Eng Int Syst (2023) 5: 347–355


**Engineering**
*Intelligent Systems*

# Analysis of Spatial Distribution Characteristics and the Factors Influencing the New-Type Agricultural Business Entities of Anhua Dark Tea Cultivation

**Chun Yi and Bin Liu***

*School of Architecture and Urban Planning, Hunan City University, Yiyang, Hunan 413000, China*

In this paper, the subjects of the study are 789 new dark-tea businesse entities in Anhua county. The spatial distribution pattern, distribution mode, regional differential characteristics, and spatial autocorrelation of new-type agricultural businesses were quantitatively analyzed using the mean nearest neighbor index, kernel density analysis, inequality index, spatial autocorrelation analysis, and hotspot analysis with the help of Arc GIS software. On this basis, the structural characteristics of new-type agricultural businesses were systematically sorted out, and the spatial differentiation pattern and features were revealed. Finally, geographic relation rate, vector data buffer analysis, and correlation analysis were applied to determine the main influencing factors. The spatial differentiation revealed two high-density areas, one secondary high-density area, and several high-concentration areas, showing an apparent core-periphery structure.

Keywords: Anhua dark tea, new-type agricultural business entity, spatial differentiation, influencing factors

## 1. INTRODUCTION

The establishment of new agricultural business entities is an essential foundation and core subject of building a new agricultural business system (Huang and Yu, 2010), which is necessary if the agricultural sector is to be transformed and modernized (Wang et al., 2014). New agricultural business entities are an important driving force for implementing rural revitalization strategy in the new era and play a positive role in alleviating rural poverty and revitalizing the agricultural sector (2020). The reports of the $18^{th}$ and $19^{th}$ National Congress of the Communist Party of China both clearly pointed out that the establishment of new agricultural business entities has promoted the rapid development of various types of new agricultural business entities such as professional households, family farms, farmers' cooperatives, and agricultural enterprises across the country (Kong, 2014). Joint circular of the General Offices of the Ministry of Agriculture and Rural Affairs and the Ministry of Finance on providing support for the establishment of new-type agribusiness entities released in 2019 specifies their support for farmer cooperatives, family farms, and an agricultural industrialization consortium, to promote the high-quality development of new-type agricultural business entities and service recipients.

Previous studies on new-type agricultural business entities focused more on the factors influencing cultivation (Zhu et al., 2015), cultivation mode (Wang and Di, 2014), and development countermeasures (Hu, 2015). In view of the practical development problems facing new-type agricultural

*Corresponding address: Email: yichun1979_nwu@163.com

businesses, such as difficult land transfer, narrow financing channels, backward agricultural infrastructure, lack of new professional farmers, lagging agricultural industry services, and low organization (Pi and Zhou, 2015; Wang, 2015), the main direction for the cultivation and development of new-type agricultural business entities has been: promoting empowerment and the optimization of the right structure of agricultural lands (Zhang and Qu, 2014), improving the financing capacity of business entities and the innovation of financial service system (Zhang and Huang, 2015; Lin and Fa, 2015), improving new-type agricultural business entity operation modes, such as "company + farmers", "company + intermediary organization + farmers", and "company + intermediary organization + farmers", "market + government + elites + farmers", and cooperative shareholding system (Wang et al., 2015; Wen and Ruan, 2015; Mao and Xu, 2020), and perfecting the social service system (Xu, 2015) have become Cultivating talents such as young farmer elites (Liu et al., 2015), perfecting interest linkage mechanisms through innovation of rural governance capacity (Sun and Song, 2016), and supporting after entity classification (Wu et al., 2019) are new cultivation and management directions of new-type agricultural businesses. In recent years, many studies have demonstrated that new-type agricultural business entities have a positive role in reducing rural poverty (Zhang and Gao, 2017; Liu et al., 2020), promoting the integrated development of three rural industries (Chen et al., 2019; Jiang, 2019), driving the development of small farmers (Li and Zhang, 2020; Xu, 2020), and spreading ecological agricultural technology (Yang et al., 2021). The main research methods included field survey method (Chen and Zhu, 2017; Zhao et al., 2017), questionnaire survey method (Wang and Guo, 2017), comparative analysis of different regions (Wang and Luo, 2014), and analytic hierarchy process method (Pan and Huang, 2019). However, the spatial model analysis approach has rarely been applied.

As evident, previous research focused on the analysis of the current situations, such as the cultivation and management of new-type agricultural business entities, and related countermeasures, and the main research perspective is the macro development of new-type regional business entities. Most studies focused on countermeasures for financial demand, and less attention was paid to the comprehensive study of a specific industry, and in-depth analyses and the spatial distribution study of new-type agricultural business entities. Therefore, in this paper, Anhua dark tea, a typical agricultural industry, was used as an example. The spatial distribution and factors influencing the different types of new agricultural business entities were analyzed using ArcGIS software, and policy suggestions and practical guidelines are offered to encourage and support new businesses specializing in Anhua dark tea.

# 2. RESEARCH METHODS AND DATA SOURCES

## 2.1 Research Methods

### 2.1.1 Nearest Neighbor Index Method

The nearest neighbor index method, also called the nearest neighbor distance analysis method, is a method used to measure the distribution type of point-like geographic elements by comparing the value of the average nearest neighbor distance with the theoretical nearest neighbor distance. It takes complete space randomness (CSR) as the criterion for comparison. If the nearest neighbor distance of the observed pattern is greater than the nearest neighbor distance of the random distribution, the distribution tends to be scattered; otherwise, it tends to be clustered. The expression is:

$$R = \frac{r_{obs}}{r_{exp}} = \frac{\frac{\sum_{i=1}^{n} d_{min}(s_i)}{n}}{\frac{1}{2\sqrt{n/a}}} = \frac{2\sqrt{\rho}}{n}\sum_{i=1}^{n} d_{min}(s_i) \qquad (1)$$

where $R$ is the standard nearest neighbor distance index, $r_{obs}$ denotes the average nearest neighbor distance of the observation mode, $r_{obs}$ denotes the average nearest neighbor distance of the CSR mode, $d_{min}$ denotes the distance from every businesse to its nearest neighbor distance point, $S_i$ is the study object of the study area, $n$ is the number of the study object, and $A$ is the area of the study area.

(1) If $R = 1$, i.e., $r_{obs} = r_{exp}$, it indicates that A-class tourist attractions are randomly distributed.

(2) If $R < 1$, i.e., $r_{obs} < r_{exp}$, it means that A-class tourist attractions have clustered spatial distribution.

(3) If $R > 1$, i.e., $r_{obs} > r_{exp}$, it means that A-class tourist attractions are mutually exclusive in spatial distribution and tend to be scattered.

### 2.1.2 Kernel Density Estimation

The kernel density analysis method is often used to estimate the density of spatial distribution of regional geographical elements and the changes in their morphology. Its formula is:

$$\lambda_{\hat{\lambda}}(s) = \sum_{i=1}^{n} \frac{3}{\pi h^4}\left[1 - \frac{(s - s_i)^2}{h^2}\lambda\right], \qquad (2)$$

where $s$ is the spatial position of the element, $s_i$ is the element that falls within the spatial range with $s$ as the center of the circle, and $h$ is the position of the $i$-th element within the spatial range of the radius.

### 2.1.3 Hotspot Analysis (Getis-Ord G)

The Getis-Ord $G_i^*$ statistic of every element in the data set is calculated using the hotspot analysis tool in the ArcGIS platform. The positions where the high-value or low-value elements cluster in space are calculated based on the $z$ score and $p$ value obtained from the above calculation. The calculation formula is:

$$G_i^* = \frac{\sum_{j=1}^{n} w_{ij}x_j - \bar{x}\sum_{j=1}^{n} w_{ij}}{s\sqrt{\frac{\left[n\sum_{j=1}^{n} w_{ij}^2 - \left(\sum_{j=1}^{n} w_{ij}\right)^2\right]}{n-1}}}, \qquad (3)$$

where $x_j$ refers to the attribute value of element $j$, $w_{ij}$ refers to the spatial weight between elements $i$ and $j$, and $n$ is the total number of elements. Moreover,

$$\bar{X} = \frac{\sum_{j=1}^{n} x_i}{n}, S = \sqrt{\frac{\sum_{j=1}^{n} x_j^2}{n} - (\bar{X})^2}, \qquad (4)$$

For the positive $z$ score with a significant statistical significance, the higher the $z$ score, the closer is the cluster of high values (hot spot). For the negative $z$ score that has a significant statistical significance, the lower the $z$ score is, the closer the cluster of low values (cold spot) is.

#### 2.1.4 Ripley's K Function

Ripley's K function is used to determine whether elements (or values associated with elements) show statistically significant clustering or dispersion over a range of distances. The spatial clustering, uniform dispersion, and random distribution features of elements are not fixed, and their distribution trend varies with spatial scales; however, Ripley's K function can analyze the spatial structure presented by elements at different spatial scales, and its expression is:

$$L(d) = \sqrt{\frac{A \sum_{i=1}^{N} \sum_{j=1, j\neq i}^{N} K(i, j)}{\pi N(N-1)}}, \quad (5)$$

where $d$ is the distance, $A$ is the region, $N$ is the number of points, and $K(i, j)$ is the weight. When the observed value of K at a certain distance is greater than its expected value, it indicates a higher degree of clustering of the distribution. If the observed value of K is smaller than the expected value, it indicates that the distribution is more discrete.

$$Z(I) = (I - E(I))/Var(I)^{1/2}, \quad (6)$$

where $Z(I)$ refers to the mathematical expected value and $Var(I)$ refers to the variance.

#### 2.1.5 Geographic Probe

Geographical detectors have been widely used for the study of natural and social problems at different spatial scales to reveal the influencing factors and mechanisms of spatial heterogeneity. In this paper, factor detection and interactive detection are used to discriminate and analyze the factors influencing the spatial differentiation of new-type agricultural business entities of dark tea cultivation: 1) factor detection is used to measure the extent to which different factors explain the spatial differentiation of different new-type agricultural business entities; the calculation formula is shown in equation (7): 2) interactive detection is used to detect the interrelationship between variables influencing the spatial differentiation of new-type agricultural business entities. Firstly, q(x1), q(x2), and q(x1∩x2) (interaction of two factors) are calculated. Then, q(x1), q(x2), and q(x1∩x2) are compared to obtain the interaction type.

$$q = 1 - \sum_{h=1}^{L} N_h \sigma_h^2 \,/\, N\sigma^2, \quad (7)$$

where $q$ is the magnitude of the influence of factors on the spatial differentiation of new-type agricultural business entities of dark tea cultivation, [0, 1], $L$ is the spatial differentiation index or factor stratification of new-type agricultural business entities, i.e., classification or partition, $N$ and $N_h$ are the overall regional and stratified sample volumes, respectively, and $\sigma^2$ and $\sigma_h^2$ are the overall regional and stratified variances, respectively.

## 2.2 Data Sources

#### 2.2.1 Overview of the Study Area

Anhua county is in Hunan province. In 2020, the county had 23 towns and 448 administrative villages (communities), covering 4,950 square kilometers, making it the third largest county in Hunan province. The total population of the county is 1.08 million, of which 835,100 are in agriculture. The annual gross regional product is 24.012 billion yuan. The added value of the primary industry is 5.118 billion yuan, up 4.6%, the added value of the secondary industry is 7.959 billion yuan, up 4.3%, and the added value of the tertiary industry is 10.935 billion yuan, up 2.4%. The ratio of the three industries is 21.3:33.2:45.5, and the contribution rate of primary, secondary, and tertiary industries to economic growth is 23%, 46.1%, and 30.8%, respectively, contributing to gross domestic product (GDP) growth by 0.8 %, 1.6%, and 1.1%.

Anhua county is known as the hometown of Chinese dark tea. In 2020, the tea plantation area in Anhua reached 360,000 mu, the tea processing volume was 90,000 tons, the comprehensive output value was 23 billion yuan, and the tax revenue was 150 million yuan. It has been among the top ten of the top 100 counties in China's tea industry for 12 consecutive years and has become one of the top ten ecological tea-producing counties in China. Its yield of dark tea has ranked first in China for 12 years. Anhua dark tea has been recognized as being one of China's top ten tea regional public brands. Anhua dark tea is considered to be a benchmark brand with an estimated value of 63.99 billion yuan. It is the only landmark product in Hunan to enter the "China–Europe 100 + 100" geographical indication product mutual recognition and protection list. There are 789 new-type business entities in Anhua county, including 113 agricultural enterprises, 290 planting cooperatives, 171 family farms, and 215 large growers. Anhua dark-tea marketing network has spread across the country. There are more than 20,000 Anhua dark-tea stores, and the products have been exported to countries worldwide, such as South Korea, Germany, France, and Russia, and regions such as Hong Kong, Macao, and Taiwan. Several independent network sales platforms such as the "China dark tea website" and "Anhua dark tea official website" have been established, and there are more than 100,000 marketing branches and online stores.

#### 2.2.2 Big Data of New-Type Agricultural Business Entities of Dark Tea Planting

In this study, dark-tea planting agricultural enterprises, agricultural cooperatives, family farms, and large growers were selected as the research subjects, and Anhua county, the first county in terms of dark tea production in China, was taken as the study area. The data of new-type agricultural businesses engaged in dark tea planting were obtained from *Anhua County Tea Planting Enterprise Information Summary* (2020), *Anhua County Family Farm Ledger* (2020), and *Anhua County Farmer Professional Cooperative Ledger* (2020) provided by the Economic Management Station of Anhua County Agricultural and Rural Bureau, the large growers mentioned in *Anhua County (Town) Tea Garden Area Diagnostic Table*

**Table 1** Distribution of new-type agricultural business entities of Anhua dark tea

| Type | Number in 2010 | Number in 2015 | Number in 2020 |
|---|---|---|---|
| Enterprise | 15 | 58 | 113 |
| Cooperative | 13 | 130 | 290 |
| Family farm | 8 | 29 | 171 |
| Large grower | 50 | 156 | 215 |
| Total | 86 | 373 | 789 |

(2020), *Anhua County Statistical Yearbook* (2011-2020), *Anhua County Village Card Data* (2018-2020), and *Anhua County Town Card Data* (2017-2020). Family farms and professional farmer cooperatives that are not engaged in tea planting were excluded.

#### 2.2.3 Big Data of New Business Subjects of Dark Tea Planting in Anhua County

The basic data for dark tea plantation enterprises in the study area was obtained by means of web- crawling technology. The coordinate data points of the study subject were determined by Google Earth with the help of the ArcGIS10.7 operation platform and unified in the vector layer projection coordinate system to determine the spatial distribution characteristics of dark-tea plantation enterprises in the study area. Agricultural cooperatives, family farms, and large growers were contacted through WeChat according to the cellphone numbers recorded in *Anhua County Family Farm Ledger* (2020), *Anhua County Farmer Professional Cooperative Ledger* (2020), and *Anhua County (Town) Tea Garden Area Diagnostic Table* (2020). The positions were transmitted through the WeChat application programming interface (API). Finally, the coordinates of the agricultural cooperatives, family farms, and large growers were transformed to the data file of the spatial points of the new-type business entities of Anhua dark-tea plantation using ArcGIS10. 7.

## 3. SPATIAL CHARACTERISTICS

### 3.1 Spatial Pattern Features of New-Type Agricultural Business Entities of Anhua Dark Tea

With the help of the ArcGIS software platform, a clustering analysis was conducted of all new-type agricultural business entities of dark tea in different towns in Anhua county (later referred to as dark-tea business entities) in 2010, 2015, and 2020 using the natural fracture method. The spatial distribution pattern is shown in Figure 1. It was seen from Figure 1 that the number of dark tea business entities in Anhua county has increased significantly from 2010 to 2020, and the entities gradually spread to both ends with the Guanxin expressway, Pingdong expressway, and Erguang expressway as the bearings, showing an H-shaped spatial distribution pattern.

In 2010, the number of dark-tea business entities in Anhua county as a whole was small, mainly concentrated in Nanjin town, Malu town, and Jiangnan town, and there were also some dark-tea business entities in Xianxi town, Changtang town, and Quijiang town, which have good resources; in 2015, the number of dark-tea business entities increased significantly, and the areas along Guanxin expressway and Pingdong expressway have become the gathering places of dark tea; in 2020, the spatial differentiation hierarchy of dark-tea business entities has been further expanded, the number of business entities along the H-shaped highway grew extremely fast, “Nanjin Town - Malu Town”, “Jiangnan Town - Tianzhuang Town - Touxi Town” and “Lengshi town - Xiaoyan town - Changtang town - Xianxi town” has become a relatively high-concentration areas of dark-tea business entities, and the uneven distribution of business entities had a similar tendency with the local dark-tea industry development, market demand, and resource endowment conditions.

### 3.2 Spatial layout of Different New-Type Agricultural Business Entities

The nearest neighbor index was used to explore the spatial distribution patterns of business entities of Anhua dark tea with different functional types, and the calculation results of the nearest neighbor index and related parameters are shown in Table 2. The results showed that the actual observed distance of Anhua dark-tea business entities was less than the theoretical expected average distance; the nearest neighbor index was 0.6060, smaller than 1, the Z test value was less than the critical value (-2.58), and the P value was less than 0.0001, indicating that the distribution pattern of enterprises was characterized by significant clustering. In terms of different types of business entities, the nearest neighbor indexes of enterprises, cooperatives, family farms, and large growers were 0.6060, 0.6379, 0.6200, and 0.6403, respectively, and were significant at the level of 0.0001, i.e., they all showed significant clustering, and the clustering degree of enterprises was the largest, followed by family farms, cooperatives, and large growers. Thus, it was found that the new-type business entities of Anhua dark tea and different types of new-type business entities both showed a spatial distribution pattern of significant clustering, although the clustering densities were different.

### 3.3 The Distribution Characteristics of New-Type Agricultural Business Entities in Multi-Scale Space

The spatial concentration area of four types of new-type business entities of Anhua dark tea in 2020 was further identified by the kernel density estimation method. The search

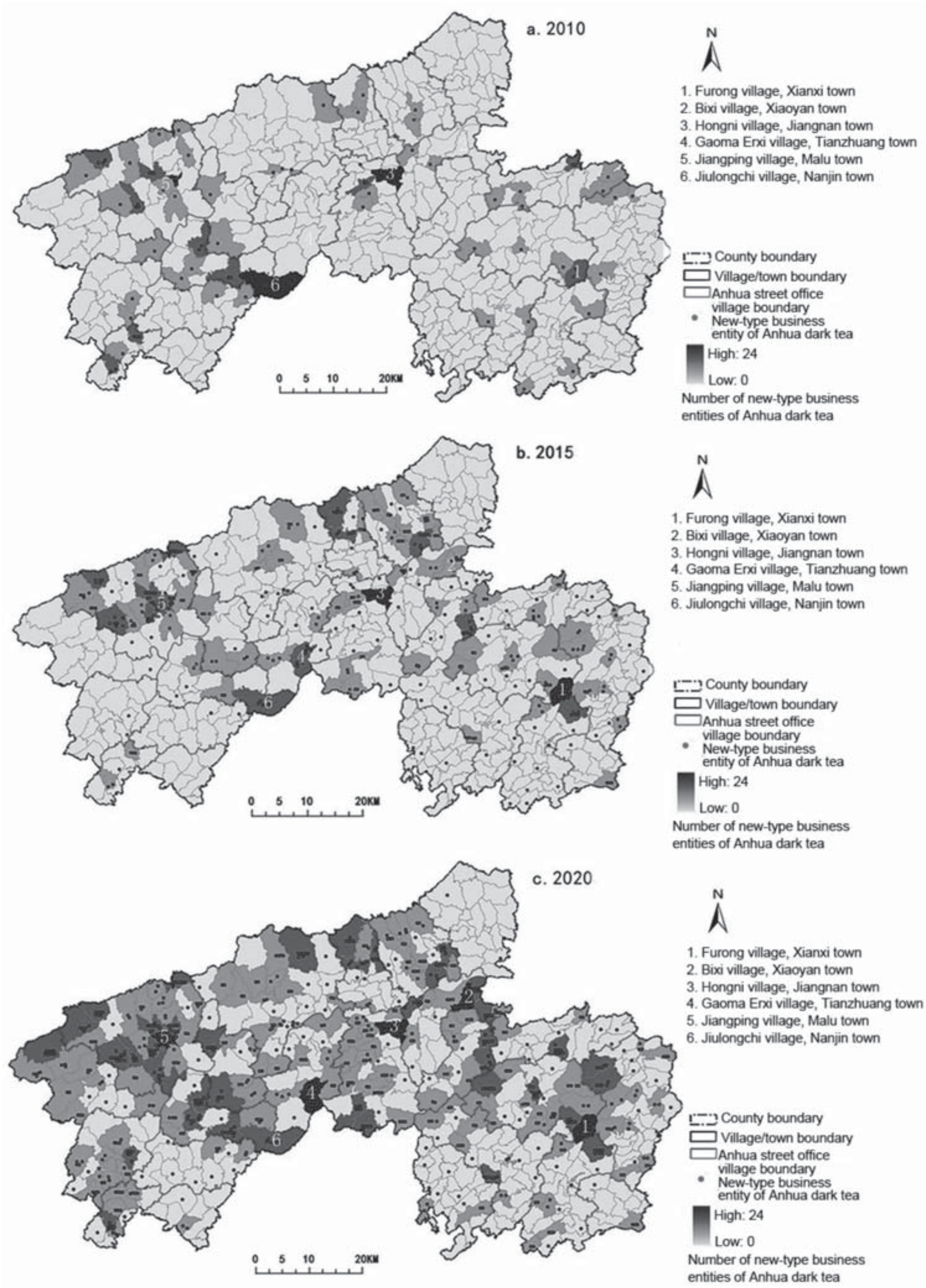


**Figure 1** Distribution of new agricultural business entities of Anhua dark tea.

**Table 2** The nearest neighbor index and related parameters of new-type business entities of Anhua dark tea

| Type | Average observation distance/km | Expected average distance/km | Nearest neighbor index | Z value | P value | Distribution mode |
|---|---|---|---|---|---|---|
| Enterprise | 2.16 | 3.57 | 0.6060 | −8.0123 | < 0.0001 | Significant Clustering |
| Cooperatives | 1.75 | 2.74 | 0.6379 | −11.7764 | < 0.0001 | Significant Clustering |
| Family farm | 2.21 | 3.61 | 0.6200 | −9.6117 | < 0.0001 | Significant Clustering |
| Large growers | 2.06 | 3.21 | 0.6403 | −10.0901 | < 0.0001 | Significant Clustering |
| Overall | 2.16 | 3.57 | 0.6060 | −8.0123 | < 0.0001 | Significant Clustering |

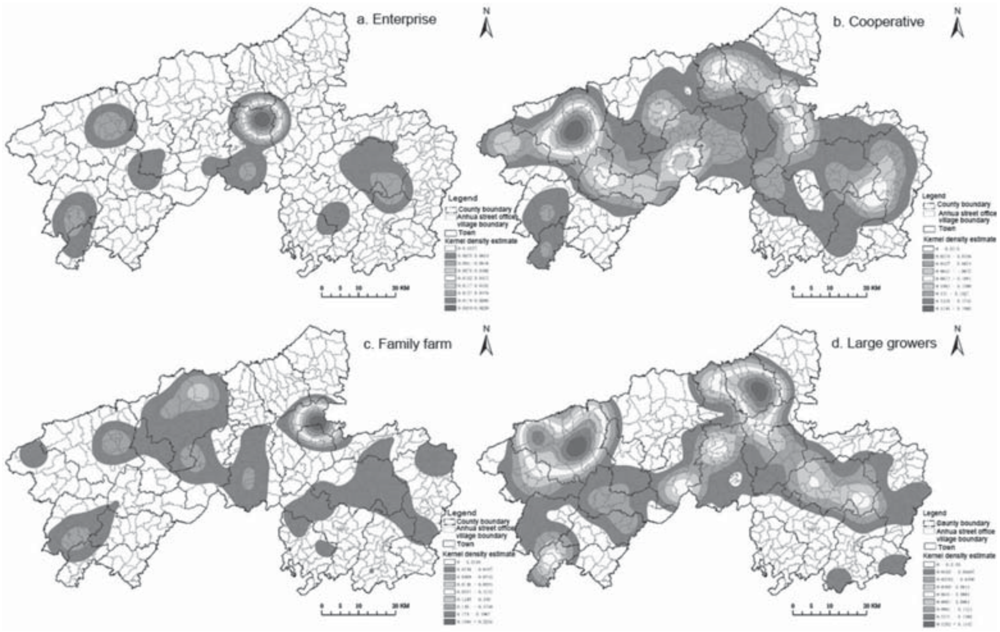


**Figure 2** Kernel density analysis of new-type agricultural business entities of Anhua dark tea.

radius was set as 10 km, and kernel density distribution is shown in Figure 2. The distribution of both enterprise and family farm types is characterized by single-core clustering, and this type of dark-tea business entity was concentrated mainly in a core area or a central town. For example, enterprises were mainly concentrated in the Hongni village of Jiangnan town. Jiangnan town is an important Anhua area of dark-tea production and also the starting point of the Ancient Tea Horse Road. The town is close to the navigation road and the Anzhangheng railroad. Anning highway and national highway G536 passed through the town. Thus, the traffic conditions in the town are excellent. Family farms mainly concentrated in Bixi village and Baihua village of Xiaoyan town, form an industrial hub mainly for dark-tea processing, and the Xiaoyan town has enjoyed the reputation of being "China's first town of dark tea". Cooperatives presented a clustering characteristic of "one primary and multiple secondaries", where "one primary" was Malu town and "multiple secondaries" were small secondary clusters formed in many towns. Large growers showed the clustering characteristic of "two primaries and one secondary". "Two primaries" were Malu town and Lengshi town, and "one secondary" was Duijiang town. Mountains in Malu town and Lengshi town stretch over a wide area, and Malu town has more than 11 mountains above 800 meters, suitable for dark-tea planting.

## 4. FACTORS INFLUENCING THE SPATIAL DISTRIBUTION OF NEW-TYPE AGRICULTURAL BUSINESS ENTITIES OF ANHUA DARK TEA

### 4.1 Influencing Factors and Index Selection

New-type agricultural business entities are important for the construction of an agricultural business system, and their agricultural operations are mainly influenced by the local natural environment, local policies, and the economy. This paper selected the following factors based on the previous research findings [1–3] and following the principles of data accessibility, objectivity, and scientificity. The first factor is elevation and slope. Generally speaking, the mountains with slopes below 20 degrees and altitudes between 200 m and 800 m have relatively sufficient light, which is more suitable for the growing of dark tea, so the distribution density of dark-tea business entities will be relatively large. The flat and open areas are not suitable for dark-tea cultivation, limiting the distribution of dark-tea business entities to a certain extent. The second factor is the scale of operation. The spatial distribution of dark-tea business entities is significantly affected by the size of the operation scale, and the operation scale is characterized by the area of tea plantations according to local statistics. The third factor is the level of per capita income. The dark-tea industry is an important economic pillar in Anhua county, and the per capita income level may directly affect the number and distribution of business entities. The fourth factor is road network density. Transportation is an important link between new agricultural business entities and customer flow. From the perspective of consumption geography, consumers' willingness to shop decreases with the increase of distance, so the difference in road network density may also have an impact on the distribution of dark-tea business entities. The fifth factor is population density. People are both consumers and producers in terms of community production. That is, they are both the main service object and an important factor in the productivity of new dark-tea agricultural business entities, so population sparseness directly affects the spatial layout of new agricultural businesses.

In this study, the administrative boundary of villages was taken as the basic unit for analyzing influencing factors (Meng and Zhao, 2019). The kernel density values of all new business entities and different types of new business entities were taken as the dependent variables for analyzing the spatial

**Table 3** The nearest neighbor index and related parameters of new-type business entities of Anhua dark tea

| Variable attribute | Variable | Detection factor | Calculation method | Expected impact |
|---|---|---|---|---|
| Land factor | Elevation | $X_1$ | The mean value of elevation grid data within the administrative boundary of the village | + |
| | Slope | $X_2$ | Elevation difference in elevation grid data within the administrative boundary of the village/horizontal distance | + |
| | Business scale | $X_3$ | Area of tea plantation within the administrative boundary of the village | + |
| Economic factor | Per capita income level | $X_4$ | Average income of all residents within the administrative boundary of the village | + |
| Service factor | Road network density | $X_5$ | Length of the road network within the administrative boundary of the village/village area | + |
| | Population density | $X_5$ | Number of the resident population within the administrative boundary of the village/area of the village | + |

**Table 4** Explanatory power of detection factors for the spatial layout of new-type agricultural business entities of Anhua dark tea.

| Detection factor | Dark tea business entities in general | Enterprise | Cooperative | Family farm | Large grower |
|---|---|---|---|---|---|
| Elevation $X_1$ | 0.10 | 0.05 | 0.16* | 0.02 | 0.29* |
| Slope $X_2$ | 0.34* | 0.26* | 0.33* | 0.32* | 0.48* |
| Operation scale $X_3$ | 0.40* | 0.27* | 0.17* | 0.31* | 0.39* |
| Per capita income level $X_4$ | 0.29* | 0.23* | 0.01 | 0.02 | 0.02 |
| Road network density $X_5$ | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Population density $X_6$ | 0.01 | 0.02 | 0.01 | 0.01 | 0.03 |

Note: * indicates passing the significance test of 0.05

distribution of new business entities of dark tea and the spatial distribution of different types, respectively. Six indicators were selected to quantitatively measure their influence on the spatial distribution of dark-tea business entities. The independent numerical variables were discretized using the natural breakpoint classification method to classify the values into five categories (Table 3).

## 4.2 Factor Detection

The explanatory power of the six influencing factors was analyzed using the geographic detector. The greater the determining power (the value of q) of an influencing factor on the spatial differentiation of new-type agricultural business entities of dark tea was, the more significant was the influence of the factor. As shown in Table 4, the land factor had the greatest influence on the overall spatial layout of the new agricultural dark-tea enterprises established in Anhua county, while the elevation factor had no significant influence. It was found from the analysis that the slope had some explanatory power (0.34) on the layout of the business entities, mainly because they tended to be distributed on the flat terrain, so the slope of the dense area was generally small. The operation scale passed the 0.05 confidence test and had a strong explanatory power (0.40) on the layout of business entities, indicating that the larger the operation scale was, the easier it was to establish business entities. Per capita income had an explanation power (0.29) for the spatial layout of the entities. Areas with high income levels drove local residents to cultivate new business entities, so the layout of business entities in areas with high income levels was more intensive. The service factor did not pass the 0.05 confidence test, so it was concluded that the road network density and population density had almost negligible influence on the overall spatial layout of dark-tea business entities.

For different types of dark-tea business entities, the explanatory power of slope, operation scale, and per capita income level on enterprises was nearly the same, at 0.26, 0.27, and 0.23, respectively, and the explanatory power of operation scale was slightly greater than that of the other two factors. Therefore, it was concluded that enterprises generally preferred to be located in areas with high slope, large operation scale, and high per capita income. Land factors had a strong influence on the distribution of cooperatives. Elevation, slope, and operation scale all determined cooperatives' spatial layout, among which slope had the greatest explanatory power (0.33), indicating that cooperatives tended to be located in places with good land conditions. Economic and social factors had a small influence on the spatial distribution. The explanatory power of slope and operation scale on family farms was 0.32 and 0.31, respectively, showing significant influences; the influence factor of the spatial layout of large growers was nearly the same as that of cooperatives, both of which were influenced by land factors.

## 4.3 Interactive Detection

The interaction in the geographic detector was used to detect the extent of the role of two factors when they jointly influenced the spatial differentiation of new-type agricultural

**Table 5** Interactive detection results of new-type agricultural business entities of dark tea in Anhua county.

| Detection factor | Elevation ($X_1$) | Slope ($X_2$) | Operation scale ($X_3$) | Income level ($X_4$) | Road network density ($X_5$) | Population density ($X_6$) |
|---|---|---|---|---|---|---|
| Elevation $X_1$ | 0.10 | | | | | |
| Slope $X_2$ | 0.45 | 0.34 | | | | |
| Operation scale $X_3$ | 0.58 | 0.74 | 0.40 | | | |
| Income level $X_4$ | .0.15 | 0.39 | 0.49 | 0.29 | | |
| Road network density $X_5$ | 0.35 | 0.35 | 0.40 | 0.10 | 0.01 | |
| Population density $X_6$ | 0.11 | 0.36 | 0.44 | 0.05 | 0.02 | 0.01 |

business entities of dark tea. The results of interactive detection are given in Table 5, which showed that the explanatory power of the interaction between two factors was greater than that of the single factor. The interaction between elevation and operation scale had the most significant influence on the spatial differentiation of the entities, and the explanation power was 0.74, the highest among all interactive factors. The interaction between elevation and operation scale and the interaction between operation scale and income level were also significant, and their explanatory power was 0.58 and 0.49, respectively; the interaction between population density and road network density had the lowest explanatory power (0_02).

## 5. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions were drawn by analyzing the characteristics and factors influencing the spatial distribution of new-type agricultural business entities of Anhua dark-tea cultivation.

Firstly, the overall spatial distribution of new-type agricultural business entities of Anhua dark tea was in the "H" pattern, and "Nanjin town - Malu town", "Jiangnan Town -Tianzhuang Town - Taoxi Town", and "Lengshi Town - Xiaoyan Town - Changtang Town - Xianxi Town" became the main gathering areas of new-type agricultural business entities of dark-tea planting.

Secondly, the spatial differentiation of various types of new agricultural business entities of Anhua dark-tea planting was large, and the spatial distribution of dark-tea planting enterprises, agricultural cooperatives, family farms, and large growers showed significant clustering characteristics, and their clustering sizes ranged from small to large.

Third, from the perspective of agglomeration characteristics, dark-tea planting enterprises and family farms had single-core agglomeration characteristics. These enterprises were concentrated mainly in Hongni village of Jiangnan town, while family farms were mainly concentrated mainly in Bixi village and Baihua village in Xiaoyan town. The agglomeration characteristic of farmer cooperatives was "one primary and multiple secondaries". "One primary" referred to Malu town, and "multiple secondaries" referred to small secondary agglomeration areas formed in multiple towns. The agglomeration characteristic of large farmers showed was "two primaries and one secondary". "Two primaries" were Malu town and Lengshi town, and "one secondary" was Qujiang town.

## ACKNOWLEDGEMENTS

This study was supported by Key Project of Scientific Research Project of Hunan Education Department (No.19A090): Rural spatial transformation of modern agriculture demonstration area under the influence of agricultural Internet of Things technology utilization.

## REFERENCES

1. Chen, L., Li, Y.Q. & Wang, Y.Q. (2019). Analysis of the income-generating effect of new agricultural business entities in promoting the integrated development of three rural industries. *Study & Exploration*, (03), 116–123.
2. Chen, X.B. & Zhu, W. (2017). Research on the development of new agricultural business entities under agricultural supply-side reform - an analysis based on the survey in Sichuan. *Rural Economy*, (08), 108–114.
3. Hu, P. (2015). The realistic troubles and countermeasures of cultivating new-type agricultural business entities. *Academic Journal of Zhongzhou*, (03), 45–48.
4. Huang, Z.H. & Yu, N. (2010). New-type agricultural business entity: current status, constraint, and development idea - an analysis taking Zhejiang province as an example. *Chinese Rural Economy*, *310*(10), 16–26+56.
5. Jiang, T. (2019). Motivation, model and countermeasure of new agricultural business entities driving rural "integration of three industries". *Academic Journal of Zhongzhou*, (10), 46–52.
6. Kong, X.Z. (2014). The status and top-level design of new-type agricultural business entities. *Reform*, *243*(05), 32–34.
7. Li, Y.F. & Zhang, Y.H. (2020). Dynamic mechanism of endogenous new agricultural operation subject driving the development

of small farmers - case study based on embeddedness theory. *Journal of China Agricultural University (Social Sciences Edition)*, *37*(01), 38–47.
8. Lin, L.F. & Fa, N. (2015). The deep reasons for the difficulty financing of new agricultural business entities and the solution path. *Nanjing Journal of Social Sciences*, (07), 150–156.
9. Liu, T.S., Mao, F. & Kong, X.Z. (2015). Study on the role of young farmers' elites in new agricultural business entities - taking Henan province as an example. *Rural Economy*, (09), 104–109.
10. Liu, Y., He, X., Li, C., Tan, J., Zhu, Z. & Wang, Y. (2020). Poverty Measurement and Evaluation at the County Level in China: From the Perspective of Nighttime Light Data. *Engineering Intelligent Systems*, *28*(1), 23–30.
11. Mao, R.N. & Xu, Y.J. (2020). The Modes of Cultivating New Agricultural Operation Entities. *Frontiers*, (23), 124–127.
12. Meng, Y. & Zhao, T. (2019). Analysis on Factors Affecting Fluctuation of Price of Financial Stock of Pharmaceutical Enterprises. *Engineering Intelligent Systems*, *27*(2), 85–90.
13. Notice of the Ministry of Agriculture and Rural Affairs on the Issuance of the Plan for the High-quality Development of New Agricultural Businesses and Service Entities (2020–2022) (Agricultural reform and development [2020] No. 2) http://www.gov.cn/zhengce/zhengceku/2020–03/24/content_5494794.htm
14. Pan, Z.J. & Huang, X. (2019). The selection and cultivation of new agricultural business subjects: the case of yongzhou city, Hunan province. *Journal of South-Central University for Nationalities (Humanities and Social Sciences)*, *39*(04), 132–137.
15. Pi, X.P. & Zhou, R.J. (2015). Research on development of new agricultural management entities from farmland transfer perspective - taking Hunan province as an example. *Journal of Social Science of Hunan Normal University*, *44*(03), 118–123.
16. Sun, Y.H. & Song, L.F. (2016). The Innovation of Rural Governance under the Development of the New Agricultural Management Main Body. *Social Sciences in Nanjing*, (12), 59–64.
17. Wang, F.Y. & Luo, K. (2014). Comparative analysis of the difficulties and aspirations of the growth of new agricultural business entities in the plains and mountainous areas - taking training course participants in 10 agricultural entrepreneurship training bases in Hubei province. *Academic Forum*, *37*(07), 41–45.
18. Wang, F.Y. (2015). Problems faced by the growth of new agricultural business entities and countermeasures. *Economic Review*, *351*(02), 31–35.
19. Wang, G.M. & Di, K.Z. (2014). Rural land property rights delineation, structural optimization and new agricultural management entities cultivation. *Reform*, (07), 150–159.
20. Wang, G.M., Yang, Y.Q. & Wang, Y.C. (2014). New-type agricultural business entity cultivation: strategic review, logical identification, and institutional assurance. *Journal of Southwest University for Nationalities*, *35*(10), 203–208.
21. Wang, Q. & Guo, X.M. (2017). Research on Financing Demand of New Agricultural Business Entities - Based on the analysis of questionnaire in Sichuan Province. *Finance & Economics*, (08), 118–132.
22. Wang, Y.T., Gao, Q. & Jin, W.B. (2015). Operation Mode of the New Farmer Management Main Body Cultivation. *Chongqing Social Sciences*, (05), 27–33.
23. Wen, Z.L. & Ruan, H. (2015). New-type agricultural management entities: multiple development mode, internal logics and regional case analysis. *Journal of Huazhong Agricultural University (Social Sciences Edition)*, (05), 32–39.
24. Wu, S.C., Hu, L.X. & Chu, Y.F. (2019). The classification and support strategy for new agricultural management entities: rethinking under the sub-subject support policy and literature. *Journal of Chongqing Technology and Business University (West Forum)*, *29*(06), 53–59.
25. Xu, L. (2015). Suggestions for the development of new agricultural business entities. *Macroeconomic Management*, (09), 69–71.
26. Xu, X.P. (2020). The coupling of peasant households and new agricultural management subjects – the empirical study from 6 villages of 6 provinces in China. *Journal of Nanjing Agricultural University (Social Sciences Edition)*, *37*(01), 38–47.
27. Yang, X.J., Qi, Z.H., Yang, C.Y. & Liu, Z. (2021). Can the new type of agricultural management promote the promotion of ecological agricultural technology: take rice and shrimp co-cultivation technology as an example. *Resources and Environment in the Yangtze Basin*, *30*(10), 2545–2556.
28. Zhang, C. & Gao, Q. (2017). Study on effect of new agricultural management entities helping poverty-stricken households to get rid of poverty. *Journal of Northwest A&F University (Social Science Edition)*, *17*(02), 73–79.
29. Zhang, H.P. & Qu, T.T. (2014). Agricultural land management rights transfer and development of new agricultural management entities. *Journal of Nanjing Agricultural University (Social Sciences Edition)*, *14*(05), 70–75+83.
30. Zhang, Q.W. & Huang, K.Q. (2015). Research on the innovation of financial service system for new agricultural business entities. *Academic Exchange*, (07), 130–135.
31. Zhao, D.W., Qu, K.X. & Wang, C.X. (2017). The New Agricultural Management Bodies of Nenjiang River Basin-Realistic Constraint and Development Ideas. *Journal of Harbin University of Commerce (Social Science Edition)*, (05), 103–110.
32. Zhu, M., Qi, Z.H., Wu, L.Y., Li, X.R. & Tang, S.Y. (2015). An empirical analysis of the factors influencing the demand for agricultural technology in new-type agricultural business entities - taking 395 large rice growers as an example. *China Rural Survey*, (01), 30–38, 93–94.