0.004	0.005	0.005	-0.001	0.002
Middle-income-upper (no China)	0.025	-0.016	0.013	0.021	-0.024	0.002
China	0.01	0.012	0.003	-0.001	0.008	0.004
High-income	-0.013	-0.025	-0.009	-0.008	-0.063	0.009
Transition economies	0.018	-0.011	-0.013	-0.004	0.033	-0.018
World	0.01	0.01	0.01	0.01	0	0.01

(Aggregated using factor shares as eights; ag land=rainfed cropland equivalents 'Land Q3')

4. Agriculture Productivity

Besides traditional inputs of labor and capita in the agriculture industry, technological improvements and management are also important to its growth. In economics, one uses the total factor productivity (TFP), also called multi-factor productivity, to measure such additional factors contributing to the growth. Total factor productivity has replaced resource expansion and input intensification as the primary source of agricultural growth in world agriculture. But low income countries are still heavily replying on the area expansion for its agriculture growth (all data/figures sources in this section are from US Department of Agriculture, <http://www.ers.usda.gov/data-products/international-agricultural-productivity.aspx>).

4.1. Agriculture Productivity (1961-1970 and 1971-1980)

Table 10. Agriculture Productivity (1961-1970 and 1971-1980).

Agriculture Total Factor Productivity Growth	1961-1970 Growth Partition						
	A=B+C	B=D+E	D	E	C=F+G	F	G
Income Class	Output	Area	Irrig	New land	Yield	Input/Area	TFP
Low income	0.025713	0.013355	0.001963	0.011392	0.012359	0.01126222	0.001096
Lower-middle-income	0.023569	0.010318	0.004215	0.006102	0.013251	0.0067537	0.006498
Middle-income-upper	0.038023	0.011546	0.002666	0.00888	0.026477	0.02029468	0.006182
Middle-income-upper (no China)	0.03024	0.015224	0.000571	0.014653	0.015017	0.00711879	0.007898
China	0.048739	0.008005	0.006651	0.001354	0.040734	0.03175571	0.008978
High-income	0.020467	0.004605	0.001395	0.003209	0.015863	0.00794561	0.007917
Transition economies	0.035439	0.000133	0.001045	-0.00091	0.035306	0.04216074	-0.00685
World	0.027918	0.007286	0.002212	0.005075	0.020632	0.02062549	6.26E-06

Table 10. Continued.

Agriculture Total Factor Productivity Growth	1971-1980 Growth Partition						
	A=B+C	B=D+E	D	E	C=F+G	F	G
Income Class	Output	Area	Irrig	New land	Yield	Input/Area	TFP
Low income	0.01932	0.005933	0.003039	0.002893	0.013388	0.010985	0.002403
Lower-middle-income	0.026688	0.00697	0.004783	0.002187	0.019718	0.012494	0.007223
Middle-income-upper	0.033309	0.008279	0.002958	0.005321	0.02503	0.013645	0.011385
Middle-income-upper (no China)	0.033494	0.008212	0.000742	0.00747	0.025282	0.01219	0.013092
China	0.033062	0.008336	0.00668	0.001656	0.024726	0.018493	0.006233
High-income	0.019404	0.000896	0.001285	-0.00039	0.018508	0.002711	0.015797
Transition economies	0.012888	0.003706	0.002885	0.000821	0.009182	0.014775	-0.00559
World	0.022935	0.005029	0.002802	0.002227	0.017906	0.012338	0.005568

4.2. Agriculture Productivity (1981-1990 and 1990-2000)

Table 11. Agriculture Productivity (1981-1990 and 1990-2000).

Agriculture Total Factor Productivity Growth	1981-1990 Growth Partition						
	A=B+C	B=D+E	D	E	C=F+G	F	G
Income Class	Output	Area	Irrig	New land	Yield	Input/Area	TFP
Low income	0.020732	0.018746	0.003406	0.01534	0.001986	7.93E-05	0.001906
Lower-middle-income	0.035737	0.012154	0.005138	0.007016	0.023582	0.011719	0.011864
Middle-income-upper	0.034848	0.006169	0.002065	0.004105	0.028679	0.016881	0.011798
Middle-income-upper (no China)	0.025731	0.008711	0.001032	0.007678	0.017021	0.009162	0.007859
China	0.04492	0.00354	0.001362	0.002177	0.041381	0.023532	0.017849
High-income	0.007469	0.000826	0.000891	-6.50E-05	0.006643	-0.00443	0.01107
Transition economies	0.008043	0.001024	0.001811	-0.00079	0.00702	0.004472	0.002547
World	0.021016	0.006111	0.002335	0.003776	0.014905	0.008749	0.006156

Table 11. Continued.

Agriculture Total Factor Productivity Growth	1991-2000 Growth Partition						
	A=B+C	B=D+E	D	E	C=F+G	F	G
Income Class	Output	Area	Irrig	New land	Yield	Input/Area	TFP
Low income	0.024837	0.012652	0.002837	0.009815	0.012185	0.005034	0.00715
Lower-middle-income	0.029745	0.01097	0.005242	0.005728	0.018775	0.008012	0.010763
Middle-income-upper	0.040896	0.00654	0.002686	0.003854	0.034356	0.005035	0.029321
Middle-income-upper (no China)	0.02878	0.00419	0.000679	0.003512	0.02459	0.010118	0.014472
China	0.051576	0.008966	0.004916	0.004049	0.04261	0.002696	0.039914
High-income	0.013724	-0.00296	0.000412	-0.00337	0.016686	-0.00313	0.019814
Transition economies	-0.03614	-0.01042	-0.0012	-0.00922	-0.02572	-0.02977	0.004052
World	0.021712	0.003085	0.001926	0.001159	0.018627	0.00324	0.015387

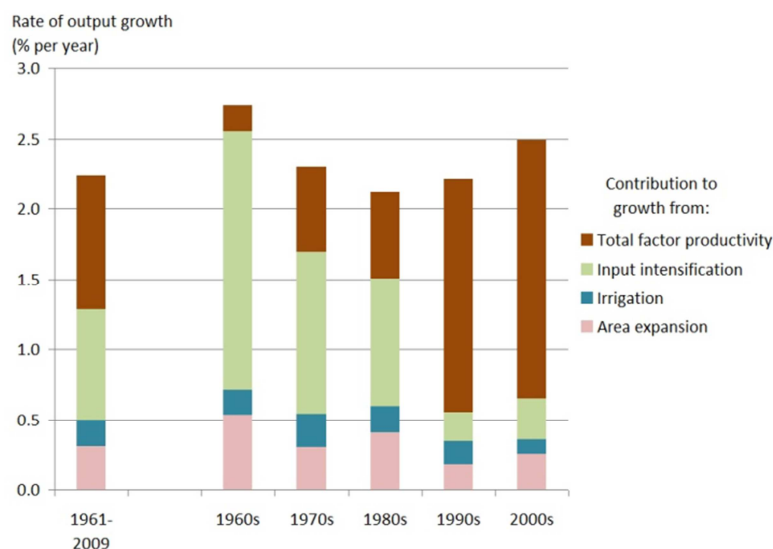


Figure 2. Sources of Agriculture Growth (1961-2009).

Sources of Global Agricultural Growth

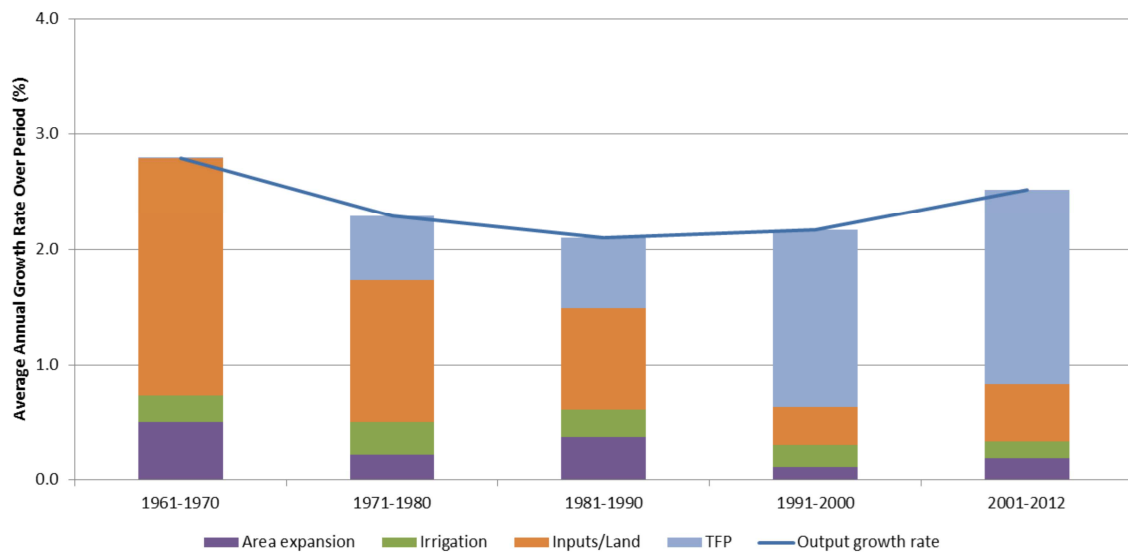


Figure 3. Sources of Global Agriculture Growth.

HIGH INCOME COUNTRIES

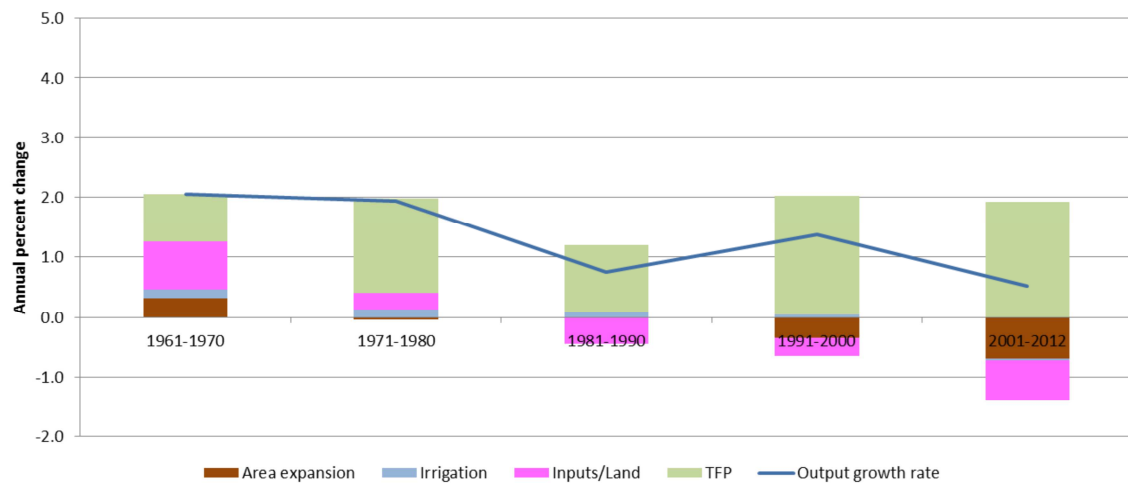


Figure 4. Sources of Agriculture Growth-High Income Countries.

Lower Middle-Income Countries

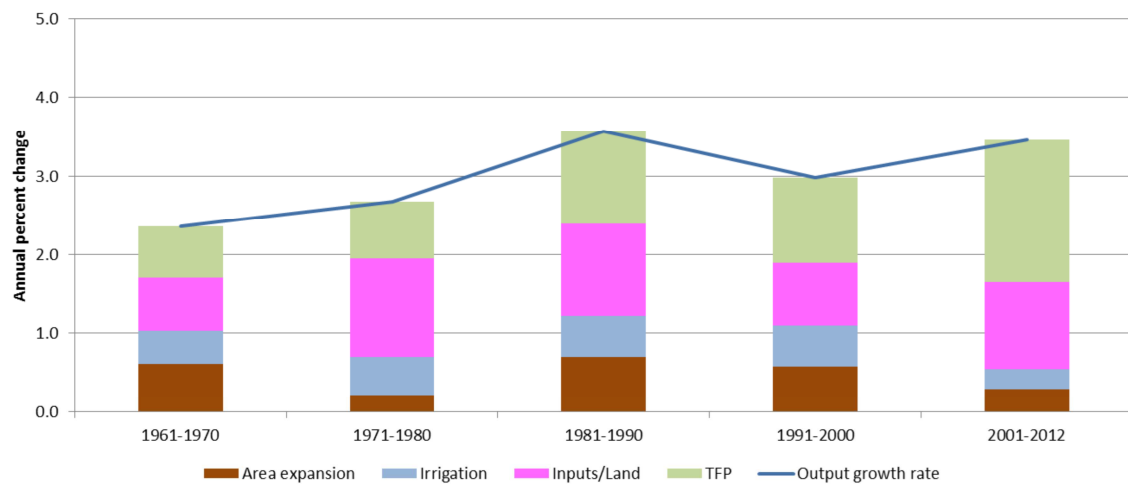


Figure 5. Sources of Agriculture Growth-Low Middle Income Countries.

Low Income Countries

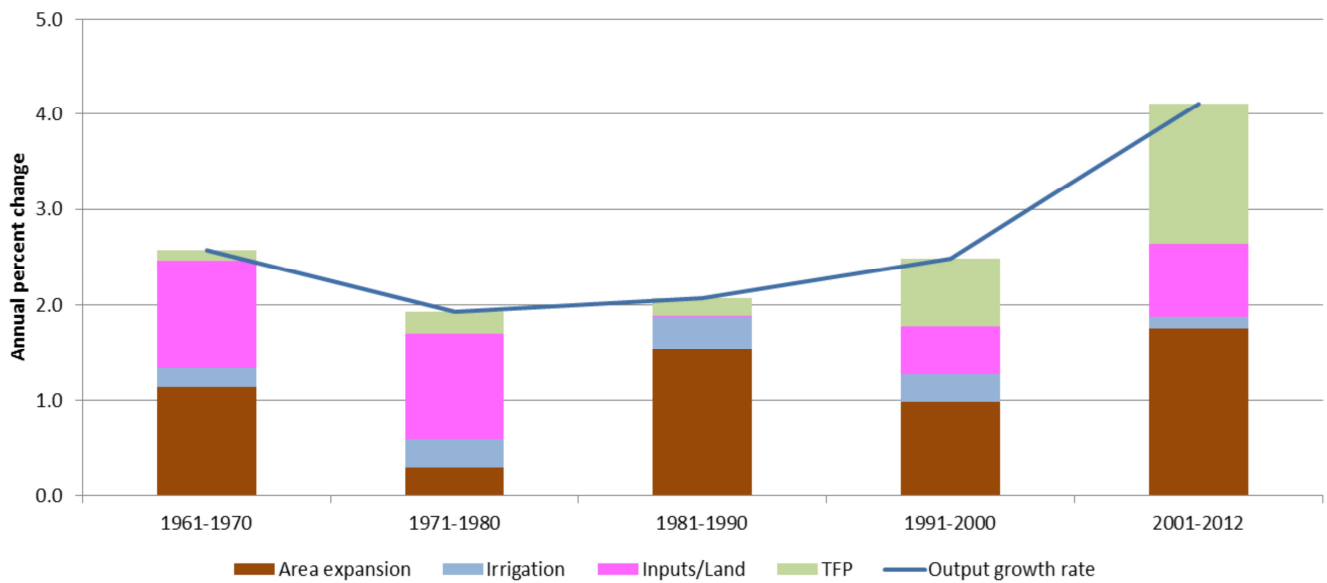


Figure 6. Sources of Agriculture Growth-Low Income Countries.

Figure 7 shows the agriculture productivity per worker and per hectare of land. China's land per worker is lower than the world average but above most Asian countries. Notably, China's productivity per worker is above the world average but much lower than developed countries.

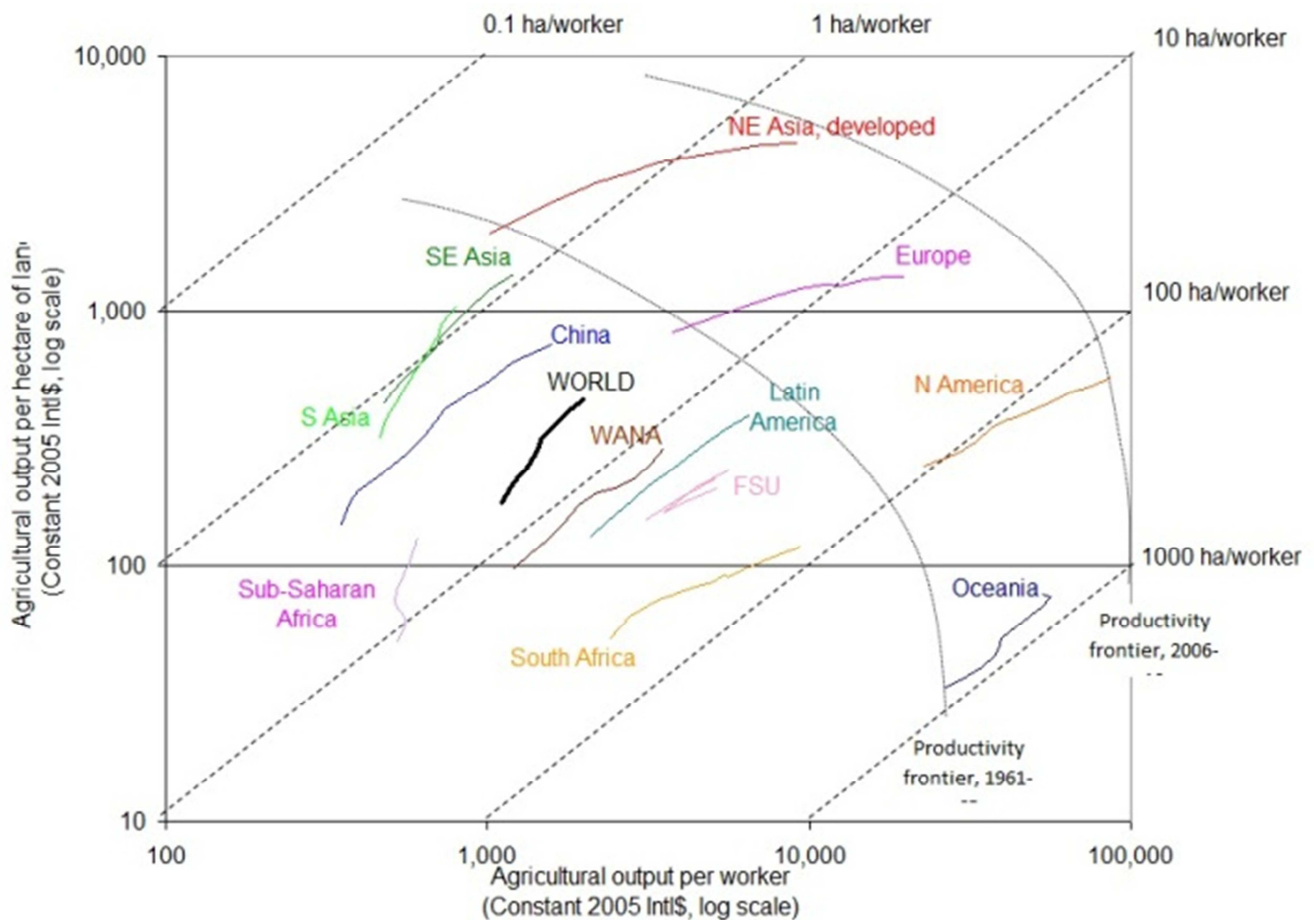


Figure 7. Agriculture Productivity per worker and per hectare of land.

4.3. Agriculture Research and Government Spending (% of Agriculture GDP)



Figure 8. Agriculture research and government spending (% of agriculture GDP).

Figure 8 shows the agriculture research and government spending as the percentage of the agriculture output (GDP). Among developed countries, this ratio is between 2-6%. China's relevant ratio should be much less than 2%.

5. What China can Learn from the Others

Generally speaking, China's agriculture industry has the middle-level of productivity and competitiveness in the world. China's inputs to this sector are also at the average level of the world. China's agriculture will face more challenges and competition when it opens widely to the world markets. It will import more foreign agriculture products as required by the WTO Agreement; its farmers will lose its market shares and many of them will be forced to exit.

The second challenge is the food price. Although the world's population has been increasing and the demand for agricultural products are increasing, the price of food has been lowering over the years (see Figure 1). In order to make enough profits from its products, farmers need to improve their productivities through adoptions of new technologies, innovations and better management. Governments also need to help farmers.

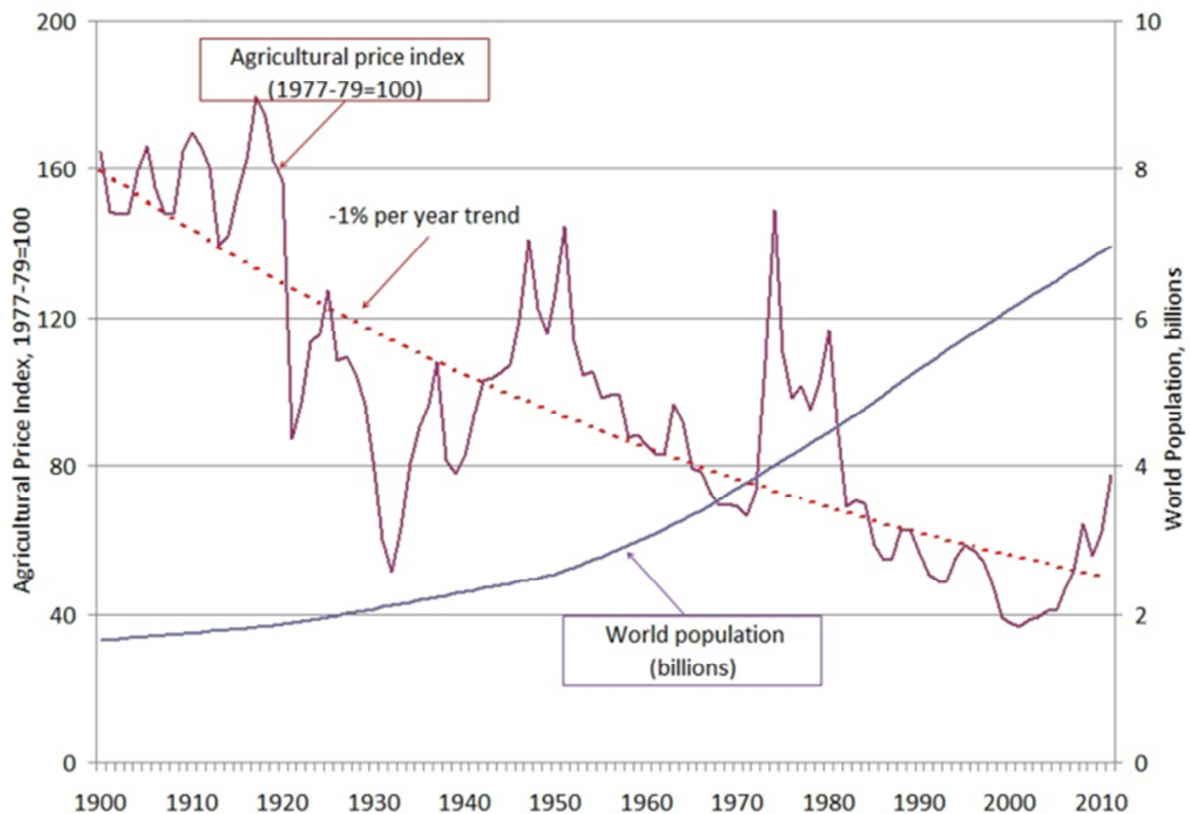


Figure 9. Decreasing Trend of Agriculture Price.

There are three types of agriculture development models:

1. US Model (also, Canada and Australia): specialization, large scales and focusing on several main agricultural products (wheats, beans and corns, etc);
2. Japan Model (also South Korea and Taiwan): small farmers and associations and direct sales;
3. Israel Model (also Singapore and Hong Kong): high tech and government subsidies.

China needs to identify its appropriate development models. Large farmers should learn from the US model and its successful experience. They need to be more specialized and focused. They need to use social and other professional services to lower fixed operating expenses, instead of owning and doing everything. For many small farmers, the Japan model will be more relevant. Governments should help them with better organized and associated and reduced middle-agents so that farmers can sell their products more directly and earn higher profit margins

Continuously improving its total factor productivity (TFP) will be the key to China's agriculture development. Developed countries like US rely mainly on increasing TFP to expand its agriculture industry and its competitiveness ([3], [4], [7], [9]). Innovations, using new technologies and better management, will be crucial to achieve better TFP. Governments, relevant research institutions, and farmers should invest more in R&D to produce more needed products and improve productivities ([9], [10], [12], [18], [21], [24], [25]).

Appropriate use of synthetic fertilizers can improve agriculture productivity and increase outputs, but overuse of that will have side effects. Lands may be polluted and/or destroyed. Compared with other countries, China has overused synthetic fertilizers. That will negatively affect its agriculture productions in the long-term.

Irrigation is important to the agriculture industry. Currently, China has the average level of the irrigated areas. China should continue to expand its irrigations so that its outputs will be more stable and less influenced by the weather.

China still has a large population working in the agriculture industry. More such labors should and will be shifted into manufacturing and/or service sectors. At the same time, the agriculture industry needs to use more machinery to be less labor-intensive.

6. Conclusions

This paper compares the agriculture industry in different countries and aims at how developing countries like China should learn from the others to improve and strengthen its agriculture industry. With the advancement of an economy, the agriculture industry will gradually share less the percentage of the GDP and employment in the total economy; but this still is a crucial and important industry in all economies.

Developing countries should focus on raising the total factor productivity of the agriculture in order to maintain its competitiveness and strength. Particularly they should invest more into agriculture research and developments, better use

new technologies and innovations, better train more people and raise farmers' knowledge and skills. They need to reform its economic systems and improve its management and regulations to encourage entrepreneurship and market competitions.

Data Sources and Acknowledgement

Unless otherwise mentioned, all data are from the World Bank at www.worldbank.org. This paper was presented at the 26th Int'l Conference on Pacific Rim Management, Taiwan, June 16-18th, 2016. The author wants to thank the financial support from the UWest through the Faculty Research Grant. Also, the author wants to thank Kathleen Wu for her fine research assistance.

References

- [1] Alexandratos, Nikos (2005), "Countries with rapid population growth and resource constraints: issues of food, agriculture, and development", *Population and Development Review*, v31 n2: 237-258.
- [2] Baker, Matthew J (2008), "A structural model of the transition to agriculture", *Journal of Economic Growth*, v13 n4: 257-292.
- [3] Baier, Scott L, Gerald P Dwyer, and Robert Tamura, "How important are capital and total factor productivity for economic growth?", *Economic Inquiry*, v44 n1: 23-49.
- [4] Ball, V., Carlos San-Juan-Mesonada, and Camilo Ulloa (2014), "State productivity growth in agriculture: catching-up and the business cycle." *Journal of Productivity Analysis* 42.3: 327-338.
- [5] Chen, Yueyun (Bill) (2015), "China's path to the sustainable, stable and rapid economic development: from the largest to the strongest manufacturing country; *Journal of World Economic Research*, August;
- [6] Chen, Yueyun (Bill) (2015), "International comparisons of the service industry," 25th Int'l Conference on Pacific Rim Mgt, Los Angeles, July.
- [7] Colman, David (2013), "Productivity growth in agriculture: an international perspective." *European Review of Agricultural Economics* 40. 3: 531-534.
- [8] Deininger, Klaus and Hans P Binswanger (1995), "Rent seeking and the development of large-scale agriculture", *Economic Development and Cultural Change*, v43 n3 (Apr 1995) 493.
- [9] Delmer, DP (2005), "Agriculture in the developing world: Connecting innovations in plant research to downstream applications", *Proceedings of the National Academy of Sciences of the United States of America*, Nov 1; 102 (44): 15739-46.
- [10] Delmer, Deborah P, Carol Nottenburg and Greg D Graff; Alan B Bennett (2003), "Intellectual property resources for international development in agriculture", *Plant Physiology*, v133 n4: 1666-70.

- [11] Dennis, Benjamin N., and Talan B. İşcan (2011), "Agricultural distortions, structural change, and economic growth: a cross-country analysis." *American Journal of Agricultural Economics* 93.3: 881-902.
- [12] Doug Parker, Federico Castillo, and David Zilberman (2001), "Public-private sector linkages in research and development: the case of U.S. agriculture", *American Journal of Agricultural Economics*, v83 n3: 736-741.
- [13] Douglas Gollin, Stephen Parente, and Richard Rogerson (2002), "The role of agriculture in development", *The American Economic Review*, v92 n2: 160-164.
- [14] Ehmke, M D (2011), "The Economics of American agriculture: evolution and global developments", *American Journal of Agricultural Economics*, 93, no. 1: 241-242. Fitzroy, F. R. (2008), "Agriculture: New developments", *Ecologist*, v38 n3.
- [15] Gehlhar, Mark J, Thomas W Hertel, and Will Martin (1994), "Economic growth and the changing structure of trade and production in the Pacific Rim", *American Journal of Agricultural Economics*, v76 n5: 1101.
- [16] Hengyun, Ma, et al. (2013), "Capital formation and agricultural growth in China." *Asian Economic Papers* 12.1: 166-193.
- [17] Jeanneney, Sylviane Guillaumont, Ping Hua, and Zhicheng Liang (2006), "Financial development, economic efficiency, and productivity growth: evidence from China", *The Developing Economies*, v44 n1: 27-52.
- [18] Jensen, Farrell E and C Arden Pope (1987), "The changing structure of US agriculture and implications for research in agribusiness firms", *Agribusiness*, v3 n2: 139-150.
- [19] Jorgenson, Andrew K, and Kennon A Kuykendall (2008), "Globalization, foreign investment dependence and agriculture production: pesticide and fertilizer use in less-developed countries, 1990-2000", *Social Forces*, v87 n1 p529-560.
- [20] Karimi, Akbar, and Reza Ardakanian (2010), "Development of a dynamic long-term water allocation model for agriculture and industry water demands." *Water Resources Management* 24.9: 1717-46.
- [21] Kothamasi, David and Saskia Vermeulen (2011), "Genetically modified organisms in agriculture: can regulations work?" *Environment, Development and Sustainability*, v13 n3: 535-546.
- [22] National Research Council (U.S.) (1997), *Precision agriculture in the 21st century: geospatial and information technologies in crop management*; Washington, D. C.; National Academy Press.
- [23] National Research Council (U.S.) (1999), *Our common journey: a transition toward sustainability*; Washington, D. C.; National Academy Press.
- [24] National Research Council (U.S.) (2014), *Spurring innovation in food and agriculture: a review of the USDA agriculture and food research initiative program*; Washington, D. C.: National Academies Press.
- [25] Organisation for Economic Cooperation and Development (OECD) (2012), *Fostering innovation and productivity growth in agriculture*. Paris.
- [26] Royal Society (2000), *Transgenic plants and world agriculture*; Washington, D. C.: National Academies Press.
- [27] United Nations. Economic and Social Commission for Asia and the Pacific (2002), *Organic agriculture and rural poverty alleviation: potential and best practices in Asia*; New York: United Nations.
- [28] Vallianatos, Evaggelos (2012), "The democratic and sacred nature of agriculture", *Environment, Development and Sustainability*, v14 n3: 335-346.
- [29] Sauer, Timm, et al. (2010), "Agriculture and resource availability in a changing world: the role of irrigation." *Water Resources Research* 46.6.
- [30] Suh, Jin Kyo (2000), "Agricultural development and structural change in the context of general economic growth." Order No. 9985337 University of Maryland College Park.
- [31] Wang, H. Holly, Wang Yanbing and Michael S. D. Elgado (2014), "The Transition to modern agriculture: contract farming in developing economies." *American Journal of Agricultural Economics* 96.5: 1257-1271.
- [32] Yang, Dennis Tao, and Xiaodong Zhu (2013), "Modernization of agriculture and long-term growth." *Journal of Monetary Economics* 60.3: 367-382.
- [33] Zhang, Wei-Bin (2014), "Growth and land use with agriculture and industry." *Journal of Reviews on Global Economics* 3: 271-92.