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Risk and Strategy of Pork Supply and Demand in China

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Risk and Strategy of Pork Supply and Demand in China

Abstract

This study adopts the DIIS theory and methodology in think tanks to investigate the status of China's swine industry and the rise of pork price. It collects accurate and reliable data, conducts statistics and analysis, and reveals the problems in the development of swine industry. The relevant departments are interviewed to investigate the risks caused by the imbalance between supply and demand. The results show that the decline of pork production and the rise of pork price in China have a great influence on the society, which is closely related to the low production efficiency of pig breeding in China, the epidemic of African swine fever, the great pressure of environmental protection, and the imperfect working system. In order to alleviate the price rise caused by the imbalance between supply and demand of pork in China, relevant departments should strengthen macroscopical control and guidance, improve the top-level design, and carry out work from the aspects of improving the level of biosafety protection, optimizing the distribution of local pig breeding, and adjusting the structure of food consumption.

Keywords

DIIS theory and methodology in think tanks; social risk control; pork supply and demand risk; African swine fever; emergency management

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Risk and Strategy of Pork Supply and Demand in China

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Abstract: This study adopts the DIIS theory and methodology in think tanks to investigate the status of China's swine industry and the rise of pork price. It collects accurate and reliable data, conducts statistics and analysis, and reveals the problems in the development of the swine industry. The relevant departments are interviewed to investigate the risks caused by the imbalance between supply and demand. The results show that the decline of pork production and the rise of pork price in China have a great influence on the society, which is closely related to the low production efficiency of pig breeding in China, the epidemic of African swine fever, the great pressure of environmental protection, and the imperfect working system. In order to alleviate the price rise caused by the imbalance between supply and demand of pork in China, relevant departments should strengthen macroscopical control and guidance, improve the top-level design, and carry out work from the aspects of improving the level of biosafety protection, optimizing the distribution of local pig breeding, and adjusting the structure of food consumption. **DOI:** 10.16418/j.issn.1000-3045.20191123001-en

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China reported its first case of African swine fever in Liaoning Province in August 2018 and later outbreaks were reported in several other provincial regions. The Chinese government has taken vigorous measures to kill diseased pigs and shut down the pig farms in epidemic areas, which has reduced the supply of live pigs from the source [1]. Due to the dietary habits of Chinese residents, the demand for pork in China is steady, and thus the decline in the supply of live pigs has led to a serious supply and demand imbalance of pork. The swine industry is an important part of China's animal husbandry, with pork production accounting for more than 60% of the country's meat. Therefore, the development of swine industry determines the benefit of animal husbandry in China to a certain extent [2]. The African swine fever epidemic, with wide distribution, long duration, and gradually deepened impact, has directly led to the rise of pork price and supply risk in China. Using the DIIS (data, information, intelligence, and solution) method to study the supply risk of China's swine industry can provide countermeasures to alleviate the continuous rise of pork price, maintain the steady development of agriculture and rural construction, and theoretically guide long-term planning of animal husbandry.

This paper first introduces the DIIS framework for pork supply risk and then discusses the methods for maintaining the pork supply and demand balance based on statistical data. The experience of dealing with animal diseases is then summarized, based on which the specific policy recommendations to deal with the sudden rise of pork price in China are developed.

1 DIIS framework for pork supply and demand risk

The DIIS theory and methodology in think tanks, being problem-orientated, collects and organizes relevant data and systematically uses the research methods of various disciplines to reveal the nature and characteristics of the research object. Besides, the corresponding experts are selected to conduct research and evaluation and then generate a solution to the problem. We adopt the DIIS theory and methodology in think tanks (Figure 1) to study pork supply and demand risk in China [3].

(1) Data. The current situation of the swine industry and the recent rise in pork price in China are comprehensively investigated, and accurate and reliable swine industry data are collected and analyzed. The data of China's population, agricultural production, and food consumption used in this

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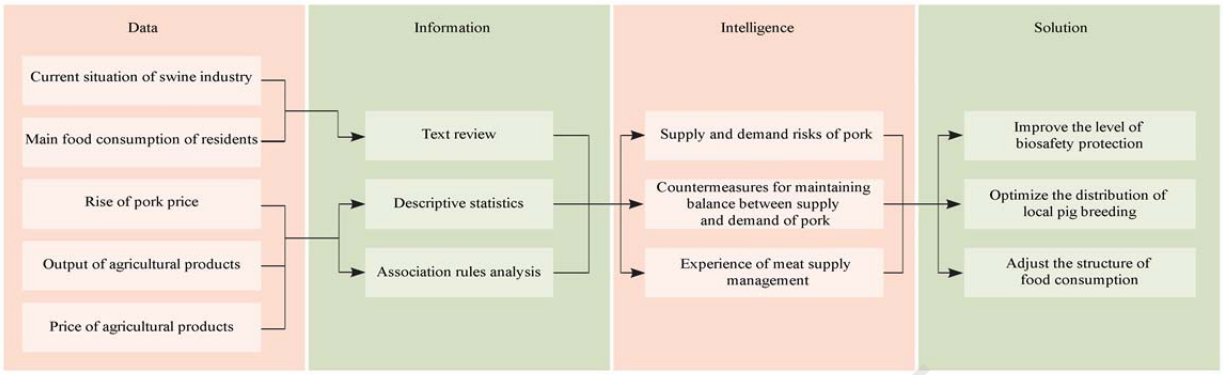

Figure 1 Framework of DIIS theory in the research of pork supply and demand risk

study were mainly from *China Statistical Yearbook* ①. The data of main food prices in 2017 and before were mainly from *China Yearbook of Agricultural Price Survey* ②. The data of main food prices since 2018 were from the official website of the Price Monitoring Center of the National Development and Reform Commission of China ③.

(2) Information. With reference to the current situation of China's swine industry and the recent rise in pork price, we analyze the collected data, describe and count the main food consumption structure of Chinese residents, pork production, pork price trend, and the difference between pork production and sales in various provinces. The association rules of pork production decline and pork price rise with the sales of other food products are mined using the FP-growth algorithm [4]. The frequent itemsets and association rules are mined based on the following parameters: itemsets containing pork; support > 0.9; nodes with confidence > 1 and conviction > 2 ④.

(3) Intelligence. According to the revealed main food consumption structure, pork production and price trend, pork production and sales balance in each province, and the relationship between pork and other food, we interviewed relevant departments and integrated the results of expert discussion to explore the supply and demand risk of pork, the countermeasures for maintaining the balance of pork supply and demand, and the experience of food risk management. Based on the descriptive statistics, the fluctuations of pork output and price were analyzed to reveal the dilemma of China's swine industry. The countermeasures for maintaining the balance of pork supply and demand are developed based on literature data, descriptive statistics, and association rules analysis, striving to innovate solutions. In view of the pork supply decline caused by African swine fever, we summarized the management experience of meat supply in the context of this epidemic based on case analysis.

(4) Solution. With consideration to the current situation of China's swine industry, the recent rise of pork price, main food consumption structure, pork production, and price trend, the difference between pork production and sales in various provinces, and the association rules between pork and other food products, we put forward the solutions to cope with the risk of pork supply in China by combining the opinions and suggestions of experts.

2 Risks of pork supply and demand in China

2.1 Fluctuations of pork production and price

In recent years, the main food consumption structure of Chinese residents has been basically stable. In 2018, the consumption of grain, vegetables, fruits, poultry, eggs, and meat accounted for 35.86%, 27.09%, 14.68%, 2.54%, 2.73%, and 7.36%, respectively (Figure 2). The consumption of pork, beef, and mutton respectively accounted for 6.44%, 0.56%, and 0.36% of main food consumption. Compared with beef, mutton, poultry, and eggs, pork occupied a large proportion in the main food consumption of Chinese residents. Therefore, the price change of pork has a much greater impact than that of other meat products and eggs.

From 2002 to 2018, China's annual pork output and pork price rose slowly. The rise of pork price was more stable than that of beef and mutton prices (Figure 3). From 2014 to 2016, China's pork production declined and pork prices rose significantly. From 2017 to 2018, the annual output and price of pork were relatively stable. Since July 2019, China's pork price has risen sharply. In July, August, September, and October of 2019, the month-on-month increase of pork price was 12.54%, 41.62%, 8.64%, and 30.27%, respectively. Till October 2019, the pork price has doubled that in June 2019.

① China Statistical Yearbook. [2019-11-02]. http://www.stats.gov.cn/tjsj/ndsj/.
② China Yearbook of Agricultural Price Survey. [2019-11-02]. http://tongji.cnki.net/kns55/Navi/YearBook.aspx?id=N2017030068&floor=1.
③ Price Monitoring Center of National Development and Reform Commission. [2019-11-02]. https://www.baidu.com/link?url=yi-cK3qm-ZszzysZAAbgRSZc1wv1fiy7B0kzZvpe2XCw-_itGJghxclZJTamEEM&wd=&eqid=dfb0224b000e2593000000035dd19daa.
④ FP-growth is an association rule-mining algorithm based on co-occurrence rate. The high support indicates the high probability of co-occurrence. The high confidence indicates the high probability of post-event occurring when the pre-event occurs. The high conviction indicates the strong independence of pre-event and post-event.

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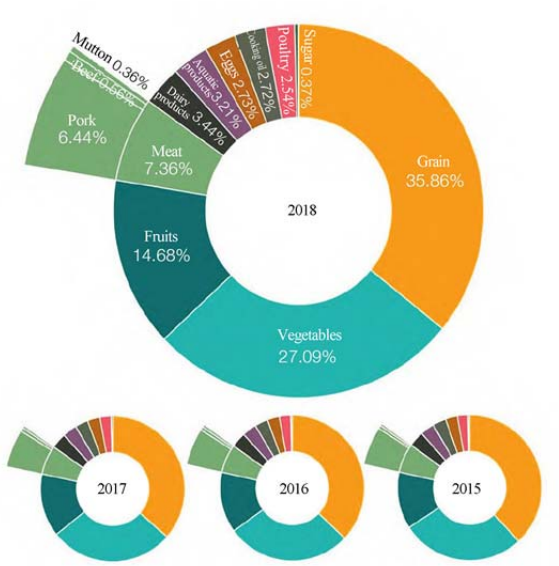

Figure 2 Structure of main food consumption in China from 2015 to 2018

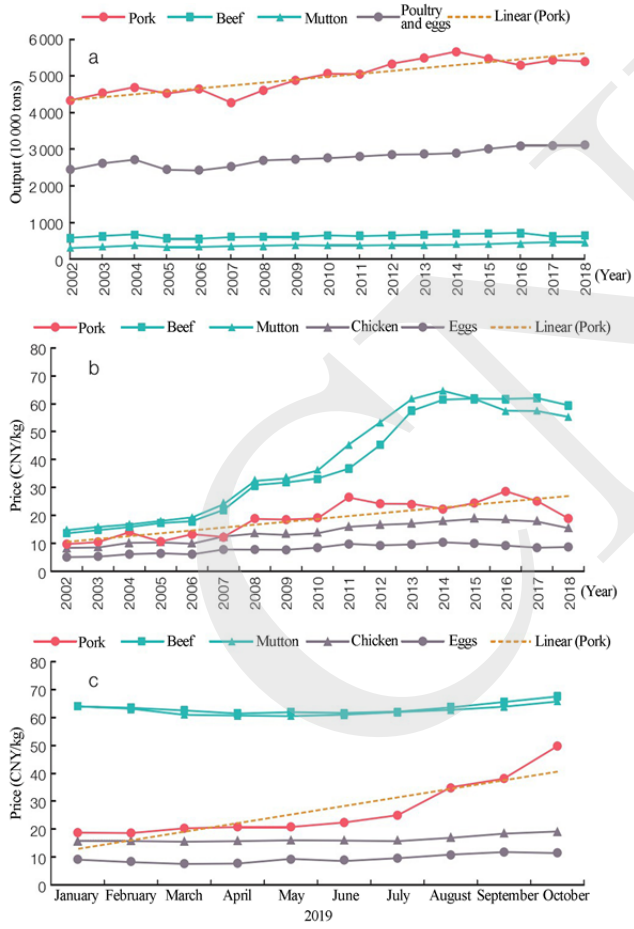

Figure 3 Output and price trends of major meat and egg products in China

(a) Output of major meat and egg products in 2002–2018, China; (b) Price of major meat and egg products in 2002–2018, China; (c) Price of major meat and egg products from January to October in 2019, China.

2.2 Dilemma of the swine industry

Although the supply capacity of China's swine industry has been improved, there are still problems such as the immature industrial system, unreasonable industrial distribution, small production scale, and unsound epidemic prevention system. The lasting African swine fever has exposed the weakness of swine industry and resulted in difficulties in pork supply and price guarantee, directly affecting the basic life of residents. Generally, the problems of swine industry can be summarized in the following five categories.

(1) Production and breeding. The current pig breeding and production in China have low production efficiency, low output-input ratio, and old production system. Since 2007, scale pig breeding has been popularized in China, while scattered pig breeding is still the main production mode at present, and only 5% of the farmers employ scale production. The scattered small pig farms lack specialized high-quality breeding and thus have problems such as low efficiency, old production modes, low output-input ratio, and environmental pollution [5]. In the process of pig production and processing, it is difficult to realize the tracking and supervision of pork quality due to large capital investment, technical difficulties, and imperfect traceability systems [6].

(2) Market price. The problem of the market price is reflected in the obvious fluctuation of pork price in recent 20 years. China's pig production presents a trend of "benefiting in the first year, losing in the second year, and balancing in the third year," which is called a pig cycle [7]. The pig cycle precisely shows the instability and vulnerability of the swine industry. Besides, pork price is linked to the prices of other agricultural products, and its fluctuation will lead to the instability of agricultural product prices.

(3) Diseases. Blue ear disease, classical swine fever, pseudorabies, porcine circovirus disease, foot-and-mouth disease, and African swine fever are easy to break out in pigs. Among them, foot-and-mouth disease is a zoonotic disease that directly endangers human health. The spread of diseases causes not only the farmers' losses but also social panic, influencing the national economy and people's livelihood.

(4) Environmental problems. Environmental problems generally refer to the sanitation problems and environmental pollution caused by pig farming. Due to the lack of management and planning, many farms cannot effectively treat and recycle wastes, causing pollution to the air, water, and soil. In addition, cleaning in scattered small farms can hardly be guaranteed [8].

(5) Employee issues. The lack of specialized and professional30.27 veterinarians has been serious. Veterinarians are the foundation of epidemic prevention system. The grass-roots veterinarian team serves not only the swine industry but also the farming of other animals. However, the education level and welfare of veterinarians in China need to be improved.

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3 Countermeasures for maintaining pork supply and demand balance

3.1 Changing the production mode and expanding the production scale

China, a big country of pork consumption, basically keeps the balance between pork consumption and production. Imported pork can participate in China's market competition only if it meets the standards of quarantine. China's domestic pork purchasers will choose the foreign suppliers they want to cooperate with according to the price and other factors. Since the supply of pork in the international market is limited, the rise in pork price and import demand caused by the pork supply shortage in China can be hardly alleviated by import from the international market.

However, the rise in pork price will be an opportunity for China to optimize production mode. Small-scale scattered production mode and multi-link sales mode bring difficulties in supervision and control, which makes the diseases easy to spread and difficult to track. In recent years, small pig farms have been demolished in China, which provides an opportunity for the development of intensive farming. Scale development and construction of scale production demonstration areas should be encouraged. The approval process of pig production expansion should be simplified to improve approval efficiency. The research, development, introduction, and promotion of science and technology related to the swine industry should be supported, and the whole industry chain should be automated. In addition, the production and consumption concepts should be innovated.

3.2 Implementing the rationing policy for pig production

There is an inconsistency between production and marketing in China's animal husbandry. As of 2018, pork production in most provinces of China is greater than the pork consumption of local residents, which can realize self-sufficiency and has sufficient resources for processing and export (Figure 4). However, the consumption exceeds production in Beijing, Tianjin, Shanghai, Zhejiang, Fujian, Guangdong, and Tibet.

The production and sales of pork follow the law of market and are difficult to carry out micro regulation and control. The adding of requirements during the implementation of relevant policies may affect the enthusiasm of pig production in local areas. Therefore, it is suggested to use animal production index to facilitate national supervision. The pig production index should be assigned based on the pig consumption of each province, autonomous region and municipality over the years. The provinces with pig production that cannot meet the local pig consumption should purchase the index of pig production from other provinces through local financial means. The application of pig production index can motivate local governments to develop animal husbandry and ensure the supply of pig products from the source of production.

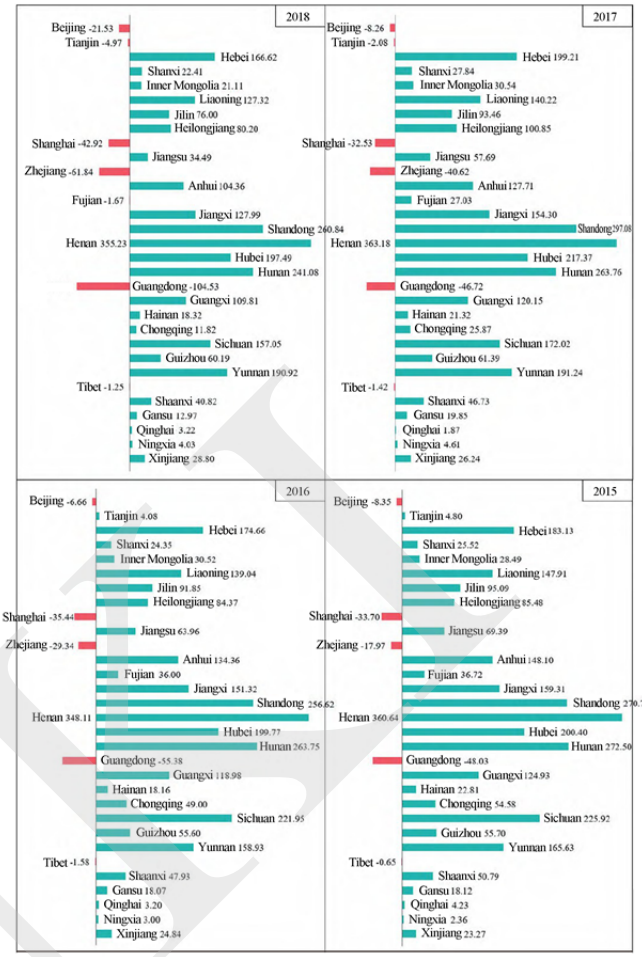

Figure 4 Difference of pork production and sales in China from 2015 to 2018 (10 000 tons)

3.3 Guaranteeing the supply of dry and fresh fruits, aquatic products, meat, and eggs

While revitalizing the local swine industry, adjusting the food consumption structure of residents and looking for pork substitutes are also effective means to solve the rising pork price. The results of the association rules analysis showed that from 1998 to 2017, the decline of pork production in China had strong associations with the increase in sales of fruits, poultry, aquatic products, eggs, beef, and nuts; the rise of pork price was strongly associated with the increase in sales of fruits, fresh vegetables, beans, nuts, aquatic products, poultry, eggs, and cooking oil. Changes in pork prices were weakly associated with the sales of grain, tuber crops, dairy products, sugar, and alcohols (Table 1).

Pork, as a kind of nutritional food, can meet the similar dietary needs of residents like other nutritional food including dried and fresh fruits and aquatic foods. Beef, poultry, and eggs are in the same food category as pork, which can help to regulate the shortage of pork. However, cereal and tuber

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Table 1 Chinese residents' dietary association rules

Category	Number	Association rules	Confidence	Conviction
Decline in pork production → Rise in food sales	A1	{pork}→{fruits}	1	2.0
	A2	{pork}→{poultry, fruits}	1	2.6
	A3	{pork}→{aquatic products, fruits}	1	2.2
	A4	{aquatic products, pork}→{fruits}	1	2.0
	A5	{poultry, aquatic products}→{fruits}	1	2.0
	A6	{poultry, pork}→{eggs, fruits}	1	2.2
	A7	{beef, pork}→{poultry, nuts}	1	2.1
Rise in pork price → Rise in food sales	B1	{pork, fresh vegetables}→{beans}	1	2.4
	B2	{fruits, pork}→{nuts}	1	2.2
	B3	{nuts, pork}→{fruits}	1	2.0
	B4	{fruits, pork}→{poultry, nuts}	1	2.8
	B5	{nuts, pork}→{poultry, fruits}	1	2.6
	B6	{pork, fresh vegetables}→{poultry, beans}	1	2.6
	B7	{fruits, pork}→{aquatic products, nuts}	1	2.4
	B8	{fruits, pork}→{beef, nuts}	1	2.4
	B9	{nuts, pork}→{beef, fruits}	1	2.4
	B10	{pork, fresh vegetables}→{eggs, beans}	1	2.4
	B11	{nuts, pork}→{aquatic products, fruits}	1	2.2
	B12	{dairy products, pork}→{poultry, cooking oil}	1	2.0

crops that can solve the basic needs of food and clothing as well as accompaniments such as dairy products, sugar, and alcohols can hardly replace the role of pork in the dietary structure of Chinese residents. In the case of decreasing pork production and rising pork price, the supply of dry and fresh fruits, aquatic products, meat, and eggs will help to alleviate the social risks brought about by the imbalance between supply and demand of pork.

4 Experience of meat supply management in the context of epidemics

4.1 China's experience in dealing with highly pathogenic avian influenza

African swine fever is a major reason for the rise of pork price in China, 2019. Similarly, the highly pathogenic avian influenza (HPAI) has also caused fluctuations in poultry food prices in China. HPAI is a zoonotic disease [9] with rapid spread, severe damage, and high mortality. It is listed as a class A animal disease by the World Organization for Animal Health [10]. Similar to the African swine fever, HPAI is a major animal disease with serious impact in China. Due to the multiple epidemics, HPAI has also classified as a class A animal disease in China [11]. The market price of livestock and poultry is sensitive to the occurrence of animal epidemics. Upon the outbreak of an animal epidemic, the prices of the corresponding animal products will plummet or soar. Upon the outbreak of H5N1 avian influenza in May 2005, China, the price of broiler chicken fell from 2.55 CNY/kg to 1.42 CNY/kg and that of live chicken from 11.17 CNY/kg to 9.09 CNY/kg. In March 2013, human infection with HPAI led to 10.15% and 23.43% decreases in the national average prices of live chicken and broiler chicken respectively in April 2013, both of which were the largest drop in the year. After the epidemic, the short-term contradiction between supply and demand pushed up the prices [12].

In the face of frequent and turbulent outbreaks of HPAI, China has formulated a series of policies and measures to legalize and standardize the prevention and control of HPAI. At present, the major relevant laws in China include the *Animal Epidemic Prevention Law of the People's Republic of China* and *Law of the People's Republic of China on the Entry and Exit Animal and Plant Quarantine*. In addition, there are a series of procedures, norms, standards, and regulations, such as *Standards for Avian Influenza-Free Broiler Compartments* (*Trial version*), *Control Measures for Report on Animal Epidemic Situation*, and *National Emergency Plan for Major Animal Epidemics*. In conclusion, China's measures to deal with HPAI can be summarized as follows. (1) Large-scale culling of diseased animals in the areas with avian influenza is carried out, and farmers are subsidized according to the subsidy standards. (2) Strict isolation measures are implemented and the uninfected domestic birds are vaccinated. (3) Positive isolation and protection measures are taken to prevent the spread of avian influenza to human beings. (4) The epidemic situation is timely reported and close contact with international organizations is kept. (5) Preferential conditions including financial subsidies and interest-free loans are given to the existing poultry breeding and processing companies, and incentive policies are introduced to encourage poultry farmers to restore production capacity and thus ensure the supply of poultry.

4.2 Experience of the United States in dealing with classical swine fever

Classical swine fever is a contagious disease first discovered in the United States in 1833. In 1903, the classical swine fever virus (CSFV) was isolated. In 1906, the United States began to produce hyper-immune serum against classical swine fever. In 1912, more than 30 states in the United States began to use the hyper-immune serum. Around 1950, many farmers and veterinarians began to use the attenuated vaccine. By 1956, two-thirds of the swineherds in the United States had used vaccines to prevent classical swine fever, among which the attenuated vaccine accounted for more than

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90% and the rest were inactivated vaccines. The successful development and application of safe and efficient vaccines made it possible to eliminate classical swine fever. The state governments advocate the use of vaccination for pig farmers to reduce the incidence, and the costs are borne by the farmers. From 1961 to 1977, the United States carried out the classical swine fever eradication program, which helped to eliminate classical swine fever in 17 years. However, the improper use of vaccines had brought serious consequences. After the start of the classical swine fever eradication program, the incidence of swine diseases caused by vaccination showed a straight-line rise. During this period, more than 35 million pigs were vaccinated, some of which caused diseases, and about 29% of vaccinated pigs became new infectious sources. Subsequently, the United States carried out nationwide action to ban the use of inactivated vaccines, and the states successively banned the use of inactivated vaccines against classical swine fever [13].

In addition to vaccination, the United States government checked the pig production areas and took measures for the prevention and control of classical swine fever. The main measures include: (1) improving farmers' knowledge of swine fever and awareness of prevention and control through training; (2) making the local governments attach importance to swine fever, and formulating emergency plans and guidelines for prevention and control; (3) timely reporting the latest progress of the epidemic situation; (4) culling the pigs found to be infected in time.

5 Conclusions

Employing DIIS theory and methodology in think tanks, we investigated the current situation of the swine industry and pork price rise in recent years in China. Meanwhile, we collected and analyzed the data of main food production, price, and consumption, and put forward solutions to deal with the rise of pork price and alleviate pork supply and demand risk.

Compared with other meat and egg products, pork occupies a large proportion in China's main food consumption structure. Therefore, the decline in pork production and the impact of price changes on people's lives will be far greater than that of other meat and egg products. In recent years, China's annual pork production has shown a downward trend, and the pork price rose sharply from July to October in 2019. The imbalance between supply and demand of pork has exposed the problems of low production efficiency, the extensive impact of African swine fever, great pressure on environmental protection, and the imperfect employment system of pig production in China. In order to alleviate the price rising problem caused by the imbalance between supply and demand of pork in China, the following measures can be taken.

(1) Improving the level of biosafety protection. The monitoring system should be established to improve biosafety protection and implement key prevention and control measures. The slaughtering self-inspection system should also be implemented and the quarantine of pig producing areas should be standardized. The development and promotion of efficient and safe vaccines against African swine fever should be enhanced. The construction of a modern system for the swine industry should be accelerated to improve the quality and technical capabilities of farmers and related personnel.

(2) Optimizing the distribution of local pig production. Moderate-scale production should be developed and the role of local government should be given full play to optimize the distribution of local pig production. According to local conditions, the advantages of local industries can be exploited to guide the investment of capital and technology in the swine industry, alleviate the impact of environmental supervision, and innovate modern pig production mode.

(3) Adjusting the structure of food consumption. The law of the market and the needs of residents should be valued and thus the food consumption structure can be adjusted. China's food market should be prospered and efforts should be made to enrich residents' dietary choices. In addition, the government needs to pay attention to quality and safety management and look for pork substitutes to ease the pressure on pork price.

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