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CHINA'S FOOD SECURITY PROBLEM UNDER THE NATIONAL INDUSTRIALIZATION

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ABSTRACT

Being a populous country, food security has emerged as one of the most important issues for China's state administration and social stability. Presently China is going through a rapid pace of industrialization process. The objective of this research is to study the impact of the process on China's food security, and also to analyze the interaction and relationship between the process and food security. Using the definitions and evaluations of China's food security level and industrialization, an over view of their developments is given for twenty years. These definitions were also the input of a regression analysis. The regression analysis reveals that industrialization is a driving force to the food security. Based on the evaluations and regression analyses, the details of interactions between China's industrialization and food security are discussed from the aspects of food consumption and food supply.

KEY WORDS:*Food Security, Industrialization, Regression Analysis, China*

1.INTRODUCTION

The aftermath of the three years (1959-1961) great famine in China has resulted in both the government and researchers emphasizing long time focus on Chinese food security which is of great social importance to China and even the world (Findlay and Watson, 1999; Hanjra and Qureshi, 2010). Although large area famines never occurred in China after the year 1961, food production has not been steady but fluctuating, and the food supply is often under pressure (Bruins and Bu, 2006).

Since 2012, the Chinese government has put forward a development strategy that lays stress on industrialization. There were a few researches focused on the relationship between the China's industrialization and food security, Zhang (Zhang, P. 1969) first developed the theory of the relationship between agriculture and industry and how to realize industrialization in poor agricultural countries. According to his theory, agriculture is the resource of food production which in turn is the foundation of industrialization that propels economic growth. With the acceleration of the industrialization process that followed opening up of the country and reforms, the positive and negative effects of industrialization to food security have been released

gradually (Brown, 2006). Zeng (Zeng, 2010) argued that compared to the positive effects there would be more negative effects to China's food security caused by the rapid industrialization process. The negative effects would come from the shortage of arable land, labor transfer, capital movement, food planting cost rise, natural environment problems and so on. Other researches show that in the industrialization process, high-quality labor force move to urban areas from rural areas, causing food consumption to increase because of the population structure change, and which at the same time depletes the resource of food production in China (Li,Y, 2007; Zeng, 2010). In addition, industrialization augments the usage of chemical fertilizer which causes food price inflation and the increasing demand of grain for industrial use (Wang and Lin, 2005). Interestingly, few studies have focused on the positive effects of industrialization process to China's food security especially in quantitative research.

2. BACKGROUND

According to the data released by National Bureau of Statistics of China, China's gross grain production in 2012 was 58.95 million tons, and it was the ninth time increase in gross grain production since 2004. The following chart (figure 1) shows the trend of China's gross grain production and gain production per capita from 1992-2011.

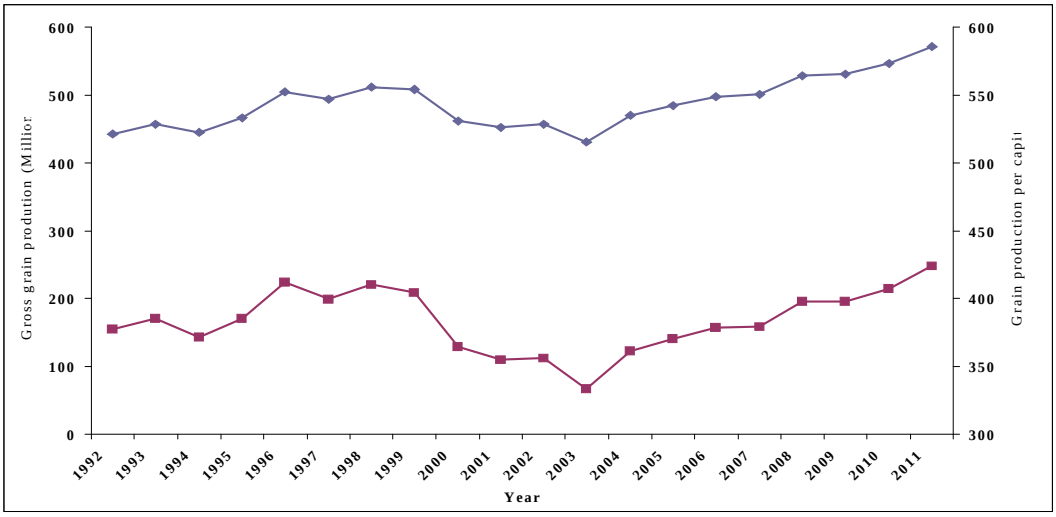

Fig.1. The trend of China's gross (the upper line) and per capita (the lower line) grain production from 1992-2011 (Data consolidated from Chinese Year Book 2012)

The chart (figure 1) shows that in the past two decades, gain production generally kept growing with only two time decreases, which happened in 1994 and 2003. The reason for the first decrease was that the Chinese government hadn't raised the government grain purchase price until 1994 when China experienced a high currency inflation period which dampened the enthusiasm of farmers to grow grain resulting in the decline of gain production (Chang and Hou, 1997). During the early part of the 21st century, the cost of grain production sharply rose, caused by higher than before prices of chemical fertilizer and mechanical power. This dangerous scenario was not eased until the Chinese central government abolished the agricultural tax and launched the Chinese new subsidy system (Du et al., 2011).

After 2004, although the grain production per capita in China kept growing most years, grain consumption quickly outpaced production. . From 2003 to 2011, grain consumption per capita in China changed from 334Kg to 471Kg, the cumulative increase being 41% while the gross grain production increase was 33% during the same period (Data consolidated from Chinese Year Book 2012). If population growth is taken into account the gap between grain production and consumption would be even huge. The current food security situation might be formed by synthetic factors like income increase, dietary structure change or demographic changes. In order to penetratingly research the underlying reasons so as to find better solutions in the context of China's national industrialization process, the food security level in China should be valued first.

3. DATA CONSOLIDATION

3.1 The evaluation of China's food security situation:-

For the purpose of evaluation, the indexes and criteria with regard to China's food security situation were carefully chosen by experts of AAFC (Agriculture and Agri-Food Canada) and USTC (University of Science and

Technology of China). Besides the indexes and criteria, the AHP (The Analytical Hierarchy Process) (Saaty, 1990) method which was used to define the index weights was also formed by the same experts. Generally the national food system can be classified into grain production (S1), food circulation (S2) and food consumption (S3). In grain production index, there are two secondary indexes: the insufficiency of food per capita (S11) and the arable land per capita (S12). In food circulation index, there are two secondary indexes: the food dependence on foreign trade (S21) and the food price rising rate (S22). The food consumption index contains these two secondary indexes: urban Engel coefficient (Timmer et al., 1983) (S31), rural Engel coefficient (S32) (Fang, 2006). Through the AHP method the weight of those six indexes were set as follow:

Table 1. The weight definition of indexes by AHP method

	S_1	S_2	S_3	weight	order
	0.540	0.301	0.163		
S_{11}	0.66667			0.36	1
S_{12}	0.33333			0.18	3
S_{21}		0.66667		0.200	2
S_{22}		0.33333		0.1	4
S_{31}			0.5	0.08	5
S_{32}			0.5	0.08	5

Because the unit of each index is different from each other, and the optimal value and the worst value are also needed, the optimal and worst value were defined for each index through Delphi, and the unit was uniformed by these two equation: (Si-Smin) /(SMAX-Smin) for positive indexes; (SMAX-Si) /(SMAX-Smin) and negative indexes (Deb, 2001).

In detail, by referring to the research by Lin and Yang (Lin and Yang, 2000), the worst scenario (MIN)) in insufficiency of food per capita (S11) was set at 150Kg, while by referring to the historical grain production data, the best scenario was set at -10Kg (MAX), which means food production was higher than food consumption by 10Kg per capita. All the data are from the "China Grain Yearbook" and "China Rural Statistical Yearbook", and the range is from 1992 to 2011.

Arable land per capita (S12) is an important index as a kind of production element investment for food production, which is also the crucial limitation factor for China's food production. The data is from "China Statistical Yearbook" (The data for 2010 and 2012 is not available, so linear interpolation method was used to substitute the real data). Refer to the UN standard of arable land area cordon (Shao et al., 2005), 0.053 hectare was set as the worst scenario (min) and 0.2 was set as the best scenario (MAX). Refer to other countries.

The food dependence on foreign trade (S21) reflects China's food retention capability in the world food market. According to the global total food trade volume, 70% was set as the worst scenario (min) for food dependence on foreign trade, which means that the import of food by China accounts for about 70% of its total food consumption, and -2% was set as the best scenario (MAX) since China could hardly maintain its food consumption without food import.

The food price rising rate (S22) is highly relevant to the purchasing power of the consumers. If food prices rise too quickly, the availability of food to ordinary people in China will be threatened which is another aspect of food crisis. According to the lesson drawn from the world food crisis in 2008, price rising at 100% per year was set for the worst scenario (min) and the best was -15% which means price fall at 15% (MAX).

The upper bound of urban Engel coefficient (S31) was set at 0.6 (min) and 0.25 (MAX), and a little higher in rural Engel coefficient (S32), which has reference to the US level (Wei and Bao, 2011) and Latin America (Wodon and Ayres, 2000).

Table 2a and Table 2b show original data and the data after uniformity with the final score of China's food security level in recent two decades.

Table 2a. The original data of China's food security

Year\Index	S_{11}	S_{12}	S_{21}	S_{22}	S_{31}	S_{32}
Weight	0.36	0.18	0.2	0.1	0.08	0.08
1992	-1.6	0.107	-0.002	0.243	53.8	57.6
1993	-3.8	0.103	-0.014	0.277	53	58.1
1994	6.7	0.102	-0.006	0.507	50.3	58.9
1995	15.9	0.101	0.042	0.368	50	58.6
1996	2.8	0.100	0.021	0.076	50.1	56.3
1997	-1.6	0.098	-0.003	0.089	48.8	55.1
1998	-0.4	0.098	-0.004	-0.031	46.6	53.4
1999	-5	0.097	0.0003	-0.031	44.7	52.6
2000	3.6	0.096	-0.001	-0.114	42.1	49.1
2001	1.8	0.094	0.018	-0.007	39.4	47.7
2002	-6.3	0.093	-0.002	-0.017	38.2	46.2
2003	13.7	0.091	0.001	0.023	37.7	45.6
2004	15	0.094	0.053	0.264	37.1	47.2
2005	20.2	0.091	0.046	0.014	37.7	45.5
2006	16.4	0.090	0.051	0.027	36.7	43
2007	22.8	0.083	0.044	0.064	35.8	43.1
2008	28.1	0.082	0.069	0.143	36.3	43.7
2009	33.2	0.083	0.083	0.07	37.9	41
2010	43	0.082	0.108	0.072	36.5	41.1
2011	47.4	0.081	0.107	0.118	35.7	40.4
MAX	-10	0.200	-0.02	-0.15	25	27
min	150	0.053	0.3	1	60	62

Table 2b. The final score of China's food security level

1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0.686	0.692	0.646	0.608	0.679	0.706	0.723	0.736	0.737	0.728
2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0.764	0.713	0.659	0.671	0.683	0.663	0.625	0.614	0.579	0.567

In Table 2, the final score of China's food security kept declining in recent years, despite the year to year increase in grain gross production for the recent nine years. The condition reveals that China's food security system weakened in recent years because of some effect factors that may have been spawned by China's industrialization process. Based on this hypothesis, China's industrialization level was valued in the following paragraphs.

3.2 The evaluation of China's industrialization:-

Considering that food security and industrialization are interactive to each other, clarifying China's industrialization level is the initial step to research their mutual influences. . Referring to the Chenery Standard Method (Chenery, 1960), and other related studies (Wang and Lin, 2005; Zeng, 2010), six indexes were chosen as the description of Chinese industrialization: GDP per capita (I1), urbanization rate (I2), the proportion of non-agricultural industries value added in GDP (I3), the proportion of non-agricultural employment in national total employment (I4), the proportion of service sector value added in GDP (I5), and the proportion of Research and Development funds in GDP (I6). Also by employing AHP and Delphi methods the weight of each index was set as 0.25, 0.2, 0.1, 0.125, and 0.125.

With regard to index I1, and reference to the average GDP of developed countries in 1992 and 2011, the best scenario (MAX) was set as 19073 US dollars per capita in 1992 and 32360 USD in 2011. Because the Chinese GDP in 1992 was too low compared to these countries, zero was set as the worst scenario (min). In addition, the exchange rate changes between the US dollar and Renminbi (RMB) was taken into consideration.

With regard to index I2, urbanization rate is highly related to industry development level. , China experienced a rapid urbanization process after 1980, which is a significant signal of economic progress and

industrialization. Compared to the data of countries like OECD (Organization for Economic Co-operation and Development) and China's population, 0.8 was chosen as the best scenario (MAX), 0.2 as the worst (min).

The proportion of non-agricultural industries value added in GDP (I3) is a basic symbol of industry development according to Kuznets law (Kuznets, 1955), which means briefly that there is a positive correlation between the proportion of non-agricultural industries value added in GDP and industrialization. Also through comparison of data between countries like OECD (Organization for Economic Co-operation and Development) and China's historical condition, 0.95 was chosen as the best scenario (MAX), 0.7 as the worst (min).

The proportion of non-agricultural employment in national total employment (I4) is an index similar to (I3), with the same methods, and 0.9 was chosen as the best scenario (MAX), 0.3 as the worst (min).

The proportion of service sector value added in GDP (I5) shows the economic development level according to the Chenery Standard Method, with the same methods, and 0.65 was chosen as the best scenario (MAX), 0.2 as the worst (min).

R&D funds in GDP (I6) reveal scientific and technological strength and also the industrial strength, which is a symbol of industrial modernization. Generally the proportion of R&D funds in GDP in developed countries like the US and Japan is beyond 0.025, so 0.025 was chosen as the best scenario (MAX), 0.01 as the worst (min) with reference to China's related historic date. .

All the data is from "China Grain Yearbook" and "China Science and Technology Yearbook", and the time range is from 1992 to 2011. Table 3a and Table 3b show original data and the data after uniformity with the final score of China's industrialization level in the recent two decades.

Table 3a. The original data of China's industrialization

I	I_1(US dollar)*	I_2	I_3	I_4	I_5	I_6
Weight	0.25	0.2	0.2	0.1	0.125	0.125
1992	419	27.63	78.21	41.5	34.76	0.78
1993	520	28.14	80.29	43.6	33.72	0.73
1994	469	28.62	80.24	45.7	33.57	0.64
1995	604	29.04	80.14	47.8	32.86	0.57
1996	703	29.37	80.31	49.5	32.77	0.57
1997	774	29.92	81.71	50.1	34.17	0.64
1998	821	30.4	82.44	50.2	36.23	0.65
1999	865	30.89	83.53	49.9	37.67	0.76
2000	949	36.22	84.94	50	39.02	0.9
2001	1042	37.66	85.61	50	40.46	0.95
2002	1135	39.09	86.26	50	41.47	1.07
2003	1274	40.53	87.2	50.9	41.23	1.13
2004	1490	41.76	86.61	53.1	40.38	1.23
2005	1732	42.99	87.88	55.2	40.51	1.32
2006	2070	43.9	88.89	57.4	40.94	1.39
2007	2652	44.94	89.23	59.2	41.89	1.4
2008	3414	45.68	89.27	60.4	41.82	1.47
2009	3749	46.59	89.67	61.9	43.43	1.7
2010	4430	49.68	89.9	63.3	43.14	1.76
2011	5432	51.27	89.88	65	43.1	1.83
MAX	19073-32360	80	95	90	65	2.5
min	0	20	70	30	20	0.1

Table 3b. The final score of China's industrialization level

1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0.192	0.210	0.208	0.208	0.214	0.237	0.251	0.270	0.311	0.329
2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0.348	0.366	0.373	0.398	0.420	0.437	0.451	0.478	0.500	0.518

In Table 3, the final score of China's industrialization level kept increasing in the past two decades. Although some indexes declined a little in certain years, the entire development of China's industrialization was still showing progress. In 2011, generally speaking China moved into the middle and later stage of industrialization.

4. METHODS

In this research, we assume that China's food security is highly influenced by industrialization process, and the development level of the process and food security were evaluated by the real indexes from year books in theprevious paragraph. So in this part, multivariate linear regression was used to study the relationship between China's food security level and the process. After that the pairwise relationship between China's food security level and the process were studied according to the results of the regression analysis.

Regression models involve the following variables:

The unknown parameters, denoted as β, which may represent a scalar;

The independent variable X;

The dependent variable Y;

A regression model relates Y to a function of X and β in the following format:

Y H" f (X , β)

In this research Y refers to the S, which is China's food security level, the X refers to China's industrialization level (I), so the format of the regression equation is as follow:

S H" β_II

With regard to the goodness of fit test and significance testing, if R2 is higher than 0.7 and the P value is lower than 0.1, the results could be accepted (Cohen et al., 1975). The input data were summarized from Tables 2, 3:

Table 4. The input data of the Regression Analysis

Year	S	I
Worst	0.0000	0.0000
1992	0.6857	0.1922
1993	0.6919	0.2097
1994	0.6460	0.2085
1995	0.6077	0.2084
1996	0.6787	0.2144
1997	0.7057	0.2366
1998	0.7233	0.2507
1999	0.7358	0.2705
2000	0.7372	0.3114
2001	0.7277	0.3288
2002	0.7636	0.3485
2003	0.7129	0.3658
2004	0.6588	0.3734
2005	0.6715	0.3980
2006	0.6830	0.4202
2007	0.6628	0.4371
2008	0.6247	0.4511
2009	0.6141	0.4782
2010	0.5787	0.4996
2011	0.5672	0.5178
Best	1.0000	1.0000

5. RESULTS

By the SPSS software, S was treated as the dependent value, I was treated as the independent value, and the following tables show the results of the regression analysis.

Table 5a The goodness of fit test of the Regression Analysis

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.574(a)	.330	.296	.143

a Predictors: (Constant), I

Table 5b The equation significance testing

ANOVA[b]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.201	1	.201	9.833	.005[a]
	Residual	.410	20	.020		
	Total	.611	21			

a. Predictors: (Constant), I
b. Dependent Variable: S

Table 5c The coefficient significance testing

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.479	.065		7.386	.000
	I	.511	.163	.574	3.313	.005

Dependent Variable: S

From Table 5a, the goodness of fit test show that R2 is 0.330, which shows that the relationship between S and I is not significantly close. From table 5b, the total significant level of the equation is much lower than 0.1, which means that the regression equation is meaningful. From table 5c, the significant level of each coefficient is lower than 0.1, which means that I should be included in the regression hypothesis.

The regression analysis results indicate these several conclusions: China's food security level has certain connection with the industrialization process, and the process interactively influences China's food security level; The β values in Table 5c indicate that industrialization is a driving force to food security; The regression analysis shows the generally interacting relationship between the S and I, but the detailed mode of action between China's food security and the process still needs further discussion. So in the following paragraphs, the detail of influence of the process to China's food security is discussed by taking the regression results into consideration.

6 .DISCUSSIONS

The regression analysis shows that industrialization has a kind of positive effect on food security in China from the integrated perspective. However industrialization also exerts negative effect on food security, thus the specifics of influence still needs further discussion.

First, the impact of industrialization to food consumption: Industrialization motivates food consumption by the increase of industrial food use. Nowadays, industrial food use accounts for about 20% of the total food production, especially food used for alcohol products which has seen rapid growth. In 2011, the annual gross alcohol production was 9,167,800,000 liters, which is 11.45% more than the year 2010. If based on the 1:3 changing rate, the total food use is about 30 million tons which accounts for about 6% of the annual gross food production. Furthermore a few scholars argue that China's industrial food use will assert fast growth in the future, which will bring great pressure to the food security level in China (Hong-bin, 2008; Yu and Tao, 2009). Another impact

of the industrialization to food consumption is dietary changes. Because of improvement in living standard , meat consumption like pork, beef, egg, poultry, and dairy products constitute a greater percentage in current Chinese diet, and because meat food needs more grain to produce, the gross grain demand is going higher and higher. The following figures show the dietary changes in the recent two decades.

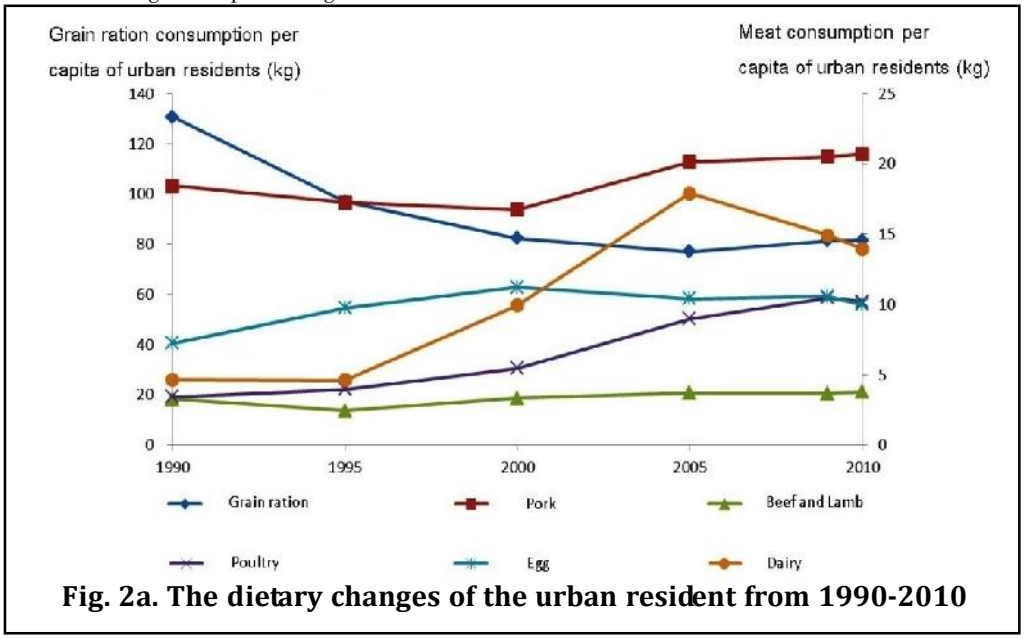

Fig. 2a. The dietary changes of the urban resident from 1990-2010

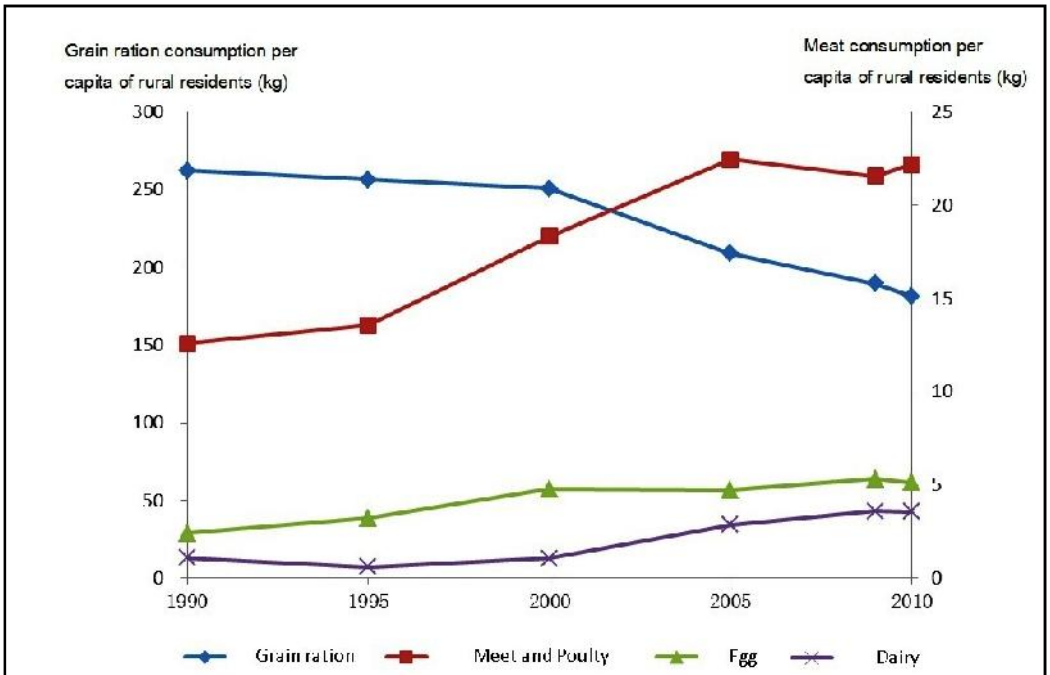

Fig. 2b. The dietary changes of the rural resident from 1990-2010

Second, the impact of industrialization to food supply: China's industrialization has transferred tremendous rural labor to the urban area since the 1980s (De Brauw et al., 2002). The number of agricultural workers decreased from 390 million to 260 million from 1992 to2011. Even in the current 260 million rural labors, a good number of them have part time jobs in urban areas. In 2011 the number of peasant-workers in china had gone down to 250 million, which means that the real number of pure farm workers has gradually decreased over the years. . However, compared to the number of American farm workers which stands at a total of only 6 million, the figure of China's rural labor force is still excessive, so the industrialization process in China is actually doing a favor by bringing about a change to the labor force structure by streamlining it. Another impact of industrialization to food

supply is the flow of industrial capital into the rural area, and the symbol of this impact is the evolution of the land transfer system (Yuneng and Bo, 2011). With the development of land transfer system, scale operation and mechanized planting of grain and production have become more and more popular in China now. In order to get some empirical support, we surveyed the rural land transfer practice in the rural area of Luan City in Anhui Province of China two times, that is in the winters of 2009 and 2010, and the survey results are summarized as follow: 1. 90% of the towns in Luan City established rural land transfer service centers; 2. In 2009, 14% of the total arable land was transferred to scale food producers; 3. An agricultural company called Tianye founded several huge farms ranging in size from 100-500 hectares to scale produce high quality rice through land transfer; 4. The citizens' government of Luan plans to establish 12 national level rice production farms bigger than the previous farm scale. Such scale of farming has been made possible by the inflow of industrial capital. Based on the above two phenomena, that is, the welcome restructuring of rural labor force and provision of industrial capital to rural economy, we might argue that China's industrialization is a relatively positive factor to the food supply.

7. CONCLUSIONS

From the year 2004 to 2012, the gross food production in China has been increasing year on year for nine years, and the food production per capita recorded a historic highest in 2012., However the results of this research indicate that China's food security situation is getting worse, and there appears to be more challenges to food security in China to be faced from quarters like industrialization, urbanization, pollution, and lack of recourse etc. So despite the food production growth, China's food security issue needs more attention than ever before.

The results of the regression analysis indicate that China's industrialization has had positive effect on food security. Based on these results, further discussions reveal the following management implications: Through evaluation of China's industrialization, we believe that China has come into the post-industrialization era. The industrialization impact the food security just like the' two sides of a coin: food consumption may be increased by enhanced industrial use of food; food supply can be upgraded by the flow of industrial capital to rural area.

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