Designation of R & D on Pig Production Intelligent Monitoring and Early Warning[1]

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Abstract. This paper analyzed live pig production, consumption and price, and proposed the monitor system and the early warning mechanism. It is indicated that the study has a theoretical and practical significance in this area in China. In the view of the unusual fluctuation in the current live pig and its product prices, we carried out more works in live pig risk factors, fluctuation, detection methods, model building, as well as R & D relevant circumstances. In order to facilitate future studies in this field and to provide a useful exploration, we additionally proposed the implementation of the program of research and design at the last part of the paper.

Key words: live pig prosperity, price fluctuation, forecasting, price movement

1   Background

Pork is a main source of animal-derived food for Chinese urban and rural residents. In 2010，pigs in the stock totaled 46.46 million in China, compared with the years 2000 and 1990, increased 11.59% and 28.20% respectively, and 1.52 times that of 1980. Slaughter capacity was 66.69 millions，rose 28.58% and 115.18% respectively

compared with 2000 and 1990, and was 3.36 times that of 1980. Pork production increased to 5.07 million tones, 27.87% and 122.31% up from 2000 and 1990 respectively, and 4.47 times that of the year 1980. Though the livestock produce structure had been adjusted, and the rate of pork production in the meat decreased step by step, it still accounts for 63.98%. The pork possession per capita is 37.82 kg in 2010, which is 3.29 times that of the year 1980, and 20.86% and 89.56% more than that in 2000 and 1990 respectively.

However, from January to November 2000, pork price in China tended to fluctuate continuously and significantly (Figure 1). The price was stable in the period of January 2000 to May 2003. But after then, the price went higher and fluctuated largely, especially after June 2006, the pork price increased from 10.58 yuan/kg to 26.08 yuan/kg in February 2008. During the 20 months, the price fluctuation range got 146.50%. After that, it quickly declined by 39.88% to 15.68 yuan/kg, and followed by 16.04 yuan/kg. In September 2011 the price reached 30.35 yuan/kg, continuously went up 86.61% in 15 months,   The fluctuated pork price seemed like a "roller coaster", which made "live pig production stable development" difficult to be realized. So, it is in urgent need to make a live pig price control plan.
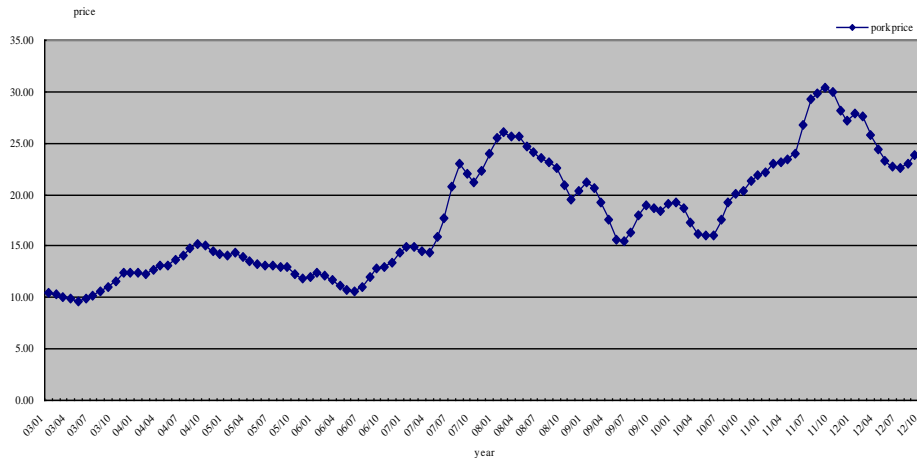

Fig. Trend of Pork Price(2003-2012)yuan/kg

The price of pork has been an important livelihood issue, and concerned by the society. For example, in March 2011, during NPC (the National People's Congress) and CPPCC (the Chinese People's Political Consultative Conference), "live pig" became a hot topic of representatives and committee members. Continuous

fluctuations of pork price had been a very important factor to push CPI (the consumer price index) fluctuations1. In July 2011, Premier Wen Jiabao asked about the price 3 times during 10 days, he said that " we should study the fundamental policy, avoid cyclical fluctuations out of pig production，and try to achieve the sustainable development of stable and healthy". At the same time, the Ministry of Agriculture unveiled a number of initiatives to encourage pig production, to guarantee market supply and stabilize market prices. Therefore, facing the abnormal fluctuations of live pigs and their products prices, we should do more research on monitoring of risk warning mechanism, which is important theoretical and practical significance.

In recent 10 yr, the scholars at home and abroad have achieved an important progress in pig production and consumption, price volatility, monitoring and early warning, and etc. From The Big Crisis in the 1930s', the economists have been seeking theoretical explanations for the agricultural price fluctuations. For pig production and the pork price volatility, Kaldor proposed the cobweb model. Arthur A. Harlow determined the cobweb model as the applicability of the theoretical framework to explain the pig cycle when he analyzed the relationship between live pig production and price. Bollerslev proposed GARCH model. Anthony N. Rezitis applied the standard GARCH model, the asymmetric GARCH model and nonlinear GARCH models to study the pork expect and price volatility. Li Bing-long explained the reasons for pork price volatility in China. Xin Yin, Tan Xiang-yong built a causing model of pig price fluctuations. Peng Tao studied the "convergence-type spider web" trend of pig production and prices. Chen Yongfu et al. analyzed pig production and price cycles by continuous - short-term (PT) model and the information share (IS) model. Zhang Cun-gen, Wang Ji-min, Liu Gui-zhen also studied more on pig price volatility from different angles and by using different methods.

In forecasting and early-warning, Sims proposed VAR model to study the agricultural price transferring and fluctuations. B. Petersen raised the food security by the computerized monitor methods, so as to reveal the risk factors for each stage of production. Shao Renyuan used "Monte Carlo simulation model" to simulate pork price and forecast net income for the pig producers. M.L. Shiha used CBR-based analysis method to construct a price forecasting model. Boccaletti.S. used causal analysis method to analyze the Italian wholesale pork prices and retail prices. Ma Xiaobin built VAR model to forecast pig market price. Zhao Ruiying established a pig price risk warning model based on BP artificial neural network. Wang Mingli et al.

studied the persistent effects of the pork market based on the variance ratio measure of the random shocks. The Commerce Department of China established a pig monitoring and early warning system in Sichuan Province, who therefore was regarded as the first one to develop this system. As for economic prosperity and its monitoring methodology, W.C. Mitchell discussed the possibility of the economic prosperity indicator for monitoring the macroeconomic theory. Economic prosperity monitoring method was first applied in the U.S. macroeconomic analysis, subsequently, the scope of application expanded to dozens of countries and regions. Its applications also expand to more related fields, i.e., the international economic prosperity, the regional economic prosperity, industry prosperity, economy and market prosperity. Abdollahzadeh adopted the synthetic index and proposed agricultural development index. In recent years, China has made a good progress in prosperity monitoring research and application. The study was launched in a social risk, the SME economy, business prosperity monitoring, the macroeconomic climate, regional economic prosperity. Up to now, the prosperity monitoring has been widely used and accepted. Around the prosperity research goals, we have engaged in a large number of studies on the Composite Index, the AC models, data base, neural network-based monitoring, and early warning, and etc.

Even though the important progress has been made on the research of pig production monitoring and early warning, many problems still remain to be resolved in this field. Firstly, integrative study is limited in pig production, pork prices and pig prosperity rules, but the laws of pig prosperity have not been developed. Secondly, the pig prosperity risk factors are not formed. Thirdly, the research on price fluctuation is so less that the monitoring data have seldom been used and the monitoring methods have not been established. Actually the monitor research has not been carried out in China. Fourthly, early warning is mentioned more, while the research on establishing early warning indicators, dividing into early-warning warning-limit, building the model and its mechanism are limited. The early warning mechanism of the theoretical framework is not yet paid special attention.

2   Main Content of R&D

Focusing on exploration and analysis of the pig prosperity fluctuation rules, the optimization of the monitoring pig prosperity and the solution of the model of pig

prosperity warning three key issues referred above, the goals of the R & D are designed as follows: (ⅰ) verify pigs risk and its risk factors; (ⅱ) propose the rule of the pig prosperity fluctuations; (ⅲ) construct the pig prosperity monitoring methodology system; (ⅳ) build the pig prosperity warning model; (ⅴ) form a theoretical framework of risk early warning mechanism for the pig prosperity monitoring. To achieve these goals, the main five aspects of R & D were studied by us as follows.

Pig Risk and Its Factors We carried out the research on pig natural risks and economic risks, i.e., the basic properties, types, the degree of risk influencing, the probability of risk occurrence, risk loss, and conducted the pig prosperity risk policy scenario simulation. The pig risk factors were analyzed by using the approach of risk management. Based on a number of risk factors, the risk factors known as the "candidate risk factors", which may affect the consumption of pig production, were initially selected. Comparing with the pig fluctuation, assimilating to historical data of candidate risk factor, and scenario simulating to the impact of the candidate risk factor, analyzing the sensitivity and relevance of the simulation results, and we finally confirmed the risk factors of the live pig.

Pig prosperity Fluctuating Rules According to the pig industry development situation, combining the sectors of pig production, circulation and consumption, we built the pig sentiment indicator system using quantitative and qualitative analysis, and integrating other relevant indicators. By comparing and selecting of quantitative and qualitative methods, such as Analytic Hierarchy Process (AHP), theory of Gray Model GM (1, 1), Support Vector Machines (SVM), BP artificial neural network, Delphi Method, the link between the characteristics of pig production and consumption in different periods and backgrounds was formed. In addition, in order to determine the indicators in the basic period; we therefore put forward the scientific "pig prosperity index algorithm". In the future, we are going to analyze the historical data of live pig production to get live pig prosperity index data; and to apply live pig prosperity index algorithm to work out the live pig prosperity index in the past 30 years. Sequentially, we will explore the character, circle, account of increasing and summarize the law of live pig prosperity fluctuation.

Pig Prosperity Monitoring Method By applying monitoring methods in actual warning and emergency, and the risk information on pig prosperity, the research was carried out on pig prosperity monitoring methods involving the aspects of survey range, place, quantity, methods and data transformation.

Pig Prosperity Warning Model The safety interval and the risk interval of the pig industry were obtained using Value at Risk (VaR) to measure and assess the risk of the pig industry. Then by comparing the Pig prosperity index with the safety interval and the risk interval of pig risk, we determined the degree of pig prosperity. The warning results showed with the lights. The releasing mechanism was first established in China. The mechanism consists of the main body, subject, publishing content, distribution channels, means and frequency of publication.

Pigs Prosperity Monitoring and Risk Warning Mechanism Theory We formed the A • D • Hall three-dimensional structure for pig prosperity monitoring and early warning with the methodology of systems engineering. Studying on the pig risks and risk factors, the pig prosperity fluctuation, the pig prosperity monitoring method, and the pig prosperity warning model, we applied the basic conceptions of the system science, risk management and early warning analysis, and finally formed the theoretical framework of the pigs prosperity monitoring and risk early warning mechanism.

3   The Program Implementation of R&D Designation

To collect and analyze the historical data of live pig industry in the past 30 year, we made the literature analysis and spot investigation.   Especially, for the missing key data, in order to get the exact information, we also took the spot investigation. Our works supported the project strongly in data.

The Value method (Value at Risk of VaR) was adopted to calculate the risk in risk management. The method was based on extreme value theory and the quartile theory of VaR calculation. Under a certain confidence level (c) and within the time interval, the means of maximum loss expected in a normal market environment was defined as:

$$P_r\left\{r_i \leq F_{i/i-1}^{-1}(P)/I_{i-1}\right\} = 1 - C$$

In order to test the VaR model, Kupiec statistical tests were applied to verify its validity. Through mathematical statistics and econometric methods, Analytic Hierarchy Process (AHP), Theory of gray system Model--- GM (1, 1), Support vector machine (SVM), BP artificial neural network, Delphi Method and other quantitative and qualitative methods were compared to determine the base period index, and therefore the scientific pig prosperity index algorithm was finally proposed. The

prosperity indicators, the warning status were denoted with Liket's five-point scale method. The safety interval and risk interval of the swine industry are corresponded to no warning, and warning in the early warning system. As the warning system included light warning, middle warning, heavy warning and great warning, we adjusted and calibrated the related parameters to optimize early warning model.

Theoretical analysis methods were also used in our study, i.e., the methodology of system engineering was applied to establish A • D • Hall three-dimensional structure for pig prosperity monitoring and early warning. We proposed the comprehensive risk analysis and assessment of system to pigs, pig prosperity fluctuation, monitoring method, early warning techniques and methods, pig risk prevention and control, and the theory framework and risk early warning mechanism. The specific works involved were as follows. Firstly, we confirmed the issues to be researched. Based on China pig production and consumption practices, we carried out literature analysis, more spot investigations, theory analysis, and expert consult. Secondly, we collected and analyzed data and information of live pig in the past 30 years using risk management so as to find live pig risk and its risk factors. Thirdly, we built the pig prosperity index system to propose the pig prosperity index algorithm, and explore the law of live pig prosperity fluctuation. Fourthly, we established pig prosperity monitoring system including the contents of flowing such as the monitoring area, sites, indictors, methods, information transmission and data processing, and we also founded seven pig bases to monitor pig prosperity. In the end, we utilized the monitor data and calculated the live pig prosperity. With live pig risk consults, we constructed the live pig prosperity early-warning system as well as the pig warning releasing mechanisms and risk warning based on the three-dimensional structure of AD Hall. We put forward a theoretical framework for the pig prosperity monitoring. The project adopted the technology roadmap shown in Figure 2.
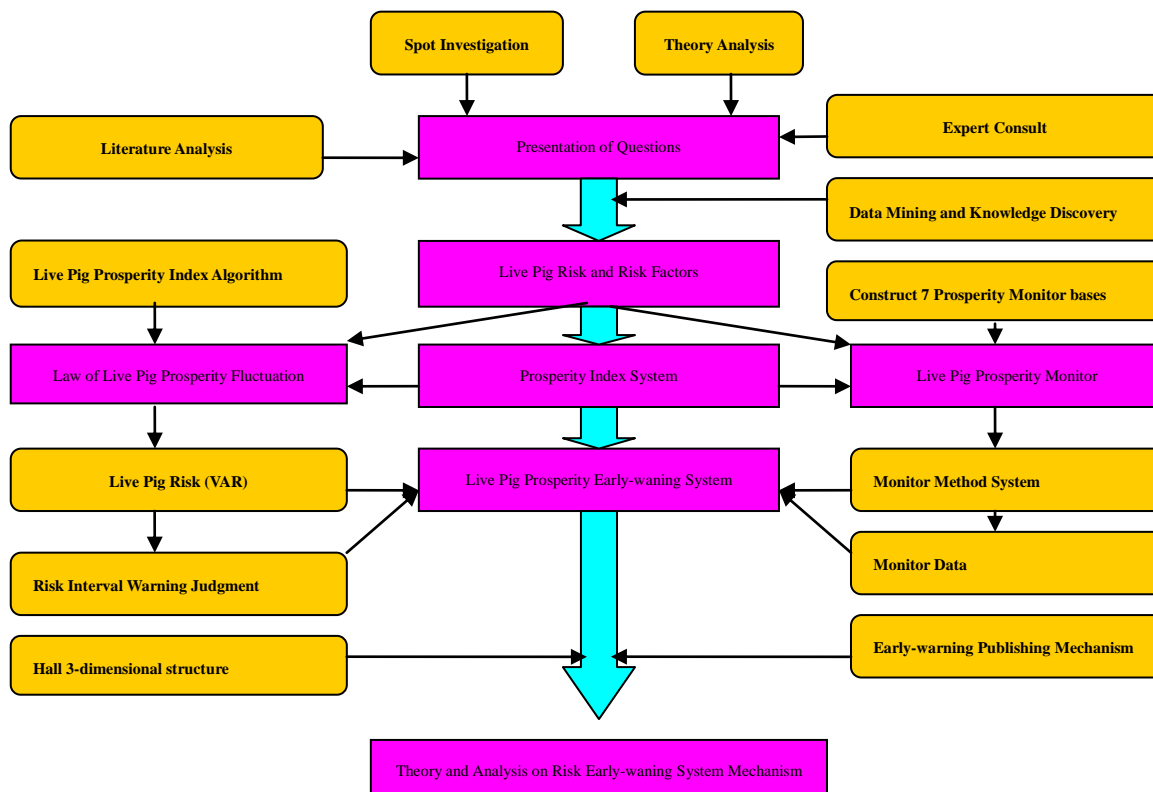
Fig 2. Technology roadmap adopted in this program

To date, we have established 7 demonstration bases to monitor pig prosperity, such as the Fengtai District of Beijing, Huailai County and Dingxing County? in Hebei Province, and the Jia Taifeng Agricultural Science and Technology Demonstration Park in Suzhou of Jiangsu Province, Beijing, Tianjin, Jilin, Shandong, Guangdong, Hunan, Sichuan and other provinces and cities. Therefore, it is possible for us to take advantages of the demonstration bases on the agricultural market price for short-term forecasting. In times to com, we will set up bases to monitor pig prosperity, so as to provide data support and demonstration pilot and to collect and transfer monitor with the PDA data. Agricultural Information Institute of the Chinese Academy of Agricultural Sciences (AII-CAAS) and Tsinghua University have jointly developed a portable agricultural market information collection (handheld PDAs), and now it is at the stage of pilot consulting, planning and promoting. The project intends to use a

handheld PDA to collect monitoring data in order to improve the intelligent, precision and timeliness of it. Integrating the related system and demonstrating the warning results, Prof. Xu Shiwei, the chief scientist of AII-CAAS, has established China's agricultural monitoring and early warning model system (the CAMES model), and achieved initial results, thereby provided a good platform for cooperative research and development on this study.

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