

Impact of Agricultural Mechanization on Grain Production in China

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Abstract: The main purpose of this article is to investigate the relationship between agricultural mechanization and grain production. Our main country of study is China because it is a large agricultural country, and the choice of China is representative and meaningful. The methodology chosen in this paper is to de-trend the data, which helps us to put aside the time factor to see the relationship that exists between them in a more objective and clear way. The time period of the data that be collected is from 2003 to 2021 because this time period is the period of rapid development of agricultural mechanization in China. The author also details the history of agricultural mechanization in China in the article. Finally, it can be seen that based on the results, agricultural mechanization and grain yield are positively and strongly correlated, and mechanization has a strong impact on grain yield. This paper also provides some policy recommendations for agriculture and farmers based on our research; it can be believed that the policies can really help agriculture because a lot of research has been conducted. The author also hopes that this article will be of some help to readers.

Keywords: Agricultural Mechanization, De-trend, China

1. Introduction

China's social and economic growth has entered a new period with the achievement of the objective of creating a moderately wealthy society, and common prosperity has become an essential goal for the nation in the current developmental stage [1]. However, in this process, China's agriculture faced the problem of low yield and low quality, so agricultural mechanization began to be considered by the state to promote. Agricultural mechanization refers to the use of advanced and applicable agricultural machinery and equipment for agriculture, improving agricultural production and management conditions, and continuously improving the production technology level of agriculture and the economic and ecological benefits of the process. Agricultural mechanization is an important part of agricultural modernization. Agricultural mechanization, such as crop cultivation, drainage and irrigation, plant protection, and harvesting. Agricultural basic construction mechanization its role is to improve labor productivity, reduce labor intensity, and improve agricultural production per unit area.

Firstly, from 1979 to 1995, as the rural reform with the family contract responsibility system as the core began to break, the main body in the field of agricultural mechanization appeared "a retreat and an advance" two major changes, the government gradually withdrew from agriculture, the main body of farmers entered the agricultural market in large numbers. Then, came 1996 to 2003, the

government began to promote agricultural mechanization vigorously and forcibly, and made great progress. Then came 2004 to 2013, the rapid increase in demand for agricultural mechanization. The country also strongly supported agricultural mechanization and the introduction of many subsidy policies, During this period, China's agricultural mechanization developed very rapidly, the rapid growth of the total amount of agricultural equipment, agricultural equipment structure is significantly optimized. Finally, from 2014 to now, China's agricultural mechanization has a certain bottleneck and is seeking a breakthrough.

Since China's agricultural data has been relatively open and transparent, our data sources are from a Chinese national data website. The data published by the state is also very credible, so the author used.

All in all, the time period chosen for the study is 2003 to 2021, which is a very meaningful and valuable time period, and the tremendous growth of Chinese agriculture and the astounding rise in productivity come at a great price in terms of the deterioration of ecosystems and the services they provide [2].

2. Literature Review

Agricultural development has always been a fundamental issue for a country because it involves the quality of life of the people and if food production is not guaranteed, then the people will suffer. But how to improve the efficiency of agriculture and keep farmers motivated has always been a challenge. So, people thought of agricultural mechanization to improve production efficiency. However, due to its uniqueness, China has gone through many processes regarding agricultural mechanization. Numerous issues in Chinese agriculture have led to poor production and consequently low revenue for farmers. Before the mechanization of agriculture, the level of agricultural production in China was very poor. It is difficult for the Chinese people to have a full meal, and all kinds of food are very scarce. As illustrated in Figure 1, taking one crop, corn, as an example, it can be seen from the figure that prior to the industrialization of agriculture, our production of corn was consistently lower than that of the US. So, it is necessary to carry out agricultural mechanization.

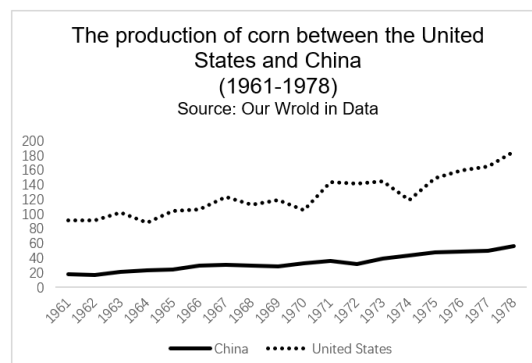


Figure 1: The production of corn between the United States and China

The following factors that contribute to China's inefficient food production have been the subject of previous research. One study mentioned that China's low agricultural productivity is due to environmental issues, whether it is the loss of arable land, water quality, or availability that affects China's agricultural development [3].

One article mentions that China's urbanization also benefits China's food production. In China, the Household Contract Responsibility System (HCRS), which takes into account both the amount and quality of their holdings, distributes croplands to all rural people equally in each village. This is a key factor in farmland. China's fragmentation which impedes the large-scale production of agriculture [4].

Another study says this: Due to aging and migration, China must deal with a decline in farm labor and rural populations. Domestic commodity prices are under pressure due to rapidly expanding global supply chains that include producers and wholesalers from an increasing number of countries. This threatens farm incomes, increases subsidy rates, creates market instability, and drives away the "best and the brightest" from careers in agriculture [3].

Based on these realities, ideas about China's agricultural mechanization have been put forward by experts. However, there are several issues with China's agricultural mechanization. One expert believes that Training in agricultural technology may also be a barrier. The average household income of those enrolled in agricultural technology training was only 0.151 times greater on a mean logarithmic scale than that of untrained families. Farmers' access to training may be restricted by both internal and external variables, such as training techniques, topic, methodology, and teachers, as well as by their personal characteristics, such as education level, age, and income level [5].

Nevertheless, agricultural mechanization also has many benefits. One study illustrates how agricultural mechanization can help reduce the overall and high-end gaps in farm household income while helping to reduce the non-farm economic gap [5]. In turn, it can be thought that narrowing the income gap will help increase farmers' motivation to produce, maintain a stable output of food, and ensure national food security.

In general, based on the current situation in China, the characteristics of low grain production and poor quality, as well as the unreasonable use of arable land. Agricultural mechanization must be implemented, although agricultural mechanization is constrained by certain conditions, but from the general point of view of agricultural mechanization is more advantageous than disadvantageous.

Based on the above statements, the author decided to adopt a de-trending approach to explore the impact of agricultural mechanization on China's grain production and farmers' income, and the time period from 2003 to 2021 was chosen because this is the period when Chinese agricultural mechanization is vigorously developed.

3. Methodology and Data

The methodology used to test the impact of agricultural mechanization on grain yield is a de-trending approach. The years chosen are from 2003 to 2021, the period when China's agricultural mechanization has been vigorously developed, and the data from this period are most representative. Table 1 shows the number of tractors owned by farmers and grain production from 2003 to 2021. As a whole, there was a general trend of growth, although there was a decline in the second half of the year. The reason for choosing this methodology is that it clearly shows the relationship between mechanization and grain production because the author will use the correlation data. Thus, the author can visualize the magnitude of the effect. This methodology also helps us to rule out the effects of time-series data.

Table 1: Total number of tractors owned by farmers and Grain production (Raw data)

Year quantities	Total number of tractors owned by farmers	Grain production (Unit: 10,000 tons)
2003	14757616	43069.53
2004	15667915	46946.95
2005	16664897	48402.19
2006	17397242	49804.23
2007	18253878	50413.85
2008	20219315	53434.29
2009	21024788	53940.86

Table 1: (continued)

2010	21779644	55911.31
2011	22519134	58849.33
2012	22824700	61222.62
2013	22793000	63048.2
2014	22977200	63964.83
2015	23103300	66060.27
2016	23169695	66043.51
2017	23043200	66160.73
2018	22402494	65789.22
2019	22242868	66384.34
2020	22048732	66949.15
2021	21730586	68284.75

Table 2: Cyclical of total number of tractors owned by farmers and Cyclical of grain production

Year quantities	Cyclical of total number of tractors owned by farmers	Cyclical of grain production
2003	-27.66	-7.04
2004	-24.67	-1.46
2005	-21.38	-1.16
2006	-19.44	-0.97
2007	-17.01	-2.32
2008	-9.72	0.93
2009	-7.76	-0.61
2010	-6.10	0.55
2011	-4.55	3.27
2012	-4.86	4.73
2013	-6.55	5.18
2014	-7.31	4.14
2015	-8.28	5.05
2016	-9.45	2.62
2017	-11.33	0.45
2018	-15.10	-2.24
2019	-16.96	-3.32
2020	-18.89	-4.30
2021	-21.22	-4.03

4. Discussion

The first thing has to do is to find two sets of data. Here the author defines agricultural mechanization as the number of tractors owned by farmers, the data that have to be found are: the total number of tractors owned by farmers, and grain production. (All data are from China National Data Network)

Next, the equation for the chart is calculated by least squares. For the Total number of tractors owned by farmers, the equation is $y = 399181x + 2E+07$. For Grain production, the equation is $y = 8.011x + 351.58$. Then, the author needs to bring the data (e.g. 1 represents 2003) from the table into the respective equations to calculate the trend, and after we calculate the trend, we subtract the trend from the original value. Finally, we need to divide the difference from the points by the trend times 100 to calculate the cyclical. The formula can be expressed as: $\text{difference}/\text{trend} \times 100$. This way, we can get the cyclical for each data. The cyclical data is the important data that helps us to dislodge disturbances in the time series data. As table 2 demonstrates the cyclical of the total number of tractors owned by farmers and cyclical of grain production.

Once the cyclical has been calculated, we can start looking at the relationship between the data. We can first calculate the standard deviation of each set of data according to the formula for standard deviation. The standard deviation of cyclical of the total number of tractors owned by farmers is 7.19. The standard deviation of cyclical grain production is 3.51. In addition, we can see the correlation between the two sets of data. The correlation between the cyclical total number of tractors owned by farmers and the cyclical of grain production is 0.84. It may be more intuitive to use one graph to express.

Table 3: The results

	Cyclical of total number of tractors owned by farmers	Cyclical of grain production
Standard deviation	7.19	3.51
Correlation	0.84	

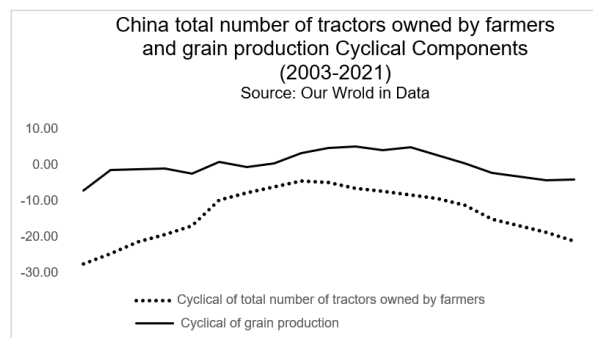


Figure 2: China total number of tractors owned by farmers and grain production cyclical components

5. Results

For the reader's convenience, Figure 2 depicts the correlation and degree of variations of the final findings, respectively, and table 3 displays the results directly. According to the cyclical results, it can be seen that the cyclical of the number of tractors and the cyclical of crop production have a positive correlation, and the relationship is very strong. Moreover, we can see that the number of tractors is also increasing year by year, which indicates that our mechanization is also advancing, and the positive correlation also shows that the promotion of mechanization helps to increase food production. We can also see from the standard deviation that the standard deviation of the tractor is larger, indicating that the fluctuation of the tractor is very large, which in turn verifies that our country actively promotes this achievement of agricultural mechanization. At the same time, the standard deviation of the grain output is also larger, indicating that the change of grain output is also obvious.

However, there are some flaws in this methodology: we can see from the raw data that they are not a steadily increasing trend but a downward trend, so the fit between the straight line we calculated with the least squares method and the raw data is not perfect and there is a certain amount of error, but the overall trend is still in line, and the results are informative. Also, our data on mechanization only refer to the number of tractors, which can be somewhat one-sided, as there are many advanced tools for agricultural mechanization.

6. Conclusion

Overall, the purpose of this article is to examine the relationship between the degree of agricultural mechanization and food production. If the relationship is strong, it shows that it makes sense for us to promote mechanization. The author uses a de-trending approach to better visualize the correlation

between the various factors and to facilitate a more intuitive study. After calculating the cyclical factors and then deriving the standard deviation and correlation of each data. For the first, the author found that the correlation between the number of tractors and grain yield was 0.84. According to the results, we can conclude that the more the number of tractors, the greater the grain yield and the more obvious the effect of mechanization to promote agricultural development. Secondly, we can also see the size of the standard deviation. The standard deviation of the cyclical of total number of tractors owned by farmers is 7.19, and the standard deviation of cyclical of grain production is 3.51. These data can be very good to help us analyze the great role of agricultural mechanization on agricultural production but also allow us to intuitively see whether the agricultural mechanization of agriculture has really led to the development of agriculture.

These results show that there is a role in promoting agricultural mechanization in our country. However, although grain production has increased, we should consider the issue of how to improve farmers' income more because the little pay available from agriculture has significantly lowered agricultural laborers' enthusiasm for many years [3]. Because grain production and farmers' income involve many parts, although we have explored the relationship from mechanization, there are many other factors that affect farmers' income, such as policies, education level, and land is also an important part.

The policy recommendation is to further promote the development of agricultural mechanization based on the consolidation of the existing achievements of agricultural mechanization while vigorously researching new technologies to provide more advanced machinery for agriculture, improve food production and reduce the intervention of weather conditions on agriculture. The government also increases investment to support the development of agricultural mechanization. Policies can also be formulated to limit agricultural pollution and ensure the quality of water, which is also beneficial to the development of agriculture as a whole. In terms of the treatment of farmers, we can appropriately raise the price of agricultural products to increase farmers' income, provide more care, or enhance publicity to make people aware of the hard work of farmers. Another recommendation is that we hope that each region will develop according to local conditions because China's territory is very vast, so there are various types of land, such as red soil or black soil. Because the land is different, the way to develop agriculture is different, we need to understand the reality, specific, and formulate the appropriate strategy, rather than using the same standard for development.

Looking toward the future, food security and sustainability will continue to be two primary goals of the agricultural sector in China [2]. Agricultural mechanization should also progress in the direction of more advanced and smarter.

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