Optimizing Leisure Agriculture by Analyzing Spatial Patterns and Tourists' Perceptions: Evidence From Wuhan, China

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Leisure agriculture can meet the leisure needs of residents and promote farmers' income, which is an important way to achieve rural revitalization. However, the unreasonable spatial patterns and weak competitiveness of leisure agriculture seriously restrict its sustainable development. This paper proposes a framework for optimizing leisure agriculture development, including spatial patterns analysis of leisure agriculture based on big data, quality analysis of leisure agriculture based on tourists' perceptions, and strategies for optimizing leisure agriculture based on spatial patterns and tourists' perceptions. Taking Wuhan city as an example, the results show that: 1) the main types of leisure agriculture are leisure farms, fishing, and picking gardens, showing an agglomerative distribution pattern; 2) considering tourists' emotional perceptions, most comments are positive, and leisure farms should enhance the tourist experience; 3) tourists' dissatisfaction mainly involves the environment, price, and travel, while product and service factors are relatively satisfactory; and 4) moderate agglomeration is beneficial to the quality of leisure agriculture, while excessive agglomeration has adverse effects. This study explores the development law of regional leisure agriculture, improves the relevant theoretical research system and methods, and provides decision-making references for promoting the development of leisure agriculture.

Keywords: leisure agriculture, spatial patterns, tourists' perceptions, quality evaluation, optimization strategy

1 INTRODUCTION

In recent years, with the rapid development of industrialization and urbanization, urban residents' demands to live close to and access nature have been gradually increasing (Jing et al., 2018; Qiu et al., 2019). In the suburbs of some large cities, leisure agriculture has become a regular pastime for urban residents (Barbieri, 2020; Chase et al., 2018). Additionally, traditional agriculture is no longer the only economic force in most rural areas (Wu, 2018). The quality of rural areas attracts visitors and leads people to prefer a natural and harmonious lifestyle (Jacobsen and Tommervik, 2016). In places with rich natural resources and beautiful scenery, the development of tourism and the service industry is also very important.

The growing popularity of leisure agriculture has many positive effects. On one hand, it promotes the development of the agricultural and rural economy, including increasing the household incomes

of farmers, expanding employment capacity, and increasing tax revenue (Giaccio et al., 2018). On the other hand, leisure agriculture also provides an environment where urban residents can have a pleasant leisure experience and promotes people's physical and emotional health (Sgroi et al., 2018). More importantly, it promotes the development of agriculture from traditional to diversified models and creates new possibilities for the local economy (Su et al., 2019), which is an important path to realizing rural revitalization (Tao, 2019).

Driven by market demand, leisure agriculture in China is developing rapidly, showing strong vitality and growth prospects. However, such rapid development can create many problems related to the spatial patterns and quality of leisure agriculture in mainland China (Ren and Dong, 2016). In terms of spatial patterns, most businesses are small-scale operations and have poor planning practices. Industrial agglomeration of leisure agriculture can guide production factors to flow to rural areas, form agglomeration effects, and improve overall competitiveness, but excessive agglomeration can lead to vicious competition (Kim et al., 2021; Pejanović et al., 2017). Therefore, we need to scientifically measure the spatial patterns of leisure agriculture, explore the relationship between spatial patterns and quality and engage in detailed planning. Similarly, many leisure agriculture businesses are low quality and have single brands, weak core competitiveness, and other factors that prevent them from meeting the gradually diversifying and personalized tourism consumption needs, resulting in a decline in the number of tourists who visit the area (Guo and Lv, 2008). To date, the overall integration of leisure agriculture has not been accomplished, and there are no large-scale companies with high-quality multifunctional services. Therefore, it is important to optimize the development of leisure agriculture by combining the spatial patterns and quality improvement of leisure agriculture.

Scholars mostly use GIS spatial analysis to study patterns of leisure agriculture (Bajgier-Kowalska et al., 2017; Baležentis et al., 2012; Walford, 2001), and measurement indicators include the nearest-neighbor index, the geographic concentration index, the coefficient of variation, kernel density estimation, the spatial dispersion index, and the spatial distribution curve, among others (Chang et al., 2018; Liu et al., 2017; Xu et al., 2021). The measurement of leisure agriculture quality is based on the tourist satisfaction model and focuses on the evaluation of service quality (Liu and Yen, 2010; Reichel et al., 2000). The measurement index covers the product, environment, service, price, travel, and other aspects (Goossen and Langers, 2000; Zhao and Chang, 2014). A questionnaire is the most common method to obtain tourists' perceptions data (Dubois et al., 2017; Tew and Barbieri, 2012). The analyses in this field mainly adopt fuzzy comprehensive evaluation and factor analysis (Rozman et al., 2009). Development strategies of leisure agriculture have been offered from the perspectives of spatial distribution, tourists' motivation, and tourism development (Yang et al., 2016). The development of leisure agriculture should rely on the regional resource endowment, reasonably optimize the layout (Wu and Cai, 2006), enhance the tourism image (Ohe and Kurihara, 2013), improve tourist satisfaction (Choo and Petrick, 2014; Lee, 2012),

focus on rural characteristics and rural value (Shen et al., 2019) and increase the participation of local residents (Xue and Kerstetter, 2019).

The existing research has the following shortcomings. First, evaluations of the tourist experience of leisure agriculture mostly draw on the evaluation tourists' experiences in scenic spots rather than their experiences with the specific characteristics of leisure agriculture. A scientific and reasonable quality evaluation model for leisure agriculture has not been formed. Second, most studies rely on statistical data from government departments or surveys with small samples, resulting in unrepresentative suggestions (Wu and Cheng, 2017). In contrast, multisource, large-sample, and multidimensional big data with geographical locations obtained from social media platforms provide new research means and observation perspectives to understand urban socioeconomic perceptions (Liu et al., 2015; Zhang et al., 2019). Using big data ensures that researchers possess a sufficient amount of data, reduces the cost of data collection, and can help scholars analyze people's perceptions (Li et al., 2018). Tourist evaluation data come from active volunteers, and this format more effectively captures participants' emotions. Analyzing these data facilitates large-scale regional, multi-perspective qualitative and quantitative research and aids in decision-making in resource allocation, planning, and quality improvement of leisure agriculture.

This paper aims to propose a quality assessment model for leisure agriculture and further explores optimization strategies for the development of leisure agriculture. The main contribution of the paper is to explore the optimization strategies of leisure agriculture by combining spatial patterns and tourists' perceptions. Through this approach, we can obtain a comprehensive understanding of the role of spatial patterns in the development of leisure agriculture and explore the sustainable development model of leisure agriculture. Furthermore, this study sheds light on the analysis of big data. China's experiences with leisure agriculture could provide valuable references for other developing countries. This study is structured as follows: (1) a spatial patterns analysis of leisure agriculture based on big data; (2) evaluations of leisure agriculture based on tourists' perceptions; (3) quality evaluation of leisure agriculture based on tourists' perceptions; and (4) optimization strategies for the development of leisure agriculture that combine spatial patterns and tourists' perceptions.

2 MATERIALS AND METHODS

2.1 Research Framework

The rapid development of the tourism industry has created an obvious industrial agglomeration phenomenon and trend in some regions (Chhetri et al., 2017). The concept of tourism agglomeration originated from economic geography and was introduced by Alfred Marshall. Tourism industry agglomeration is the concentration of tourism enterprises based on rich tourism resources in a certain geographical space (Estevão and Ferreira, 2012). Spatial agglomeration has two sides in tourism development (Lee et al., 2020; Novelli et al.,

FIGURE 1 | Theoretical framework.
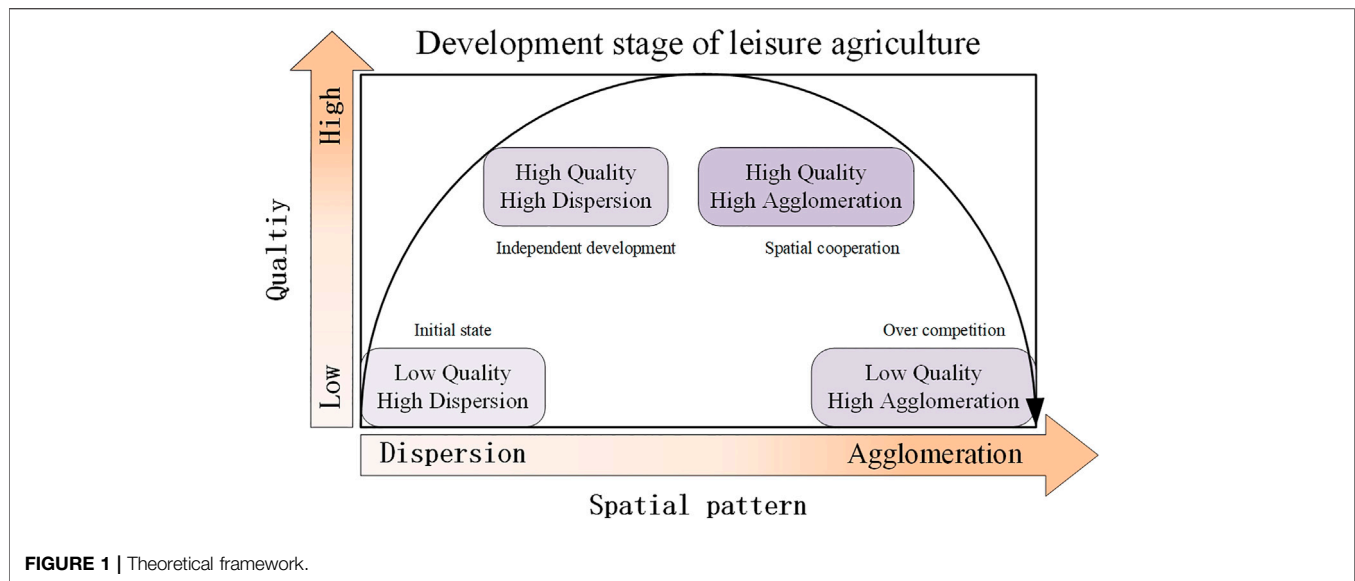
2006). On one hand, spatial agglomeration can enhance the competitiveness of enterprises (Chen et al., 2021), produce multiplier and external effects, promote the interaction and synergy between enterprises (Hawkins, 2004), and promote the sustainable development of tourism destinations (Benur and Bramwell, 2015). On the other hand, spatial agglomeration easily produces a substitution effect and vicious competition (Weidenfeld et al., 2011). The evaluation index of the quality of leisure agriculture usually comes from tourists' perceptions. Tourists' perceptions are tourists' understanding of tourism products and services. Leisure agriculture is an industry in which tourists are the main consumers, thus, their experiences are very important (Kastenholz et al., 2018; Volo, 2021). Regions with high tourists' evaluation can attract more visitors (Da Liang et al., 2020; Nazariadli et al., 2018).

At present, there is no consensus about the role of spatial agglomeration in the development of leisure agriculture. In other words, it is not clear whether the agglomeration pattern or the dispersion pattern is conducive to industrial development. **Figure 1** presents a theoretical framework for understanding spatial patterns and the quality of leisure agriculture. The framework helps identify strategies for leisure agriculture development. It is based on the two features of leisure agriculture products: the spatial patterns of leisure agriculture (from dispersion to agglomeration) and the quality of leisure agriculture (from low quality to high quality). As the spatial patterns of leisure agriculture change from dispersion to agglomeration, its quality also changes. There are four typical states, among which there are different transition states: low quality and high dispersion, high quality and high dispersion, high quality and high agglomeration, and low quality and high agglomeration. The category of low quality and high dispersion is usually the primary stage of leisure agriculture development, characterized by low quality and small scale. The category of high quality and high dispersion indicates that regional leisure agriculture presents a single point development mode, and the

spatial distribution is dispersed. In this state, the leisure agriculture spots have no influence on each other, and the existence of high-quality leisure agriculture spots has not driven the development of other leisure agriculture in the region. The high-quality and high-agglomeration group is the "ideal type", which gives full play to the advantages of industrial agglomeration and spatial synergy, and forms a high-quality leisure agriculture agglomeration area with a scale effect within the region. Low quality and high agglomeration indicate that the agglomeration distribution of regional leisure agriculture does not promote high-quality development of the practice. This type of leisure agriculture may produce vicious competition and is considered to be large scale and of low quality.

2.2 Study Area

Wuhan is the central city in central China. In 2019, the city governed 13 districts with a permanent resident population of 11.212 million and an urbanization rate of 80.49%. Wuhan has the advantage of possessing agricultural resources, with 2,938.6 km^2 of cultivated land; it is known as a "land of fish and rice". Bodies of water occupy approximately one-quarter of the city's area, ranking Wuhan first in the country. Rich agricultural and water resources provide good opportunities for the development of leisure agriculture, including picking, fishing, recreation, and other practices. Furthermore, Wuhan is a national historical and cultural city. In 2019, there were 44 A-level scenic spots in Wuhan, and the tourism industry developed rapidly. The total number of tourists who visited the area during the year reached 318.98 million, and the total tourism income was 357.08 billion yuan. The rapid rise of the tourism industry has driven the development of the leisure agriculture market.

2.3 Data

The data for this study include the leisure agriculture database of user-generated content (UGC) and the administrative division

FIGURE 2 | Research process.
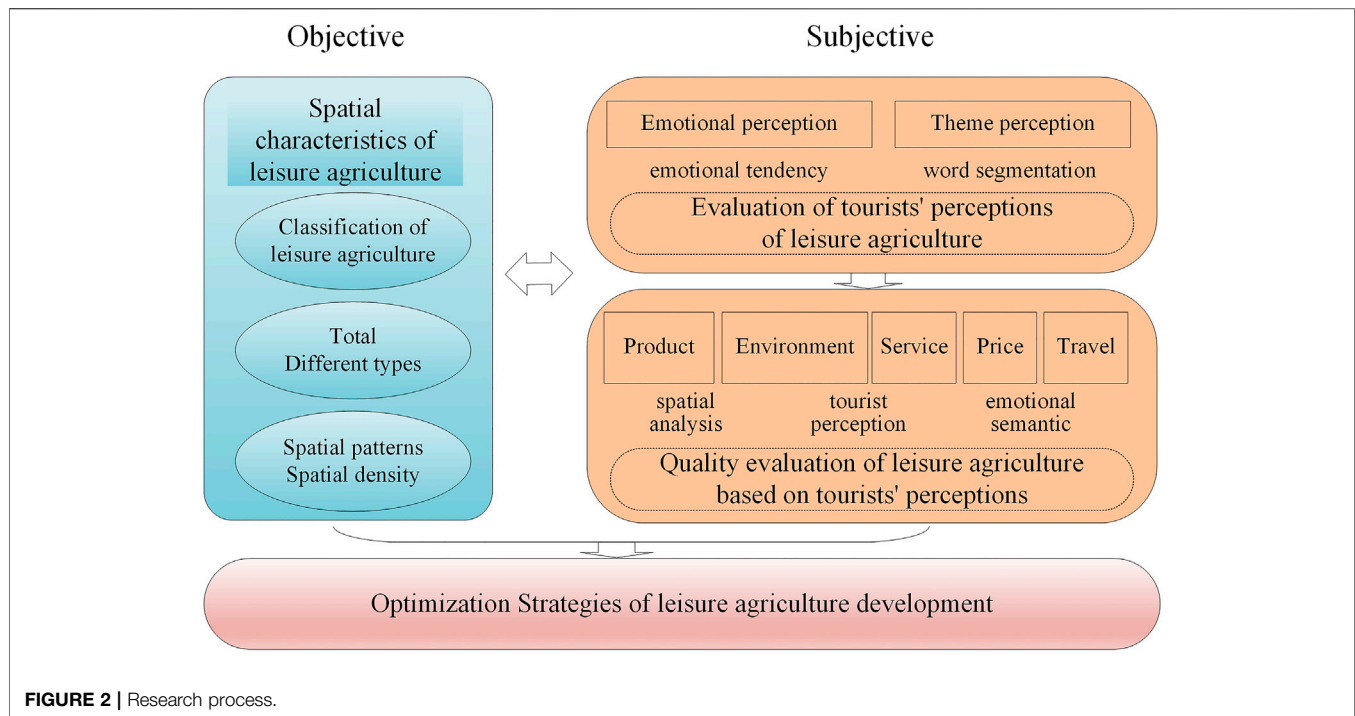
data of Wuhan in 2018. The leisure agriculture data were obtained from Dianping.com using a web crawler tool. These data include the latitude and longitude of leisure agriculture sites, comment information (comment text, comment time), basic information about the reviewers (gender, community level), and other factors. Dianping.com is a leading third-party consumer comment platform in China that began operating in April 2003 (Wu et al., 2015). Members can freely express their opinions about businesses and consumption experiences through the website, providing information for potential consumers. Public comment data identify the spatial location and attribute information of leisure agriculture businesses, with large coverage, high accuracy, and representativeness. ArcGIS was used for the spatial processing of information and to build a leisure agriculture database based on big data.

2.4 Methods

This paper constructs an optimization framework for the development of leisure agriculture using big data (**Figure 2**). First, we analyzed the spatial patterns characteristics of different types of leisure agriculture, which is an objective analysis. The types of leisure agriculture are divided according to differences in their function and scale (Busby and Rendle, 2000). The spatial characteristics need to identify the spatial patterns and density. GIS spatial analysis was used to analyze the agglomeration or dispersion characteristics of leisure agriculture. Second, this paper evaluates leisure agriculture tourists' perceptions from two perspectives: emotional perception and theme perception. The emotional tendency analysis module of the Baidu Ai platform was used to analyze the positive and negative emotions of tourists, and word segmentation analysis helped us explore the core issues of tourists' concerns (Wu, 2019).

Then, we constructed a quality evaluation method for leisure agriculture based on tourists' perceptions, focusing on the product, environment, service, price, travel, and other factors. Finally, we explore the optimization strategies for leisure agriculture by combining spatial patterns and tourists' perceptions.

2.4.1 Analysis of the Spatial Characteristics of Leisure Agriculture

The spatial characteristics of leisure agriculture were measured in terms of the spatial pattern and density. Each measure is described here.

Average nearest neighbor

The average nearest neighbor index was used to analyze the spatial distribution of leisure agriculture after measuring the distance between each leisure agriculture as follows:

$$ANN = \frac{\overline{D_0}}{\overline{D_e}} = \frac{\sum_{i=1}^{n} d_i / n}{\sqrt{n/A}/2} \tag{1}$$

where $\overline{D_0}$ is the observed mean distance between each leisure agricultural point and its nearest neighbor, $\overline{D_e}$ is the expected mean distance for the features given in a random pattern; n corresponds to the total number of leisure agricultural points, and A is the area of the study area. If ANN is less than 1, the distribution of leisure agriculture points is considered clustered; if the index is greater than 1, the leisure agriculture points are considered dispersed.

Kernel density

A kernel density was used to measure the spatial density of leisure agriculture. The kernel density estimation calculation formula is:

TABLE 1 | Evaluation index of leisure agriculture quality.

Target layer	System layer (w_k)	Index layer (w_j)
Evaluation index of leisure agriculture quality	Product (0.3)	Quality (0.6667)
		Facilities (0.3333)
	Environment (0.2)	Scenery (0.2274)
		Health (0.4231)
		Space (0.1222)
		Environment (0.2274)
	Service (0.2)	Attitude (0.3333)
		Feeling (0.6667)
	Price (0.2)	Price (1.0000)
	Travel (0.1)	Traffic (0.5000)
		Position (0.5000)

$$f(x) = \frac{1}{nh} \sum_{i=1}^{n} k\left(\frac{x - x_i}{h}\right) \qquad (2)$$

where $f(x)$ is the density estimation at the location (x), n is the number of leisure agriculture points, h is the bandwidth, k is the kernel function, and $(x - x_i)$ is the distance between location (x) and the location of the ith observation.

2.4.2 Evaluation of Tourists' Perceptions of Leisure Agriculture

This paper uses emotional tendency analysis to analyze the positive and negative emotions of tourists. We applied the emotional tendency analysis module of the Baidu Ai platform. The method automatically judges the emotional polarity category of the tourists' comments, and the corresponding confidence level is given. Emotional polarity is divided into positive, negative, and neutral. Emotional tendency analysis estimates the emotional tendency of text that contains subjective information, which helps users make decisions. Based on deep learning training, the system automatically learns deep semantic and syntactic features and has high generalization ability, which is highly effective, even for relatively long sentences (Yan et al., 2018).

Using word segmentation analysis, this paper explores the core issues of tourists' concerns and the advantages and disadvantages of current leisure agricultural products. It then analyzes the concerns of leisure agriculture tourists with different emotional tendencies. We use the Python Jieba cut to segment the tourists' comments. After excluding common pause words, we calculate statistics for the common words in the comment text and uncover the most important concerns of tourists about leisure agriculture. Then, based on emotional analysis, this paper uses word segmentation analysis to mine the advantages and dissatisfaction factors expressed by tourists.

2.4.3 Quality Evaluation of Leisure Agriculture Based on Tourists' Perceptions

We searched the comments offered by leisure agriculture tourists from the public comment websites. According to existing research and data availability (Rozman et al., 2009), the quality characteristics of leisure agriculture are divided into

five dimensions: product (quality and facilities), environment (scenery, health, and space), service (attitude and feelings), price, and travel (traffic and location), as shown in **Table 1**. The emotional semantic dimensions of leisure agriculture were classified and scored to evaluate tourists' experiences of these different dimensions of leisure agriculture; on this basis, the weights of the dimensions were determined to comprehensively evaluate the quality of leisure agriculture. The specific steps were as follows:

Text preprocessing: This step involved sentence segmentation, tokenization, and removing stop words.

Extracting feature–opinion pairs: The assumption was that each sentence evaluated a dimension of the feature object, with direct links between opinion words (sentiment) and noun words (feature) in a clause.

Weight determination: The analytic hierarchy process was used to determine the weight.

Emotional score calculation: The emotional score was calculated using the polarity and degree of the emotion (Yang and Ai, 2018) as follows:

$$f_i = p_i \times d_i \qquad (3)$$

where f_i is the emotional score of the segmented sentence i, p_i is the emotional polarity of the segmented sentence i, and d_i is the emotional degree of the segmented sentence i. Emotional polarity is classified as positive, neutral, or negative, expressed by 1, 0, and −1, respectively. The emotional degree is divided into three levels—strong, medium, and weak, expressed by 3, 2, and 1, respectively.

Score calculation by dimension: Considering that different sentences may evaluate the same features of leisure agriculture, feature sentences were combined according to the previously defined dimension feature dictionary. Through the calculation of each dimension score, all dimensions of leisure agriculture businesses were evaluated:

$$S_k = \sum_{j=1}^{b} \frac{1}{c_j} \sum_{i=1}^{c_j} f_i \cdot w_j \qquad (4)$$

where S_k is the score of the kth dimension of the system layer, j is the dimension of the index layer, b is the number of index layers, c is the number of sentences after the jth dimension

TABLE 2 | Types and characteristics of leisure agriculture.

| Type	Characteristics
Picking garden	Relying on orchards, vegetable gardens, melon gardens, flower beds, and so on, tourists can enjoy the scenery and work in the garden to experience rural life
Fishing	Relying on reservoirs, fish ponds, and other water bodies for fishing, boating, and other forms of entertainment on the water
Leisure farm	Can provide large-scale agricultural and recreational activities, fishing, and sightseeing. Provides comprehensive services, such as food, accommodation, travel, entertainment, shopping, and experiences
Agritainment	Can provide small-scale agricultural and recreational activities. Mainly takes farmers as the unit; includes farm food and agricultural products and farmers' life experiences and leisure activities
Planting and breeding	Nursery cultivation and animal husbandry
Agriculture technology	Relies on modern scientific and agricultural technology, high-tech agricultural demonstration parks, and agricultural companies
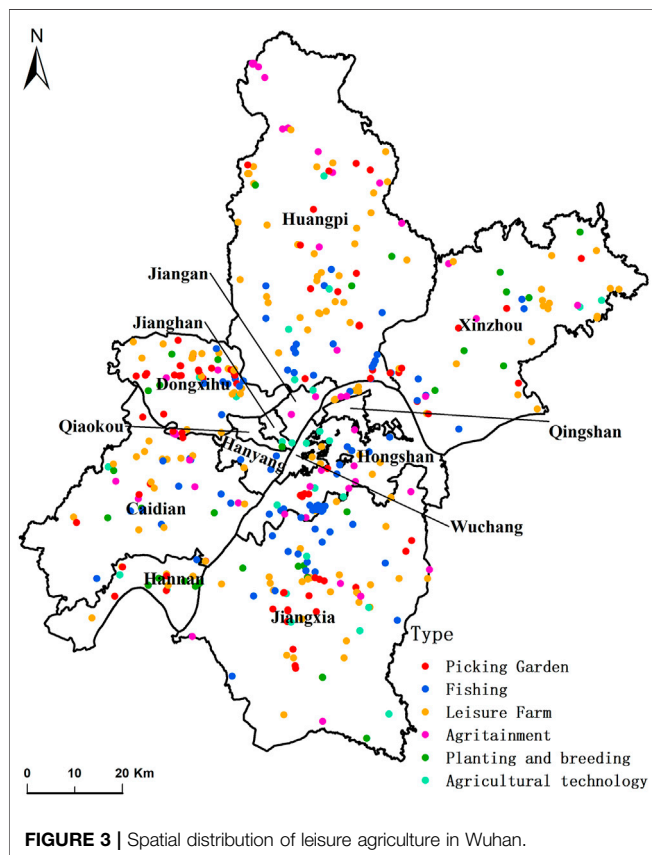
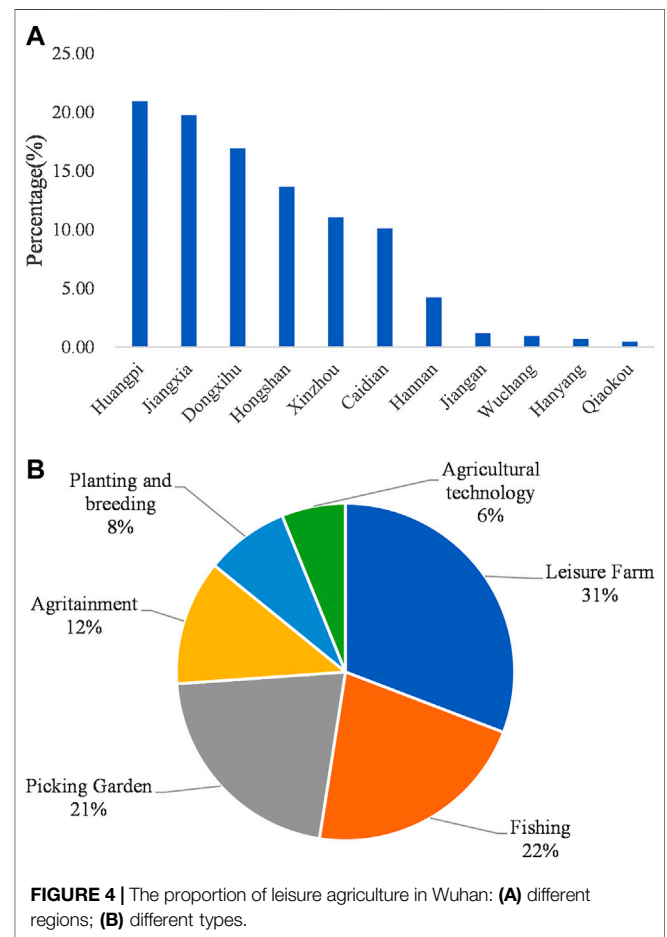**FIGURE 3 |** Spatial distribution of leisure agriculture in Wuhan.

FIGURE 4 | The proportion of leisure agriculture in Wuhan: **(A)** different regions; **(B)** different types.

segmentation of the index layer, and w_j is the weight of the index layer.

Total quality score calculation:

$$Score = \sum_{k=1}^{a} S_k \cdot w_k \qquad (5)$$

where $Score$ is the total score for quality, k is the dimension of the system layer, a is the number of system layers, and w_k is the weight of the system layer.

Based on the multidimensional experience evaluations of tourists, this paper offers suggestions for the development of leisure agriculture in terms of products, environment, service, price, and travel, among others.

3 RESULTS

3.1 Analysis of Spatial Characteristics of Leisure Agriculture Based on Big Data

Based on the leisure agriculture data, using the method of text recognition, and combining the characteristics of the scale and function (Guo and Lv, 2008; Ren and Dong, 2016) of leisure agriculture businesses, the leisure agriculture activities were divided into six types (**Table 2**): picking garden, fishing, leisure farm, agritainment, planting and breeding, and agricultural technology.

TABLE 3 | Nearest-neighbor index of different types of leisure agriculture in Wuhan.

Types	Nearest neighbor index	Z value	P value	Average observation distance(m)	Expected average distance(m)	Layout pattern
All	0.6586	−13.4655	0.0000	1661.5626	2522.9710	cluster
Picking garden	0.6076	−7.1620	0.0000	2816.3698	4635.6083	cluster
Fishing	0.7973	−3.7199	0.0002	3207.5386	4023.1151	cluster
Leisure farm	0.8227	−3.8828	0.0001	3549.2054	4314.2367	cluster
Agritainment	0.8876	−1.5357	0.1246	6109.2066	6882.9010	random
Planting and breeding	0.9521	−0.5347	0.5928	7402.6166	7775.3470	random
Agricultural technology	0.9554	−0.4347	0.6638	8105.4862	8483.5288	random
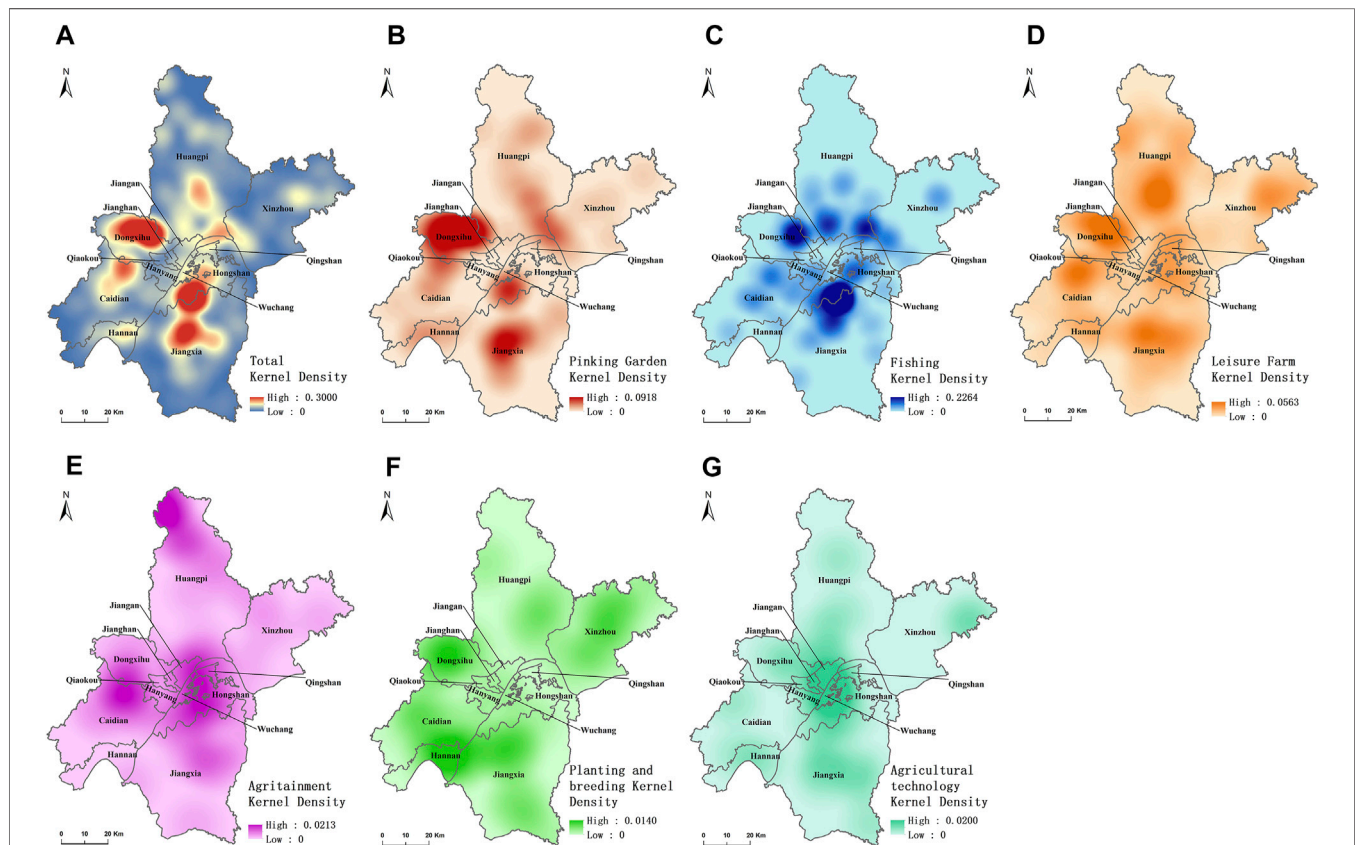
FIGURE 5 | The kernel density of leisure agriculture in Wuhan: (A) All types; (B) Picking Garden; (C) Fishing; (D) Leisure Farm; (E) Agritainment; (F) Planting and breeding; (G) Agricultural Technology.

The distribution of leisure agriculture (**Figure 3**) is found more in the outer suburbs than in the central city. Huangpi District accounts for the highest proportion (20.94%), followed by Jiangxia District (19.76%), Dongxihu District (16.94%), and Hongshan District, Caidian District, and Xinzhou District (each accounting for approximately 10%). Other districts have lower proportions. As shown in **Figure 4**, among the leisure agriculture businesses in Wuhan, the proportion of leisure farms is the highest (30.52%). Furthermore, the types of leisure agriculture are ranked in the following order: leisure farm, fishing, picking garden, agritainment, planting and breeding,

and agricultural technology. This finding indicates that leisure farms and fishing are the most popular types of leisure agriculture among tourists in Wuhan.

The results of the nearest-neighbor index analysis of the types of leisure agriculture in Wuhan are shown in **Table 3**. The leisure agriculture in Wuhan is generally in the form of agglomeration. Specifically, picking gardens, fishing, and leisure farms have clustered distributions. Agritainment, planting and breeding, and agricultural technology show random distribution patterns.

There are obvious regional differences in the spatial distribution density of leisure agriculture in Wuhan (**Figure 5**). The areas with
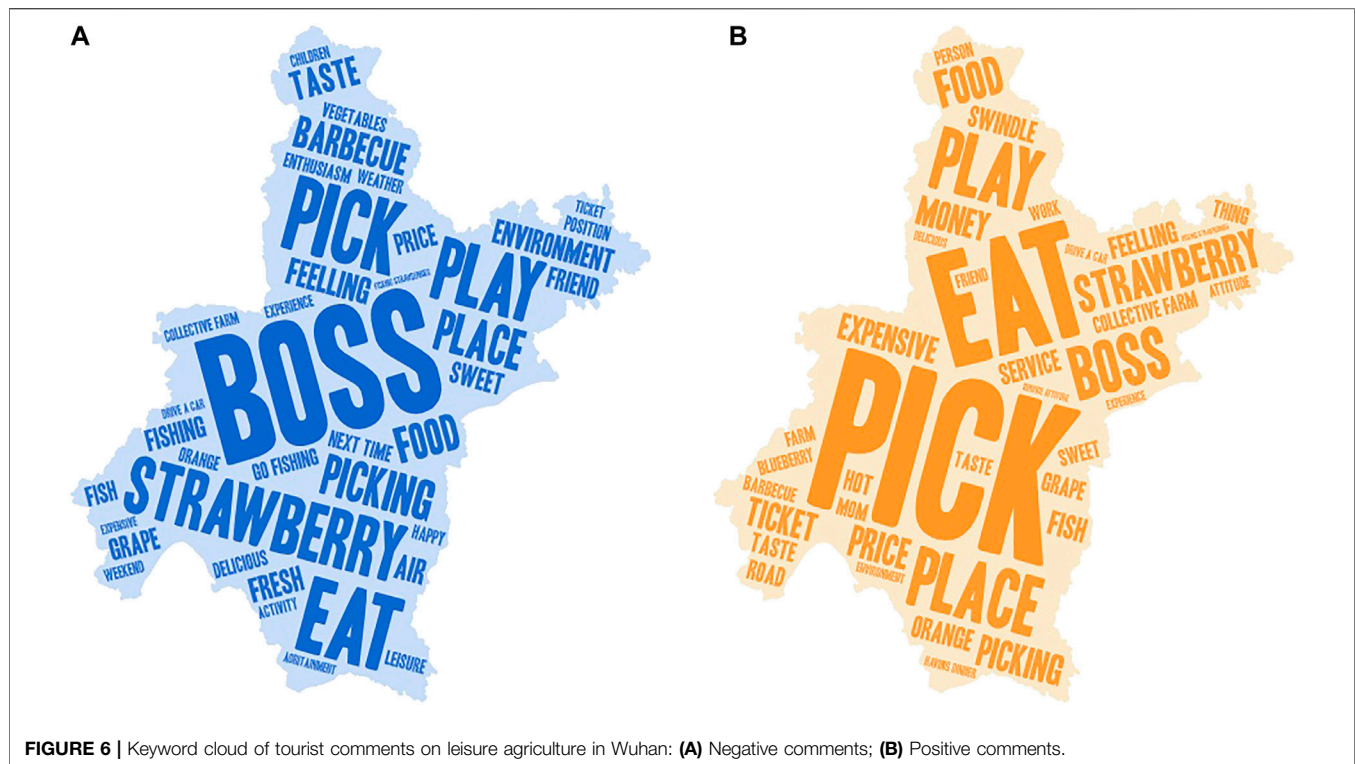
FIGURE 6 | Keyword cloud of tourist comments on leisure agriculture in Wuhan: **(A)** Negative comments; **(B)** Positive comments.

higher leisure agriculture density are mainly concentrated in central and southern Wuhan. The picking garden distribution is similar to that of leisure agriculture. Fishing is mainly distributed around the main urban area of Wuhan city, among which Liangzi Lake is the center of fishing activities. Leisure farms are distributed in almost all districts. Agritainment is mainly distributed in central and northern Wuhan, while the type of planting and breeding is concentrated in the outer suburbs. The distribution of agricultural technology is highly dependent on cities.

3.2 Evaluation of Tourists' Perceptions of Leisure Agriculture

The results (**Figure 6**) show that the overall comments on leisure agriculture in Wuhan are positive, with a positive comment rate of 79.60%, a neutral comment rate of 1.51%, and a negative comment rate of 18.89%. However, since the numbers of comments on agricultural technology and planting and breeding are small, the analyses of these categories are unreliable, so they are not considered. Evaluations of all types of leisure agriculture in Wuhan are positive. Specifically, fishing received the most positive feedback, and picking gardens received the fewest positive reactions. Likewise, in terms of negative evaluations, picking gardens had the highest number, while fishing had the lowest number. In the future, we should focus on the development of picking gardens as a form of leisure agriculture.
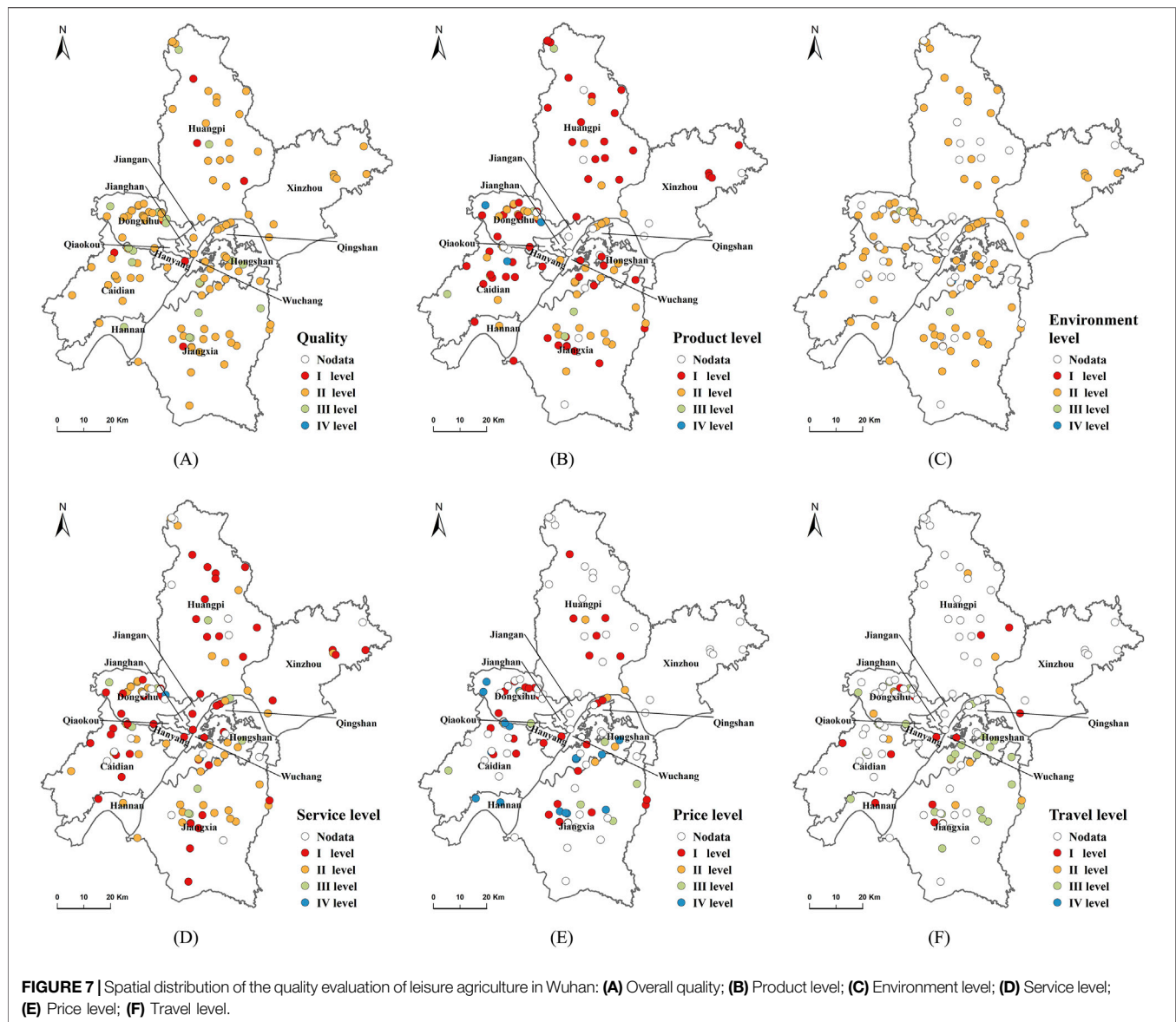
Through the word segmentation analysis, it can be seen that leisure agriculture tourists in Wuhan mainly focus on products, environment, service, price, and travel. In terms of "products", leisure agriculture activities mainly involve picking gardens and fishing, with "barbecue" and "vegetables" as the main

characteristics. "Strawberry", "grape" and "orange" are the most frequently picked foods, and "taste", "sweet" and "fresh" are the important evaluation criteria. In terms of the "environment", tourists pay attention to the quality of "weather" and "air". "Farm" and "farmhouse" are the main locations for leisure agriculture in Wuhan. In terms of "service", the main factors that tourists pay attention to are "boss", "feeling" and "enthusiasm". Furthermore, "price", "ticket" and "expensive" are high-frequency words. Finally, in terms of "travel", location is the main concern for tourists.

Wuhan, as the capital of Hubei Province, has the leading economy in the province, and it features many scenic spots. Its leisure agriculture has garnered praise from users based on services, products, and the environment. However, it still has some problems. Tourists have mixed evaluations of products, prices, services, the environment, or travel experiences. Among them, "expensive", "ticket", "money", "buy", "price" and other words frequently appear in negative comments, which shows that the cost of visiting has affected the development of regional leisure agriculture and needs to be improved. In addition, the quality of services is also an important factor.

3.3 Quality Evaluation of Leisure Agriculture Based on Tourists' Perceptions

The spatial distribution of the leisure agriculture quality evaluation scores in Wuhan is shown in **Figure 7**. The score range is −3.00 to +3.00, and the scores are divided into four levels: level I [1.50 to 3.00], level II [0.00 to 1.50), level III [−1.50 to 0.00), and level IV (−3.00 to −1.50]. Among the 425 businesses, 126 have

FIGURE 7 | Spatial distribution of the quality evaluation of leisure agriculture in Wuhan: **(A)** Overall quality; **(B)** Product level; **(C)** Environment level; **(D)** Service level; **(E)** Price level; **(F)** Travel level.

received comments. The total score is concentrated between −1.50 and +1.74, and most of the businesses are located in level II or level I. Among them, 18 businesses have ratings below 0, which is poor. In addition, high-quality leisure agriculture businesses are distributed in almost all districts, while low-quality leisure agriculture businesses are mainly located in central Wuhan. As shown in **Figure 7**, tourists' dissatisfaction is mainly due to environment, price, and travel factors, while product and service are relatively good.

The numbers of leisure agriculture businesses in product levels I–IV is 60, 38, 6, and 3, respectively. Product scores are concentrated in levels I and II. Businesses with higher scores are distributed in almost all districts, and the businesses with lower scores are mainly distributed in Dongxihu and Jiangxia District, which are located in central and southern Wuhan, respectively. The environmental scores are concentrated in level II, and the scores of most businesses are low. The numbers of leisure agriculture businesses with service scores in

levels I–IV are 51, 45, 9, and 2, respectively, showing a concentration of scores in levels I and II. The spatial distribution characteristics of service scores are similar to those of product scores. The numbers of leisure agriculture businesses with price scores in levels I–IV are 32, 8, 7, and 17, respectively. The price scores are concentrated in levels I and IV, with serious differentiation. Businesses with lower scores are mainly distributed in central and southern Wuhan. Finally, the travel scores are distributed in levels II-IV. Businesses with lower scores are mainly distributed in Hongshan District and Jiangxia District, which are located in central and southern Wuhan, respectively.

3.4 Optimization Strategies for the Development of Leisure Agriculture

Considering the spatial patterns and quality of leisure agriculture, this paper proposes an optimization strategy for the sustainable

FIGURE 8 | Quality score and spatial kernel density distribution of leisure agriculture.
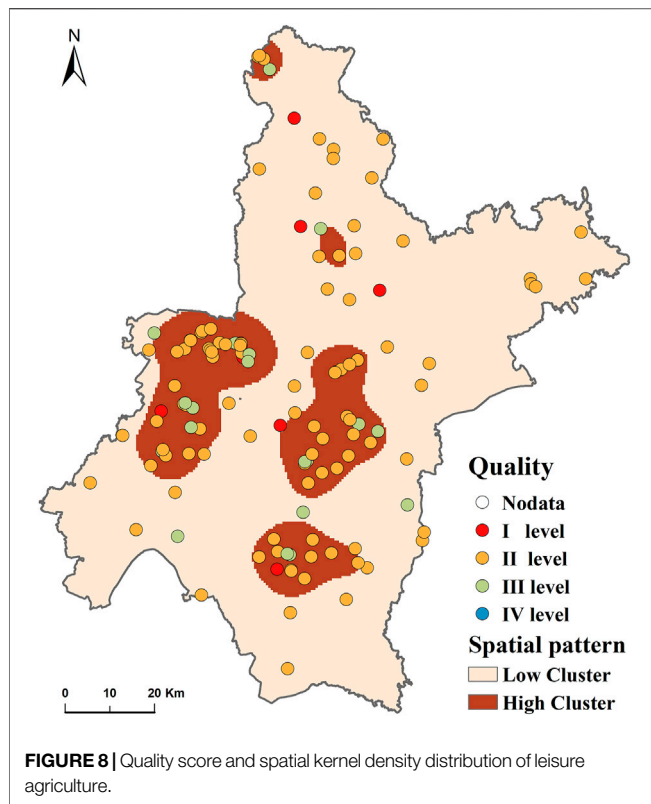
development of leisure agriculture. Taking Wuhan as an example, the kernel density of 126 leisure agriculture businesses with review data were overlaid with the quality of these businesses for analysis, and the results are shown in **Figure 8**. The findings indicate that overall leisure agriculture in Wuhan is in the form of agglomeration. The average leisure agriculture quality score is 0.6591, and most of the businesses are located in levels I and II. On the whole, leisure agriculture in Wuhan is characterized by high agglomeration and high quality. Moreover, using the natural breaks method, the core density of leisure agriculture can be divided into two types. The type with high core density is high agglomeration, and the other type is low agglomeration. The results show that the average quality score for the high-agglomeration group is 0.6285, which is lower than the average value for businesses in the whole city. This finding indicates that excessive agglomeration has a negative impact on the quality of leisure agriculture. One possible reason is the competition among the homogeneous leisure agriculture businesses. The average quality score of low-concentration businesses is 0.7072, which is higher than the average quality of businesses in the whole city. This finding suggests that the low-agglomeration pattern promotes the development of local leisure agriculture. Scientific planning is beneficial to the development of the leisure agriculture industry. It is necessary to improve the quality of leisure agriculture in highly clustered areas, avoid excessive competition among businesses in the same industry, promote the coordinated development of industries, and promote the industrial agglomeration effect.

From the perspective of development type, leisure farms are the most popular in Wuhan, followed by fishing, picking gardens, and agritainment. However, the activity that received the best tourist evaluations was fishing, followed by agritainment, leisure farms, and picking gardens. As the most widely distributed type of leisure agriculture in Wuhan, leisure farms should further improve the quality of businesses and enhance the experiences of tourists.

From the perspective of quality improvement suggestions, tourists' dissatisfaction mainly involves environment, price, and travel factors. Based on the analysis of the text of tourists' comments, the main environmental problems are poor scenery, small sites, and excessive dust, among others. We should pay attention to improving the environment of leisure agriculture businesses, selecting scenic areas when adding new businesses, and expanding business sites. The main price problems are high ticket prices and false advertising. Improvements include providing free tickets, allowing group purchases on websites, and offering discounts, among others. Travel problems mainly include inconvenient transportation, remote locations, and difficulty in finding the location. Attention should be given to increasing shop signage and offering timely telephone communication. The results suggest that the government should build roads to tourist destinations and establish public transportation or finance construction through other means. In addition, when planning new businesses, it is important to pay attention to factors such as traffic convenience and improve the comprehensive transportation system.

4 DISCUSSION

4.1 Research Findings Compared to Other Studies

Leisure agriculture has become one way to promote agricultural diversification and enhance urban-rural integration. Therefore, leisure agriculture is promoted by the Chinese government (Cui et al., 2021). This study explores the optimization strategies of leisure agriculture that combine spatial patterns and tourists' perceptions. Leisure agriculture is mostly distributed in peri-urban areas (Chang et al., 2018), which are exposed to urban pressures and land-use changes (Gao and Cheng, 2020; Zasada, 2011). Scientific spatial planning of leisure agriculture is conducive to considering the relationship between urban and rural areas. Leisure agriculture planning is mainly reflected in spatial patterns. The findings of this study regarding the agglomeration spatial patterns of leisure agriculture are consistent with multiple studies (Cui et al., 2021; Fanelli and Romagnoli, 2021; Van Sandt et al., 2018; Xiang et al., 2019), in which the authors suggest promoting the agglomeration of leisure agriculture. Our analysis has confirmed the generalizability of this view across Chinese cities. In addition, the matching relationship between the spatial patterns and the quality of leisure agriculture was analyzed. The results show that moderate agglomeration is beneficial to the quality of leisure agriculture, while excessive agglomeration has adverse effects. Leisure agriculture originated in developed countries, and gradually expanded from Europe to Japan, South Korea, Singapore, and other countries and regions in Asia. We suggest that this method be applied to the study of other cities to explore the relationship between the spatial patterns and quality of

leisure agriculture and to optimize the development of regional leisure agriculture. Through extensive empirical analysis, it will be possible to determine the best spatial pattern of leisure agriculture according to local conditions.

The improvement of leisure agriculture depends on the understanding of the roles of consumers, which takes consumers' preferences into consideration (Zasada, 2011). This study analyzes tourists' perceptions using big data, which helps to explore the core issues of tourists' concerns. A previous study found that leisure agriculture users pay attention to the requirements of diet, accommodation, and travel (Wu, 2019). We find that in addition to products and travel, the environment, service, and price are also important factors for leisure agriculture tourists in Wuhan. In addition, we evaluate the quality of leisure agriculture based on tourists' perceptions; this approach clearly identifies the characteristics of leisure agriculture quality and its spatial patterns. The research shows that tourists' dissatisfaction about leisure agriculture in Wuhan mainly results from the environment, price, and travel. This finding helps clarify the development focus of leisure agriculture in different regions and how scientific planning and management can be carried out. Moreover, these beneficial findings and discussions offer feasible suggestions for leisure agriculture development. In future development, on one hand, operators should ensure the richness of products, improve product quality, regularly maintain infrastructure, improve health and environmental conditions and service levels, and set reasonable consumer prices (Tsaur et al., 2016). On the other hand, the government and market should conduct reasonable layout planning for leisure agriculture while also scientifically managing customer complaints and improving comprehensive transportation (Liu et al., 2020).

4.2 Practical Implications

The study helps to provide recommendations for sustainable leisure agriculture: (1) The spatial disparity of leisure agriculture needs to be emphasized, and development guidance should consider local situations. Spatial analysis is recommended for integration into leisure agriculture policy-making. (2) Spatial planning needs to combine the spatial distributions and quality of leisure agriculture to promote agglomeration and avoid excessive competition. (3) The quality improvement of leisure agriculture should be guided by market demand, especially consumer demand. It is important to conduct quality evaluations of leisure agriculture, build high-quality brands and avoid homogeneous competitiveness. (4) Effective measures should be taken to strengthen the supporting facilities of public services and provide professional training for leisure agriculture practitioners.

4.3 Limitations and Prospects

First, due to limitations of the data collection, this study does not analyze the evolution of leisure agriculture from the perspective of spatiotemporal dynamic patterns. In the future, we will explore the spatiotemporal evolution of leisure agriculture to understand development trends and to offer development suggestions. Second, because of the low accuracy of the existing classification methods, this paper uses manual interpretation to judge the characteristics of leisure agriculture reviews. In later work, we plan to use natural language processing and machine learning to characterize tourists' experience evaluations and to improve the efficiency of these characterizations and the scientific rigor and accuracy of the method in later batch processing and comparative analyses between different cities.

5 CONCLUSIONS

This paper has constructed a framework for optimizing leisure agriculture using big data, taking Wuhan city as the case study for the analysis. The results show that the main types of leisure agriculture in Wuhan are leisure farms, fishing, and picking gardens, and the spatial pattern shows an agglomeration distribution. In planning the spatial distribution of leisure agriculture, attention should be given to appropriate agglomeration. As the most widely distributed type in Wuhan, leisure farms receive low tourist evaluation, so it is necessary to improve the quality of businesses and enhance tourists' experiences.

High-quality leisure agriculture businesses are distributed in almost all districts in Wuhan, while low-quality sources are mainly located in the central part of the city. Tourists' dissatisfaction with leisure agriculture mainly includes the environment, price, and travel factors, while products and services are relatively satisfactory. The sustainable development of leisure agriculture needs to take quality-building as the core, deeply tap into the regional industrial characteristics, and cultivate the competitiveness of leisure agriculture development. The purpose of this study was not only to guide the development of leisure agriculture in Wuhan, but also to explore tourist experiences and identify a suitable way forward for the development of leisure agriculture on a wider scale.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

CW: Conceptualization, Methodology, Writing–original draft. SW: Methodology, Writing–review and editing. WY: Methodology, Software, Data curation. HB: Conceptualization, Writing–review and editing. JZ: Investigation, Data curation. XW: Writing–review and editing.

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