USING PEST ANALYSIS TO EXPLORE THE IMPACT AND MECHANISM OF CHINESE AND AMERICAN BREEDING PATENTS ON THE DEVELOPMENT OF AGRICULTURAL SCIENCE AND TECHNOLOGY

Changyun Lu

- Library, China Agricult ural University, Beijing, 100083, China
- Information Research Center of China Agricultural University, Beijing, 100083, China

Longjiao Zhu

- Coll Food Sci & Nutr Engn, Beijing Adv Innovat Ctr Food Nutr & Human Hlth, China Agricultural University, Beijing, 100083, China

Wentao Xu

- Coll Food Sci & Nutr Engn, Beijing Adv Innovat Ctr Food Nutr & Human Hlth, China Agricultural University, Beijing, 100083, China

Yuan Cao*

- Library, China Agricultural University, Beijing, 100083, China
- Information Research Center of China Agricultural University, Beijing, 100083, China
- E-mail: caoy1004@cau.edu.cn

Reception: 10 January 2024 | **Acceptance**: 26 January 2024 | **Publication**: 19 February 2024

Suggested citation:

Lu, C., Zhu, L., Xu, W. and Cao, Y. (2024). **Using PEST analysis to explore the impact and mechanism of Chinese and American breeding patents on the development of agricultural science and technology**. *3C TIC. Cuadernos de desarrollo aplicados a las TIC, 13*(1), 117-137. https://doi.org/10.17993/3ctic.2024.131.117-137

ABSTRACT

In recent years, PEST analysis and its application in decision-making has become a hot topic, and this paper proposes a new model of PEST analysis based on neutral cognitive map static analysis.The proposed framework consists of five activities, identifying PEST factors and sub-factors, modeling the interrelationships among PEST factors, calculating centrality measures, categorizing the factors, and ranking the factors.The results show that the impact factor of the US breeding patent on the development of agricultural science and technology has reached the level of interrelationship, and the uncertainty is included in the analysis. Using this model to analyze the impact of U.S.-China breeding patents on the development of agricultural science and technology, we ranked the factors according to their interrelationships and incorporated uncertainty into the analysis. The results showed that the impact factor of U.S. breeding patents on the development of agricultural science and technology reached 0.70, and the index of the Gross Agricultural Product (GAP) caused by patents was greater than 100. The quantitative analysis of the impact of Sino-US cooperation in agricultural science and technology using PEST analysis has scientifically and accurately grasped the quantitative law of Sino-US agricultural science and technology cooperation.

KEYWORDS

Agricultural science and technology; Breeding patents; PEST analysis; Neutral cognitive map; Breeding technology

https://doi.org/10.17993/3ctic.2024.131.117-137

INDEX

https://doi.org/10.17993/3ctic.2024.131.117-137

1. INTRODUCTION

For thousands of years, the development of agricultural science and technology has contributed to the growth of human population and the expansion of social complexity [1].In fact, the ability to meet the basic needs of the world's food supply and to gradually improve the quality of life of the rich people in the employment of fewer and fewer people is mainly due to the development of agricultural science and technology. At present, in the context of economic globalization and rapid development of science and technology, it is important to explore the impact and mechanism of the Chinese and U.S. patents in the area of agricultural science and technology development [2]. Currently, in the context of economic globalization and rapid development of science and technology, it is of great significance to investigate the impact and mechanism of Sino-US breeding patents on agricultural science and technology development[2].As the world's two largest economies, the progress of China and the United States in the field of agricultural science and technology has a far-reaching impact on the global food security and sustainable agricultural development[3]. The new technologies created by China and the United States in the field of agriculture can significantly increase the world's agricultural production and maintain the sustainability of the world's agricultural development. the promotion of new disease-resistant hybrid varieties, the reduction of the use of pesticides, the scientific prevention and control of biological pests, the improvement of cultivation technology of agricultural products, etc. agricultural science and technology can increase the production of agricultural products, and promote agricultural development. Intellectual property management is not only related to the incentive mechanism of technological innovation, but also affects the competitive pattern of the global agricultural market [4].In addition, with the global climate change and population growth brought about by the pressure of food supply, improve crop yield and adaptability has become an urgent need, which is the core goal of the innovation of breeding technology [5].Therefore, an in-depth understanding of the development of the U.S. and Chinese breeding patent situation, the differences in patent policy and its impact on the development of their respective and global agricultural science and technology. Therefore, in-depth understanding of the development of Chinese and American breeding patents, patent policy differences and their impact on the development of their respective and global agricultural science and technology is the key to grasp the pulse of the global agricultural science and technology development, guide the future development of agricultural policy and promote international cooperation.

This paper utilizes PEST analysis to systematically analyze the impact and mechanism of agricultural science and technology development, and comprehensively assesses the factors from political, economic, social and technological dimensions, so as to provide powerful strategic support for promoting the healthy development of agricultural science and technology and global agricultural cooperation. In order to reduce the dependence between the influencing factors, this paper employs the NCM to model the integrated structure of the sub-factors of

https://doi.org/10.17993/3ctic.2024.131.117-137

PESTEL, and to stratify and refine the impact of agricultural science and technology through the measurement of the influencing factors. In order to reduce the dependence between the influencing factors, this paper adopts NCM to model the comprehensive structure of PESTEL sub-factors, and to refine the influence of agricultural science and technology by stratifying the influence of the influencing factors through the measurement of the influencing factors.In the exploration and analysis, the performance of Sino-US breeding patents in different PEST dimensions and the role of breeding patents on the development of agricultural science and technology are used to validate the reasonableness of the methodology of this paper, so as to comprehensively and systematically sort out the history of the cooperation between China and the United States in agricultural science and technology and to summarize the basic mode of the cooperation in agricultural science and technology between China and the United States. We quantitatively analyze the influence of Sino-US agricultural science and technology cooperation.

2. LITERATURE REVIEW

Zhang, F et al. elaborated the mechanism of agricultural science and technology innovation to promote the green development of agriculture through spatial spillover from the perspective of multi-dimensional approach, from the perspective of factor spillover path and product spillover path, and measured the level of China's agricultural green development by using grey correlation analysis and analyzed the spatial and temporal evolution of the green development of China's agriculture [6]. Wang, Y proposed a program design for the intelligent platform of agricultural science and technology park, and listed the basic content of the construction of the intelligent park. The proposed intelligent platform program design applies new ICT technologies such as 5G, artificial intelligence, cloud computing, Internet of Things, mobile Internet, etc., and solves the problems faced by traditional agricultural science and technology parks for a long time such as lack of experience in service, poor integrated security, low operational efficiency, high management cost, and difficult business innovation [7]. Mahapatra, B. used autoregressive distributed lag combined with F-test and investigated the impact of agricultural credit on total cereal, grain and rice production using ARDL regression modeling framework. The empirical results of bounded F-test showed that there was a statistically significant relationship between agricultural credit and total cereal, millet and rice production at 1% level, which verified the long-run equilibrium relationship in the model [8].Wang, Z designed a set of agricultural digital greenhouse system based on ZigBee wireless sensor network technology. At the same time, in the corresponding data acquisition and processing problems, this paper adopts the PID controller under the particle filtering optimization technology to optimize the error of the corresponding data acquisition system, eliminate the corresponding noise and interference, so as to ensure the stability and effectiveness of the corresponding data acquisition system in the digital greenhouse, reduce the power consumption of the whole system, and ensure the stable transmission of data[9].

https://doi.org/10.17993/3ctic.2024.131.117-137

Aragie, E applied economic modeling in economics to assess the relative efficiency of alternative investment choices for agricultural performance and household welfare. To explain the linkages, as well as the direct and indirect impacts of alternative public expenditure policies, the study used a general equilibrium model of Ethiopia calibrated according to a well-decomposed socio-accounting matrix representing the structure of the economy in the year 2010 [10]. Gurnovich, T. The innovation and investment processes in the agricultural economy were studied by using system analysis methods taking into account the manifestations of the trend of digitization of the agro-industry. Structural changes and imbalances in the process of investment and innovation in the agricultural sector of the economy were revealed. Statistical and economathematical methods were used to forecast the development of agricultural production [11].Habtewold, The impact of climate-smart agricultural technology on multidimensional poverty of rural households in Ethiopia was used by T. To estimate the impact of the mentioned technology, propensity score matching and endogenous switching regression methods were used. The increase in income/consumption by increasing the returns to production reduces the technology-induced multidimensional poverty. This impact is transmitted more through the non-food expenditure pathway. Finally, the impact of technology adoption on the Finally, the impact of technology adoption on multidimensional poverty reduction has also been revealed [12].Treurniet, M. used exogenous variation in the probability of a baseline survey to estimate the impact of a baseline survey on the adoption by subsistence farmers of a new agricultural technology that improves food security, and found that acceptance of the survey had a large and statistically significant impact [13].

3. CONSTRUCTING AN IMPACT MECHANISM FOR AGRICULTURAL SCIENCE AND TECHNOLOGY DEVELOPMENT BASED ON PEST ANALYSIS

3.1. PEST ANALYTICAL FRAMEWORK

PEST analysis is used to assess these four external factors related to the business situation, when including environmental and legal factors, it is called PESTEL, i.e., the analysis of political, economic, socio-cultural, technological, environmental, and legal factors [14]. In the use of PEST analysis to explore the impact and mechanism of the influence of the Chinese and American breeding patents on the development of agricultural science and technology, PEST analysis framework provides a comprehensive method to examine the various external environmental factors. The PEST analysis framework is shown in Figure 1, and the framework includes four main dimensions: political, economic, social, and technological. The PEST analysis framework is shown in Fig. 1, which includes four main dimensions: political, economic, social and technological. This will help identify opportunities and challenges, provide decision support for policy makers and the industry, and promote the healthy and sustainable development of agricultural science and technology.

https://doi.org/10.17993/3ctic.2024.131.117-137

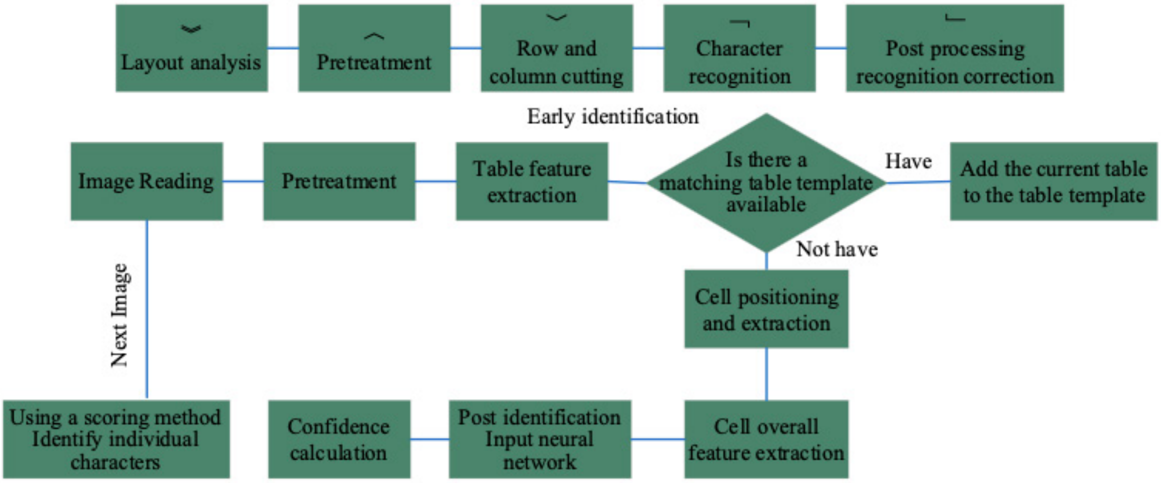

Figure 1. PEST analysis framework

3.2. IMPACT OF U.S.-CHINA BREEDING PATENTS ON AGRICULTURAL SCIENCE AND TECHNOLOGY DEVELOPMENT

3.2.1. POLITICAL FACTORS

The governments of China and the United States influence the protection and application of breeding patents through the formulation of relevant policies and legal frameworks. Intellectual property laws, the duration of patent protection, and the regulation and restriction of biotechnology all have a direct impact on the development and application of breeding technologies [15-16]. trade agreements and diplomatic relations between China and the United States also have an impact on breeding patents. the provisions of trade agreements on agricultural products and biotechnology affect technology exchanges and market access. The level of government funding and support for research in agricultural science and technology has a significant impact on the innovation and application of breeding patents, and government-sponsored research programs may drive the development of new varieties and technological innovations. government public policies, including attitudes toward genetically modified products and consumer right-to-know policies, may also affect the market acceptance and application of breeding patents. In some cases, breeding technologies and patents are also linked to national security and food safety policies, and breeding technologies that improve crop yields and resilience may be considered part of a national food safety strategy.

3.2.2. ECONOMIC FACTORS

The development of breeding patents requires significant R&D investment, and the rate of development of new technologies and varieties is determined by the investment made by companies and research institutions in the U.S. and China. the

https://doi.org/10.17993/3ctic.2024.131.117-137

patent system provides a level of protection that encourages such investment in the hope of obtaining a return on that investment through exclusivity during the term of the patent. the holder of a patented technology can gain a competitive advantage in the marketplace, influencing the price of seed and the planting choices of farmers. at the same time, a market with a high degree of patent concentration can lead to market monopolization and affect fair competition. At the same time, markets with high patent concentration can lead to market monopolization and affect fair competition in the marketplace. patent protection for breeding technologies also plays an important role in international trade. the entry of patented products for export is affected by differing IPR protection laws and market access rules in different countries, which has a direct impact on the competitiveness of the U.S. and China in the global marketplace for agricultural products. patented technologies for breeding affect the cost and efficiency of agricultural production. New breeding technologies can improve crop yields and resistance to pests and diseases, reduce the cost of agricultural production, and increase farmers' income [17].

3.2.3. SOCIAL FACTORS

Public attitudes towards breeding technologies, especially transgenic technologies, have a direct impact on the market acceptance of breeding patents, and societal concerns about food safety and environmental impacts may lead to boycotts or restrictions on certain breeding technologies, thus affecting the commercialization of these technologies.The degree of societal awareness of intellectual property rights (IPRs) protection, especially in the agricultural sector, has a significant impact on the filing and enforcement of breeding patents [18]. In societies with strong awareness of intellectual property protection, patents are likely to be better defended, thus stimulating more innovation and investment. breeding patents, especially those involving gene editing and transgenic technologies, often lead to moral and ethical debates in society, which may influence the formulation of governmental policies, and consequently, the development and application of breeding technologies. the degree of importance that societies attach to education and training in agricultural science and technology determines the training of human resources in the field of agricultural science and technology. The level of social emphasis on education and training in agricultural science and technology determines the cultivation of human resources and dissemination of technology in the field of agricultural science and technology, and a high level of scientific education and technical training can accelerate the progress of agricultural science and technology by facilitating the understanding and application of breeding technology. changes in consumer demand for food products, such as the preference for organic and non-GMO products, can affect the commercial prospects of patents on breeding technology, and the market demand for crops with specific characteristics, such as higher nutritional value and better taste, can also drive breeding technology. Market demand for specific crop characteristics, such as higher nutritional value and better taste, will also drive the direction of breeding technology.

https://doi.org/10.17993/3ctic.2024.131.117-137

3.2.4. TECHNICAL FACTORS

The existence of breeding patents encourages technological innovation, particularly in areas such as gene editing and transgenic technologies, and patent protection provides inventors with a window of time to recoup their R&D investment, thereby stimulating additional R&D activities and innovation attempts. patenting standards and specifications for breeding technologies differ in the U.S. and China, affecting the direction of the technologies and the scope of their application. the technical standards in the patenting and approval process determine which innovations can be protected and disseminated. Breeding patents affect the accessibility and diffusion of technologies, and the licensing of patented technologies determines how easily they can be applied and under what conditions they can be used by other researchers and developers. the patent system facilitates technology transfer and international cooperation to a certain extent. Through patent licensing and cooperative agreements, advanced breeding technologies can cross national boundaries and contribute to the development of global agricultural science and technology [19].The development of breeding technologies has a direct impact on the efficiency and sustainability of agricultural production.For example, new drought- or disease-resistant varieties can increase crop yields and reduce the reliance on chemical fertilizers and pesticides, thus contributing to the sustainable development of agriculture.

4. MODELING OF INFLUENCING FACTORS

4.1. DATA ACQUISITION

PEST analysis is a premise analysis whose main function is to identify the environment in which a company or project operates and to provide data and information to enable the organization to anticipate new situations and circumstances [20], Figure 2 shows the process of data collection for agro-technology influencing factors.

Political factors include government regulation of business, commercial law, labor legislation, tax legislation, legislation in the field of import and export regulation, competition protection, consumer protection, and environmental protection laws. It can be expressed as $GSl = G/T$, $TRI = A/T$, $IPPI = P/TP$, where GS is the government support index, G is the financial support for agricultural science and technology from government agricultural policy, and T is the total agricultural science and technology development budget. TRI is the trade relationship index, A is the volume of agricultural trade between China and the U.S., and T is the total volume of agricultural trade. $IPPI$ is the intellectual property protection index, P is the number of patents on breeding, and TP is the total number of patents on agricultural science and technology.

https://doi.org/10.17993/3ctic.2024.131.117-137

Economic factors include E i.e. inflation, GDP, interest rate, exchange rate, unemployment etc. as well as ratio, intensity and type of contest between small, medium and large enterprises, private and state owned property etc. denoted as $AIG = I/GDP$, $PVR = (P_{\max} - P_{\min})/Pavg$, $RDEP = R\&D/TA$. Where AI is agricultural investment as a percentage of GDP, I is investment in the agricultural sector, and GDP is the GDP to the overall state of the country's economy. PVR is the price volatility of agricultural products, P_{max} is the highest point of the price of key agricultural products, P_{min} is the lowest point of the price of key agricultural products, $Pavg$ is the average price. $RDEP$ is the ratio of agricultural research and development expenditures, $R\&D$ is the expenditures on agricultural research and development, TA is the total agricultural expenditures.

Socio-cultural factors s cover demographic trends including age, sex, number of people, natural growth rate, birth rate, death rate, population migration, educational level and social groups in the population, cultural beliefs and values, and people's individual needs. i.e., $PGR = (Pend - Pstart)/Pstart$, $CSl = CC/TCC$, and $REI = ER/TR$. where PGR is the Population Growth Rate, $Pend$ is the end of the year population, and $Pstart$ is the beginning of the year. CSI is the Consumer Concern Index, which is the score of the survey on consumer concern about the quality and sustainability of agricultural products, and the total survey score. CC is Consumer Concern Survey Score on Quality and Sustainability of Agricultural Products, TCC is Total Survey Score. REI is Rural Education Level, ER is Percentage of Educated Population in Rural Areas, TR is Total Population.

The analysis of technological factors covers innovation and creativity, technology transfer, availability and access to patents, attitudes of researchers toward copyright, and availability and access to the services of research institutes, which can be denoted as $ATI = NP/TP$, $DAI = DA/TA$, and $ICPI = CRC/TRC$, where ATI is the Agricultural Technological Innovation Index, NP is the number of new patents in the field of agriculture, and TP is the total number of patents. DAI is the Digital Agriculture Adoption Rate, DA is the number of agricultural operators that have adopted digital technologies, and TA is the total number of agricultural operators; $ICPI$ is the index of cross-country scientific research cooperation, CRC is the number of joint research projects between China and the U.S. in the field of agricultural science and technology, and TRC is the total number of research projects.

https://doi.org/10.17993/3ctic.2024.131.117-137

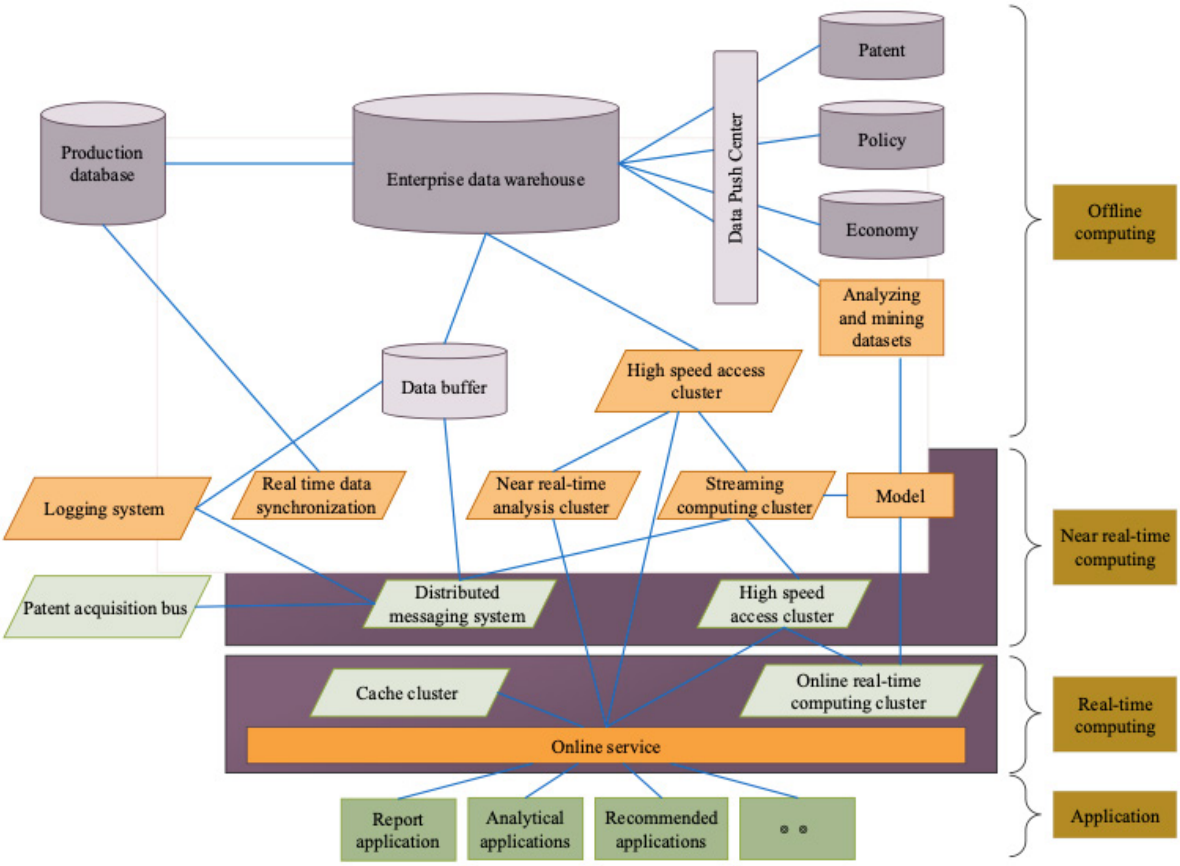

Figure 2. Data acquisition process

4.2. MODEL BUILDING

The interdependence between the analyzed factors. In addition, the structure of the factors and sub-factors is characterized by ambiguity, vagueness and uncertainty. Therefore, this study proposes a model to solve the problems encountered in the process of measuring and evaluating the PEST analysis. The composition of the model is shown in Fig. 3. The interdependence between the sub-factors is also taken into account. The comprehensive structure of the PESTEL sub-factors is modeled using the NCM.A quantitative analysis is also carried out on the basis of the static analysis.

https://doi.org/10.17993/3ctic.2024.131.117-137

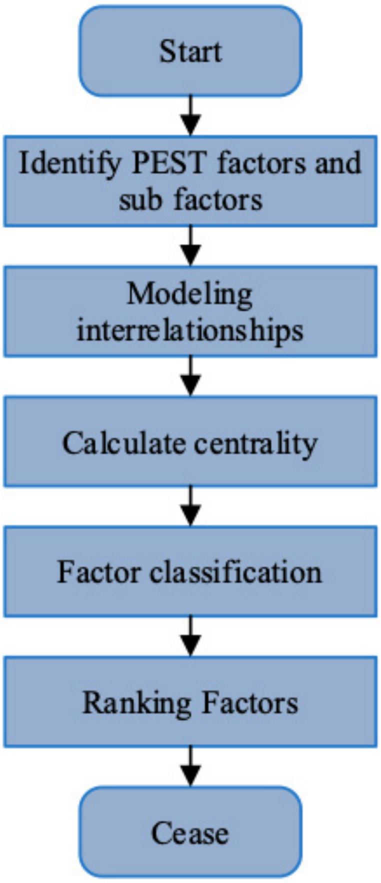

Figure 3. Proposed framework for PEST analysis.

Neutral logic was introduced in 1995 as a generalization of fuzzy logic, especially intuitionistic fuzzy logic. The logical proposition P is characterized by three neutral components.

$$NL(P) = (T, I, F) \quad (1)$$

Where T is the degree of truth, F is the degree of falsity and I is the degree of uncertainty.

A neutral matrix is a matrix in which the elements $a = (a_{ij})$ have been replaced by elements in $\langle R \cup I \rangle$, where $\langle R \cup I \rangle$ is a ring of neutral integers. a neutral map is a map in which at least one of the edges is a neutral edge. a cognitive map is called a neutral cognitive map if uncertainty is introduced into the cognitive map. the NCM uses neutral logic to represent the uncertainty and uncertainty in the cognitive map. a NCM is a directed graph in which at least one edge is uncertainty as represented by the dashed line, an example of a fuzzy neutral cognitive map is shown in Fig. 4. An example of a fuzzy neutral cognitive map is shown in Figure 4. The static analysis results of the mental model in the form of NCM are in the form of neutral numbers. Finally, a de-neutralization process is applied to give the final ranking values. In this study, the model is extended and detailed to deal with the classification and prioritization of factors.

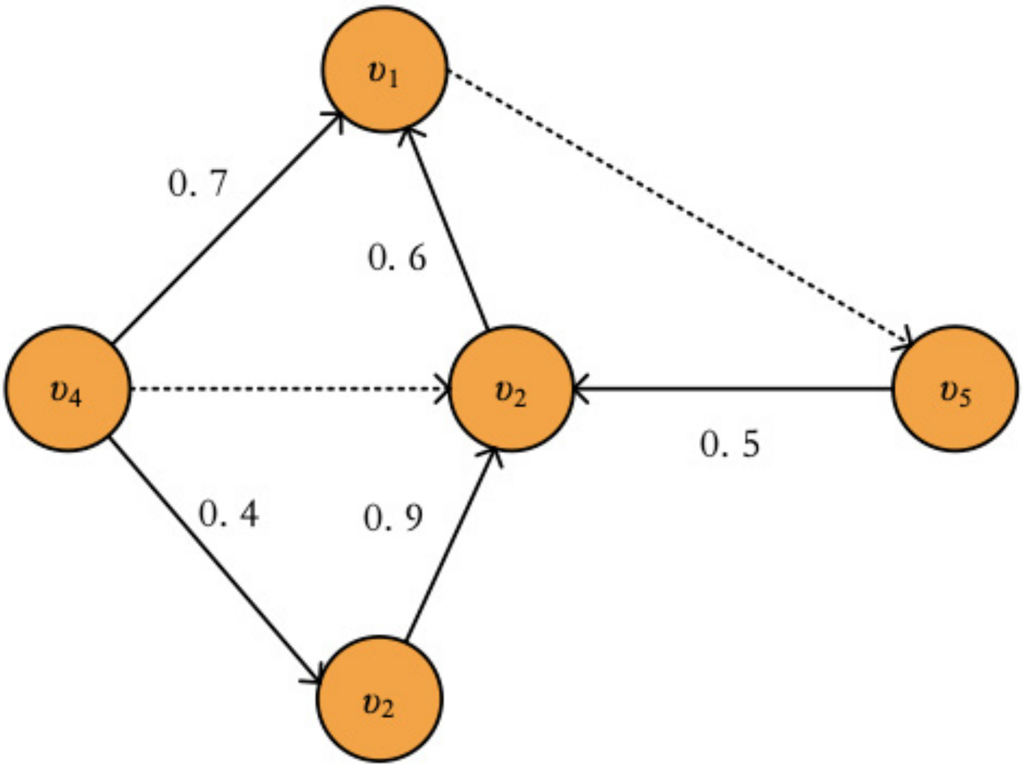

Figure 4. Fuzzy Neutrosophic Cognitive Maps example.

4.3. IMPACT FACTOR METRICS

4.3.1. COMPUTATIONAL CENTRALITY MEASURE

The following metrics are computed using the absolute values of the NCM adjacency matrix.

1. The out-degree $od(v_i)$ is the row sum of the absolute values of the variables in the neutral adjacency matrix, showing the cumulative strength c_{ij} of the connections of the exit variables.

$$od(v_i) = \sum_{i=1}^{N} c_{ij} \quad (2)$$

2. Input $id(v_i)$ is the column sum of the absolute values of the variables, showing the cumulative strength of the input variables.

$$id(v_i) = \sum_{i=1}^{N} C_{ij} \quad (3)$$

3. The total degree of centrality of a variable, $td(v_i)$, is the sum of its in- and out-degrees, which is then calculated as follows.

https://doi.org/10.17993/3ctic.2024.131.117-137

$$td(v_i) = od(v_i) + id(v_i) \tag{4}$$

4.3.2. FACTOR CLASSIFICATION

Factors are categorized according to the following rules.

1. Transmitter variables have positive or uncertain out-degree $od(v_i)$ and zero in-degree $id(v_i)$.
2. Receiver variables have positive or uncertain in-degree $id(v_i)$, and zero out-degree $od(v_i)$.
3. Ordinary variables have non-zero in-degrees, and ordinary variables can be more or less receiver or transmitter variables, depending on the ratio of their in-degrees to their out-degrees.

4.3.3. RANKING FACTORS

The process of de-neutralization gives the number of intervals of centrality. this is based on the maximum and minimum values of *I*. Neutrality values are transformed in intervals with two values, the maximum and the minimum [0,1].

The contribution of a variable in a cognitive map can be understood by calculating its degree centrality, which shows how well the variable is connected to other variables and what is the cumulative strength of these connections. the median of the extremes is used to give the centrality value.

$$\lambda\left(\left[a_1, a_2\right]\right) = \frac{a_1 + a_2}{2} \tag{5}$$

Then:

$$A > B \Leftrightarrow \frac{a_1 + a_2}{2} > \frac{b_1 + b_2}{2} \tag{6}$$

Hierarchical refinement of the impact of breeding technology on agricultural science and technology based on PEST, the variables were ranked as shown in Table 1 for factor prioritization and/or reduced values.

https://doi.org/10.17993/3ctic.2024.131.117-137

Table 1. The hierarchical model of PEST of breeding patents.

Political	Economic	Social	Technology
Political stability (P1)	Labor force level (E1)	Entrepreneurial spirit (S1)	Government investment measures (T1)
Intellectual Property (P2)	Investment incentive measures (E2)	Purchase product (S2)	Government support for scientific research (T2)
Environmental Protection Law (P3)	National Income (E3)	Citizen attitudes towards breeding technology (S3)	Technological Innovation (T3)
		Positive media promotion (S4)	

5. MECHANISM OF ACTION ANALYSIS

5.1. PERFORMANCE OF CHINESE AND U.S. BREEDING PATENTS ON DIFFERENT PEST DIMENSIONS

The data on the political, economic, social and technological dimensions of breeding patents in China and the United States were collected through the data collection system, and hypothetical analyses were conducted to investigate the significance of the impact of these factors on breeding patents.Table 2 shows the results of the hypothetical analyses.The policy factor represents the impact of the political environment on breeding patents, including policy support, changes in the law, etc.The economic impact factor includes R&D investment, market size, etc.The social impact factor reflects social attitudes, consumer preferences, etc.The technological impact factor represents technological progress, innovation speed, etc.The number of breeding patents is the number of applications filed by the country in a given year. The social influence factor reflects the social attitude and consumer preference, etc. The technology influence factor represents the technological progress and innovation speed, and the number of breeding patents is the number of breeding patent applications in a specific year.The political influence factor of China and the United States increases year by year from 2019 to 2021, and by 2022, the technology influence factor reaches 0.70, and the economic influence factor reaches 0.60, which reflects that the governments of the two countries increase the number of breeding patents during this period. This reflects that the governments of the two countries have increased their policy support for agricultural science and technology during this period, such as providing more R&D funds and optimizing the intellectual property protection system, etc. This improvement in the policy environment may have played a positive role in promoting the application and implementation of breeding patents.

https://doi.org/10.17993/3ctic.2024.131.117-137

Table 2. Hypothesis Analysis Results

Time	Country	Political influence factors	Economic impact factors	Social impact factors	Technical impact factors	Number of breeding patents
2019	United States	45	0.60	0.50	0.70	150
2019	China	0.50	0.55	0.45	0.65	130
2020	United States	0.47	0.62	0.52	0.72	155
2020	China	152	0.58	0.48	0.68	135
2021	United States	49	0.65	0.55	0.75	160
2022	China	0.55	0.60	0.50	0.70	140

The NCM was used to identify and model the interdependencies. The weights of the NCM are shown in Table 3.The weights are all below 0.5.

Table 3. Neutrosophic Adjacency Matrix

	P1	P3	E1	E2	E3	S1	S2	S3	S4	T1	T2	T3	P1
P1	0	0	0	0	0	0	0	0	0	0	0.7	0.6	0
P3	0	0	0	0	0.4	0	0	0	0	0	0	0	1
E1	0	0	0	0	0	0	0	0	0	0	0	0	0
E2	0	0	0	0	0	0	0.6	0	0	0	0	0	0
E3	0	0	0	0	0	0.3	0.4	0	0	0	0	0	0
S1	0	0	0	0	0	0	0	0.8	0	0	0	0	0
S2	0	0	0	0	0	0	0	0	0	0	0	0	0
S3	0	0	0	0	0	0	0	0	0	0	0	0	0
S4	0	0	0	0	0	0	0	0	0	0	0	0	0
T1	0	0	0	0	0	0	0	0	0	0	0	0	0
T2	0	0	0	0.2	0	0	0	0	0	0	0	0	0
T3	0	0	0	0	0	1	1	0	0.4	0.5	0	0	0
0	0	0	0	0	0	0	0.4	0	0	0	0	0	0

https://doi.org/10.17993/3ctic.2024.131.117-137

5.2. THE ROLE OF BREEDING PATENTS IN THE DEVELOPMENT OF AGRICULTURAL SCIENCE AND TECHNOLOGY

5.2.1. CHANGES IN THE AGRICULTURAL ECONOMY

China and the United States agricultural science and technology cooperation, directly promote China's agricultural science and technology level, and the level of agricultural science and technology is called the important driving force of the development of the agricultural economy. therefore, this paper adopts the trade in agricultural products as a measure of the index to measure the impact of China-US cooperation in agricultural science and technology on the agricultural economy has a certain degree of reality and reasonableness. figure 5 for the species of the country's agricultural output value index in the year 2001-2023 ring changes in the trend of agricultural output value index, from the From the point of view of agricultural output value index, after excluding the price fluctuation factor, the output value index of agriculture, forestry, animal husbandry, fishery, plantation, forestry, pasture and fishery are all greater than 100 except for a few years, indicating that China's agricultural output value is still showing an obvious year-on-year growth, which also fully demonstrates the momentum of China's agricultural development.

From 2001 to 2023, the index of agricultural output value shows an overall trend of first growth and then decline, and gradually tends to stabilize, in which the index of total output value and agricultural output value reached the maximum value in 2008, while the index of forestry, animal husbandry and fishery output value reached the maximum value in 2007, from the point of view of the stability of the index of recent years, they are all stable at 105 or above, that is, in recent years, the index of total output value of agriculture is still showing obvious growth year by year, which also shows that China's agriculture has a rapid development momentum. From the perspective of the flat stability of the chain index in recent years, they are all stabilized at 105 or above, which means that the agricultural industry has shown a coordinated growth in recent years, and the growth rate of the chain index is around 5%.。

https://doi.org/10.17993/3ctic.2024.131.117-137

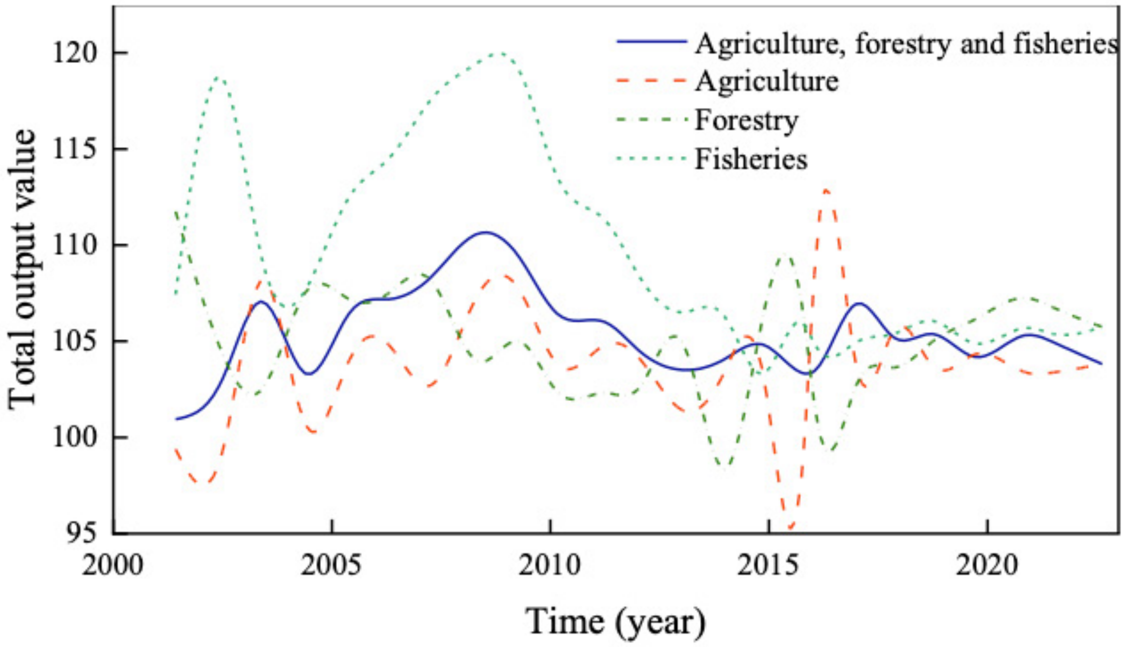

Figure 5. 2001-2023 trend of the output value index

5.2.2. U.S. IMPORTS OF CHINESE AGRICULTURAL PRODUCTS

Agricultural products is the final reflection of the results of agricultural science and technology, China and the United States agricultural trade is an important carrier of agricultural science and technology cooperation between the U.S. and China. China and the United States agricultural products there are greater complementarity, in recent years in the agricultural trade in the cooperation is becoming closer and closer. figure 6 for the U.S. imports of agricultural products from China's total amount and share of the 2009 year, the U.S. exports of agricultural products year-on-year will be reduced by 17 billion U.S. dollars, while the amount of China's exports of agricultural products to the United States will be Further increase, to 3.42 billion U.S. dollars, the past four years China's total exports of agricultural products to the U.S. has doubled. from the development trend, 1990-2008 U.S. imports of agricultural products from China's total amount and share of the total amount of obvious growth. 1990 U.S. imports of agricultural products from China's amount of 273 million U.S. dollars, accounting for the U.S. value of the total value of agricultural products imported 1.19%. 2008 U.S. imports of agricultural products of Chinese origin and share of the total value of the U.S. value of 1.19%. In 2008, the total value of U.S. imports of agricultural products of Chinese origin amounted to 3454 million U.S. dollars, an increase of 11.65 times compared with 1990, with an average annual growth rate of 15.14%. 2008 imports of agricultural products of Chinese origin accounted for the proportion of U.S. imports of agricultural products to the total value of 4.29%, an increase of 3.1 percentage points compared with 1990.

https://doi.org/10.17993/3ctic.2024.131.117-137

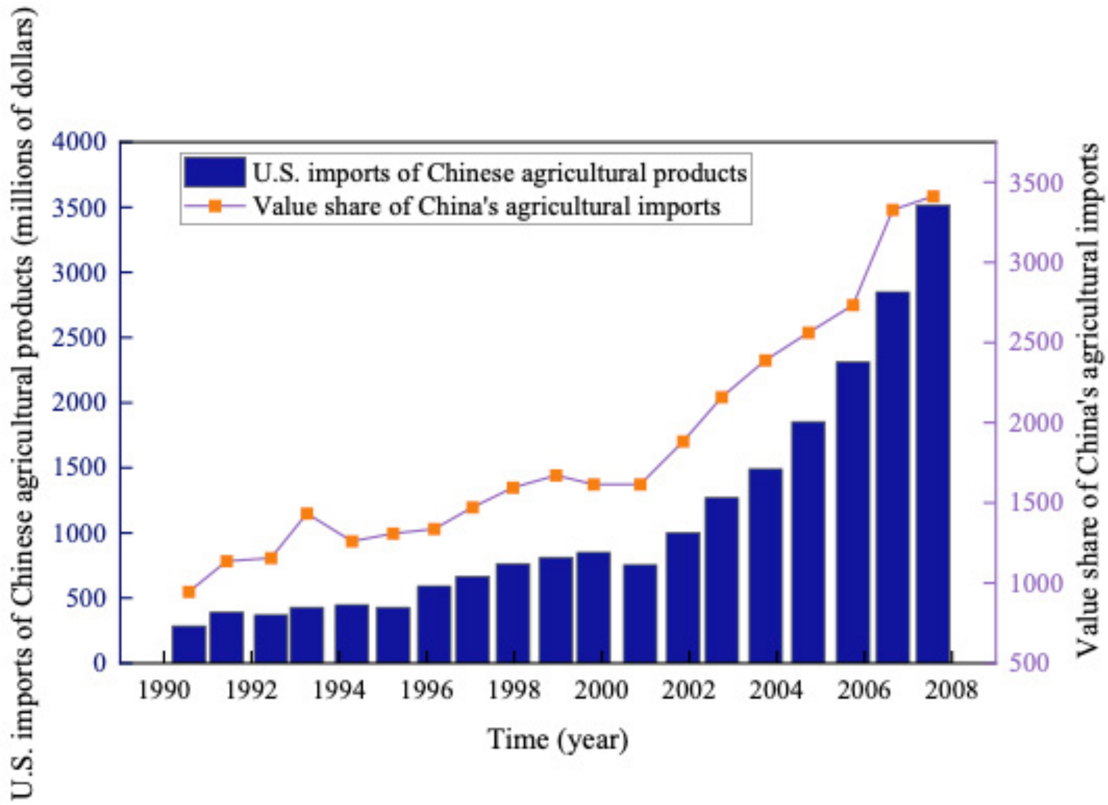

Figure 6. Total amount and proportion of U. S. imports of agricultural products from China

6. CONCLUSION

In this paper, the impact and mechanism of U.S. breeding patents on the development of agricultural science and technology is taken as the target, and the PEST analysis combined with the static analysis of sexual cognitive map is used to construct the model of the impact factors and validate it. The conclusions are as follows.

1. For the performance of Chinese and American breeding patents in different PEST dimensions, by 2022, the technological impact factor reaches 0.70, and the economic impact factor reaches 0.60, reflecting that the governments of the two countries have increased their policy support for agricultural science and technology during this period, and this improvement in the policy environment may play a positive role in promoting the application and implementation of breeding patents.

2. In the analysis of the role of breeding patents on the development of agricultural science and technology, Chinese and American breeding patents make China's total agricultural output value is greater than 100, and in 2008, imports of agricultural products of Chinese origin accounted for the proportion of total U.S. imports of agricultural products also rose to 4.29%.

https://doi.org/10.17993/3ctic.2024.131.117-137

FUNDING

This work was supported by Young Elite Scientist Sponsorship Program by BAST [BYESS2022133], National Key Research and Development Program of China [2022YFF0607900], 2115 Talent Training Plan of China Agricultural University [00109012] and Key Research and Development Program of Hebei Province [21372801D].

REFERENCES

(1) Singh, D., & Kalra, R. (2019). Extent of utilization of services provided by agricultural technology and information centre (atic). *International Journal of Current Microbiology and Applied Sciences, 8*(10).

(2) Correa, C. M., Correa, J. I., & De Jonge, B. (2020). The status of patenting plants in the global south. *The Journal of World Intellectual Property, 23*(1/2), 121-146.

(3) Tudi, M., Ruan, H. D. D., Wang, L., Lyu, J., & Phung, D. T. (2023). Agriculture development, pesticide application and its impact on the environment. *International journal of environmental research and public health, 18*(3), 1112.

(4) Delay, N. D., Thompson, N. M., & Mintert, J. R. (2021). Precision agriculture technology adoption and technical efficiency. *Journal of Agricultural Economics*, 195-219.

(5) Khan, N., Ray, R. L., Sargani, G. R., Ihtisham, M., Khayyam, M., & Ismail, S. (2021). Current progress and future prospects of agriculture technology: gateway to sustainable agriculture. *Sustainability, 13*.

(6) Zhang, F., Wang, F., Hao, R., & Wu, L. (2022). Agricultural science and technology innovation, spatial spillover and agricultural green development—taking 30 provinces in china as the research object. *Applied Sciences, 12*(2), 845.

(7) Wang, Y., Sun, Z., Wang, X., & Yang, C. (2020). Scheme design of smart platform for the agricultural science and technology park. *Journal of Physics: Conference Series, 1673*(1), 012062 (6pp).

(8) Mahapatra, B., & Jena, D. (2023). Impact of agricultural credit disbursement on cereals yield in odisha. *International Social Science Journal, 73*(248), 373-391.

(9) Wang, Z. (2021). Greenhouse data acquisition system based on zigbee wireless sensor network to promote the development of agricultural economy. *Environmental Technology & Innovation, 101689*.

(10) Aragie, E., & Jean Balié. (2020). Public spending on agricultural productivity and rural commercialization: a comparison of impacts using an economy-wide approach. *Development Policy Review*, O21-O41.

(11) Gurnovich, T. G., Piterskaya, L. Y., Agarkova, L. V., Buraeva, E. V., & Chistyakova, M. K. (2021). Trends in the development and financing of investment and innovation activities in the agricultural sector of the economy. *IOP Conference Series: Earth and Environmental Science, 745*(1), 012013 (9pp).

(12) Habtewold, T. M. (2021). Impact of climate-smart agricultural technology on multidimensional poverty in rural ethiopia. *Journal of Integrative Agriculture, 20*(4), 1021-1041.

(13) Treurniet, M. (2021). The impact of being surveyed on the adoption of agricultural technology. *Economic Development and Cultural Change, 71*, 941 - 962.

(14) Mihailova, M. (2020). The state of agriculture in bulgaria - pestle analysis. *Bulgarian Journal of Agricultural Science, 5*(26), 935-943.

(15) Xiaoqing, H. (2020). Analysis of innovation degree of agricultural science and technology service system based on markov decision process. *Dynamic Systems and Applications, 29*(5).

(16) Smulders, M. J. M., Wiel, C. C. M. V. D., & Lotz, L. A. P. (2021). The use of intellectual property systems in plant breeding for ensuring deployment of good agricultural practices. *Agronomy, 11*(6), 1163.

(17) Agnès Ricroch, Martin-Laffon, J., Rault, B., Pallares, V., & Kuntz, M. (2022). Next biotechnological plants for addressing global challenges: the contribution of transgenesis and new breeding techniques. *New Biotechnology, 66*, 25-35.

(18) Salzano, A., Cotticelli, A., Marrone, R., D'Occhio, M., D'Onofrio, N., & Neglia, G., et al. (2021). Effect of breeding techniques and prolonged post dry aging maturation process on biomolecule levels in raw buffalo meat. *Veterinary sciences, 8*(4).

(19) Shahzad, R., Jamil, S., Ahmad, S., Nisar, A., Khan, S., & Amina, Z., et al. (2021). Biofortification of cereals and pulses using new breeding techniques: current and future perspectives. *Frontiers in nutrition, 8*, 721728.

(20) Kolomiets, A., Grinchenkov, D., & Vodenko, K. (2019). Pest- and swot-analysis of university internationalization factors. *Journal of Physics Conference Series, 1415*, 012003.