

Spatial Distribution Characteristics and Influencing Factors of Geographical Indication Agricultural Products in Shaanxi Province

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ABSTRACT

Geographical indication agricultural products are of great significance to promote the high-quality development of rural revitalization due to their unique quality and brand value. Based on the geographical concentration index, the nearest neighbor index and the kernel density estimation method, this paper empirically studies the spatial distribution characteristics and influencing factors of 117 geographical indication agricultural products in Shaanxi Province. The results show that the spatial distribution of geographical indications in Shaanxi is extremely uneven, showing the characteristics of 'dense in the south and sparse in the north, regional agglomeration'. From the perspective of density distribution characteristics, the overall spatial distribution of geographical indications in Shaanxi shows a distribution pattern of 'three high and three times', and the three high-density areas show a agglomeration distribution pattern of 'pin-shaped'. The difference between the north and the south is obvious, and the overall distribution pattern is 'cold in the north and hot in the south'. The spatial distribution pattern of geographical indications in Shaanxi is affected by many factors. Natural factors are the basis, social and economic factors strengthen the spatial distribution pattern of geographical indications, and government-led and policy factors play a regulatory and guiding role. It is suggested to optimize the spatial distribution pattern of geographical indications in Shaanxi, rely on local social resources, give full play to the leading role of the government, and actively promote the industrialization development of geographical indication products.

KEYWORDS

Geographical indication agricultural products; Spatial distribution; Influencing factors; Shaanxi Province

1. INTRODUCTION

The concept of Geographic Indications originated from France. After a long period of development and improvement, geographical indications have become an internationally recognized intellectual property and have been protected, which has attracted great attention from all countries in the world. In 1994, the World Trade Organization defined the concept of geographical indications, that is, geographical indications are signs that mark products originating in a member country or a region or place of that member country. Since China's accession to the World Trade Organization (WTO) in 2001, China has gradually established a standardized system and legal system for the declaration, review and protection of geographical indications. As a large agricultural country, the products protected by geographical indications are mainly characteristic agricultural products [2]. In 2014, the Ministry of Agriculture issued the "Regional Layout Planning of Characteristic Agricultural Products (2013-2020)" (hereinafter referred to as "Planning"). The characteristic agricultural products

mentioned in the "Planning" are geographically marked agricultural products, which refer to agricultural products produced in a specific area. The quality, reputation or other characteristics depend on the unique natural or human factors of the origin, and are approved by the relevant government departments to be named after the geographical name [3]. Geographical indication agricultural products are an important basis for the development level of modern agriculture and are regionally derived.

At present, the research on geographical indication products has attracted more and more attention in academia, but most of the research focuses on intellectual property rights and economics. Intellectual property rights mainly focus on how to establish the protection mechanism of geographical indication products: Yang Yiping proposed to strengthen the protection of geographical indications and promote the development of national agricultural economy [5]; chen Feilong proposed that geographical indication brand managers should further improve the quality characteristics of geographical indication products and strengthen the system construction of geographical indication brands [6]; based on the overall development of geographical indication agricultural products in China, Jiang Yan put forward relevant suggestions to promote the construction of the protection and development mechanism of geographical indication agricultural products [7]. In terms of economics: Dogan et al. proposed that geographical indications are a symbol of identity culture in a region. If used properly, geographical indications will become a marketing tool with great economic value [8]; liu Huajun pointed out that geographical indications have a strong positive effect on regional agricultural economic development and farmers' income [9]. In general, the current domestic research on geographical indication agricultural products is constantly expanding and deepening. Although some scholars have studied the spatial and temporal distribution characteristics of national geographical indication agricultural products, the research content of provincial geographical indication agricultural products is less. Shaanxi Province is rich in agricultural resources and has a large number of geographical indication agricultural products, but there are still some problems in the protection and development of geographical indication agricultural products in Shaanxi Province. Therefore, based on 10 cities in Shaanxi Province as the research area, this paper uses the geographic concentration index, the nearest neighbor index and the kernel density estimation method to analyze the spatial distribution of 117 geographical indication agricultural products in Shaanxi Province and explore its influencing factors, and puts forward corresponding suggestions for the problems of geographical indication agricultural products in Shaanxi Province, in order to provide the basis for the protection and development of geographical indication agricultural products in Shaanxi Province, and contribute wisdom to the high-quality development of geographical indication agricultural products to promote rural revitalization.

2. RESEARCH METHODS AND DATA SOURCES

2.1. Overview of the Study Area and Data Sources

2.1.1. Overview of the study area

Shaanxi Province is located in the hinterland of China, the middle reaches of the Yellow River, located between 105 ° 29 ' -111 ° 15 ' E, latitude 31 ° 42 ' -39 ° 35 ' N, under the jurisdiction of 10 prefecture-level cities (including Xi 'an as a sub-provincial city), 31 municipal districts, 7 county-level cities, 69 counties, the province's permanent population of 39.529 million people, land area of 205,600 square kilometers. Shaanxi Province is narrow in the north and south, with diverse landforms. It spans three climatic zones: northern subtropical zone, warm temperate zone and middle temperate zone. It is divided into three natural areas: Loess Plateau area, Guanzhong Plain area and Qinba Mountain area. It has a long culture, diverse ecology, rich resources and distinct characteristics. Shaanxi Province has diverse regions and climate types, and rich agricultural resources. Northern Shaanxi is one of the dominant potato producing areas in China, and it is also a production base for

facility agriculture, small grains and sheep. Weibei and southern Shaanxi are the world's largest concentrated contiguous base of high-quality apples. Guanzhong area is the concentration area of grain production and facility agriculture in the whole province, and the only 'double milk source' base of dairy cows and dairy goats in the country. Southern Shaanxi is the second largest selenium-rich region in China, the highest latitude tea producing area in the world, and the traditional ecological breeding base. It is rich in edible fungi, Chinese herbal medicines, walnuts, konjac and so on. At the same time, Shaanxi is an advantageous area for modern agricultural science and technology and opening to the outside world. It is a bridgehead for the development of the western region in the new era and an important node of the "Belt and Road". Yangling County has become the first agricultural high-tech industry demonstration area in China by relying on the agricultural science and technology platform of Northwest A & F University. It is also the only agricultural free trade zone in China.

Shaanxi Province has a total cultivated land area of 59.7435 million mu, of which the commonly used cultivated land area is 45.1578 million mu. The province's rural population is 14.759 million, accounting for 37.3 % of the resident population. Shaanxi Province is a major province with tight food balance, basic meat self-sufficiency and fruit transfer. The province's grain output is 12.75 million tons, vegetables and edible fungi are 19.5766 million tons, garden fruits are 18.0803 million tons, meat is 1.064 million tons, and aquatic products are 169,000 tons. The added value of the province's primary industry is 226.754 billion yuan, accounting for 8.7 % of GDP. The annual added value of agriculture is 170.871 billion yuan, the added value of forestry is 7.019 billion yuan, the added value of animal husbandry is 47.031 billion yuan, and the added value of fishery is 1.832 billion yuan. There are 608 leading enterprises of agricultural industrialization above the provincial level, 63,000 farmers' professional cooperatives, and nearly 20,000 registered rural collective economic organizations. The per capita disposable income of rural residents is 13,316 yuan, and the income ratio of urban and rural residents is 2.84: 1. In addition, Shaanxi has a number of highly influential and competitive characteristics of agricultural products, especially apple, kiwifruit, dairy goat industry 'three national first'. The province's apple area is 9.327 million mu, and the output is 11.8521 million tons, accounting for 27 % of the country's output. Kiwifruit has an area of 918,200 mu and a yield of 1,158,300 tons, accounting for 35 % of the country's output. There are 2.486 million dairy goats in stock and 648,000 tons of milk production. The market share of stock, goat milk production and goat milk products accounts for 45 %, 55 % and 85 % of the country respectively. The area of facility agriculture is 3.62 million mu, ranking first in the northwest.

2.1.2. Data sources

This paper mainly obtains the number, product name and origin of geographical indication agricultural products in Shaanxi Province from the national geographical indication agricultural product query system website (<http://www.anluyun.com/>). As of January 31, 2023, a total of 117 geographical indication agricultural products were distributed in Shaanxi Province, covering planting, animal husbandry and aquaculture. The socio-economic data are derived from the 'Shaanxi Statistical Yearbook' and industry data in 2021, including cultivated land area, rural population, output of various agricultural products, added value of agriculture, forestry, animal husbandry and fishery, and disposable income of rural residents. The administrative division data of Shaanxi Province is derived from the national 1: 1 million basic data. In addition, DEM elevation data, water system data and road density data are also selected.

2.2. Research Methods

2.2.1. Geographical concentration index

Geographical concentration index is an important index to measure the concentration degree of research objects [10]. Its calculation formula is:

$$G = 100 \times \sqrt{\sum_{i=1}^n \left(\frac{X_i}{T}\right)^2} \quad (1)$$

In the formula: G represents the geographical concentration index; X_i represents the number of geographical indication agricultural products in the first city; T on behalf of the total number of geographical indications of agricultural products in Shaanxi Province, a total of 117; n is the number of cities in Shaanxi Province, a total of 10. The value range of geographical concentration index is 0-100. When the value is closer to 100, it means that the distribution of agricultural products with geographical indications is more concentrated. When the value is closer to 0, it means that the distribution of agricultural products with geographical indications is more dispersed.

2.2.2. The nearest neighbor index

The nearest neighbor index is a measurement method that uses the random distribution as a standard to measure the actual point distribution [11]. Its calculation formula is:

$$R = \frac{\bar{r}_1}{\bar{r}_E} = 2\sqrt{D} \times \bar{r}_1 \quad (2)$$

In the formula: R represents the nearest neighbor index; \bar{r}_1 represent the average distance between the nearest points; \bar{r}_E represents the nearest distance of the theory; D represents the density of the distribution of adjacent points.

$$\bar{r}_E = \frac{1}{2\sqrt{n/A}} = \frac{1}{2\sqrt{D}} \quad (3)$$

In the formula: A represents the area of the case area; n represents the number of geographical indications of agricultural products. $R=1$ showed that the geographical indication agricultural products in Shaanxi Province tended to be randomly distributed; $R>1$ showed that the geographical indication agricultural products in Shaanxi Province tended to be evenly distributed; $R<1$ showed that the geographical indications of agricultural products in Shaanxi Province tended to agglomerate.

2.2.3. Kernel density estimation method

The kernel density estimation method is a non-parametric estimation method for analyzing the density of geographical elements in the surrounding areas. The kernel function assigns different weights to the sample points to reveal the density attributes of the region [12]. Its calculation formula is:

$$f(x) = \frac{1}{nh} \sum_{i=1}^n K\left(\frac{x-x_i}{h}\right) \quad (4)$$

3. ANALYSIS OF THE RESULTS

3.1. Spatial Distribution Characteristics of Different Types of Geographical Indications of Agricultural Products

Table 1. Quantity and geographical concentration index of different types of GI agricultural products in Shaanxi Province

	Type	Quantities	Proportion (%)	Index	Area
Planting industry	Vegetable	21	17.95	47.86	Hanzhong, Xianyang, Weinan
	Fruit	47	40.17	53.18	Xian, Hanzhong, Shangluo
	Foodstuff	15	12.82	37.74	Yulin, Hanzhong, Xianyang
	Edible mushrooms	6	5.13	67.58	Hanzhong
	Oilseeds	1	0.85	100	Shangluo
	Tea	6	5.13	46.82	Ankang, Shangluo
	Medicinal herbs	8	6.84	40.36	Ankang, Hanzhong, Tongchuan
	Perfume	1	0.85	100	Tongchuan
	Cotton	2	1.71	100	Ankang, Yulin
	hemp silk				
Animal husbandry	Meat	5	4.27	48.62	Hanzhong, Ankang, Xianyang
	Bee	3	2.56	74.58	Hanzhong, Baoji
Aquatic industry	Aquatic product	2	1.71	100	Ankang
	Total	117	100		

According to the different biological attributes and commodity attributes of agricultural products with geographical indications, they can be divided into three categories: planting industry, animal husbandry and aquaculture. Among them, planting industry includes vegetables, fruits, grains, edible fungi and other 9 categories; animal husbandry can be divided into two categories: meat products and bee products. The aquatic industry category can be divided into aquatic animal category 1. Among them, the planting industry in Shaanxi Province has the most geographical indication agricultural products, a total of 107 (table 1), while the animal husbandry category has a total of 8, and the aquaculture industry has a total of 2. From the geographical concentration index of the three major categories of geographical indication agricultural products in Shaanxi Province, the geographical concentration index of various types of geographical indication agricultural products is greater than 40 (table 1), showing a more obvious concentration distribution characteristics. Among them, 11 of the 47 fruit agricultural geographical indications of planting industry are from Xi'an, with a geographical concentration index of 53.18, while the agricultural geographical indications of edible fungi and bees are all greater than 70, showing obvious concentrated distribution characteristics. According to the law of normal distribution, when the independent variables are randomly distributed, the mathematical expectation is μ , that is, the mean value, and the one-time standard deviation is σ . When a certain type of agricultural geographical indication of a prefecture-level city accounts for the proportion of the province $\geq \mu + \sigma$, it can be considered that the prefecture-level city is the concentrated distribution area of this type of agricultural geographical indication. From the perspective of the concentrated distribution area of different types of agricultural geographical indications in Shaanxi Province, the concentrated distribution area of the four types of agricultural

geographical indications of vegetables, edible fungi, meat products and bee products is Hanzhong City; the concentrated distribution area of the four types of agricultural geographical indications of tea, medicinal materials, cotton, hemp, silk and aquatic animals is Ankang City; the concentrated distribution area of the three types of geographical indication agricultural products, such as fruit, oil and tea, is Shangluo City; xi'an City, Tongchuan City, Yulin City, Xianyang City and other types of agricultural geographical indications are concentrated. The distribution types of geographical indication agricultural products vary from region to region, most of which are concentrated in the central and southern regions of Shaanxi Province, such as Hanzhong City, which has abundant climate resources and forest resources.

3.2. Spatial Distribution Characteristics of Agricultural Products with Geographical Indications in Different Cities

As of January 31, 2023, there were 117 geographical indication agricultural products in Shaanxi Province, covering planting, animal husbandry and aquaculture. From the spatial distribution of geographical indication agricultural products in Shaanxi Province, the geographical concentration index is about 35.79, which is quite different from the value (about 8.26) in the uniform distribution state, indicating that the spatial distribution of geographical indication agricultural products in Shaanxi Province is more obvious. Specific to the prefecture-level cities, Hanzhong City (24), Ankang City (18), Yulin City (14), Xi'an City (13), compared with other prefecture-level cities, the total number of geographical indications of agricultural products is more, accounting for 20.51 %, 15.38 %, 11.97 %, 11.11 %. Relatively speaking, as of 2023, there are only two geographical indications of agricultural products in Yan' an City, accounting for only 1.71 %. In general, the distribution of geographical indication agricultural products in Shaanxi Province is relatively concentrated, mainly distributed in the central and southern regions of Shaanxi Province.

The spatial agglomeration characteristics of geographical indication agricultural products in Shaanxi Province were analyzed by using ArcGIS10.8 average nearest neighbor distance analysis tool. The results show that the average observed nearest neighbor distance of 117 geographical indications in Shaanxi Province is 13.09 km, the expected nearest neighbor distance is 16.82 km, and the R value is 0.778635 ($R < 1$). Therefore, it can be judged that the spatial distribution of geographical indication agricultural products in Shaanxi Province generally shows significant agglomeration characteristics.

Table 2. Number and geographical concentration index of geographical indication agricultural products in 10 cities in Shaanxi Province

City	quantities	Proportion (%)
Xian	13	11.11
Tongchaun	5	4.27
Baoji	5	4.27
Xianyang	13	11.11
Weinan	11	9.40
Yanan	2	1.71
Hanzhong	24	20.51
Yulin	14	11.97
Ankang	18	15.38
Shangluo	12	10.26
Total	117	100
Index	35.79	

3.3. Point-based Analysis of Hot Spots of Geographical Indications Agricultural Products in Shaanxi Province

In order to further explore the main agglomeration areas of the spatial distribution of geographical indication agricultural products in Shaanxi Province, the kernel density analysis tool of ArcGIS10.8 software was used to generate the kernel density spatial distribution map of geographical indication agricultural products in Shaanxi Province.

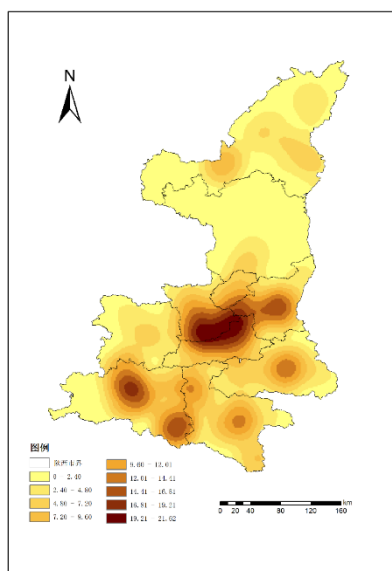


Figure 1. Nuclear density map of geographical indication agricultural products in Shaanxi Province

As shown in Figure 1, it can be found that there are three high-value areas of nuclear density in the overall spatial distribution of agricultural products with geographical indications in Shaanxi Province, that is, the three high-value areas of Xianyang City, Xi'an City and Hanzhong City show a 'pin-shaped' agglomeration distribution pattern, and the three sub-high-value areas are Weinan City, Shangluo City and Ankang City. On the whole, the spatial distribution of geographical indication agricultural products in Shaanxi Province is quite different between the north and the south. The distribution of geographical indication agricultural products in the northern region is small and sparse, and the distribution of geographical indication agricultural products in the central and southern regions is large and concentrated, especially Xianyang City, Xi'an City and Hanzhong City in the southwest region are the most distributed and concentrated.

4. INFLUENCING FACTORS OF SPATIAL DISTRIBUTION OF GEOGRAPHICAL INDICATION AGRICULTURAL PRODUCTS IN SHAANXI PROVINCE

4.1. Natural Factors

Natural factors are the basis of human survival and development, and also the basic conditions for human production activities. The spatial distribution of geographical indications is mainly affected by natural factors such as geology, geomorphology and hydrology. The terrain of Shaanxi Province is high in the north and south, low in the middle, and has various terrains such as plateaus, mountains, plains and basins. Beishan and Qinling divide Shaanxi into three natural regions: the northern Loess Plateau, the central Guanzhong Plain, and the southern Qinba Mountains. In addition, the climate difference between the north and the south of Shaanxi Province is large. Southern Shaanxi belongs to subtropical monsoon climate, Guanzhong and most of Northern Shaanxi belong to temperate monsoon climate, so the precipitation shows a trend of more in the south and less in the north.

Southern Shaanxi is a humid area, Guanzhong is a semi-humid area, and Northern Shaanxi is a semi-arid area. The geographical indication agricultural products in Shaanxi Province are mainly distributed in Xianyang City, Xi'an City and Weinan City in the Guanzhong Plain, as well as Hanzhong City, Ankang City and Shangluo City in the Qinba Mountains. The regional climate is humid, and the Weihe River, Hanjiang River and other water systems flow through, and the agricultural foundation is good, while the climate in the northern plateau area is dry, the agricultural planting foundation is poor, and the geographical indication agricultural products are less distributed. In addition, the central and southern plains and mountains are conducive to the growth and development of geographical indications agricultural products to a certain extent due to the good development of geographical location and traffic conditions. This shows that the natural environment of Shaanxi Province determines the overall distribution pattern of Shaanxi geographical indications agricultural products along the mountain and water.

4.2. Social Factors

Considering the two main social factors of regional economy and regional population, regions with developed regional economy and large regional population will have sufficient financial and human resources to promote the publicity and management of geographical indications. As the main planting area in Shaanxi Province, the excellent natural ecology and geographical environment determine the growth and agglomeration development of geographical indication agricultural products to a certain extent. It can be seen that although regional economic and demographic factors play a role in promoting the growth and development of geographical indications, the distribution of geographical indication agricultural products in Shaanxi Province depends more on the regional ecological environment and natural conditions.

4.3. Government-led and Policy Factors

As a collective intellectual property right in a specific region, geographical indications belong to public resources and are generally declared and protected by the government. Therefore, the cognition, development and policy support of local governments are very important to the development of geographical indications. In recent years, Shaanxi Province has taken active and effective measures to strengthen the cultivation and protection of geographical indication agricultural products, introduced the "Measures for the Protection of Geographical Indications Products in Shaanxi Province" on comprehensively promoting rural revitalization and accelerating the implementation of agricultural and rural modernization opinions, and promoted the integration and development of geographical indication agricultural products and local characteristic industries. It has played an important role in mining and cultivating a number of geographical indication brands with independent intellectual property rights, high market credibility and wide influence. The government's policy guidance plays an important role in the protection and development of geographical indications.

5. CONCLUSIONS AND SUGGESTIONS

5.1. Conclusion

Through the study of the spatial distribution characteristics and influencing factors of geographical indication agricultural products in Shaanxi Province, the following conclusions are drawn: (1) From the perspective of the overall distribution characteristics of geographical indications, as of January 2023, 117 geographical indications in Shaanxi Province were distributed in 10 prefecture-level cities, but the distribution was extremely uneven, showing a distribution pattern of 'dense in the south and sparse in the north, regional agglomeration'. (2) From the perspective of spatial agglomeration characteristics, the distribution of geographical indication agricultural products in Shaanxi generally shows significant agglomeration characteristics; (3) From the perspective of density distribution

characteristics, the overall spatial distribution of geographical indication agricultural products in Shaanxi shows a distribution pattern of 'three high and three times', and the three high-value areas of nuclear density show a agglomeration distribution pattern of 'pin-shaped'. (4) The difference between the north and the south is obvious, and the overall distribution pattern is 'cold in the north and hot in the south'. The number in the north is small and not concentrated, and the central and southern regions, especially the southwest, are distributed more and very dense. Geographical indications have strong regional spatial correlation and spatial neighbor effect in spatial distribution. Subject to the similarity of regional geographical environment, social economy and other factors, geographical indications tend to be adjacent in geographical distribution. (5) The spatial distribution pattern of geographical indication agricultural products in Shaanxi Province is affected by many factors. Natural factors are the basis, and social and economic factors strengthen the spatial distribution pattern of geographical indications. Government-led and policy factors play an important role in regulating and guiding the protection and development of geographical indications.

5.2. Suggestion

As an important part of China's agricultural economy, geographical indications have the characteristics of uniqueness, regionality and scarcity. Under the background of current urban-rural transformation and rural revitalization, exploring the research, protection and development and utilization of geographical indications in the new era has become an important part of poverty alleviation and beautiful rural construction. In view of this, the following three recommendations are made:

First, gradually optimize the spatial distribution pattern of geographical indications in Shaanxi. Geographical indications have more advantages than ordinary similar products in terms of price positioning and market demand, which can bring more benefits to the local agricultural economy. Governments at all levels should give full play to the government's functions of organization, guidance, supervision and management, and actively organize the declaration and protection of geographical indications, especially in northern Shaanxi, where geographical indications of agricultural products are less distributed. They should actively carry out a survey of characteristic resources within the region, excavate the cultural connotation of local products, clarify regional characteristics, adapt to local conditions, cultivate products with development potential, and organize the declaration of geographical indications in a planned way, so as to optimize the spatial distribution pattern of geographical indications in Shaanxi and realize the healthy development of geographical indications of agricultural products in Shaanxi.

Second, relying on local social resources, give full play to the leading role of the government. Geographical indication agricultural products belong to regional public resources, which are mainly declared and protected by the government. Government departments at all levels should support the establishment and development of various industry groups or agricultural product associations, and give full play to the role of social organizations in the application, cultivation and development of geographical indications. At the same time, encourage industry organizations and local enterprises to actively participate in the production, operation and promotion of geographical indications of agricultural products, improve the standardization and industrialization of the production and operation of geographical indications of agricultural products, and then improve the brand value of geographical indications of agricultural products, use public media to increase the publicity of geographical indications of agricultural products, improve the public awareness of geographical indications of agricultural products.

Third, actively promote the industrialization of geographical indications of agricultural products. Geographical indication agricultural products are an important part of the rural economy. At present, Shaanxi geographical indication agricultural products have little effect on economic growth. The application and utilization of geographical indication agricultural products have not brought about

the improvement of regional economy and the increase of farmers' income. Therefore, while paying attention to the declaration of geographical indications, governments at all levels should pay more attention to the follow-up development of the geographical indication industry and promote the industrialization of geographical indications. Relevant government departments should actively support industry associations, leading enterprises and other relevant subjects, establish a multi-level supervision mechanism, effectively supervise from the production end of products, improve farmers' understanding of geographical indications, and ensure the excellent quality of products; at the end of product consumption, with the help of media resources such as network and television, we actively promote, let more consumers know, and bring products to the market through various sales channels. Through the implementation of production, supply and marketing integration business model, the brand effect of geographical indications is used to improve the economic benefits of products, increase farmers' income, and promote the regional economic development of Shaanxi.

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