

An Empirical Study on the Impact of the Three Basic Foods on Food Security in China

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Abstract: One of the biggest challenges the world facing now is how to ensure that a growing global population - projected to rise to around 10 billion by 2050 – has enough food to meet their nutritional needs. To feed another two billion people in 2050, food production will need to increase by 50 percent globally. Food security is a complex condition requiring a holistic approach to all forms of malnutrition, the productivity and incomes of small-scale food producers, resilience of food production systems and the sustainable use of biodiversity and genetic resources. Food security is very important to China, the largest country with the largest population. The purpose of this paper is trying to find the relationship between the price fluctuation of the three basic foods and the situation of food security in China. Entropy weight method is used to analyze coefficient of the price and food security. We found the price factor is not the most important one which influences food security. In contrast, we believe that the other two variables are even more important. Based on the analysis, we give the following policy recommendations: 1) taking steps to improve the agricultural production capacity, 2) developing the ecological agriculture, 3) enlarging the agriculture insurance to make sure protect the profit of rural farmers, 4) relying on the “One Belt and One Road” strategy to further participate in global food and grain security, 5) speeding up the formulation of a food security law.

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1. Introduction

Food security is a condition related to the availability of food supply, group of people such as ethnically, racial, cultural and religious groups as well as individuals' access to it. It is the "availability at all times of adequate, nourishing, diverse, balanced and moderate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" Later definitions added demand and access issues to the definition. The final report of the 1996 World Food Summit states that food security "exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. We must ensure China's food security so that we always have control over our own food supply, emphasized by President Xi Jinping. Agricultural modernization has steadily advanced, with annual grain production reaching 600 million metric tons over the past five years. It is important not only for the Chinese Economy Security but also for the sustainable development of the whole society. Therefore, ensuring the food market supply, ensuring

food price stability, improving the food emergency reserve system, and minimizing food security risks are government responsibilities and important parts of the food security system. Regardless of the stage of economic development, food security is a constant topic.

2. Literature Review

The balance between developing agriculture and population increase is crucial to ensuring food security. Malthus believes that, without barriers, the population increases geometrically, and food can only increase in an arithmetic progression. Therefore, food tension will always exist.

Li (2014) pointed out that China's food security is in a state of tight balance. Cui (2018) emphasized that China has basically solved the problem of food and clothing for the population of 1.4 billion. It uses 7% of the nation's cultivated land to feed nearly 20% of the population and officials believe that ensuring a high yield of the three basic foods will safeguard food security, resources, the environment, and sustainability. On the other hand, Lester (1994) predicted that China's grain demand will reach 651

million tons (calculated by assuming a population of 1.63 billion people) in 2030, and the total grain output was 267 million tons in 1994, and the gap between the supply and demand of grain was as high as 384 million tons, and the self-sufficiency rate of grain in China fell to 41%.

Yao (2015) constructed an index system for evaluating China's food security using four metrics: food production resources, food stability, food availability, and food utilization levels. His model used the entropy method with the data of China from 1990-the present. In 2011, the food security situation was evaluated quantitatively. A working paper composed of the research of Gary and others published by the US Department of Agriculture in 2000 stated that food insecurity is a complex and multidimensional systemic problem that must pass through 18 systematic indicators of the "core module". Simply determining what is missing is not enough to determine food security or to identify unsafe conditions and standards.

Fu et al. (2001) analyzed the correlation between changes in the amount of cultivated land and the state of quality and grain production. They believe that with the development of the economy and the process of industrialization, a large number of non-agricultural uses of agricultural land has negatively affected food security. Li and Yang (2006) used data of 50 years of cultivated land in Anhui Province to predict the future amount of cultivated land and the security of food production there. The results showed that by 2020, the amount of cultivated land will be lower than that required for food security. Han et al. (2016) believe that cultivated land resources are the most basic material conditions for agricultural production, and their quantitative changes have a direct impact on grain production and thus affect food security. Furthermore, the population and demographic structure is also an important factor in food security. Wang (2017) conducted an empirical study on the relationship between urbanization and food security using panel data from 31 provinces and cities from 1997 to 2015. The results show that the development of urbanization has an adverse effect on food security.

With regard to the early warning mechanism for food security, domestic scholars have also made meaningful analyses. An (1998) believes that the essence of an early warning system is to focus on the dynamic monitoring of the food supply and demand, strength measurement and warning. Ma et al. (2001) believe that a food security early warning system should assess and predict future food security conditions and issue forecasts in advance so that relevant departments can take corresponding long-term and short-term countermeasures to prevent and resolve food insecurity risks. Xu (2009) applied the theory and methods of early warning to evaluate the indicators

that can reflect the state of food security, which means to first assess the status quo of food security, the degree of risk, and the trend of development, so as to predict the trend of food security and issue early warnings. Li (2011) believes that a food security early warning system should break through the traditional mode of thinking based solely on the balance of total grain supply and demand, and take into consideration several factors, including the total balance of supply and demand, reasonable structure of industrial and reliable quality from the perspective of globalization, and establish early warning indicators. The system, the establishment of warning indicators, and the identification of warning signs, establish a cordon and assess the future food security situation. Once a potential risk arises, it can trigger an alert and can deter major monitoring sources so that necessary measures can be taken to control or reduce the risk of food insecurity. Li and Chen (2013) divide China's food security into three system levels: macroscopic, medium, and microscopic. They conduct research through scenario simulations and practical analysis. The macro level mainly reflects the balance of grain supply and demand at the national level, that is, the balance between the total grain supply and the food consumption demand. The medium level describes the rationality of the regional layout and species structure under the balance of meso-level intensity. The micro level mainly reflects the family level. Under the condition of established income constraints, the food demand protection status must meet certain quantity and quality requirements. The study is dedicated to exploring countermeasures to eliminate possible food security crises by searching for sources of food security.

China's food security situation is quite different from other countries. The national food security strategy must ensure that the production of grain is basically self-sufficient and rations are absolutely safe. Based on the dietary habits of the people and the endowment of agricultural resources, the supply and demand of the three basic foods has become an important determinant for safeguarding this strategic goal. This article focuses on three basics: [1] An analysis of the impact of price fluctuations on food security; [2] an analysis of the main factors affecting the price changes of the three basics; [3] and a discussion of how to maintain their basic price stability, ensure adequate supply, and clarify the price fluctuations of the three basic foods.

3. The Status of the Three Basic Foods in China

What is a basic food? Crops that become basic crops must be able to be produced in large areas and on a large scale; they can be stored in large quantities for a long period of time; most people choose to eat

them; they furnish a major proportion of the three daily meals; and they can provide most people with the energy and the nutrients they need. For the sake of this research project, the three basic foods are defined as wheat, rice and corn. Currently, China is about 95% self-sufficient in raising these crops. in the daily diet of residents in China. They are the main grains produced, processed, and stored in China, and thus have important significance for national food security. In recent years, production and price fluctuations of the three basic foods have been basically stable. Fig. 1 shows the changes in the output of China's three basic foods since 1998. It can be seen that under the backdrop of a continual increase in grain production in China since 2004, the production of the three basics also shows steady growth. Thus, China has laid a good foundation for food security.

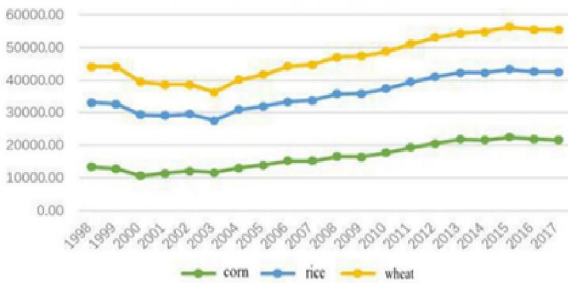


Fig.1 Three basic food's volume of production (1998-2017)

In terms of prices, since the year of 2009, the prices of the three basic foods have taken the purchase price as an example to show the following trends:

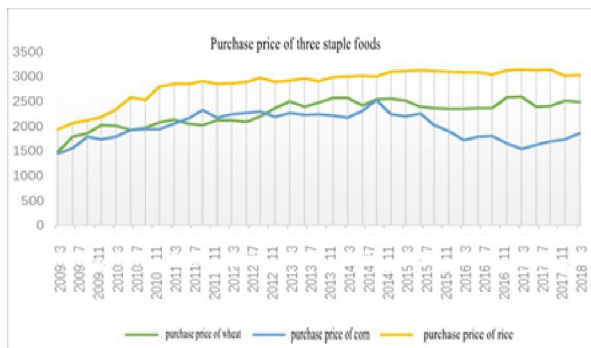


Fig.2 Purchase price of three basic foods

Due to the special position of the three basic foods in China, the impact of price fluctuations on food security is even more important. As can be seen from Figure 1, grain purchase prices have been steadily rising since 2009, and have been in stable fluctuations from April 2011 to December 2013. In November 2014, the purchase price of corn reached its peak. Since January 2015, the purchase price of corn

has dropped significantly. The change in grain prices at this stage is gradually showing a downward trend in the fluctuation. From 2014 to 2015, the purchase price of grain experienced a sharp rise and fall, which directly affected the income of hundreds of millions of farmers. Data shows that the sharp fall in food prices in 2015 may lead to a negative revenue growth of RMB 100 billion, which will be transmitted to the consumer market and will directly lead to a reduction in the scale of consumption. At the same time, the enthusiasm of farmers for grain production will decline.

4. An Empirical Analysis of the Impact of Price Changes of the Three Basic Foods on Food Security

Based on the above-mentioned transmission mechanism, this paper determines that the food security evaluation index system contains three major subsystems: food price security, food supply security, and strategic food security. The research process adopts the 2002-2015 annual statistical data, uses the entropy method to conduct empirical analysis and tests, and uses the 2002 indicator data as the research base, which was chosen because China's grain marketization reform began in that year.

The grain price security subsystem mainly adopts the grain production price index (PPI) as a measure of the price fluctuation of grain, and it conducts a descriptive analysis. At the same time, it compares horizontally the fluctuations of the three major staple food production price indexes (see Fig.3).

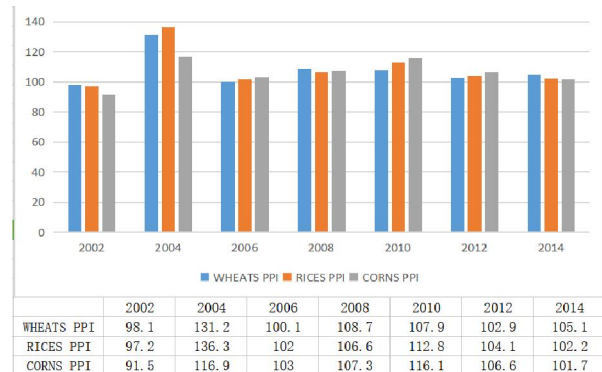


Fig. 3 Fluctuation of Three Basic Food's PPI Index

As can be seen from Chart 3, the trends of the production price index of wheat, rice, and corn from 2002 to 2014 are roughly in line with the production price index of agricultural product, with the production price index of corn being most in line with the fluctuation of agricultural products. The production price index of rice and wheat showed the most significant increases in the rising stage. The production price index of wheat fluctuated from 2006 to the end and did not show any large increase or decrease.

From Fig.4, it can be seen that the fuzzy change of the agricultural product production price index is wavy: the highest production price index reached 118.5 in 2007, and the lowest production price index was as low as 97.6 in 2009. The changes in the production price index of agricultural products are characterized by the mutual recurrence of peaks and valleys, with the exception of the large price volatility between 2007 and 2011 (a result of the effects of the global economic crisis) but prices have stabilized since 2011. recurrence of peaks and valleys, with the exception of the large price volatility in 2007-2011 (taking the effects of the global economic crisis into account) that has stabilized since 2011.

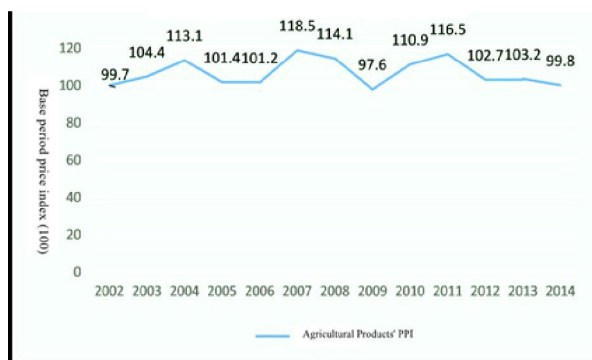
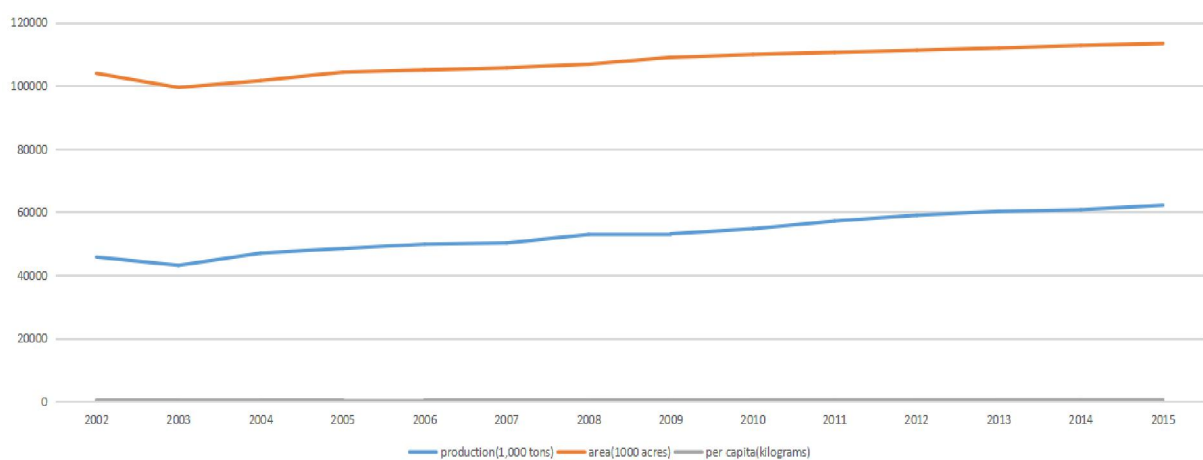


Fig.4 Fluctuation of Agricultural Product’s PPI (2002-2014)

The food supply security subsystem mainly includes Three indicators: grain output (10,000 tons), area under cultivation (thousands of hectares), and grain per capita (kg).



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
production(1,000 t	45705.75	43069.53	46946.95	48402.19	49804.23	50160.28	52870.92	53082.08	54947.71	57120.85	58957.97	60193.84	60702.61	62143.92
area(1000 acres)	103890.8	99410.37	101606	104278.3	104958	105638.3	106782.6	108982.7	109876	110573	111204.5	111955.5	112722.5	113342.9
per capita(kilograms	356.96	334.29	362.22	171.26	379.89	380.61	399.13	398.7	408.66	425.15	436.5	443.46	444.85	453.2

Fig. 5 Indicators of The Supply Security Subsystem for Food (2002-2015)

According to the data source of Fig. 5, since 2003, the amounts have increased year by year, with grain output growing at the largest rate. Under the condition that the area under cultivation remains basically stable, the increase in food production ensures that the per capita food availability will increase year by year, thus ensuring security in the food supply.

The strategic security subsystem for food mainly includes three indicators: the import volume of the three major staple grains (10,000 tons), the per capita agricultural net income of rural residents (yuan), and

the national fiscal expenditure on agriculture (100 billion). From Fig. 6, it can be seen that the imports of the three major staples have gradually increased since 2003. The expenditure on state financial support for agriculture has increased year by year, especially in the past four years, and the absolute amount of expenditure has increased tremendously. Before 2013, the agricultural per capita net income of rural residents was determined by an independent sample survey. After 2013, the minimum income of the poverty line was used.

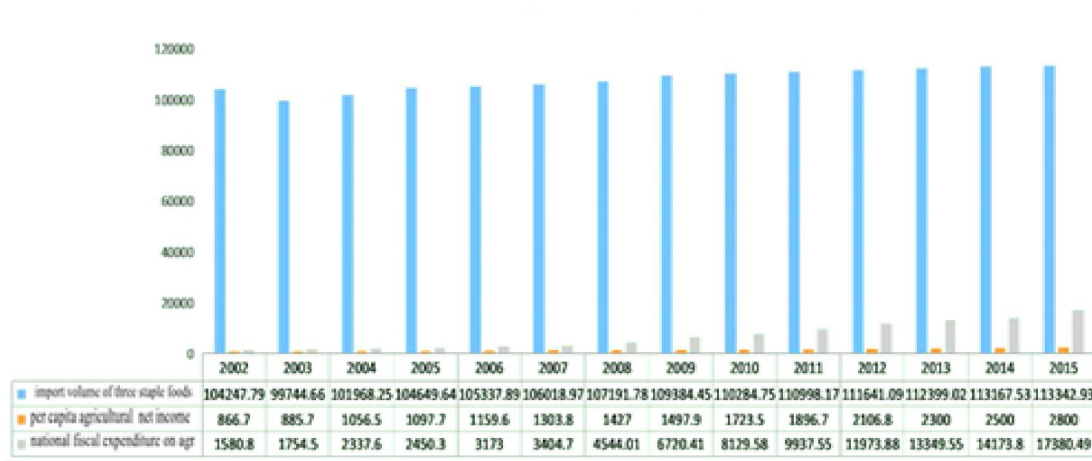


Fig. 6 Indicators of The Strategic Security Subsystem for food (2002-2015)

This paper uses the entropy method to analyze the relationship between the above three subsystems and food security. The first step in the analysis is to assign weights to each indicator and normalize the original matrix. Assuming that there are m indexes and n evaluation target systems for evaluation objects, the original matrix is D_{mn} , then we get a normalized matrix after standardized processing R_{mn} .

$$R_{mn} = \frac{D_{mn} - \min D_m}{\max D_m - \min D_m} \quad (1)$$

This article gives 9 indicators which is $D_m = \{D_1, D_2, \dots, D_n\}$, Each individual indicator selects data from 2002 to 2015, hence, n=14, the final normalization matrix has 126 data variables. Then we try to find the information entropy of the j index

$$H_j = -k \sum_{i=1}^n f_{ij} \ln f_{ij}, \quad (j=1,2,\dots,m) \quad (2)$$

Where H_j donates information entropy $k = \ln \frac{1}{n}$, $f_{ij} = \frac{R_{ij}}{\sum_{i=1}^n R_{ij}}$, when $f_{ij} = 0$, $f_{ij} \ln f_{ij} = 0$

The third step is to find the weight of the j indicator.

$$\omega_j = \frac{1 - H_j}{m - \sum_{j=1}^m H_j}, \quad (j=1,2,\dots,m) \quad (3)$$

$$0 \leq \omega_j \leq 1, \quad \sum_{j=1}^m \omega_j = 1 \quad (4)$$

After the model construction of the entropy method is completed, the data is imported for inspection and implemented using the MATLAB program. The results are as follows:

The final result shows that: price security accounts for 0.0261, supply security accounts for 0.0319, and strategic security accounts for 0.9419. The rice production price index of the price security index is weighted at 0.0106, which is higher than the wheat and corn production price index weights. The weight of the total food production index in supply security is 0.0178, which is higher than that of the sown area of food crops and the per capital possession of food. The index of national fiscal expenditure on agriculture expenditure in strategic security is 0.7426, which is higher than the import volume of the three major staple foods and the per ca-pita agricultural net income of rural residents, and even higher than all index weights. Taken together, the state financial expenditure on agriculture supports has the greatest impact on food security, followed by rural residents' per capital agricultural net income, with a weight of 0.1970.

From the above analysis results, it can be seen that the weight of price security is lower than the weight of supply security and strategic security, and it is contrary to the expectation that the price fluctuations of the three basic foods have great impact on food security. This has an important relationship with China's inadequate food market reforms. Although through the country's macro-control of food security, it is able to obtain basic guarantees for food security against the impact of international food prices, these are non-market measures. In order to better protect China's food security, we must concentrate on supply-side reforms and step up the promotion of agricultural market-oriented reforms.

The supply security of grain accounts for more than 3% of the total. Among the three indicators, the maximum weight of total food production is 0.0178, and the minimum weight is the area under cultivation. In order to ensure the use of land for agriculture, the state strictly controls the red line of cultivated land, making China's agricultural land basically in a state of stability. The area under grain cultivation is the basic natural condition for guaranteeing food security. With the development of agricultural technology, its weight is gradually reduced in the food supply security. Food production accounts for the largest proportion in food supply security, which fully explains the continuous growth of grain production and the importance of ensuring the availability of food security.

The strategic security of food was unexpectedly the largest, accounting for more than 94%, and almost more than 40 times the weight of food price security. Among them, the government's expenditure on supporting agriculture accounts for a maximum of 0.7426, that is, small fluctuations in state fiscal expenditure on agriculture will have a major impact on food security. The influence of national strategic support on food security plays a decisive role. At the same time, the per capital net income of rural households in agriculture ranks the second place, indicating that the state's fiscal subsidies for agriculture and national transfer payments have significant incentives for agricultural personnel. The decisive significance of safeguarding food security lies in the national strategic planning, reforming the structure of the supply side of agriculture and ensuring that grain production increases.

5. Conclusions and Policy Recommendations

The proportion of food price security is less than that of grain supply security and grain strategic security, indicating that drastic food price fluctuations will have an impact on food security. However, food supply security and small fluctuations in strategic food security can also have a major impact on food security. The empirical test results prove that measures must be taken to ensure China's food security from the following aspects:

First of all, we should take steps to improve our agricultural production capacity, strictly observe the red line of arable land, ensure national food security, and place the Chinese people's bread firmly in their hands. To this end, it is necessary to strengthen the construction of agricultural infrastructure and increase agricultural production capacity. In this regard, the state must continue to increase investment in agriculture, while at the same time introducing market-oriented forces and implementing a variety of measures to increase agricultural production capacity.

Second, we should vigorously develop ecological agriculture and adopt a policy of "quality and green" for food security. Food production requires the input of chemical fertilizers, pesticides, energy, water resources, and arable land, which have different effects on the environment. Due to the excessive use of pesticides and chemical fertilizers in the process of pursuing production, the environment has suffered varying degrees of pollution, especially of water, which has brought great risks to food security. To this end, it is necessary to establish a green development concept, develop environmentally-friendly methods of prevention and control of pests and diseases, strengthen resource protection and ecological restoration, promote rural green development, and create a good situation in which people and nature live in harmony.

Third, China must advance and popularize grain insurance measures. We should increase the support for agricultural insurance, expand the coverage of agricultural insurance, increase the varieties of agricultural insurance, increase the compensation standards, and reduce the cost of premiums. To this end, it is necessary to increase the proportion of premium subsidies for major food crops and increase insurance coverage and risk protection levels for the three major staple foods. As soon as possible, the main grain crop seed insurance should be included in the list of central government premium subsidies. We must explore full-cost insurance and income insurance for the three major staples, improve the multilevel agricultural insurance system, improve the level of agricultural insurance risk protection, and provide a strong guarantee for the protection of national food security.

Fourth, we should rely on the "One Belt and One Road" Initiative to further participate in global food and grain security governance and provide global safeguards for national food security. As China's foreign trade continues to increase, the level of food security has become more and more obvious due to the influence of the international agricultural product market. To this end, we must make full use of both domestic and international markets and resources to enhance China's agricultural competitiveness, actively participate in global food security governance, participate in the formulation of agricultural international trade rules, and improve international competitiveness and standards. We must make better use of the international agricultural product market and agricultural resources to effectively adjust and supplement domestic food supply.

Fifth, we must speed up the formulation of a food security law. National food security should not only be guaranteed from the policy aspect, but also should rise to the level of mandatory protection under the law. If

the National Food Security Law can be smoothly implemented, it will undoubtedly improve national

food security status in the country and provide legal protection for ensuring national food security.

Table 1. Food Safety Evaluation Index System and Indicator Weights

Sub-system	Individual indicators	Unit	Weights
Price security	Wheat Production Price Index	%Base period (100)	0.0081
	Rice Production Price Index	%Base period (100)	0.0106
	Corn Production Price Index	%Base period (100)	0.0074
Supply security	Total grain output	10,000 Tons	0.0178
	Crop planting area	Thousand hectares	0.0022
	Per capita availability	kilogram	0.0119
Strategic security	Import	10,000 tons	0.0023
	Per capital net income	Yuan	0.197
	National fiscal expenditure on agriculture	Billion	0.7426

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