

## Production Trends of China's Wheat (1990-2008)

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**Abstract:** This paper provides an overview of current wheat's sown area, production capacity, and yield trends in China and the most important wheat-producing provinces during the period 1990-2008. The research adopts time trend model and least significant difference (LSD) test based on wheat's sown area, production capacity, and yield in China and its provinces to estimate the multiple comparisons between the various provinces. The results revealed that both of China's sown area and production capacity have a decreasing general trend but China's yield has an increasing general trend during the period of the study. It also shows that Henan, Shandong, and Hebei provinces compose over 50% of China's wheat production. Anhui and Henan provinces are the only ones that have an increasing general trend in wheat's sown area, production, and yield together. On the other hand, Jiangsu province is the only one that has a decreasing general trend in wheat's sown area, production, and yield together during the period of study.

**Key words:** Production Capacity, Sown area, Yield, Wheat, China.

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### INTRODUCTION

China, the world's largest wheat producer, has been sitting on the sidelines of the global wheat panic. The last 20 years have been a period of volatility for wheat production in China. Production reached record levels in 1997, and then fell by over 35 million tons by 2003.

Wheat is one of the world's top food crops and one of the first to be cultivated. Wheat is the staple food grain in north China and is eaten in the form of steamed bread and noodles. Per capita consumption has risen, and the demand for wheat flour has increased as incomes have risen.

Chinese wheat production varies from year to year according to price and government policies. The government encourages the production of high and consistent quality wheat that has a higher value and suitable for processing, export and import replacement.

The study of production capacity for any crop is important to identify the economics of that crop. It is known that the production capacity of any crop is a function of the sown area and the yield obtained. Therefore this research will study the production capacity of wheat crop in China as a whole and the production capacity at the most important wheat-producing provinces.

#### 2. Study Objectives:

The study analyzes the current situation of China's wheat. Production, sown area and yield will be analyzed through a time trend model since 1990 to 2008. This will show a clear pattern to economists to know the economic policy of that crop in China and its provinces.

### MATERIAL AND METHOD

This research is adopted on the method of inductive in economic analysis, both qualitative and quantitative relationships between variables by analyzing the time series of different phenomena and economic relations. It depends on using statistical methods and economic models such as time trend model to compare between the estimated models, according to indicators of measuring the efficiency of the overall performance of the models, which are statistical tests ( $F$  and  $t$ ) and the coefficient of determination ( $R^2$ ). In addition to this, it has been used least significant difference (LSD) test to estimate the multiple comparisons for sown area, production and yield for wheat crop of China and its provinces to show the results and indicators that will indicate the production capacity strategy for this crop.

The research based on secondary data published during the study period 1990-2008. These data was obtained from the National Bureau of Statistics of China and Publications of Food and Agriculture Organization

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of the United Nations (F.A.O).

**Results:**

**4.1 Wheat's Production Capacity of China as a Whole:**

To measure the production capacity of China as a whole, the research will study the evolution of China's wheat sown area, China's wheat production, and China's wheat yield during the period of study (1990-2008).

**4.1.1 Evolution of China's Wheat Sown Area:**

The study of evolution of China's wheat sown area is indicated in the appendix table (1.1). It shows that wheat sown area has a fluctuation during the period of study ranged from a minimum of 21.63 million hectares in 2004 to a maximum of 31 million hectares in 1991 and the annual average of sown area amounted to 27 million hectares. Equation (1) in table (1) shows the result of estimating trend model equation for China's wheat sown area during the period (1990 – 2008).

It indicates that China's wheat sown area was decreased by 1.04 million hectares, representing approximately 3.87% of the annual average of China's sown area (27 million hectares) during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 89.4% of the changes in average sown area of Chinese wheat attributable to factors that time factor reflect them.

**4.1.2 Evolution of China's Wheat Production:**

The study of evolution of China's wheat production is indicated in the appendix table (1.1). It showed that wheat production has a fluctuation during the period of study ranged from a minimum of 86.50 million tons in 2003 to a maximum of 123.30 million tons in 1997 and the annual average of production estimated to 102.70 million tons. Equation (2) in table (1) shows the result of estimating trend model equation for China's wheat production during the period (1990 – 2008).

It indicates that China's wheat production was decreased by 2.5 million tons, representing approximately 2.43% of the annual average of China's wheat production (102.69 million tons) during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 46% of the changes in average production of Chinese wheat attributable to factors that time factor reflect them.

**4.1.3 Evolution of China's Wheat Yield:**

The study of evolution of China's wheat yield is indicated in the appendix table (1.1). It shows that wheat yield has a fluctuation during the period of study ranged from a minimum of 3 tons per hectare in 1991 to a maximum of 4.76 tons per hectare in 2008 and the annual average yield amounted to 3.86 tons per hectare. Equation (3) in table (1) shows the results of estimating trend model equation for wheat yield in China during the period (1990 – 2008).

It indicates that China's wheat yield has tended to achieve a statistically significant annual increase by approximately 0.12 ton per hectare, representing approximately 3.20% of the annual average of China's wheat yield amounted to 3.86 ton per hectare during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 91.5% of the changes in average yield of Chinese wheat attributable to factors that time factor reflect them.

**4.2 Wheat's Production Capacity of the Most Important Wheat-producing Provinces:**

Most of China's wheat production comes from the North China Plain. The three provinces that constitute most of this area, Henan, Shandong, and Hebei, collectively account for over 50 percent of China's wheat output.

**4.2.1 Evolution of Wheat's Sown Area at China Provinces:**

The study of evolution of wheat's sown area at China's provinces indicated in the appendix table (2.1) showed that wheat's sown area has a fluctuation during the period of study ranged from a minimum annual average of 1.5 million hectare in Shaanxi province to a maximum annual average of 5 million hectares in Henan province during the period of study (1990-2008).

Table (2) shows the results of estimating trend model equations for wheat's sown area at China provinces during the period (1990 – 2008). It indicates that Anhui's wheat sown area achieved a statistical significant increase by 0.01 million hectares, representing approximately 0.48% of the annual average of wheat's sown area in Anhui amounted to 2.09 million hectares during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 31.8% of the changes in average sown area of Anhui's wheat attributable

to factors that time factor reflect them. Hebei's wheat sown area decreased by 0.017 million hectares, representing approximately 0.68% of the annual average of wheat's sown area in Hebei amounted to 2.50 million hectares during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 41% of the changes in average sown area of Hebei's wheat attributable to factors that time factor reflect them. Henan's wheat sown area achieved a statistical significant increase by 0.007 million hectares, representing approximately 0.14% of the annual average of wheat's sown area in Henan amounted to 5 million hectares during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 82% of the changes in average sown area of Henan's wheat attributable to factors that time factor reflect them. Jiangsu's wheat sown area decreased by 0.05 million hectares, representing approximately 2.63% of the annual average of wheat's sown area in Jiangsu amounted to 2 million hectares during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 76% of the changes in average sown area of Jiangsu's wheat attributable to factors that time factor reflect them. Shaanxi's wheat sown area decreased by 0.04 million hectares, representing approximately 2.40% of the annual average of wheat's sown area in Shaanxi amounted to 1.5 million hectares during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 88% of the changes in average production of Shaanxi's wheat attributable to factors that time factor reflect them. Shandong's wheat sown area decreased by 0.17 million hectares, representing approximately 4.56% of the annual average of wheat's sown area in Shandong amounted to 3.75 million hectares during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 87% of the changes in average production of Shaanxi's wheat attributable to factors that time factor reflect them. Sichuan's wheat sown area decreased by 0.20 million hectares, representing approximately 11% of the annual average of wheat's sown area in Sichuan amounted to 1.82 million hectares during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 96% of the changes in average production of Shaanxi's wheat attributable to factors that time factor reflect them.

#### **4.2.2 Evolution of Wheat's Production at China Provinces:**

The study of evolution of wheat production at China's provinces is indicated in the appendix table (2.2). It shows that wheat's production has a fluctuation during the period of study ranged from a minimum annual average of 4.27 million tons in Shaanxi province to a maximum annual average of 22 million tons in Henan province during the period of study (1990-2008).

Table (3) shows the results of estimating trend model equations for wheat's production at China provinces during the period (1990 – 2008). It indicates that Anhui's wheat production achieved a statistical significant increase by 0.03 million tons, representing approximately 0.34% of the annual average of wheat's production in Anhui amounted to 7.5 million tons during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 74% of the changes in average production of Anhui's wheat attributable to factors that time factor reflect them. Hebei's wheat production achieved a statistical significant increase by 0.14 million tons, representing approximately 1.28% of the annual average of wheat's production in Hebei amounted to 11 million tons during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 50% of the changes in average production of Hebei's wheat attributable to factors that time factor reflect them. Henan's wheat production achieved a statistical significant increase by 0.75 million tons, representing approximately 3.37% of the annual average of wheat's production in Henan amounted to 22 million tons during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 90% of the changes in average production of Henan's wheat attributable to factors that time factor reflect them. Jiangsu's wheat production decreased by 0.41 million tons, representing approximately 4.77% of the annual average of wheat's production in Jiangsu amounted to 8.60 million tons during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 56% of the changes in average production of Jiangsu's wheat attributable to factors that time factor reflect them. Shaanxi's wheat production decreased by 0.04 million tons, representing approximately 0.96% of the annual average of wheat's production in Shaanxi amounted to 4.27 million tons during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 23% of the changes in average production of Shaanxi's wheat attributable to factors that time factor reflect them. Shandong's wheat production decreased by 0.61 million tons, representing approximately 3.23% of the annual average of wheat's production in Shandong amounted to 18.80 million tons during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 68.4% of the changes in average production of Shandong's wheat attributable to factors that time factor reflect them. Sichuan's wheat production decreased by 0.27 million tons, representing approximately 4.75% of the annual average of wheat's production in Sichuan amounted to 5.73 million tons during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 94% of the changes in average production of Sichuan's wheat attributable to factors that time factor reflect them.

#### **4.2.3 Evolution of Wheat's Yield at China Provinces:**

The study of evolution of wheat's yield at China provinces is indicated in the appendix table (2.3). It shows that wheat's yield has a fluctuation during the period of study ranged from a minimum annual average of 2.97 tons per hectare in Shaanxi province to a maximum annual average of 5 tons per hectare in Shandong province during the period of study (1990-2008).

Table (4) shows the results of estimating trend model equations for wheat's yield at China provinces during the period (1990 – 2008). It indicates that Anhui's wheat yield achieved a statistical significant increase by 0.10 million tons per hectare, representing approximately 2.71% of the annual average of wheat's yield in Anhui amounted to 3.61 million tons per hectare during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 49% of the changes in average yield of Anhui's wheat attributable to factors that time factor reflect them. Hebei's wheat yield achieved a statistical significant increase by 0.08 million tons per hectare, representing approximately 1.82% of the annual average of wheat's yield in Hebei amounted to 4.39 million tons per hectare during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 77.4% of the changes in average yield of Hebei's wheat attributable to factors that time factor reflect them. Henan's wheat yield achieved a statistical significant increase by 0.13 million tons per hectare, representing approximately 3% of the annual average of wheat's yield in Henan amounted to 4.5 million tons per hectare during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 92% of the changes in average yield of Henan's wheat attributable to factors that time factor reflect them. Jiangsu's wheat yield decreased by 0.19 million tons per hectare, representing approximately 4.42% of the annual average of wheat's yield in Jiangsu amounted to 4.21 million tons per hectare during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 42% of the changes in average yield of Jiangsu's wheat attributable to factors that time factor reflect them. Shaanxi's wheat yield achieved a statistical significant increase by 0.05 million tons per hectare, representing approximately 1.55% of the annual average of wheat's yield in Shaanxi amounted to 3 million tons per hectare during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 47.5% of the changes in average yield of Shaanxi's wheat attributable to factors that time factor reflect them. Shandong's wheat yield achieved a statistical significant increase by 0.04 million tons per hectare, representing approximately 0.84% of the annual average of wheat's yield in Shandong amounted to 5 million tons per hectare during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 79% of the changes in average yield of Shandong's wheat attributable to factors that time factor reflect them. Sichuan's wheat yield achieved a statistical significant increase by 0.02 million tons per hectare, representing approximately 0.60% of the annual average of wheat's yield in Sichuan amounted to 3.18 million tons per hectare during the period of study. The value of coefficient of determination ( $R^2$ ) shows that about 52% of the changes in average yield of Sichuan's wheat attributable to factors that time factor reflect them.

#### **4.3 Variance of Production Capacity:**

To indicate the variance of production capacity and its impact on sown area, production, and yield between the most important wheat-producing China provinces for wheat crop, one way analysis of variance (ANOVA) at 7 provinces was made during the period of study.

#### **4.3.1 Variance of Wheat's Sown Area at China Provinces:**

The results of analysis of variance (one-way ANOVA) shown in the appendix table (3.1) indicated that there is a statistically significant difference of wheat's sown area between the different provinces, as the value of calculated (f) amounted to 361.271, and it is significant at a probability level 0.01.

Table (5) shows the multiple comparisons of wheat's sown area between the most important wheat-producing provinces on the basis of least significant difference (LSD) test. It indicates that Henan province at the first place by an average sown area amounted to 4.90 million hectares. This average has a significant difference more than it in Shandong, Hebei, Anhui, Jiangsu and Sichuan provinces. On the other hand this average has a non significant difference more than it in Shaanxi province. Shandong province at the second place by an average sown area amounted to 3.75 million hectares. This average has a significant difference more than it in Hebei, Anhui, Jiangsu and Sichuan provinces. On the other hand this average has a non significant difference more than it in Shaanxi province. Hebei province at the third place by an average sown area amounted to 2.50 million hectares. This average has a significant difference more than it in Anhui, Jiangsu and Sichuan provinces. On the other hand this average has a non significant difference more than it in Shaanxi province. Anhui province at the fourth place by an average sown area amounted to 2.09 million hectares. This average has a significant difference more than it in Jiangsu and Sichuan provinces. On the other hand this

average has a non significant difference more than it in Shaanxi province. Jiangsu province at the fifth place by an average sown area amounted to 2.05 million hectares. This average has a significant difference more than it in Sichuan province. On the other hand this average has a non significant difference more than it in Shaanxi province. Sichuan province at the sixth place by an average sown area amounted to 1.82 million hectares. This average has a non significant difference more than it in Shaanxi province. Shaanxi province at the seventh place by an average sown area amounted to 1.46 million hectares. This average has a significant difference less than it in Henan, Shandong, Hebei, Anhui, Jiangsu and Sichuan provinces.

#### **4.3.2 Variance of Wheat's Production at China Provinces:**

The result of analysis of variance (one-way ANOVA) shown in the appendix table (3.2) indicates that there is a statistically significant difference in wheat's production between different provinces, as the value of calculated (f) amounted to 182.822, and it is significant at a probability level 0.01.

Table (6) shows the multiple comparisons of wheat's production between the most important wheat-producing provinces on the basis of least significant difference (LSD) test. It indicates that Henan province at the first place by an average production amounted to 22.14 million tons. This average has a significant difference more than it in Shandong, Hebei, Jiangsu, Anhui and Sichuan provinces. On the other hand this average has a non significant difference more than it in Shaanxi province. Shandong province at the second place by an average production amounted to 18.78 million tons. This average has a significant difference more than it in Hebei, Jiangsu, Anhui and Sichuan provinces. On the other hand this average has a non significant difference more than it in Shaanxi province. Hebei province at the third place by an average production amounted to 10.98 million tons. This average has a significant difference more than it in Jiangsu, Anhui and Sichuan provinces. On the other hand this average has a non significant difference more than it in Shaanxi province. Jiangsu province at the fourth place by an average production amounted to 8.61 million tons. This average has a significant difference more than it in Anhui and Sichuan provinces. On the other hand this average has a non significant difference more than it in Shaanxi province. Anhui province at the fifth place by an average production amounted to 7.59 million tons. This average has a significant difference more than it in Sichuan province. On the other hand this average has a non significant difference more than it in Shaanxi province. Sichuan province at the sixth place by an average production amounted to 5.73 million tons. This average has a non significant difference more than it in Shaanxi province. Shaanxi province at the seventh place by an average production amounted to 4.27 million tons. This average has a significant difference less than it in Henan, Shandong, Hebei, Jiangsu, Anhui and Sichuan provinces.

#### **4.3.3 Variance in Wheat's Yield at China Provinces:**

The results of analysis of variance (one-way ANOVA) shown in the appendix table (3.3) indicated that there is a statistically significant difference in wheat's yield between the different provinces, as the value of calculated (f) amounted to 35.906, and it is significant at a probability level 0.01.

Table (7) shows the multiple comparisons of wheat's yield between the most important wheat-producing provinces on the basis of least significant difference (LSD) test. It indicates that Shandong province at the first place by an average yield amounted to 5.03 million tons per hectare. This average has a significant difference more than it in Henan, Hebei, Jiangsu, and Anhui provinces. On the other hand this average has a non significant difference more than it in Sichuan and Shaanxi provinces. Henan province at the second place by an average yield amounted to 4.50 million tons per hectare. This average has a significant difference more than it in Hebei, Jiangsu, and Anhui provinces. On the other hand this average has a non significant difference more than it in Sichuan and Shaanxi provinces. Hebei province at the third place by an average yield amounted to 4.39 million tons per hectare. This average has a significant difference more than it in Jiangsu and Anhui provinces. On the other hand this average has a non significant difference more than it in Sichuan and Shaanxi provinces. Jiangsu province at the fourth place by an average yield amounted to 4.20 million tons per hectare. This average has a significant difference more than it in Anhui province. On the other hand this average has a non significant difference more than it in Sichuan and Shaanxi provinces. Anhui province at the fifth place by an average yield amounted to 3.61 million tons per hectare. This average has a non significant difference more than it in Sichuan and Shaanxi provinces. Sichuan province at the sixth place by an average yield amounted to 3.18 million tons per hectare. This average has a significant difference less than it in Shandong, Henan, Hebei, Jiangsu, and Anhui provinces. Shaanxi province at the seventh place by an average yield amounted to 2.97 million tons. This average has a significant difference less than it in Henan, Shandong, Hebei, Jiangsu, Anhui, and Sichuan provinces.

**Table 1:** Equations of time trend model for China's wheat during the period (1990-2008)

No.	Dependent Variable	Equation Type	Equation	Annual Average	Actual Variable (Y)	Annual Change Rate (%)	R <sup>2</sup>	F
1	Sown Area	Cubic	$\hat{Y}_t = 28.765 + 1.318 X - 0.223 X^2 + 0.007 X^3$ (21.018)** (2.282)* (-3.370)** (3.372)**	26.90	-1.04	-3.87	0.894	42.390**
2	Production	Cubic	$\hat{Y}_t = 80.168 + 11.985 X - 1.459 X^2 + 0.049 X^3$ (9.415)** (3.336)** (-3.542)** (3.584)**	102.69	-2.50	-2.43	0.461	4.283*
3	Yield	Cubic	$\hat{Y}_t = 2.861 + 0.223 X - 0.020 X^2 + 0.001 X^3$ (16.637)** (3.079)** (-2.440)* (2.696)*	3.86	0.12	3.19	0.915	54.131**

Note:

Y is the actual sown area, production and yield in the year (t); Y ?t is the estimated value of area, production and yield in the year (t). \*5% level of significance, \*\*1% level of significance.

Source: Calculated according to table (1.1) in the appendix.

**Table 2:** Equations of time trend model for wheat's sown area of China provinces during the period (1990-2008)

No.	Province (Dependent Variable)	Equation Type	Equation	Annual Average	Actual Area (Y)	Annual Change Rate (%)	R <sup>2</sup>	F
1	Anhui	Linear	$\hat{Y}_t = 1.987 + 0.010 X$ (47.913)** (2.813)*	2.09	0.010	0.48	0.318	7.910*
2	Hebei	Cubic	$\hat{Y}_t = 2.304 + 0.123 X - 0.013 X^2 + 0.0004 X^3$ (14.920)** (1.886) (-1.795) (1.527)	2.50	-0.017	-0.68	0.408	3.446*
3	Henan	Cubic	$\hat{Y}_t = 4.625 + 0.097 X - 0.012 X^2 + 0.0005 X^3$ (62.939)** (3.128)** (-3.385)** (3.903)**	4.90	0.007	0.14	0.820	22.702**
4	Jiangsu	Cubic	$\hat{Y}_t = 2.147 + 0.146 X - 0.025 X^2 + 0.001 X^3$ (12.362)** (1.997) (-3.027)** (3.318)**	2.05	-0.054	-2.63	0.761	15.936**
5	Shaanxi	Linear	$\hat{Y}_t = 1.811 - 0.035 X$ (51.295)** (-11.408)**	1.46	-0.035	-2.40	0.884	130.144**
6	Shandong	Cubic	$\hat{Y}_t = 3.858 + 0.209 X - 0.034 X^2 + 0.001 X^3$ (21.902)** (2.814)* (-3.944)** (4.066)**	3.75	-0.171	-4.56	0.870	33.333**
7	Sichuan	Cubic	$\hat{Y}_t = 1.952 + 0.241 X - 0.037 X^2 + 0.001 X^3$ (17.298)** (5.063)** (-6.814)** (6.702)**	1.82	-0.199	-10.93	0.963	128.376**

Note: (1) Y is the actual area in the year (t); Y ?t is the estimated value of area in the year (t).

(2) \*5% level of significance, \*\*1% level of significance.

Source: Calculated according to table (2.1) in the appendix.

**Table 3:** Equations of time trend model for wheat's production at China provinces during the period (1990-2008)

No.	Province (Dependent Variable)	Equation Type	Equation	Annual Average	Actual Area (Y)	Annual Change Rate (%)	R <sup>2</sup>	F
1	Anhui	Cubic	$\hat{Y}_t = 2.771 + 1.666 X - 0.187 X^2 + 0.007 X^3$ (2.252)* (3.208)** (-3.150)** (3.367)**	7.59	0.026	0.34	0.740	14.230**
2	Hebei	Quadratic	$\hat{Y}_t = 8.167 + 0.541 X - 0.020 X^2$ (10.366)** (2.983)** (-2.271)*	10.98	0.141	1.28	0.498	7.940**
3	Henan	Linear	$\hat{Y}_t = 14.687 + 0.746 X$ (21.549)** (12.473)**	22.14	0.746	3.37	0.901	155.572**
4	Jiangsu	Cubic	$\hat{Y}_t = 7.186 + 1.349 X - 0.193 X^2 + 0.007 X^3$ (6.078)** (2.704)* (-3.382)** (3.655)**	8.61	-0.411	-4.77	0.561	6.396**
5	Shaanxi	Linear	$\hat{Y}_t = 4.688 - 0.041 X$ (22.690)** (-2.279)*	4.27	-0.041	-0.96	0.234	5.195*
6	Shandong	Cubic	$\hat{Y}_t = 12.943 + 3.194 X - 0.385 X^2 + 0.013 X^3$ (9.143)** (5.347)** (-5.621)** (5.589)**	18.78	-0.606	-3.23	0.684	10.819**
7	Sichuan	Cubic	$\hat{Y}_t = 6.129 + 0.688 X - 0.108 X^2 + 0.004 X^3$ (15.518)** (4.128)** (-5.659)** (5.671)**	5.73	-0.272	-4.75	0.942	81.450**

Note: (1) Y is the actual production in the year (t); Y ?t is the estimated value of production in the year (t). (2) \*5% level of significance, \*\*1% level of significance.

Source: Calculated according to table (2.2) in the appendix.

**Table 4:** Equations of time trend model for wheat yield at China provinces during the period (1990-2008)

No.	Province (Dependent Variable)	Equation Type	Equation	Annual Average	Actual Area (Y)	Annual Change Rate (%)	R <sup>2</sup>	F
1	Anhui	Linear	$\hat{Y}_t = 2.631 + 0.098 X$ (9.496)** (4.030)**	3.61	0.098	2.71	0.489	16.244**
2	Hebei	Linear	$\hat{Y}_t = 3.594 + 0.080 X$ (30.188)** (7.623)**	4.39	0.080	1.82	0.774	58.112**

**Table 4:** Continue

3	Henan	Linear	$\hat{Y}_t = 3.160 + 0.134 X$ (28.873)** (13.992)**	4.50	0.134	2.98	0.920	195.771**
4	Jiangsu	Cubic	$\hat{Y}_t = 3.397 + 0.334 X - 0.041 X^2 + 0.001 X^3$ (8.316)** (1.938) (-2.058)* (2.230)*	4.21	-0.186	-4.42	0.422	3.644*
5	Shaanxi	Linear	$\hat{Y}_t = 2.509 + 0.046 X$ (18.709)** (3.920)**	2.97	0.046	1.55	0.475	15.369**
6	Shandong	Cubic	$\hat{Y}_t = 3.471 + 0.522 X - 0.054 X^2 + 0.002 X^3$ (12.347)** (4.398)** (-3.936)** (3.883)**	5.03	0.042	0.84	0.789	18.730**
7	Sichuan	Linear	$\hat{Y}_t = 2.992 + 0.019 X$ (59.193)** (4.266)**	3.18	0.019	0.60	0.517	18.197**

Note: (1) Y is the actual yield in the year (t);  $\hat{Y}_t$  is the estimated value of yield in the year (t). (2) \*5% level of significance, \*\*1% level of significance.

Source: Calculated according to table (2.3) in the appendix.

**Table 5:** Results of applying L.S.D test between wheat's area averages (1000 hectares) at China provinces during the period (1990 - 2008)

Governorate	Shaanxi	Sichuan	Jiangsu	Anhui	Hebei	Shandong	Henan
Average	1.46	1.82	2.05	2.09	2.50	3.75	4.90
Henan	3.44158*	3.08368*	2.85053*	2.81000*	2.39579*	1.15053*	-
Shandong	2.29105*	1.93316*	1.70000*	1.65947*	1.24526*	-	-
Hebei	1.04579*	0.68789*	0.45474*	0.41421*	-	-	-
Anhui	0.63158*	0.27368*	0.04053	-	-	-	-
Jiangsu	0.59105*	0.23316*	-	-	-	-	-
Sichuan	0.35789*	-	-	-	-	-	-
Shaanxi	-	-	-	-	-	-	-

\*. The mean difference is significant at the 0.05 level.

**Table 6:** Results of applying L.S.D test between China's production averages (1000 Tons) of wheat during the period (1990 - 2008)

Governorate	Shaanxi	Sichuan	Anhui	Jiangsu	Hebei	Shandong	Henan
Average	4.27	5.73	7.59	8.61	10.98	18.78	22.14
Henan	17.86789*	16.41368*	14.55737*	13.53158*	11.16737*	3.36263*	-
Shandong	14.50526*	13.05105*	11.19474*	10.16895*	7.80474*	-	-
Hebei	6.70053*	5.24632*	3.39000*	2.36421*	-	-	-
Jiangsu	4.33632*	2.88211*	1.02579	-	-	-	-
Anhui	3.31053*	1.85632*	-	-	-	-	-
Sichuan	1.45421*	-	-	-	-	-	-
Shaanxi	-	-	-	-	-	-	-

\*. The mean difference is significant at the 0.05 level.

**Table 7:** Results of applying L.S.D test between China's yield averages (ton / hectares) of wheat during the period (1990 - 2008)

Governorate	Shaanxi	Sichuan	Anhui	Jiangsu	Hebei	Henan	Shandong
Average	2.971	3.182	3.610	4.208	4.390	4.503	5.033
Shandong	2.0619*	1.8510*	1.4226*	0.8245*	0.6426*	0.5292*	-
Henan	1.5327*	1.3218*	0.8934*	0.2953	0.1134	-	-
Hebei	1.4193*	1.2084*	0.7799*	0.1818	-	-	-
Jiangsu	1.2375*	1.0266*	0.5981*	-	-	-	-
Anhui	0.6394*	0.4285*	-	-	-	-	-
Sichuan	0.2109	-	-	-	-	-	-
Shaanxi	-	-	-	-	-	-	-

\*. The mean difference is significant at the 0.05 level.

**Table 1.1:** China's sown area, production quantity and yield for wheat crop, 1990-2008

Year	Sown Area (million hectares)	Production (million tons)	Yield (ton per hectare)
1990	30.75	98.23	3.194
1991	30.95	95.95	3.100
1992	30.50	101.59	3.331
1993	30.24	106.39	3.518
1994	28.98	99.30	3.427
1995	28.86	102.21	3.542
1996	29.61	110.57	3.734
1997	30.06	123.29	4.101
1998	29.77	109.73	3.686
1999	28.86	113.88	3.946
2000	26.65	99.64	3.739
2001	24.66	93.87	3.807
2002	23.91	90.29	3.776
2003	22.00	86.49	3.931
2004	21.63	91.95	4.251

**Table 1.1:** Continue

2005	22.79	97.45	4.276
2006	23.61	108.47	4.594
2007	23.72	109.30	4.608
2008	23.62	112.46	4.761
Average	26.90	102.69	3.859

**Table 2.1:** China's sown area (in million hectares) of wheat by province, 1990-2008

Year	Anhui	Hebei	Henan	Jiangsu	Shaanxi	Shandong	Sichuan
1990	2.07	2.51	4.78	2.40	1.69	4.15	2.22
1991	2.06	2.53	4.80	2.36	1.69	4.20	2.28
1992	1.97	2.54	4.71	2.37	1.66	4.13	2.30
1993	2.08	2.53	4.84	2.28	1.64	4.16	2.34
1994	2.02	2.46	4.82	2.11	1.62	4.05	2.31
1995	1.99	2.50	4.81	2.15	1.60	4.01	2.33
1996	2.07	2.59	4.87	2.22	1.60	4.03	2.36
1997	2.14	2.72	4.93	2.34	1.60	4.04	2.38
1998	2.10	2.76	4.96	2.32	1.61	3.98	1.86
1999	2.06	2.73	4.88	2.25	1.59	4.01	1.82
2000	2.13	2.68	4.92	1.95	1.54	3.75	1.61
2001	1.96	2.58	4.80	1.71	1.42	3.55	1.50
2002	2.06	2.45	4.86	1.72	1.36	3.40	1.46
2003	2.01	2.19	4.80	1.62	1.23	3.11	1.32
2004	2.06	2.16	4.86	1.60	1.15	2.97	1.26
2005	2.11	2.38	4.96	1.68	1.21	3.28	1.26
2006	2.12	2.42	5.01	1.73	1.20	3.35	1.27
2007	2.33	2.41	5.21	2.04	1.14	3.52	1.32
2008	2.35	2.42	5.26	2.07	1.14	3.53	1.29
Average	2.09	2.50	4.90	2.05	1.46	3.75	1.82

**Table 2.2:** China's production (in million tons) of wheat by province, 1990-2008

Year	Anhui	Hebei	Henan	Jiangsu	Shaanxi	Shandong	Sichuan
1990	5.98	9.28	16.40	9.24	4.64	16.12	6.85
1991	3.15	9.00	15.54	8.48	4.46	18.89	7.14
1992	6.12	9.18	16.51	10.06	4.18	18.78	7.18
1993	7.17	9.02	19.22	9.42	4.96	19.36	7.02
1994	7.10	9.22	17.98	8.77	4.04	19.37	7.04
1995	6.99	10.60	17.54	8.93	4.10	20.61	7.31
1996	7.48	11.39	20.27	10.14	4.06	20.53	7.20
1997	9.41	13.31	23.72	10.65	5.63	22.41	7.40
1998	5.99	12.53	20.73	7.60	5.04	20.24	6.01
1999	8.53	12.81	22.91	10.71	4.06	21.18	5.43
2000	7.07	12.08	22.36	7.96	4.19	18.60	5.32
2001	7.42	11.23	22.99	7.04	4.07	16.55	4.49
2002	6.84	11.00	22.48	6.45	4.05	15.47	4.59
2003	6.43	10.19	22.93	6.09	3.96	15.65	4.26
2004	7.90	10.53	24.81	6.88	4.10	15.85	4.16
2005	8.08	11.50	25.78	7.29	4.01	18.01	4.27
2006	9.67	11.50	28.23	8.18	4.16	18.90	4.39
2007	11.11	11.94	29.80	9.74	3.59	19.96	4.52
2008	11.68	12.22	30.51	9.98	3.92	20.34	4.27
Average	7.59	10.98	22.14	8.61	4.27	18.78	5.73

**Table 2.3:** China's yield (in ton/hectare) of wheat by province, 1990-2008

Year	Anhui	Hebei	Henan	Jiangsu	Shaanxi	Shandong	Sichuan
1990	2.889	3.697	3.431	3.850	2.746	3.884	3.086
1991	1.529	3.557	3.238	3.593	2.639	4.498	3.132
1992	3.107	3.614	3.505	4.245	2.518	4.547	3.122
1993	3.447	3.565	3.971	4.132	3.024	4.654	3.000
1994	3.515	3.748	3.730	4.156	2.494	4.783	3.048
1995	3.513	4.240	3.647	4.153	2.563	5.140	3.137
1996	3.614	4.398	4.162	4.568	2.538	5.094	3.051
1997	4.397	4.893	4.811	4.551	3.519	5.547	3.109
1998	2.852	4.540	4.179	3.276	3.130	5.085	3.231
1999	4.141	4.692	4.695	4.760	2.553	5.282	2.984
2000	3.319	4.507	4.545	4.082	2.721	4.960	3.304
2001	3.786	4.353	4.790	4.117	2.866	4.662	2.993
2002	3.320	4.490	4.626	3.750	2.978	4.550	3.144
2003	3.199	4.653	4.777	3.759	3.220	5.032	3.227



**Table 2.3:** Continue

2004	3.835	4.875	5.105	4.300	3.565	5.337	3.302
2005	3.829	4.832	5.198	4.339	3.314	5.491	3.389
2006	4.561	4.752	5.635	4.728	3.467	5.642	3.457
2007	4.768	4.954	5.720	4.775	3.149	5.670	3.424
2008	4.970	5.050	5.800	4.821	3.439	5.762	3.310
Average	3.610	4.390	4.503	4.208	2.971	5.033	3.182

**Table 3.1:** One-Way ANOVA for wheat's sown area at China provinces

ANOVA	Sum of Squares	df	Mean Square	F
Between Provinces	172.552	6	28.759	361.271**
Within Provinces	10.030	126	.080	
Total	182.582	132		

**Table 3.2:** One-Way ANOVA for wheat's production at China provinces

ANOVA	Sum of Squares	df	Mean Square	F
Between Provinces	5223.019	6	870.503	182.822**
Within Provinces	599.948	126	4.761	
Total	5822.966	132		

**Table 3.2:** One-Way ANOVA for wheat's yield at China provinces

ANOVA	Sum of Squares	df	Mean Square	F
Between Provinces	64.505	6	10.751	35.906**
Within Provinces	37.727	126	.299	
Total	102.232	132		

### Conclusions:

The research showed the production capacity of China and its most important wheat-producing provinces during the period 1990-2008. The study indicated that China's sown area had a decreasing general trend by a statistically significant annual rate represents 3.87% of the annual average for wheat's sown area amounted to 27 million hectares during the period of study. China's wheat production had a decreasing general trend by a statistically significant annual rate represents 2.43% of the annual average for wheat's production amounted to 102.70 million tons during the period of study. On the other hand, China's wheat yield had an increasing general trend by a statistically significant annual rate represents 3.20% of the annual average of wheat's yield amounted to 3.86 tons per hectare during the period of study.

Most of China's wheat production comes from the north china plain. The three provinces that form most of this area are Henan, Shandong and Hebei, where their annual averages of sown area are 5, 3.75, and 2.50 million hectares respectively during the period of study. The sown area of China provinces had a decreasing general trend by statistically significant annual rates except Anhui and Henan provinces, they have an increasing general trend by statistically significant annual rates represent 0.48% and 0.14% respectively of the annual average for Anhui's Henan's sown area amounted to 2 million hectares and 5 million hectares respectively during the period of study.

Henan, Shandong, and Hebei produce over 50% of China's wheat production, where their annual averages of production are 22, 18.80, and 11 million tons respectively during the period of study.

Jiangsu, Shaanxi, Shandong, and Sichuan provinces have a decreasing general trend in wheat's production but Anhui, Hebei, and Henan provinces have an increasing general trend in wheat's production during the period of study.

Wheat's yield at China provinces (included in this study) have an increasing general trend, except Jiangsu province where it has a decreasing general trend in wheat's yield during the period of study.

From the above conclusions, it is noted that Anhui and Henan Provinces are the only provinces that have an increasing general trend in wheat's sown area, production, and yield. On contrast, it is noted that Jiangsu province is the only one that has a decreasing general trend in wheat's sown area, production, and yield during the period of study.

The least significant difference (LSD) test showed that Henan is the first province in average sown area (5 million hectares) and average production (22 million tons), but it is the second province at average yield (4.5 hectares per ton) during the period of study. It also indicated that Shandong is the first province in average yield (5 hectares per ton), but it is the second province at average sown area (3.75 million hectares) and average production (18.80 million tons). Shaanxi is the last province of the studied provinces in average sown area (1.5 million hectares), average production (4.3 million tons), and average yield (3 hectares per ton).

## REFERENCES

- Colby, Hunter, Xinshen Diao and Agapi Somwaru, 2000. “*Cross-Commodity Analysis of China’s Grain Sector*” U.S. Department of Agriculture, Economic Research Service, Technical Bulletin, 1884.
- Huang, J., S. Rozelle and M. Rosegrant. 1999. “*China’s Food Economy to the Twenty-first Century: Supply, Demand and Trade*,” *Economic Development and Cultural Change*, 30: 737-56.
- Mohamed, H.K., 2007. “*An Economic Analysis of Flax in Egypt*” M.Sc. Tanta University, Egypt. (in Arabic)
- National Bureau of Statistics of China, 1990-2008. *China Statistical Yearbook*, Yearly data.
- Rozelle, S. and J. Huang, 2000. “*Transition, Development and the Supply of Wheat in China*” *Australian Journal of Agricultural and Resource Economics*, 4(4): 543-571.
- MAJID, S.A., 1993. “*Solving the Sraffian System of Production Via the Use of a Computer Model*”, *Kybernetes*, 14(3): 163-166.
- Yang, Weilu, 2000. (ed.) “*Analyses and Forecasts of Wheat and Flour Market in 2000*,” Unpublished report, National Grains and Oils Information Center, Beijing, China, pp: 122.