REALIS
Revista de Estudos
AntiUtilitaristas e PosColoniais

THE CURRENT STATE OF THE VITIVINICULTURAL SECTOR IN MAINLAND CHINA[1]

O estado atual do setor vitivinícola na China continental

HU, Daohua[2]

XU, Qian[3]

WANG, Yanjun[4]

Abstract: China's vineyard surface area accounts for the second place in the world, its grape production the first place, and its wine consumption and imports the fifth place. The vitivinicultural sector is playing an increasingly important role in the world. At the same time, vitivinicultural sector has also played an important role in poverty reduction in rural areas of China.Based on the background of the world vitivinicultural sector, it is of great significance to analyze the characteristics of China's domestic vitivinicultural sector, especially the situation of the primary, secondary and tertiary industries, to help China continue to reduce poverty in the countryside, optimize the industrial structure, and promote the integration of the three industries. At the same time, it also provides a reference for the consumption and trade of grape products between China and the world. This paper collected the authoritative statistical data of vitivinicultural sector in the world and China for the past two decades, including global national data and China's provincial data, and analyzed the development trend of grape industries in China from the perspectives of vineyard surface area, grape production, grape use, wine production, consumption and trade in an international context. For the first time, China's POI information of grape-related enterprises in Baidu online map was retrieved, and the spatial and temporal distribution characteristics of domestic grape industries were analyzed by using ArcGIS software. It includes the comparative analysis of grape surface area and production in different provinces, the development analysis of grape-related primary, secondary and tertiary industries, the trend analysis of grape cultivation in different provinces, and the shift analysis of industrial spatial gravity center. The result

[1] Enviado em: 23 Out 2021. | Aceito em: 10 Nov 2021.

[2] Associate professor Faculty of Resources and Environmental Science, Hubei University, Wuhan, China. MSc. degree in human geography. http://orcid.org/0000-0003-0690-1531. Email: hdh@hubu.edu.cn

[3] Faculty of Resources and Environmental Science, Hubei University, Wuhan, China. http://orcid.org/0000-0001-8312-0718. Email: hdh@hubu.edu.cn

[4] Faculty of Resources and Environmental Science, Hubei University, Wuhan, China. http://orcid.org/0000-0003-4191-3060. Email: hdh@hubu.edu.cn

not only shows the changes of grape producing areas in China, but also tries to explore the distribution and integration of the three industries at the provincial scale in different parts of China. The future development of grape industry in 31 provinces in mainland China was predicted.

Keywords: China; vitivinicultural sector; Baidu Map POI; ArcGIS; spatial distribution.

Abstract: A área de superfície dos vinhedos da China ocupa o segundo lugar no mundo, sua produção de uvas em primeiro lugar e seu consumo e importação de vinho em quinto. O setor vitivinícola está desempenhando um papel cada vez mais importante no mundo. Ao mesmo tempo, o setor vitivinícola também desempenhou um papel importante na redução da pobreza nas áreas rurais da China. Com base nos antecedentes do setor vitivinícola mundial, é de grande importância analisar as características do setor vitivinícola doméstico da China, especialmente a situação das indústrias primária, secundária e terciária, para ajudar a China a continuar a reduzir a pobreza no campo, otimizar a estrutura industrial e promover a integração das três indústrias. Ao mesmo tempo, é também uma referência para o consumo e comercialização de produtos derivados da uva entre a China e o mundo. Este artigo coletou dados estatísticos confiáveis do setor vitivinícola do mundo e da China nas últimas duas décadas, incluindo dados nacionais globais e dados provinciais da China, e analisou a tendência de desenvolvimento das indústrias de uvas na China a partir das perspectivas da área de superfície dos vinhedos e produção de uvas, uso da uva, produção, consumo e comercialização de vinho em um contexto internacional. Pela primeira vez, as informações de POI da China de empresas relacionadas à uva no mapa online do Baidu foram recuperadas e as características de distribuição espacial e temporal das indústrias domésticas de uva foram analisadas usando o software ArcGIS. Inclui a análise comparativa da área de superfície e produção da uva em diferentes províncias, a análise do desenvolvimento das indústrias primárias, secundárias e terciárias relacionadas com a uva, a análise de tendência do cultivo da uva em diferentes províncias e a análise de deslocamento do centro de gravidade espacial industrial. O resultado não só mostra as mudanças nas áreas produtoras de uvas na China, mas também tenta explorar a distribuição e integração das três indústrias em escala provincial em diferentes partes da China. O futuro desenvolvimento da indústria da uva em 31 províncias da China continental foi previsto.

Palavras-chave: China; setor vitivinícola; Mapa Baidu POI; ArcGIS; distribuição especial.

1 Introduction

China's vitivinicultural sector has leaped to the top of the world, and it is a big country in the world in terms of vineyard surface area, total grape output, fresh grape

production and consumption, wine consumption and grape product import. According to the report of the International Organization of Vine and Wine (IOV) , China's vineyard surface area has become the second largest in the world since 2014(Vine & Wine, 2017). China's grape production has been the first place in the world since 2016.

The consumption and production of table grapes in China has ranked first in the world since 2014, while the consumption of table grapes accounting for 36% of the total. Since 2016, China's wine consumption has ranked fifth in the world, while wine imports volume also the fifth. And there are considerable imports of table grapes. Fore years, China never lose it's records. But there were no matching attention and research of China's vitivinicultural sector compared with its scale.

Grape industry is also an important means of poverty reduction in rural areas and an important part of the development of modern agriculture in China. The United Nations Millennium Development Goals (MDGs) have been basically achieved in China (J. P. Xi, 2015), the United Nations Sustainable Development Goals (SDGs) are being implemented, and China's agriculture is also in the process of transforming into modern agriculture. Agriculture is no longer a single planting industry, but should be the integration of primary, secondary and tertiary industries. The trend of large-scale, specialization, commercialization and branding of agricultural industry is becoming more and more obvious.

Taking 2019 as an example, the proportion of table grapes accounted for 84.1% of China's total grape output (OIV, 2019), and the proportions were much lower for dried grape and grape juice and musts, which are higher value-added fruit processing industry, not mention the wine production which is the wine manufacturing industry. Grape-related trade and tourism industries have just started. The import demand for grapes and grape products is large. It is also necessary to continue to study the situation of China's grape industry and its subordinate industries, in order to solve the problem of the imbalance of China's agricultural varieties structure, meet the requirements of upgrading people's consumption structure, increase the degree of industrial integration,

and take into account the linkage between domestic and foreign markets.

Scholars have already had certain research results about the research of Chinese grape industry. Li Hua (Li, Li, & Yang, 2009) and Chao Wuji (Cao, 2009) reviewed the development of China's grape and wine industry in the 30 years of China 's reform and opening up , and the development of China's vitivinicultural sector in the 60 years since the founding of the People's Republic of China respectively. Luo Guoguang (G. G. Luo, 2003) discussed the challenges and countermeasures faced by the vitivinicultural sector after China's entry into the WTO. Lu Qingfeng (Lv, 2013) reviewed the development of Chinese wine industry. In different periods, different scholars have conducted research on the current situation and development suggestions of China's vitivinicultural sector. For example, in 2007, Zhai, Heng (Zhai et al., 2007) studied the development situation of Chinese vitivinicultural sector. In 2009, Tian Shufen (Tian, 2009) comprehensively analyzed the main problems and development trends of China's vitivinicultural sector from the aspects of area and productiond of grape cultivation, cultivars structure, post-production processing, storage and low temperature logistics, export market trade volume, and the main development direction of the vitivinicultural sector. In 2017, Luo Siyi (S. Y. Luo, 2017) conducted research on China's vitivinicultural sector and its tourism development. In 2018, Tian Shufen (Tian, 2018) once again discussed the development of China's vitivinicultural sector and technology. Compared with the comprehensive research on the Chinese vitivinicultural sector, there are many more special studies on the Chinese wine industry (Shao, 2007) (D. Z. Xi, Liu, Meng, & Jia, 2008)(Shao Fang, 2007) (Xi Dezhi, Liu Wenzhong, Meng Qing, & Jia Yuliang, 2008) (Yang & Xue, 2008) (Y. Zhang & Zhu, 2009) (Yang & Xue, 2008) (Y. Zhang & Zhu, 2009) (Chen, Zhao, Yang, Yang, & Zhao, 2017) and so on. Scholars also considered the climate and other characteristics of different grape producing areas in China, and conducted more targeted research on grape tourism or wine tourism in the grape producing areas, such as Northeast (Song, 2002) , North (Song, 2002) , Xinjiang (Pu, Zhang, Ding, & Ma, 2013) , Ningxia (J. J. Wang, Yang, Shi, & Wang, 2011) , Shandong (An et al., 2019) , Yunnan (W.

Zhang et al., 2015) , Jiangsu (X. C. Wang, Wu, Zaho, Wang, & Qian, 2015) , etc.

Although previous studies are rich, the data used are time-sensitive, the content more or less emphasizes technical issues. Most of the scholars take the wine industry as the main research object. When talking about grape tourism industry, most of the studies are about wine tourism only. This paper is not do confine the target in the literature summary research, but hopes to have the breakthrough in two aspects. Firstly, in view of the difficulty of data collection in existing studies, this paper will review in detail the authoritative statistical data of the world's and China's grape industry in the past two decades, including global national data and China's provincial data. China's grape industry will be analyzed from a macro perspective in the international context. Secondly, it is the first time to use the online data acquisition method to obtain the latest POI information from Baidu map, and to use GIS spatial analysis modules to visualize the characteristics and trends of China's grape industry. The spacial distribution status of the primary, secondary and tertiary industries in the vitivinicultural sector will be discussed, too.

2 Materials and Methodology

2.1 Division of the vitivinicultural sector

According to their uses, grapes can be divided into two categories: table grape cultivars and processed cultivars (Peng, 1995). Some grapes are suitable for fresh food and can be processed. They are called dual-use cultivars. According to their main purposes, they are classified as table grapes or processed. In the processed grape cultivars, it can be subdivided into wine grapes, dried grapes and juice grapes. For the sake of comparison, this paper simplified the classification of grapes into table grapes, wine grapes, dried grapes, and juice grapes.

According to China's national industry classification standard "Classification and Code of National Economic Industries (GBT 4754-2017)", we can take into account four types of grapes, and simplify the classification of the vitivinicultural sector as follows:

Primary industry: fruit planting, including table grape planting and wine grape planting

Secondary industry: wine manufacturing, beverage manufacturing (juice), fruit processing (dried grapes processing)

Tertiary industry: wholesale and retail, technical services, tourism services (grape picking gardens, wine tourism, etc.)

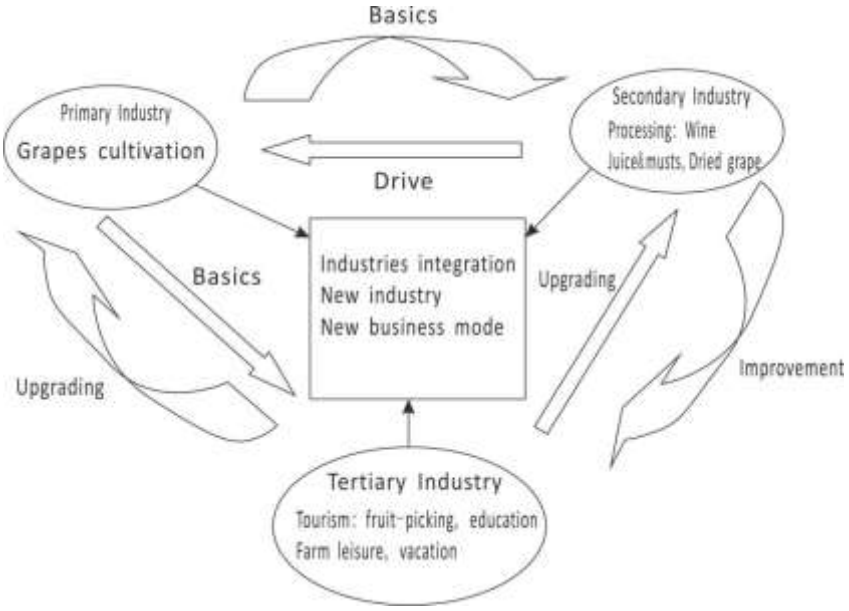
From the perspective of the government, promoting the integrated development of rural primary, secondary and tertiary industries (hereinafter referred to as rural industries) is an important measure to broaden farmers' income growth opportunities and build a modern agricultural industry system. It is an important measure to accelerate the transformation of agricultural development methods and explore the path to agricultural modernization with Chinese characteristics.(Council, 2016) .

The essence of the integration of the agricultural industry is to realize the integrated development of the primary, secondary and tertiary industries in rural areas by encouraging farmers to engage in diversified operations, the development of food processing industry, agricultural material manufacturing, and agricultural product circulation, sales, and tourism. This allows farmers to better obtain the value-added benefits of processing and circulation, and enhance the vitality of agricultural development. The integrated development of primary, secondary and tertiary industries in rural areas can produce a multiplier effect and form new benefits and competitiveness.

From the industries related to the vitivinicultural sector, it also involves the industrial integration based on the agriculture. Grape planting, processing, and tourism also involve the primary, secondary, and tertiary industries.

The relationship of the vitivinicultural sector integration can be represented by the following figure (Figure 1):

Figure 1. Industry convergence of vitivinicultural sector



2.2 **Data sources**

The analysis data mainly comes from five aspects: basic geographic information data, international statistical data, domestic statistical data, Baidu map POI acquisition, and data in research literature.

2.2.1 Basic geographic information data

Spatial analysis requires basic geographic information data of the research area.

Three-level administrative division data of provinces, cities and counties in China, sourced from OpenStreetMap , website: https://www.openstreetmap.org/

China's DEM digital elevation data, from the geospatial data cloud, website: http://www.gscloud.cn/sources/accessdata/421 ? Pid=302

2.2.2 International vitiviniculture statistics

Mainly from two sources:
FAO database, website: http://www.fao.org/faostat/en/#data
International Organization of Vine and Wine, website: https://www.oiv.int/

The paper retrieved the data needed including the global and major countries ' vineyard surface area, grape production, table grape production, dried grape production, grape juice and musts production, wine production, wine consumption, and wine import and export data in the past two decades (2000-2019).

2.2.3 China's vitiviniculture statistics

Mainly from the database of the National Bureau of Statistics of China, website: https://data.stats.gov.cn/english/

Data retrieved includes dozens of vitiviniculture-related worksheets, hence sorted as the vineyard areas, grape productions, wine productions, etc. of nation level and the provincial level for the last two decades (2000-2019).

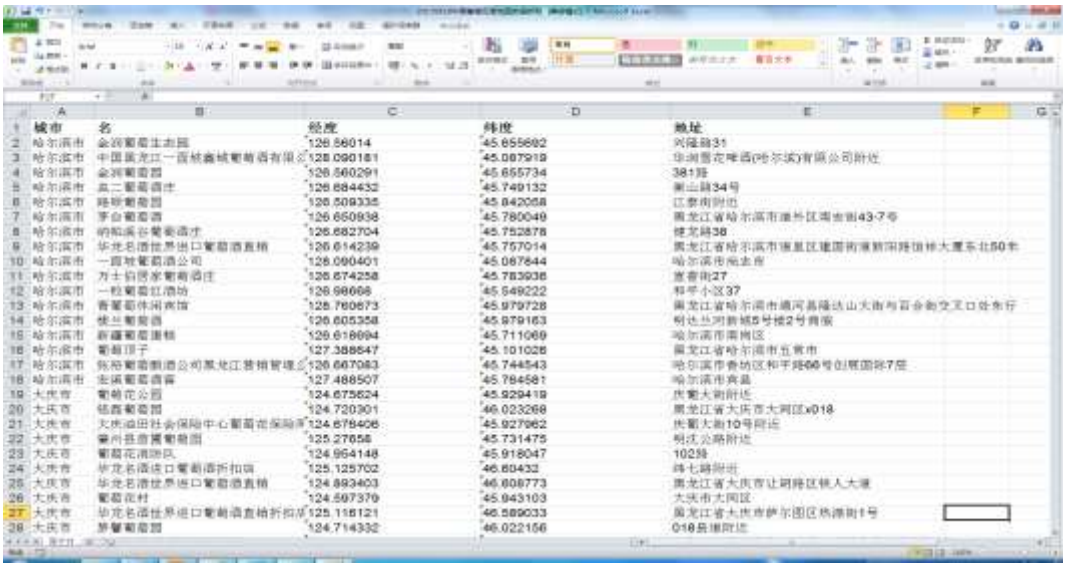
All statistics about China in this paper only include 31 provinces, municipalities and autonomous regions in the mainland, excluding Hong Kong SRA, Macao SRA and Taiwan regions.

2.2.4 Baidu Map Points of Interest (POI)

(1) Retrieve the names of units related to "Grapes" in Baidu online map to get the Point of Interest (POI).

(2) Data retrieved include 3918 pieces of original records , and the information of each record includes: city, name of POI, longitude, latitude, and address (Figure 2).

Figure 2. Baidu Map Points of Interest of vitivinicultural sector in Mainland China



2.2.5 Data from the research literature

The data from the literature mainly refers to the spatial data of the main grape producing areas in China admitted in the literature. After decades of development, China's vitivinicultural sector has gradually formed ten major grape producing areas (Anonymous, 2011a) (Anonymous, 2011b) , which set up the foundation of China's vitivinicultural sector for the 21st century. After processing the literature data, we can learn about China's main producing areas, representative regions, main grape cultivars, and representative wine companies.

Table 1. China traditional Top10 grape producing areas

Producing area	Representative regions	Main grape cultivars	Representative wine company
Yellow River Old Course Producing Area	Lankao and Minquan in Henan, Xiaoxian in Anhui and parts of northern Jiangsu	Cabernet Sauvignon	Minquan
Yunnan Producing Area	Maitreya, Mengzi, Dongchuan and Chenggong counties	Rose Honey, Merlot, Cabernet Sauvignon, Vitis quinquangularis Rehd	Gaoyuan, Shenquan
Hexi Corridor Producing	Wuwei, Minqin, Gulang, Zhangye and other counties	Cabernet Gernischt, Cabernet Sauvignon, Pinot	Mogao, Qilian

Area		Noir, Merlot	
Northeast Producing Area	Changbai Mountain and Northeast Plain	Vitis amurensis	Tonghua
Xinjiang Producing Area	Shanshan, Manas Plain and Shihezi area in Turpan Basin	Cabernet Sauvignon, Cabernet Franc, Chardonnay, Italian Riesling	Loulan, CITIC Guoan, Xintian International
Changli Producing Area	Changli, Lulong, Funing, Qinglong County	Cabernet Sauvignon, Merlot, Chardonnay	Langes, COFCO, Maotai
Shacheng Producing Area	Xuanhua, Zhuolu, Huailai County, etc.	Longan, Cabernet Sauvignon, Chardonnay	Chateau SunGod GreatWall, Rong Chen, Martin, Domaine Franco Chinois
Tianjin Producing Area	Tianjin Ji County , Hangu, etc.	Muscat Hamburg, Cabernet Sauvignon, Merlot	
Helan Mountain Producing Area	Ningxia area	Cabernet Sauvignon, Cabernet Gernischt, Merlot, Syrah, Chardonnay	Xixia King, Guangxia, Xiangshan, Imperial Horse , Yuquan
Jiaodong Peninsula Producing Area	Yantai, Pingdu, Penglai, Longkou, etc.	Chardonnay, Cabernet Sauvignon, Cabernet Gernischt	Changyu, COFCO, Dynasty, Grand Dragon

Source: According to literature and network data

2.3 **Research methodology**

(1) Literature method

Literature method is used to retrieve data or researches from statistical yearbooks, professional organization databases, governmental websites, journal databases etc. to understand the status of the global and China vitivinicultural sector.

(2) GIS spatial analysis method

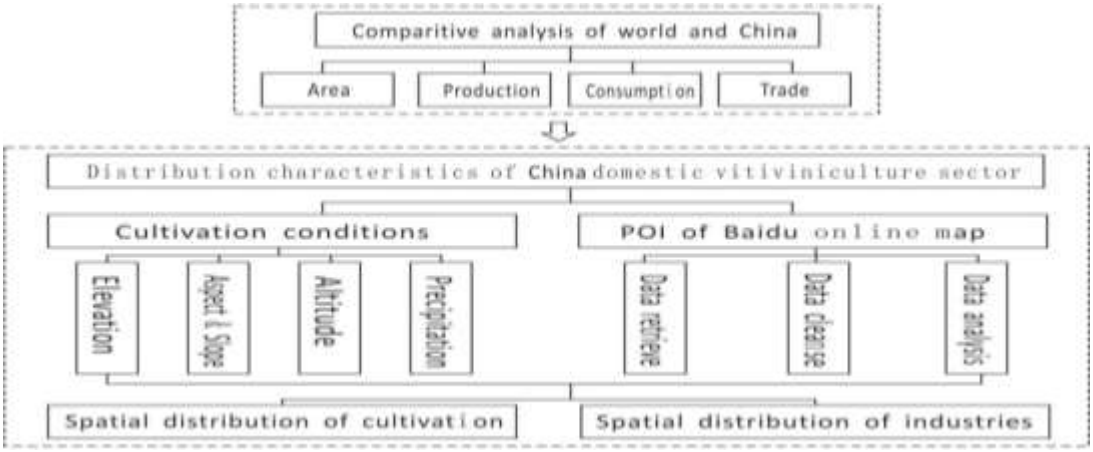
Retrieve China's POI information related to the vitivinicultural sector in Baidu Maps.

Then establish a national vitivinicultural sector spatial database, including vitivinicultural sector statistical data of the 31 provinces from 1996 to 2019, geographic location data of the relevant units of the retrieved Baidu POI, the natural conditions data for grape planting, data of administrative districts by levels of provinces, cities, and counties, location data of potential markets by GIS buffer of 100km and 200km circles centered on provincial capitals, etc. Comprehensively consider the interrelationships between various elements, and use GIS related spatial analysis modules to analyze the current characteristics of China's vitivinicultural sector.

(3) Research roadmap

The research roadmap is as showed in (Figure 3).

Figure 3. Research roadmap



2.4 **Data processing**

2.4.1 POI data cleaning, classification and verification

Data cleaning. Baidu Maps POI is retrieved by using "Grape" as the key word. There are 3918 pieces of records. Some of the records are the name of places irrelative with vitivinicultural sector. These data should be cleaned up, the terms like Putao Cun (Grape Village), Putao Jie (Grape Street), Putao Gou (Grape Valley), Putao Ling (Grape Ridge), etc.

After cleaning, 3175 effective data are left.

Data Classification. Effective data is simply classified according to the requirements of industry analysis and spatial analysis, mainly including grape plantations, grape processing, wineries, grape tourism, grape consumption, grape research, etc. Of all the records, there are W1183 grape gardens, 9 grape juice and musts plants, 16 dried grapes plants, 59 wineries, 143 wine chateaus, 357 grape-related tourist attractions (including 29 grape-picking gardens, 217 vineyards, 20 grape farms, 20 grape villas), 1736 wine shops, 87 research institutes and technology Associations.

In this database, the primary industry mainly includes grape planting, the secondary industry includes grape processing (wine, grape juice and musts, dried grapes), and the tertiary industry includes grape trade, scientific research, tourism, etc. Some records may overlap, for example, the grape-picking garden must also be a grape plantation (Table 2).

Table 2. Industry categories and codes of vitivinicultural sector POI

POI keywords	**Industry category**	**Industry category**	**Self- coding**
vineyard	primary industry	Fruit cultivation	101
Grape plantation	primary industry	Fruit cultivation	102
Vine Professional Cooperative	primary industry	Fruit cultivation	103
Grape base	primary industry	Fruit cultivation	104
Grape picking garden	primary industry	Fruit cultivation	105
Vineyard	primary industry	Fruit cultivation	106
Grape farm	primary industry	Fruit cultivation	107
Grape hills	primary industry	Fruit cultivation	108
Winery	Secondary industry	Wine making	201
Grape juice and musts factory	Secondary industry	Beverage manufacturing	202
dried grape Plant	Secondary industry	Fruit processing	203
Wine store	Tertiary Industry	Wholesale and retail	301
Grape Research Institute	Tertiary Industry	Technical Services	302
Grape picking garden	Tertiary Industry	Tourism services	303
Vineyard	Tertiary Industry	Tourism services	303
Grape farm	Tertiary Industry	Tourism services	303
Grape hills	Tertiary Industry	Tourism services	303

Note: Partly refer to "Classification and Code of National Economic Industries (GBT 4754-2017)"

Data validation. Baidu map data certainly cannot reflect the situation of all the vitivinicultural sector sites in China, but at least it is the most timely and reliable data source available. We need to check whether the coverage of the data is complete and take samples to understand the authenticity of the data. After comparing one by one, among the 347 prefecture-level cities and 4 municipalities directly under the Central Government on Baidu Maps, 55 prefecture-level cities are data deficient. Most of them are situated in provinces such as Hainan, Qinghai, Yunnan, and Xizang (Tibet) whose natural conditions are not suitable for grape cultivation. That's shows that the retrieved Baidu map data coincides with the facts. In addition, a random inspection of the data in Wuhan City, Hubei Province, shows that it was basically consistent with the actual situation.

2.4.2 Compilation of China's vitivinicultural sector statistics

In the data preparation process, the data retrieved in the UN Food and Agriculture Organization's database, the International Organization of Vine and Wine's annual reports, and the National Bureau of Statistics of China have been sorted out and checked. The general principle is that the international comparative data adopts data from international organizations, and the data analyzed in China adopts data from the National Bureau of Statistics of China. Where there are inconsistencies between the new and old data, replace the old data with the new ones.

The annual macro data of China is attached here (Table 3, Table 4, Table 5), because these data are the basis of the analysis later and may be of some reference value for readers. China's sub-provincial data and data of other countries are not included in this paper.

Table 3.Main Orchards surface area in Mainland China(1996-2019)

Indicators(1000 hectares)	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Area of Orchards	8,553.00	8,648.00	8,535.00	8,667.00	8,931.58	9,042.55	9,097.87	9,436.52	9,768.18	10,034.80	10,122.56	10,119.50
Area of Bananas Orchards	175.5	180	178.02	202.69	249.19	244.98	247.94	255.53	264.42	276.35	285.65	302.12
Area of Apples Orchards	2,986.80	2,838.30	2,621.47	2,439.14	2,254.13	2,066.22	1,938.31	1,900.37	1,876.60	1,890.37	1,898.88	1,873.26
Area of Citrus Orchards	1,279.80	1,309.20	1,270.42	1,282.83	1,271.78	1,323.68	1,404.53	1,505.73	1,627.23	1,717.01	1,814.59	1,836.96
Area of Pears Orchards	931.9	924	927.8	976.67	1,014.64	1,026.46	1,042.26	1,061.51	1,078.60	1,112.04	1,087.11	1,019.72
Area of Grapes Orchards	153.5	157.9	176.44	223.21	282.97	334.38	392.33	420.83	413.5	407.92	418.73	427.28

Indicators(1000 hectares)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Area of Orchards	10,220.71	10,454.39	10,681.02	10,808.06	10,989.70	11,043.33	11,607.66	11,212.20	10,916.64	11,148.62	11,874.85	12,276.68
Area of Bananas Orchards	309.42	320.86	333.78	354.67	357.47	364.37	365.47	355.39	350.1	351.03	331.9	
Area of Apples Orchards	1,853.66	1,882.37	1,930.27	1,945.75	1,976.42	1,967.08	1,974.06	1,983.02	1,945.53	1,946.95	1,938.57	
Area of Citrus Orchards	1,900.75	2,000.23	2,025.35	2,077.21	2,111.72	2,175.95	2,160.72	2,229.80	2,327.56	2,439.02	2,486.69	
Area of Pears Orchards	1,011.22	994.8	970.27	975.53	969.72	979.62	964.24	974.17	930.82	922.78	943.42	
Area of Grapes Orchards	433.07	465.52	513.17	550.28	612.75	646.57	689.05	716.41	716.21	706.55	725.1	

Note:According to the results of the Third National Agricultural Census, data on agricultural production from 2007 to 2017 were revised.

Data Sources：National Bureau of Statistics

Table 4. Output of main fruits in Mainland China (1996-2019)

REALIS | **Digital Object Identifier (DOI):** 10.51359/2179-7501.2021.252153

Indicators(1000 hectares)	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Area of Orchards	4,652.82	5,089.32	5,452.85	6,237.64	6,225.15	6,658.00	6,951.98	14,517.40	15,340.90	16,120.09	17,101.97	17,659.36
Area of Bananas Orchards	253.6	289.2	351.8	419.4	494.15	527.24	555.7	590.33	605.61	651.81	690.12	763.95
Area of Apples Orchards	1,704.70	1,721.90	1,948.10	2,080.20	2,043.12	2,001.50	1,924.10	2,110.18	2,367.55	2,401.11	2,605.93	2,734.72
Area of Citrus Orchards	845.7	1,010.20	859	1,078.70	878.31	1,160.69	1,199.00	1,345.37	1,495.83	1,591.91	1,789.83	2,036.40
Area of Pears Orchards	580.7	641.5	727.5	774.2	841.24	879.61	930.9	979.84	1,064.23	1,132.35	1,198.61	1,258.81
Area of Grapes Orchards	188.31	203.28	235.82	270.81	328.17	368	447.95	517.59	567.53	579.44	627.08	670.89

Indicators(10000 tons)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Output of Fruits	18,279.10	19,093.71	20,095.37	21,018.61	22,091.50	22,748.10	23,302.63	24,524.62	24,405.24	25,241.90	25,688.35	27,400.84
Output of Bananas	748.43	829.65	884.1	946.07	1,035.98	1,103.00	1,062.15	1,062.70	1,094.03	1,116.98	1,122.17	1,165.57
Output of Apples	2,899.46	3,047.49	3,164.91	3,367.28	3,581.36	3,629.81	3,735.39	3,889.90	4,039.33	4,139.00	3,923.34	4,242.54
Output of Citrus	2,296.96	2,471.73	2,581.74	2,864.12	3,089.43	3,196.39	3,362.18	3,617.53	3,591.52	3,816.78	4,138.14	4,584.54
Output of Pears	1,296.41	1,343.56	1,409.48	1,448.56	1,550.44	1,544.41	1,581.91	1,652.74	1,596.30	1,640.97	1,607.80	1,731.35
Output of Grapes	698.24	764.88	813.53	857.69	1,000.59	1,088.46	1,173.10	1,316.41	1,262.94	1,308.29	1,366.68	1,419.54

Note:According to the results of the Third National Agricultural Census, data on agricultural production from 2007 to 2017 were revised.

Data Sources：National Bureau of Statistics

Table 5. Other index of viniviticultural sector of Mainland China (2000-2019)

Indicators	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Table Grape Production (million tonnes)	1.3	1.7	2.3	2.9	3.3	3.4	3.7	3.9	4.3	4.9
Dried Grape Production (thousand tonnes)	85	85	85	90	95	105	125	150	150	185
import volume of wine（tonnes）	34571	29220	30224	41404	44105	53971	115507	148240	164861	172881
import value of wine（1000US$）	28119	23595	23085	33427	52746	75132	138181	256963	380406	457357

Indicators	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Table Grape Production (million tonnes)	5.6	6.2	7.4	8.5	9.2	9.4	10.0	10.1	10.5	9.5
Dried Grape Production (thousand tonnes)	135	100	150	165	180	190	165	180	190	
import volume of wine（tonnes）	286040	365535	394282	376690	384105	555088	638140	745364	683890	609952
import value of wine（1000US$）	797125	1436334	1580832	1554580	1518519	2038528	2364534	2797576	2855243	2444670

Data Sources：FAO, http://www.fao.org/faostat/en/#compare

3 Analysis of China's vitivinicultural sector in the global context

Although the subject of this paper is the development of China's vitivinicultural sector, the current situation of China's vitivinicultural sector compared with the international vitivinicultural sector can better illustrate the advantages and problems of China 's vitivinicultural sector.

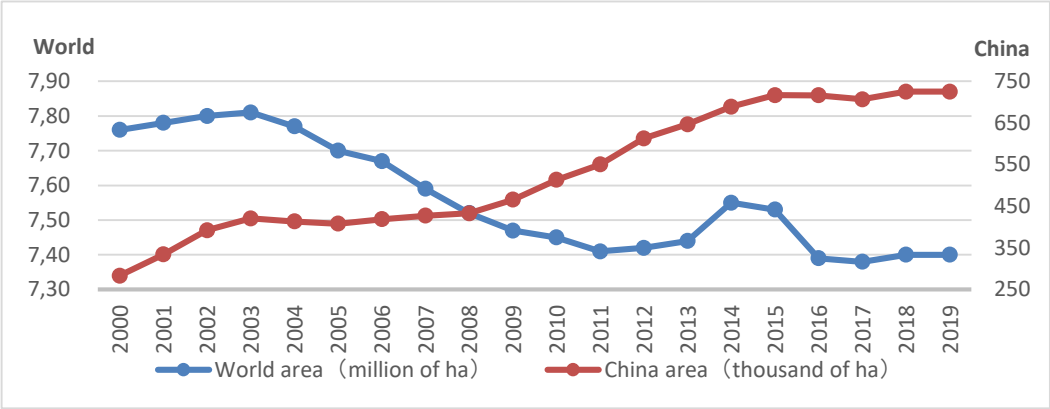
Grape is the crop with the highest agricultural output value among the global fruit crops. China has sprung up in the cultivation and consumption of grapes and trade. Comparing the status quo of China with that of the world will help to understand the status and development trend of China's vitivinicultural sector, and it will also help China to learn from international experience.

3.1 **The world's vineyard surface area has declined slightly, while China has become the second largest in the world**

Grapes are widely cultivated in the world. Europe is the traditional area of viticulture. Australia, the USA have achieved a big scale, and the Asian countries have been developing. China 's vineyard surface area has increased rapidly and has leapt to the second place in the world since 2014 (OIV, 2017) .

The evolution curve of the world's vineyard surface area reflects the changes in the world's from 2000 to 2019. It can be seen from the figure that the overall trend of the world's area has declined slightly in the past two decades. Among them, there has been a downward trend from 2000 to 2011, and only a slight rebound in 2012, experiencing slight fluctuations (Figure 4).

Figure 4. Evolution of world and China vineyard surface area



In this paper, China statistic includes mainland only, excluding Hong Kong, Macao and Taiwan

Sources: OIV, OIV Experts, Trade Press, China National Bureau of Statistics

OIV, State of the world viniviticultural sector in 2019

In China and South America (except Brazil, which seems to be proceeding with a significant restructuring of its vineyards), the total areas under vines continued to increase: these areas are the main vineyard growth centres in the world and China ranks second in the world in terms of vineyard surface area, with nearly 800 kha.in 2014 (Aurand, 2015), reaching 855 kha. in 2018 (Figure 6).

Table 6. Figure Vineyard surface area of major vine-growing countries[5]

kha	2015	2016	2017	2018 Prov.	2019 Prel.	2019/2018 % Var.
Spain	974	975	968	972	966	-0.60%
China*	859	807	830	855	855	0.00%
France	785	786	788	792	794	0.20%
Italy	685	693	699	701	708	1.00%
Turkey	497	468	448	448	436	-2.80%
USA*	446	439	434	408	408	0.00%
Argentina	225	224	222	218	215	-1.40%
Chile	214	209	207	203	200	-1.30%
Portugal	204	195	194	192	195	1.20%
Romania	191	191	191	191	191	0.00%
Iran*	217	168	153	177	177	0.00%
India*	129	131	147	149	149	0.00%
Australia	147	145	145	146	146	0.10%

[5]Countries with vineyards larger than 45 kha in 2019.

Moldova	140	145	151	147	143	-2.90%
South Africa	133	130	128	123	122	-0.20%
Uzbekistan*	129	121	111	108	108	0.00%
Greece*	107	105	*106*	106	106	0.00%
Germany	103	102	103	103	103	0.00%
Russia	85	88	90	93	95	1.40%
Afghanistan*	85	89	94	94	94	0.00%
Egypt*	81	83	84	85	85	0.00%
Brazil	87	86	84	82	81	-0.30%
Algeria*	71	76	75	75	75	0.00%
Hungary	68	68	68	69	69	-0.30%
Bulgaria	64	64	65	67	67	0.60%
Georgia	48	48	48	48	49	2.20%
Austria	45	46	48	49	48	-0.30%
Peru	33	36	38	41	48	17.40%
Other countries	687	677	671	667	668	0.10%
World total	**7540**	**7398**	**7390**	**7409**	**7402**	**-0.10%**

Sources: OIV, OIV Experts, Trade Press

Figure in Italics : OIV estimates

* Carried over from latest available data

In 2019, the world's vineyard surface area totaled 7402 thousand hectares (kha.), and the top five countries together accounted for more than half of the world's surface area, i.e. Spain, China, France, Italy, and Turkey (Figure 5).

Top 5 vine-growing countries represent more than 50 % of the world vineyard surface area in 2019.

Figure 5. Breakdown of vineyard surface area by countries in 2019

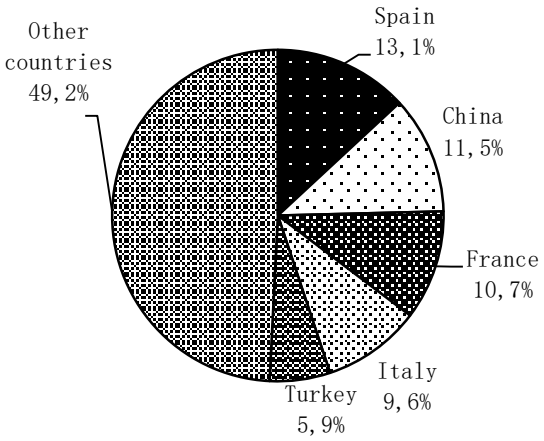


Figure in Italics: OIV estimates

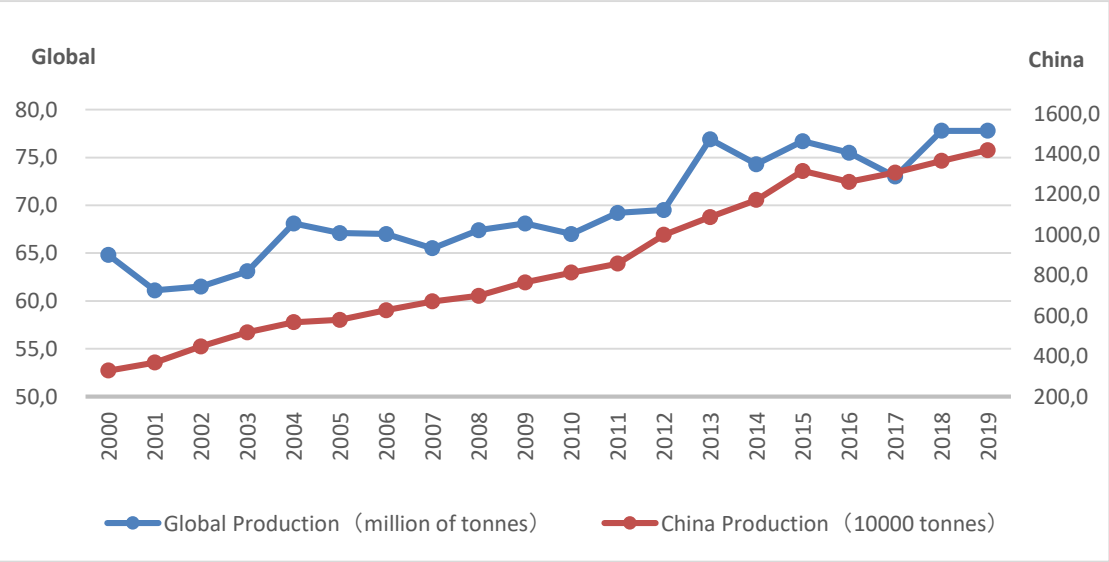
Area of China Carried over from latest available data

Sources: OIV, FAO, Press, State of the world viniviticultural sector in 2019

3.2 World production continues to rise, while China ranks first in the world

Despite the decline in vineyard surface area, global grape production has continued to rise, with slight fluctuations in recent years (Figure 6)，China 's grape production has been growing and has ranked first in the world (Figure 7).

Figure 6. Evolution of global and China grapes production



Sources: OIV, OIV Experts, Trade Press, China National Bureau of Statistics

OIV, 2019 Statistical Report On World Vitiviniculture

In the context of the decline in the world's vineyard surface area, the world's grape production continues to rise, indicating that grape planting techniques have been improved, and the yield per unit area has increased significantly.

Figure 7. Breakdown of grape production by counties in 2018

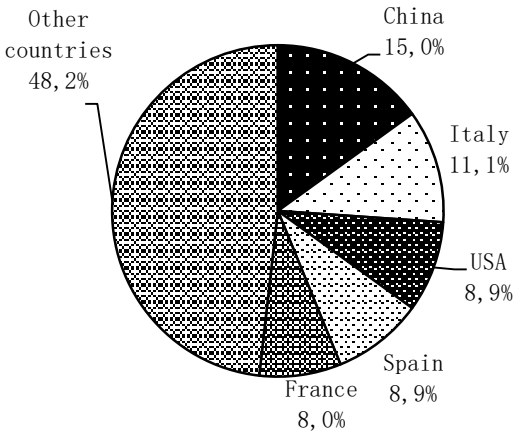


Figure in Italics: OIV estimates

Area of China Carried over from latest available data

Sources: OIV, FAO, Press, State Of The World Viniviticultural Sector In 2019

3.3 **European and American grapes are mainly used for wine-making, while China's grapes are mainly for table grapes**

In terms of grape utilization, the proportion of table grapes in the world is slowly increasing, but the share of wine grapes still accounts for the main proportion. Taking 2018 as an example, the share of wine grapes accounted for 57% , table grapes accounted for 36% , and dried grapes accounted for 7% (OIV, 2019) (Table 7).

Table 7. Major grape producers of the world[6]

million tonnes	2014	2015	2016	2017	2018	Table grape	Dried grape	Wine grape
China	12.5	13.2	12.6	13.1	11.7	84.10%	5.60%	10.30%
Italy	6.9	8.2	8.4	6.9	8.6	13.50%	0.00%	86.50%

[6]Countries with a production of more than 1 million of tonnes

USA	7.1	6.9	7	6.7	6.9	16.30%	18.10%	65.60%
Spain	6.1	6	6.3	5	6.9	4.00%	0.00%	96.00%
France	6.2	6.3	6.3	5	6.2	0.40%	0.00%	99.60%
Turkey	4.2	3.7	4	4.2	3.9	56.10%	40.70%	3.20%
India	2.6	2.6	2.6	2.9	2.9	92.60%	5.90%	1.50%
Argentina	2.7	2.5	1.9	2.1	2.7	0.90%	5.50%	93.70%
Chile	2.2	2.7	2.2	2	2.5	26.00%	3.90%	70.20%
Iran	2.3	2.3	2.3	1.9	2.3	76.30%	23.70%	0.00%
Australia	1.8	1.9	2	2.2	1.9	7.10%	1.90%	90.90%
South Africa	1.9	2	2	2	1.8	15.80%	15.50%	68.70%
Uzbekistan	1.4	1.6	1.6	1.6	1.7	78.40%	17.80%	3.70%
Egypt	1.6	1.7	1.7	1.7	1.6	99.50%	0.00%	0.50%
Brazil	1.4	1.5	1	1.7	1.6	53.50%	0.00%	46.50%
Germany	1.2	1.2	1.2	1	1.4	0.40%	0.00%	99.60%
Romania	0.7	0.8	0.8	1	1.3	6.90%	0.00%	93.10%
World	**74.3**	**76.7**	**75.5**	**73**	**77.8**	**36%**	**7%**	**57%**

sources: OIV, OIV Experts, Trade Press

Dried grape converted in fresh grape. On average 4 kg to obtain 1 kg of raisin

OIV conversion factor used: production of wine* 1.325 kg of fresh grape, average quantity necessary to obtain 1 hl of wine

Musts & juices included

Judging from the data of the top countries in the world's total grape production, Europe, America and Asia are very different in grape utilization.

In the West, especially Europe, the proportion of wine grapes is extremely high. Germany accounted for 99.6%, France 99.6%, Spain 96.0%, and Italy 86.5%.

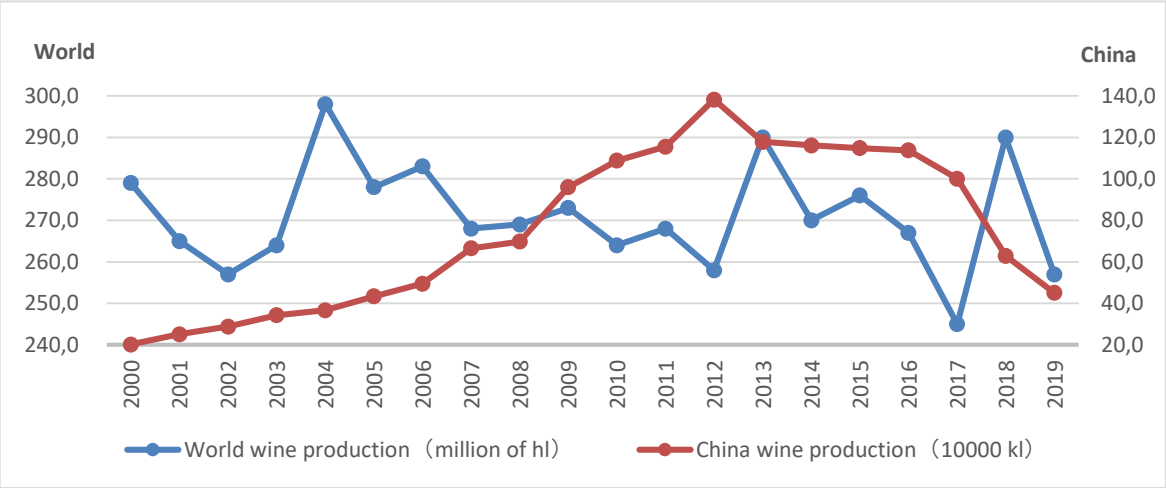
While in China, table grapes are the main product, up to 84.1%, which is in sharp contrast with Europe and the United States. Egypt’s table grapes account for 99.5% of the country’s grape production, India’s 92.6%, Uzbekistan 78.4%, and Iran 76.3%.

In terms of table grapes, according to the data in 2018, China's production is the world's largest, accounting for 34.8%, while the second-ranked country accounts for only 7%. The production of dried grapes made in China is the third in the world, behind Turkey and the United States, with a ratio of 14.1% (2019, FAO, OIV).

3.4 **The world's wine production is stable, while China's wine production is falling**

The world's wine production has not changed much. Except for 2004 and 2013, which were slightly higher, it was basically around 27 billion liters (mhl.). Such global wine production can be described as relatively average (Figure 8).

Figure 8. Evolution of world and China wine production (juices and musts excluded)



Sources: OIV, OIV Experts, Trade Press, China National Bureau of Statistics
OIV, State Of The Viniviticultural Sector In 2019

China's wine production accounted for the tenth place in the world in 2019, but the wine production has been declining year by year since 2012 , and has declined rapidly since 2016.

3.5 **World consumption and trade are active, while China's consumption and imports are strong**

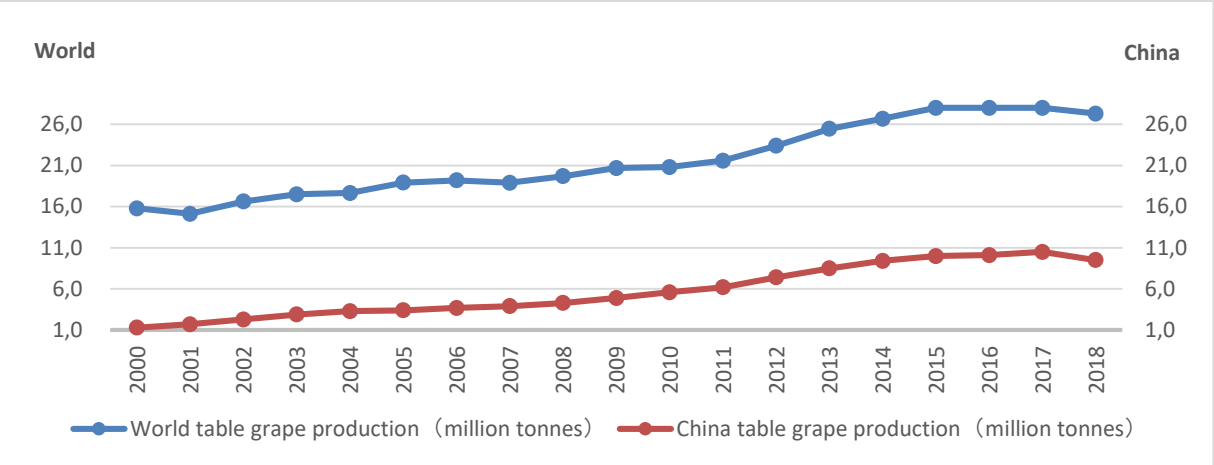
3.5.1 Consumption and trade of table grapes and dried grapes

Grape is the fruit crop with the highest total value of production in the world followed by apples, watermelons, bananas, mangoes , and oranges (Focus, 2016) . The data in 2018 is used here, which is the latest global comparison data available.

In terms of table grape production, China, India, and Turkey account for nearly half of the world's production, followed by Iran and Egypt. The production shares of these

countries are 34.8%, 7% , 7% , 6.2% , and 5.5% respectively . Chin's production in 2018 grew by 631% as against 2000, the growth rate is much higher than that of the world which is 73% (Figure 9).

Figure 9. Evolution of world and China table grape production



Sources: OIV, OIV Experts, Trade Press

FAO-OIV FOCUS 2016, Tabel and Dried Grapes, ISBN 978-92-5-109708-3, 2019 Statistical Report On World Vitiviniculture

The world's table grape consumption increased by 73% from 2000 to 2018, while China's consumption increased by 571%. In 2018, China accounted for 35% of global consumption, becoming the world's largest table grape consumer country, followed by India, Turkey, Egypt, Iran, and the United States.

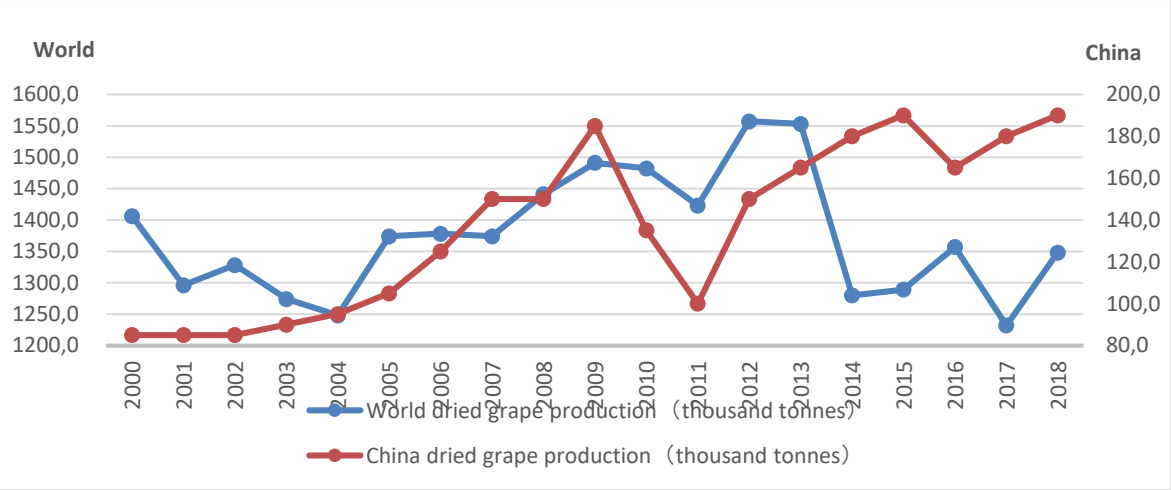
The main exporters of table grapes in the world are Chile, the United States, New Zealand, Peru, South Africa, and Turkey. The main importers are the United States, the Netherlands, Germany, Russia, the United Kingdom, China, and Canada.

Although China is the world's largest producer of table grapes and the production is growing rapidly, China rarely exports table grapes, instead, it is a great importer in the world.

Both the world and China's consumption of dried grapes have continued to grow

steadily (Figure 10). The major consumers of dried grapes in the world are the United States, Turkey, China (Mainland), Britain, Iran, Germany, the Netherlands, India, and Greece.

Figure 10. Evolution of world and China dried grape production



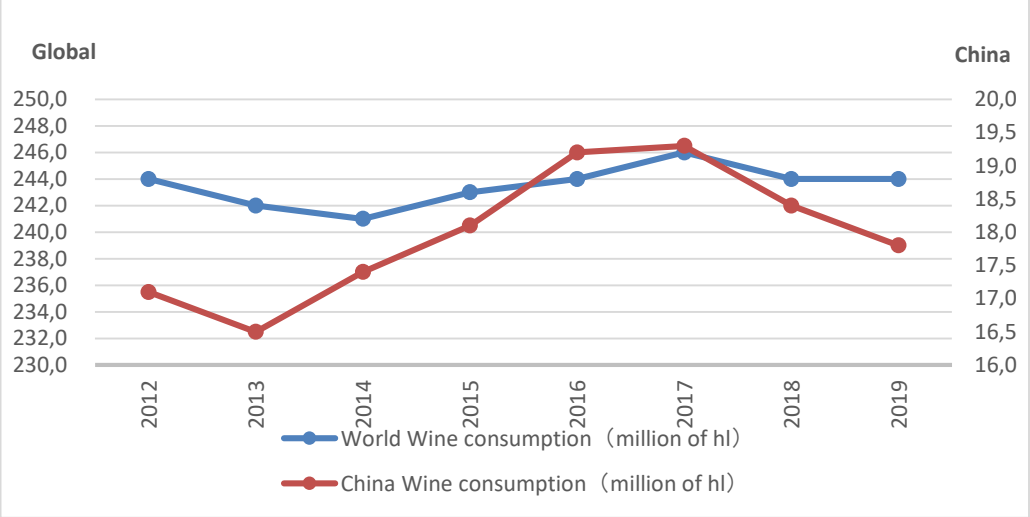
Sources: OIV, OIV Experts, Trade Press

FAO-OIV FOCUS 2016, Tabel and Dried Grapes, ISBN 978-92-5-109708-3, 2019 Statistical Report On World Vitiviniculture

3.5.2 Wine consumption and trade

The consumption of world wines (Including sparkling and special wines) has grown slowly , reaching 24.4 billion liters (mhl.) in 2019 . China accounts for the fifth place in global consumption. The main wine consuming countries are the United States (13.2%), France (11.2%), Italy (9.4%), Germany (8.1%), China (7.2%), and other countries (51.0%) (Table 8).

Figure 11. Evolution of world and China wine consumption



Sources: OIV, OIV Experts, Trade Press

OIV, 2017 World Vitiviniculture Situation, 2019 Statistical Report On World Vitiviniculture, State of the Viniviticultural Sector in 2019

Beginning in 2017, wine consumption in the world and China have both declined significantly (Figure 11).

Table 8. Major wine consumers of the world[7]

mhl.	2015	2016	2017	2018 Prov.	2019 Prov.	2019/2018 (% Var.)
USA	30.9	31.3	31.5	32.4	33	1.80%
France	27.3	27.1	27	26.7	26.5	-0.60%
Italy	21.4	22.4	22.6	22.4	22.6	0.90%
Germany	20.5	20.2	19.7	20	20.4	2.00%
Mainland China	18.1	19.2	19.3	18.4	17.8	-3.30%
UK	12.8	12.9	13.1	12.9	13	1.00%
Spain	9.8	9.9	10.5	10.9	11.1	2.30%
Russia	9.7	10.1	10.4	9.9	10	0.90%
Argentina	10.3	9.4	8.9	8.4	8.5	1.30%
Australia	5.5	5.4	5.9	6	5.9	-1.00%
Portugal	4.8	4.7	5.2	5.1	5	-2.70%
Canada	4.8	5	5	4.9	4.7	-3.40%
South Africa	4.3	4.4	4.5	4.3	4	-6.20%
Romania	4	3.8	4.1	3.9	3.9	0.00%
Japan	3.5	3.5	3.5	3.5	3.5	1.00%

[7]Countries with wine consumption equal to or more than 2 mhl. in 2019.

Netherlands	3.5	3.6	3.7	3.6	3.5	-1.80%
Brazil	3.3	3.1	3.3	3.3	3.3	0.50%
Switzerland	2.8	2.7	2.7	2.6	2.7	1.40%
Belgium	3	2.8	2.8	2.7	2.7	-2.50%
Chile	2.6	2.4	2.3	2.3	2.4	4.60%
Hungary	2.5	2.6	2.4	2.7	2.5	-8.50%
Sweden	2.3	2.4	2.3	2.3	2.3	-0.80%
Austria	2.4	2.4	2.4	2.4	2.3	-4.10%
Czech Republic	2.1	2.1	2.2	2.1	2.1	1.30%
Greece	2.4	2.4	2.4	2.2	2	-8.70%
Other countries	30.8	30.4	30.2	30.6	30.7	0.20%
World total	**243**	**244**	**246**	**244**	**244**	**0.10%**

Figure in italic: estimate OIV

Sources: OIV,FAO, Press

As shown in (Figure 11), in 2019 compared with 2018, traditional consumer countries basically maintained the consumption trend of the previous year, and Germany, Spain, and Chile even saw significant increases. However, China's decline reached 3.30%. According to Chinese scholars, this is mainly related to the return of Chinese consumers to rationality and trade conflicts (Zhao & Gan, 2020).

In terms of wine trade, China is not on the top list of exporter countries, but China ranks fifth among importer countries. More importantly, China's wine imports in 2019 increased by 113% as against 2010 (2020, FAO), the value of imports has increased by 207%, an increase far exceeding the volume of imports. The difference between the value of imports and the volume of imports also shows that Chinese wine consumers are increasingly paying attention to the quality and grade of wines (Table 9).

Table 9. Main wine importers of the world[8]

mhl.	**Volume (mhl.)**		**Value (bn EUR)**	
	2018	2019	2018	2019
Germany	14.7	14.6	2.7	2.6
UK	13.2	13.5	3.5	3.8
USA	11.5	12.3	5.2	5.5
France	7	7.2	0.9	0.9
China	6.9	6.1	2.4	2.2
Russia	4.1	4.5	0.9	1

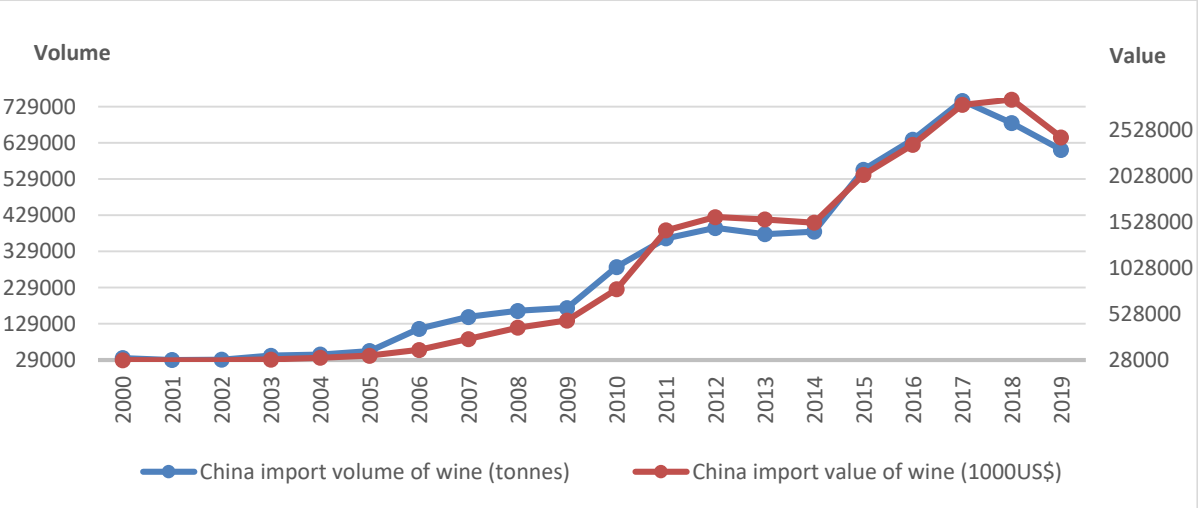
[8]Countries with import volumes equal to or over 2 mhl. in 2019.

Netherlands	4.2	4.2	1.2	1.2
Canada	4.2	4.2	1.7	1.7
Belgium	3	3.1	1	1
Portugal	2	2.9	0.1	0.2
Japan	2.6	2.8	1.4	1.6
Sweden	2.1	2.1	0.7	0.7

Sources: OIV, GTA

Although China's wine imports declined in 2017 (Figure 12), imported wine still accounted for 38.22% of China's total wine consumption in 2018 . It is predicted that China will become the world's second largest wine consumer behind the United States in 2021 (Zhao & Gan, 2020).

Figure 12. Evolution of China Wine Import Volume and Value



4 Differentiation analysis of China domestic vitivinicultural sector development

China has a vast territory, and there are much difference in latitude, altitude, topography, climate, soil, humanities and other conditions. Therefore, the cultivation of grapes in China will also show obvious spatial differences, and the development of the vitivinicultural sector will also be different. At the same time, due to the improvement of

cultivation technology and changes in market demand, grape cultivation is also a process of spatial shift. It is necessary to analyze the spatial distribution characteristics of China's vitivinicultural sector.

4.2 Data Analysis

4.1 Overall data analysis

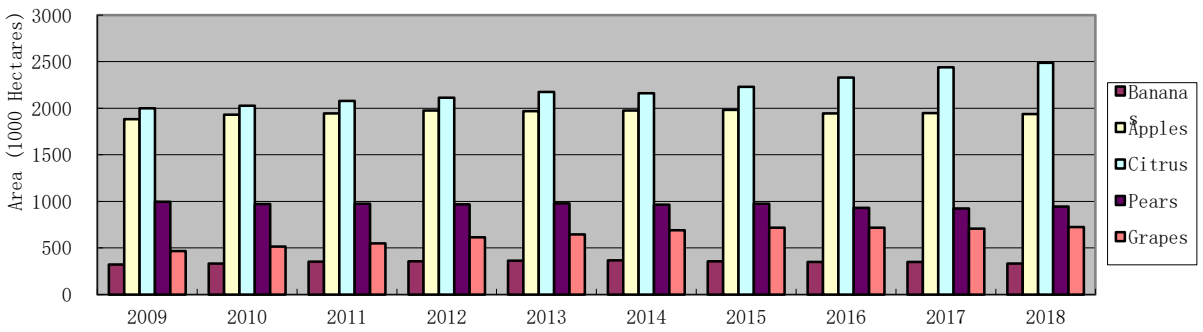
4.1.1 The relative importance of the vitivinicultural sector in China

China Statistical Yearbook provides data on the vitivinicultural sector in the past two decades. It is also possible to draw conclusions by selecting the data of ten years for analysis.

China's vineyard surface area ranks first in the world and its production ranks second. However, the status of vitivinicultural sector in China is different from that in the world. In the world, grapes occupy the first place in agricultural production value (Focus, 2016) , followed by apples, watermelons, bananas, mangoes , and oranges ; grapes occupy the second place in terms of production, the first is bananas, the third and fourth and fifth are apples, watermelons, and oranges . But in China, grapes occupy the fourth place the most. The vineyard surface area is behind citrus, apples and bananas, and the production is behind apples, citruses, and pears, the same level as bananas.

In general, the vineyard surface area and production of grapes and other major fruits in China have been continuously increasing (Figure 13, Figure 14).

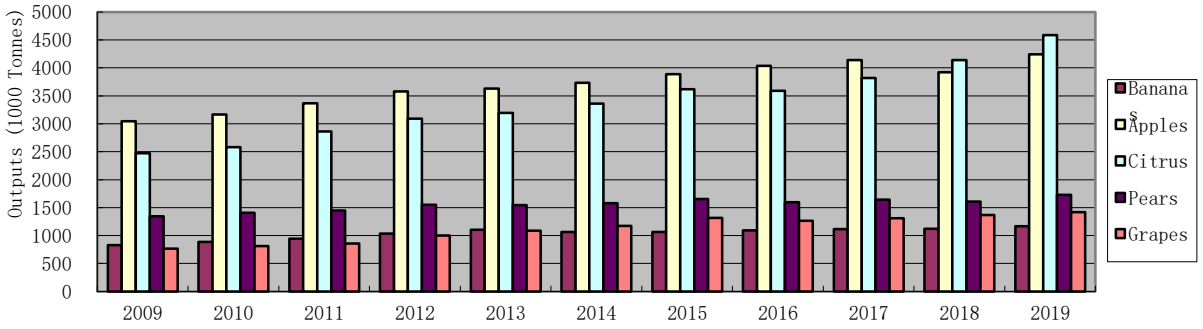
Figure 13. Evolution of the Main Orchards surface area in China



According to the results of the Third National Agricultural Census, data on agricultural production from 2007 to 2017 were revised.

Data Sources：China National Bureau of Statistics

Figure 14. Evolution of the Outputs of Main Fruits in China



According to the results of the Third National Agricultural Census, data on agricultural production from 2007 to 2017 were revised.

Data Sources：China National Bureau of Statistics

4.1.2 Changes in the distribution of vitivinicultural sector

Any economic sector is changing. As an sector that relies heavily on cultivation, the vitivinicultural sector also changes with the development of technology and social economy. A comparative analysis of the traditional industrial distribution and the current industrial distribution can reveal some characteristics.

4.1.2.1 Suitability analysis of traditional cultivation

Grapes are highly adaptable and can be grown in many places. This paper comprehensively analyzes the most suitable regions for grape growth in China from the natural conditions.

Grape growth is generally affected by altitude conditions, slope conditions, aspect conditions, latitude conditions, precipitation conditions, and soil conditions. With the improvement of breeding technology and the development of facility agriculture, the actual area where grapes are grown will be much larger than the analyzed area. The soil conditions are mainly related to grape cultivars, and this paper does not consider soil

conditions. The main conditions are as follows (Su, 2015) :

(1) Altitude conditions: the value is below 1500M.

(2) Slope conditions: the value is less than 25 degrees .

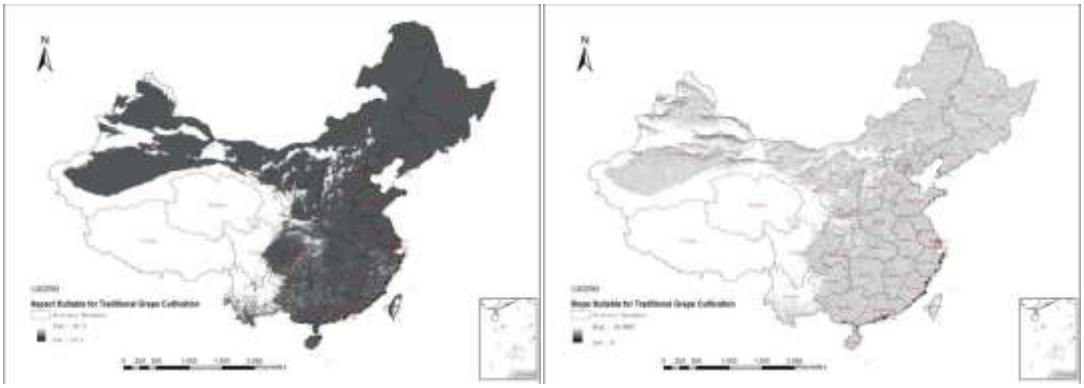
(3) Aspect conditions: south direction (including positive south direction, southwest and southeast direction).

(4) Latitude conditions: 30-43 degrees north (applicable to China)

(5) Precipitation conditions: 400-800 mm rainfall.

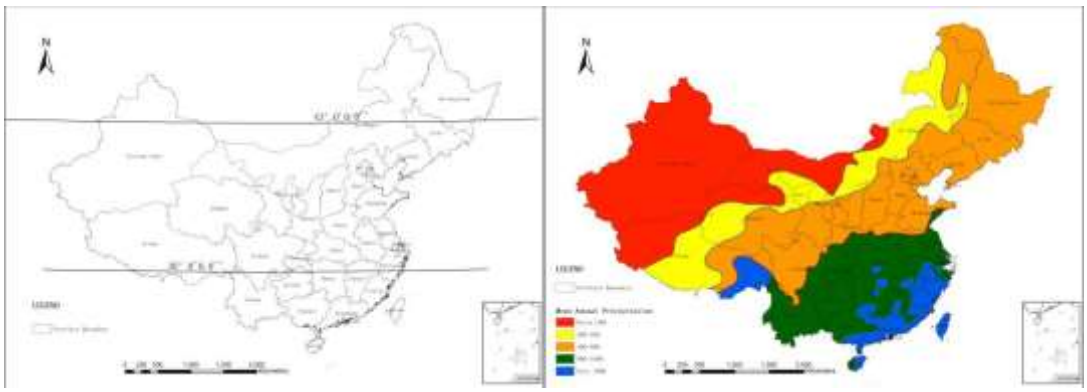
ArcGIS is the analyzing tool. Based On the DEM data of the whole country, the area below 1500 meters above sea level is extracted by using the “Raster Calculator” function under “Map Algebra” of spatial analysis tools. Then, the grape planting suitability distribution map based on terrain conditions was draw by using “Aspect” and “Slope” function of “Raster Surface” in 3D Analyst Tools (Figure 15).

Figure 15. Suitability analysis based on conditions of elevation, aspect and slope



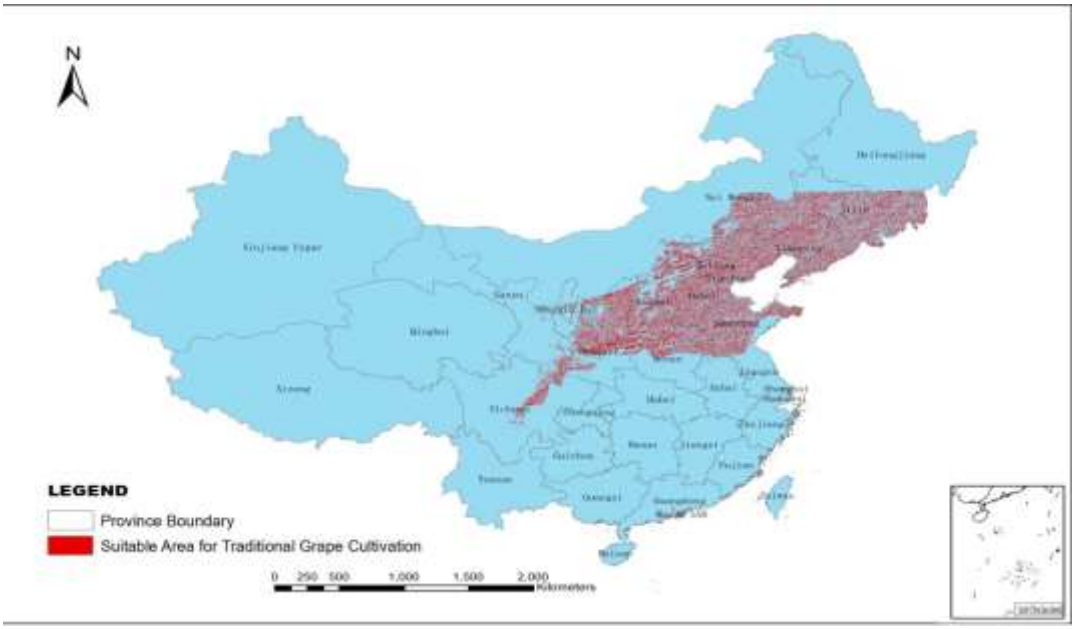
The grape planting suitability distribution map based on climate conditions was draw by using the data of latitude and precipitation (Figure 16).

Figure 16. Suitability analysis based on conditions of latitude and precipitation



The above maps are processed by overlay analysis to generate suitability analysis map of traditional grape cultivation in China (Figure 17).

Figure 17. Suitability analysis of traditional grape cultivation in China

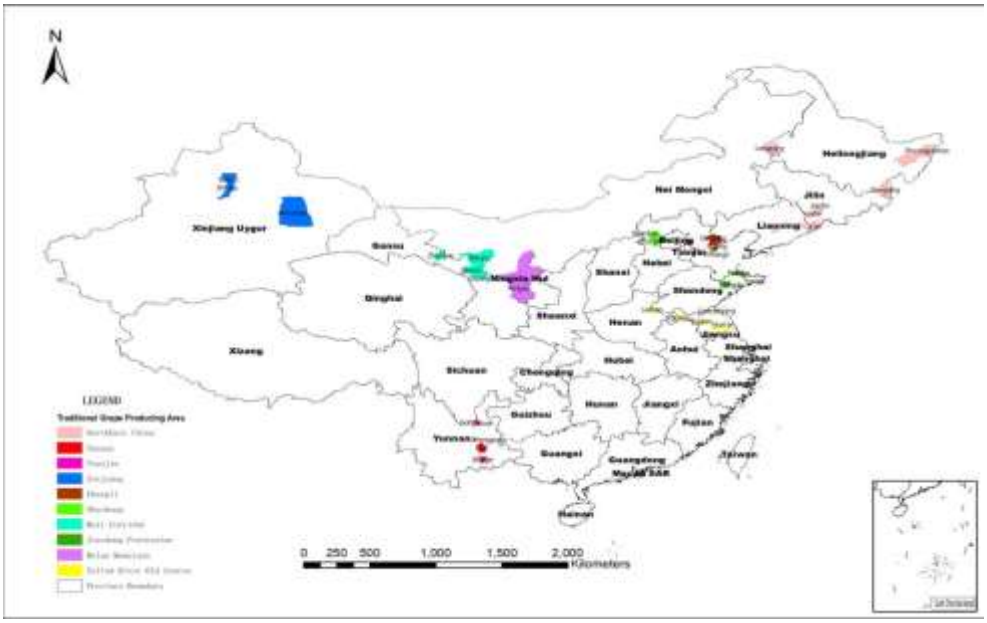


4.1.2.2 **Distribution of traditional grape producing areas**

According to the generally accepted literature, China has top ten grape-producing areas (Anonymous, 2011a) , (Anonymous, 2011b) . A map was draw in order to illustrate a more detailed visual presentation of the spatial distribution of China's grape-producing

areas. Open Street Map was processed as the base map by geographical coordinate projection and correction, of several administrative levels including counties. The important counties mentioned in the top 10 grape-producing areas were selected to form a distribution map of traditional grape producing areas in China (Figure 18).

Figure 18. China Top 10 traditional grape producing Areas

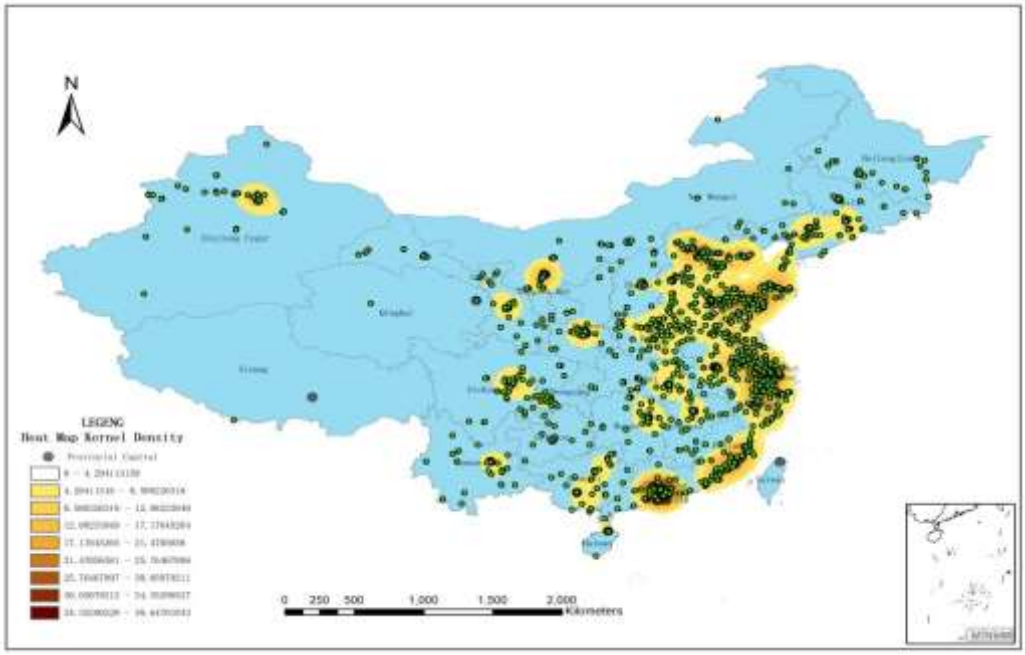


4.1.2.3 **The current degree of industry activity**

It is analyzed based on the 3175 valid Baidu map points of interest retrieved. POI contains the longitude and latitude coordinates of the points of interest, which can accurately display the spatial position of each point. Add the Baidu map POI data to China's basic geographic information database, perform Georeferencing, and establish a database for analysis.

Based on ArcGIS software, the “Kernel Density” function under “Density” in spatial analysis is used to automatically analyze the density distribution of various grape industries in China, and generate a heat map of the distribution of China's vitivinicultural sector (Figure 19). This figure illustrates the overall situation of China's current vitivinicultural sector distribution.

Figure 19. Kernel Density Heat Map of China vitivinicultural sector



Without considering the industry scale of each PIO and not singly considering farming, but taking into account the number of the primary, secondary and tertiary industries, the most active place is the Pearl River Delta region centered on Guangdong, the second level is the Yangtze River Delta region centered on Shanghai, the third level is the Shandong Peninsula region , the fourth level is Beijing , Ningxia , Liaoning and other places , and the following are the other traditional grape producing areas.

4.2 **Comparative analysis of China's vitivinicultural sector by provinces**

4.2.1 Analysis of vineyard surface area and production

The analysis of grape cultivation is based on the vineyard surface area and production data of China's provinces in 2018 and 2019 by China National Bureau of Statistics.

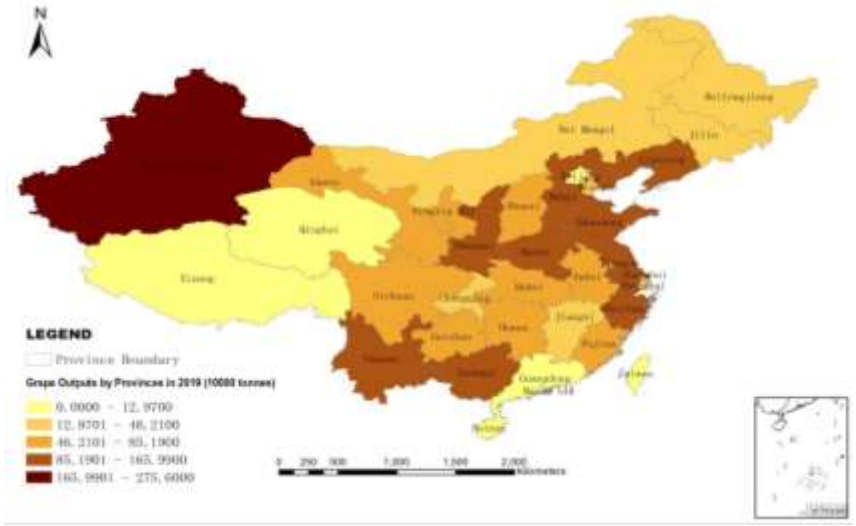
First, grape cultivation data of 31 provincial regions in China (excluding Hong Kong SAR, Macao SAR and Taiwan) were collected, including statistics of the vineyard surface area of the year 2018 and the statistics of grape production of the year 2019 (provincial areas of 2019 not yet published). Then the basic geographic information data of China

was imported into ArcMap with polygons of provincial level. New fields was added to the attribute of the province layer, with the surface area and production of the year 2018 as the new records. The provinces were classified into 5 levels by the field of vineyard surface area. It was generated the map of area of grape orchards by provinces of Mainland China in 2018 (Figure 20).

Figure 20. Area of grape orchards by provinces of Mainland China in 2018

The method is the same as above to generate the map of grape production by provinces (Figure 21).

Figure 21. Grape output by provinces of Mainland Chinain 2019

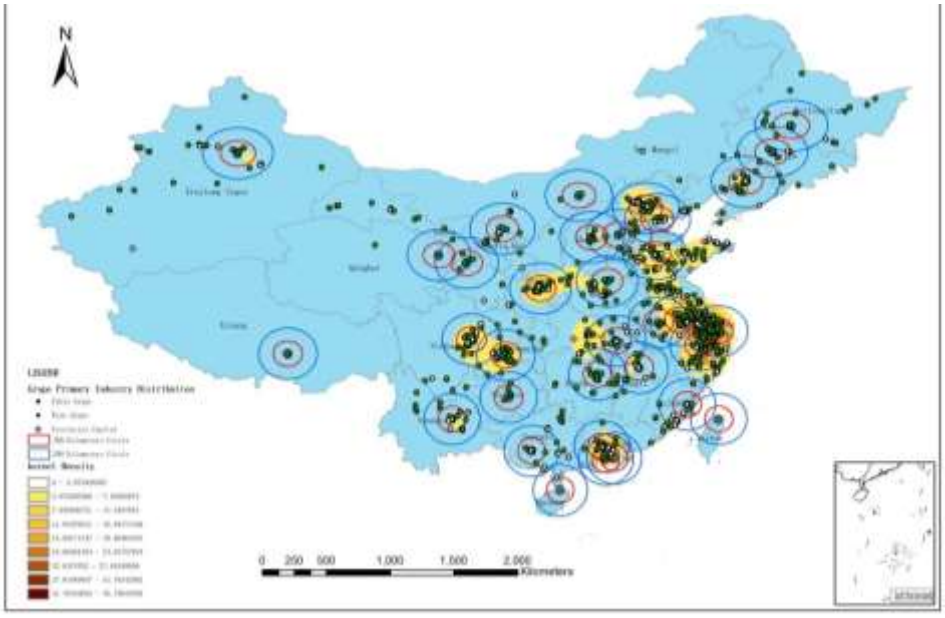


4.2.2 Analysis of the development of the primary, secondary and tertiary industries of vitivinicultural sector

Based on the industrial classification of Baidu map POI data (Table 2)，it's continued to process and refine the industrial analysis. As the industrial classification material was processed with Excel, it's needed to import the industry data into ArcMap. "Add data" of the excel datasets into the layers of MrcMap, "Display XY Data" by specify longitude as "X Field"and latitude ad "Y Field" and the shapefile of ArcGIS was generated and the points of the industries were displayed on the map. Analyze the primary industry, secondary industry, and tertiary industry respectively, and delineate two market reference circles of 100 kilometers and 200 kilometers centered on the potential markets, namely the provincial capitals.

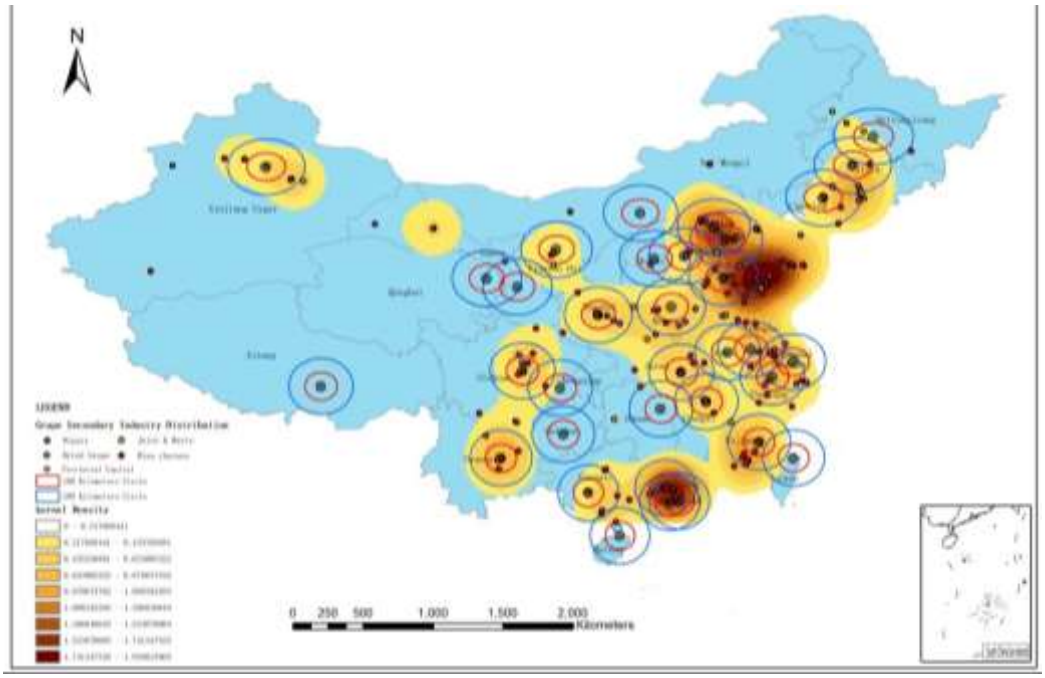
There are a total of 1183 primary industry data, which are classified into two sub-primary industry types: table grape planting and wine grape planting (including dried grapes and juice and musts grapes). Among them, there are 1040 table grape vineyards and 143 wine-making vineyards. Perform kernel density analysis on the primary industry data and mark the POI points of two types of sub-primary industries (Figure 22).

Figure 22. China grape primary industry distribution



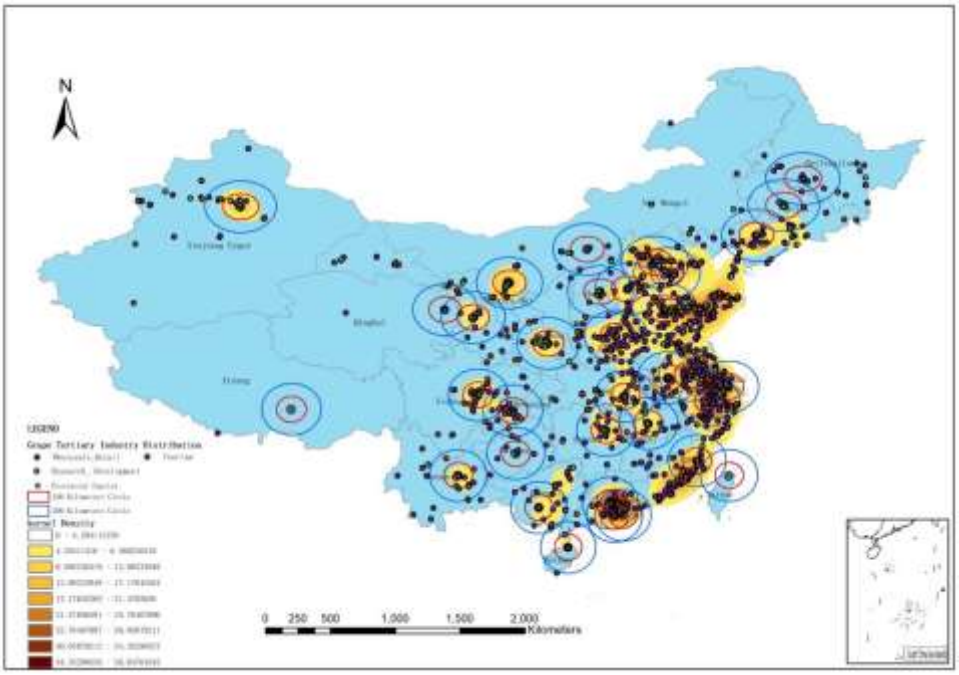
There are 227 secondary industry data, classified into four sub-secondary industry types: wine manufacturing, grape juice and musts manufacturing, dried grape processing, and chateau winery. Among them, there are 59 wineries, 9 grape juice and musts factories, 16 dried grape factories and 143 chateaus. Perform kernel density analysis on secondary industry data and mark POI points of four types of sub-secondary industries (Figure 23).

Figure 23. China grape secondary industry distribution



There are a total of 2,180 tertiary industry data, classified into three types of sub-tertiary industries: wine wholesale and retail, technical services, and tourism service. Among them, there are 1,736 wine shops, 87 technical service units, and 357 tourism attractions. Perform kernel density analysis on the tertiary industry data, and mark the POI points of three types of sub-tertiary industries (Figure 24).

Figure 24. China grape tertiary industry distribution



4.2.3 Analysis of shifts in the spatial gravity center of China's vitivinicultural sector

Due to the development of grape breeding technology and facility agriculture technology, grape cultivation has expanded from traditional vineyard surface areas to other places. The development trend of China's vitivinicultural sector can be revealed by comparing the distribution of traditional grape producing areas and calculating the changes in the spatial center of the vitivinicultural sector based on statistical data over the years.

4.2.3.1 **Growth trend of grape cultivation in various provinces**

Through the changes in the area and production of grapes planted in different provinces and regions from 1996 to 2019 , we can understand the growth trend of grape cultivation in various provinces and regions over the past two decades.(Figure 25,

Figure 26)

Figure 25. Evolution of grape orchard surface areas of Mainland China provinces

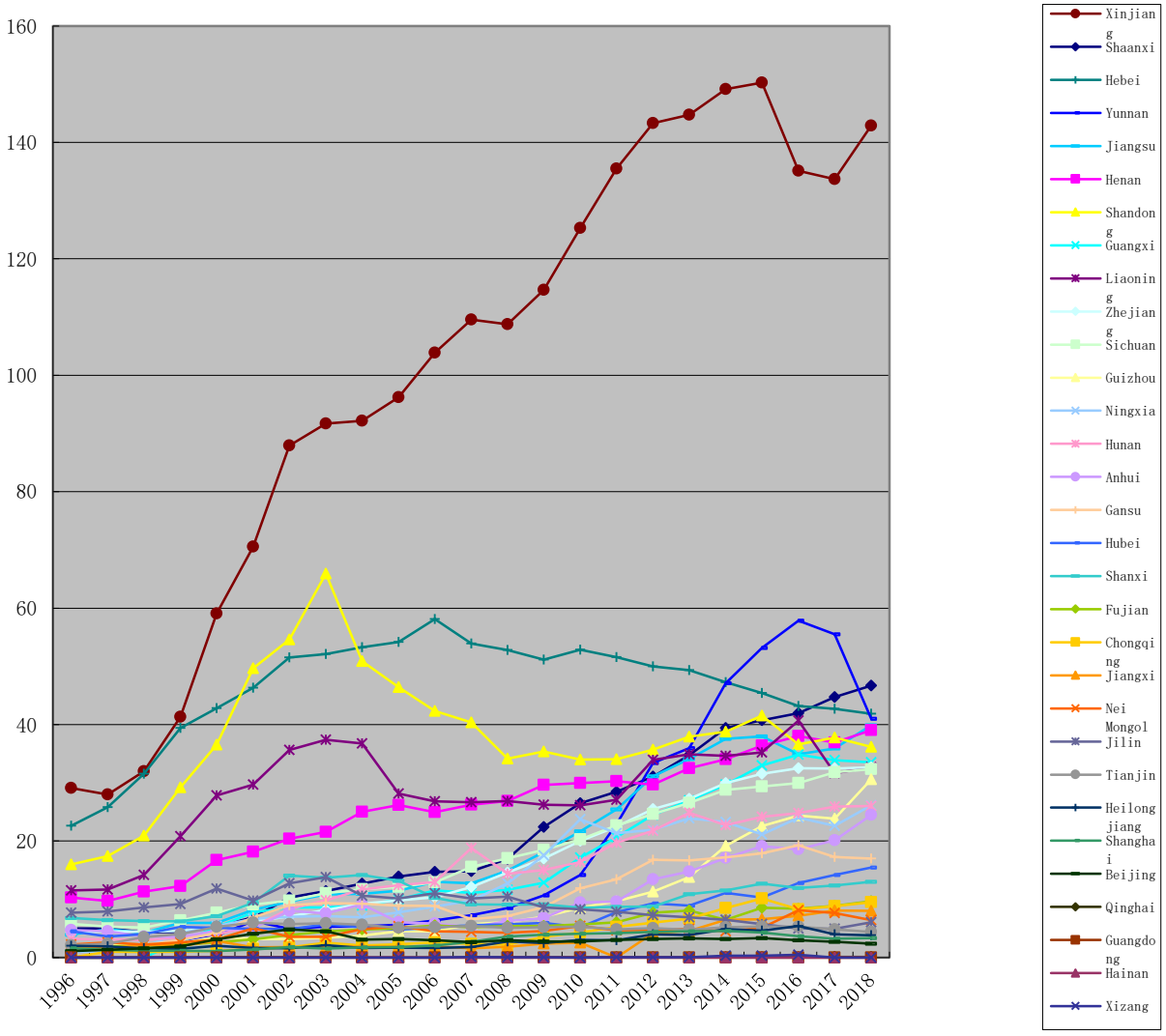
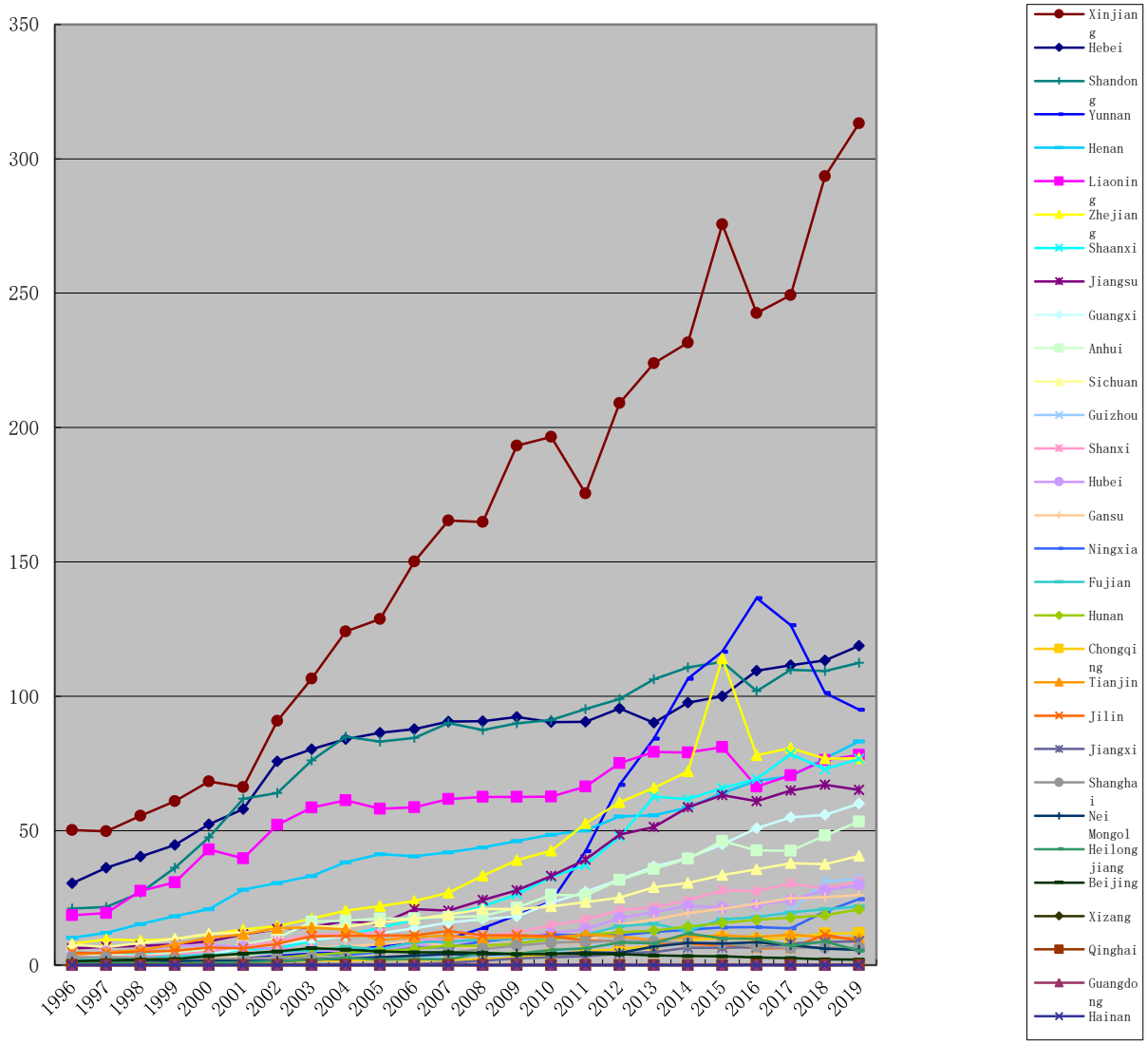


Figure 26. Evolution of grape productions of Mainland China provinces



4.2.3.2 **Shifts in the spatial gravity center of China's vitivinicultural sector**

Spatial geometric gravity center can directly express the spatial distribution characteristics of geographical objects. In the state of uneven distribution of geographical objects, the gravity center is located in the concentrated distribution area of geographical objects; the more serious the degree of uneven distribution of geographic things is, the farther the location of the gravity center is from the concentrated distribution area of geographic things (Guo, 1992). Therefore, by analyzing the differences of the geometric gravity center position of the objective in the regional

geography, we can not only find out whether the spatial distribution of the objective in the study area is balanced, but also obtain the gathering place of the objective. In this study, the formula for calculating the coordinates of the grape gravity center is as follows:

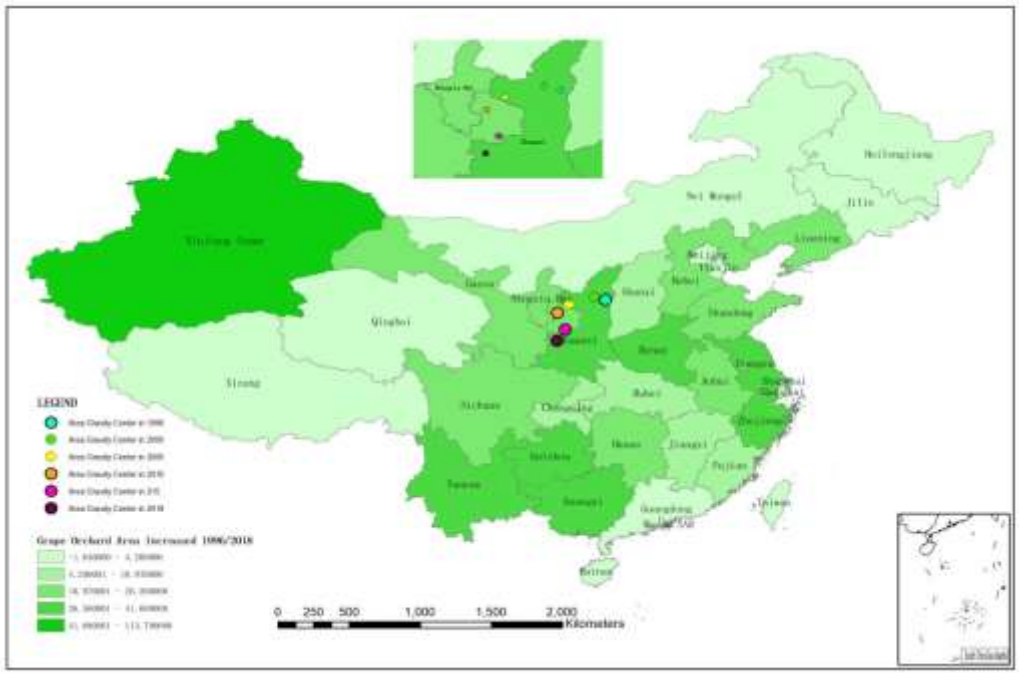
$$Xi = \sum_{i=1}^{n} Qij Xj \Big/ \sum_{i=1}^{n} Qij$$

$$Yi = \sum_{i=1}^{n} Qij Yj \Big/ \sum_{j=1}^{n} Qij$$

Where：x_j and y_j represent the longitude and latitude coordinates respectively of the gravity center of the research objects, x_i and y_i represent the longitude and latitude coordinates of the territory center of the *i* province, Q_{ij} represents the crops output (or area) of *i* province in the year *j*.

The data of vineyard surface area mainly comes from China National Bureau of Statistics. The coordinates of the geometric gravity center of each provincial regions were generated by using ArcGIS. Gravity centers based on the vineyard surface areas in different years of 1996, 2000, 2005, 2010, 2015 and 2018 were calculated by using the "Geometery Calculator" tool of ArcGIS. Then it's organized as the map of shifts of gravity centers of Mainland China vitivinicultural sector.

Figure 27. Shifts of gravity centers of Mainland China vitivinicultural sector



4.3 **Distribution characteristics of China domestic vitivinicultural sector**

4.3.1 Grape cultivation is less affected by natural conditions

Judging from the map of suitability analysis of traditional grape cultivation in China (Figure 17), the most suitable regions for growing grapes in China include the whole area of Liaoning, southern Heilongjiang, southern half of Jilin, southeastern Nei Mongol, the whole area of Beijing-Tianjin-Hebei, most part of Shandong, northern Jiangsu,northern half of Henan, all area of Shanxi, northern half of Shaanxi, central Ningxia, southern Gansu, central and northern Sichuan, etc. The distribution is coincide with the distribution of China traditional grape producing areas (Figure 18).

However, the kernel density heat map of China vitivinicultural sector (Figure 19) shows that the hot spots of grape industry in 2018 covers most parts of China, and the centers are around the Yangtze River Delta, Fujian, Central China and Southwest China, which indicates that the temperature and precipitation conditions are greatly broadened. There is no data in Hainan, Qinghai, Xizang (Tibet) and some parts of Yunnan, which shows that altitude and topographic conditions are the biggest natural factors affecting

the grape industry now. High temperature and rainy weather have a greater impact than low temperature and drought (Figure 15, Figure 16, Figure 17, Figure 19).

4.3.2 Grape cultivation is mountain and hill oriented

Comparing China's 31 provincial regions (excluding Hong Kong, Macao and Taiwan), the area and production of grapes are mostly concentrated in low mountains and hilly areas, and those in the middle and lower reaches of the Yangtze River Plain, North China Plain, and Northeast Plain are slightly smaller. This shows that grape cultivation is particularly important for the industrial development of regions located on the second topographical step of China. However, Henan and Hebei are in sharp contrast. There are more vineyards planted in Hebei and relatively fewer in Henan. It may be related to local economic and industrial policies. Hebei is part of the Beijing-Tianjin-Hebei urban agglomeration and has a huge market, which provides unique conditions for Hebei to develop its vitivinicultural sector. Henan is a major agricultural province in China and the core area of the traditional grape-producing area in the old course of the Yellow River. The vitivinicultural sector was once very developed in Henan, but the current situation is not as good as the historical status, which is related to the local development consciousness (Figure 20, Figure 21).

4.3.3 The density of the vitivinicultural sector is obviously city-oriented

From the kernel density heat map of China's vitivinicultural sector distribution (Figure 19), it can be seen that the most active regions of the vitivinicultural sector are mainly the Yangtze River Delta, the Pearl River Delta, and the Beijing-Tianjin region. The Chengdu-Chongqing region, Guanzhong region, and Shandong Peninsula followed. The Liaodong Peninsula, the Central Plains, the coastal areas of Fujian, and Ningxia are evenly distributed. The Hexi Corridor and the northern Xinjiang are distributed in a belt, and the city clusters in the middle reaches of the Yangtze River have sporadic vitality.This distribution is very similar to the distribution of China's first, second and

third-scale urban agglomerations (Fang, 2014).

4.3.4 There are spatial differences in grape industrial types

Figure 22, Figure 23, Figure 24 reflect the difference in the spatial distribution of the primary, secondary and the tertiary industries, as well as the current status of table grapes, wine grapes, juice and musts grapes, and dried grapes.

Comparatively speaking, table grapes are grown closer to large and medium cities, and wine grapes are more widely distributed. However, the the situation is opposite in four provinces, i.e. Xinjiang, Gansu, Heilongjiang, and Ningxia. The growing areas of table grapes in these four provinces are more dispersed than those of wine grapes. The reason may be that these provinces have a better vitivinicultural sector foundation and are valued by the government and practitioners. They are not worried about the disadvantages of table grape industry such as storage, transportation and pricing.

There is a positive correlation between the agglomeration of table grapes planting and tourism development around big cities, which shows that visitors from cities are very keen on experience tours such as grape picking. In addition, the density of wineries around big cities is also relatively high, which may be due to China's national conditions. China's land policy is very strict, and the control over construction land is very tight. There is a high demand for villas and other real estate projects around big cities, but the government restricts the approval. It is difficult to obtain land to build villas in rural areas with good ecological environment around the city, but it is easier to apply for projects in the name of grape cultivation and winemaking, and the buildings in the winery chateau can be used as villas.

Among all the provinces, Guangdong Province is worth studying. According to China national industrial statistics, Guangdong Province is one of the four provinces with no data because of the small area of grape cultivation. However, the POI density of Guangdong Province is unexpectedly in the forefront of China in terms of wine wholesale

and retail, wineries and grape tourism. There are three possible reasons. First, although Guangdong Province is not suitable for growing grapes on a large scale, the residents have a great demand for wine consumption and the POI for wine consumption are many. Second, the population around Guangdong is very big, and there is also a huge demand for table grapes and grape tourism. In order to meet market demand, there are many small plantations, for leisure but not for big production. Third, the relatively large number of winery chateau POI is in line with the demand for real estate mentioned above.

Analyzed from the sharp contrast between the heat map of China's vitivinicultural sector distribution (Figure 19) and the comparison of vineyard surface area and production in China's provincial regions (Figure 20, Figure 21), the planting area and output of grape enterprises in Xinjiang, Shaanxi and Hebei are very large, but the distribution of enterprises is less, which shows that the scale of grape enterprises in these areas is larger, and the scale of grape enterprises around Guangdong, Beijing and Shanghai is smaller.

4.3.5 The trend of grape cultivation in different provinces is different

Xinjiang, Yunnan, Shaanxi, Henan, Jiangsu and other provinces have been growing continuously for 20 consecutive years. Shandong, Liaoning and Hebei fluctuated violently. After a rapid development stage around 2003, they suddenly declined sharply, and then stopped sliding and turned to slight growth around 2008. Guangxi, Zhejiang, Sichuan, Guizhou, Ningxia, Hunan, Anhui, Gansu, Hubei, Shanxi and other provinces have increased slightly and steadily, with significant growth after 2008. Other provinces maintain a low growth trend (Figure 25, Figure 26). This shows that the vitivinicultural sector in Xinjiang and other three provinces has embarked on a stable track and has received continuous attention from local governments. Shandong and other two provinces are China's traditional grape-growing provinces and have innate advantages, but the grape-growing policy was not sustained and once fluctuated. All provinces have

seen significant and sustained growth since 2008, which shows that the Chinese government 's policies for the construction of new rural areas from 2006 and the subsequent rural revitalization are effective and continuous. The vitivinicultural sector has played a very important role in rural poverty reduction. Conversely, to a certain extent, Shandong, Liaoning, and Hebei have good conditions for agricultural development, and industrial development is flexible and selective except for vitiviniculture.

4.3.6 The industrial gravity centers shift to the west and southwest

In 1996, the gravity center of China's vitivinicultural sector was at the junction of Shaanxi and Shanxi. Five years later, it moved slightly to the northwest to the territory of Shaanxi. In 2005, it turned to the southwest and continued to move to the southwest and into Gansu in 2010. In 2015, the gravity center shifted to the southeast by a large margin. In 2018, the center continued to shift to the southwest based on the 2015 level. If the gravity center in 1996 is used as the origin, the gravity center in 2018 shifted to the southwest in general. Among the recent shift, Xinjiang, Shaanxi, Yunnan, Guangxi, and Jiangsu have contributed the most. Guizhou, Henan, Zhejiang, Sichuan, Ningxia, Hunan, Liaoning and Shandong have great development potentials. The overall shift trend of the industrial gravity center to the west and southwest is also closely related to the stage of China's agricultural and rural construction and rural revitalization. In the process of rural revitalization in the western and southwestern provinces, the vitivinicultural sector plays an increasingly important role (Figure 27).

5 Conclusion

This paper collects the data of the vitivinicultural sector in China in the past 20 years, and also obtains the POI data of grape industries in Baidu online map. Through the comparative analysis of the official statistical data of the world, China, 31 provinces in

mainland China and POI data of Baidu map, it presents the status of China's vitivinicultural sector in the world and the characteristics of spatial distribution of China's grape industries domestic. In the global context, grape occupies the first place in the agricultural output value of the world's major fruits, but the planting area and output of grape in China only occupy the fourth place. Even so, because of China's huge population and demand, the proportion of China's vitivinicultural sector in the world has increased dramatically since 2000. In terms of planting area, the world's vineyard surface area has declined slightly, while China has become the second largest in the world since 2014. World production continues to rise, while China ranks first in the world since 2010. In terms of grape utilization, European and American grapes are mainly used for wine-making, while China's grapes are mainly for table grapes, and the proportion of fresh grapes in China is as high as 84.1% in 2018. The world's wine production is stable, while China's wine production is falling, accounting for the tenth place in 2019 after a decline for seven consecutive years. World consumption and trade are active, while China's consumption and import are strong. China is the largest consumer of table grapes in the world, and China also accounts for the fifth place in the world's wine consumption, both wine and table grapes are imported in large quantities.

China is a populous country and a large agricultural country. The cultivation and utilization of grapes in China has a history of more than 2,000 years. However, because of the balance of China's demand for food and various agricultural products, the vitivinicultural sector accounts for a small proportion of China's fruit industry. Moreover, due to different local natural and socio-economic conditions, the distribution of China's domestic vitivinicultural sector also has distinct characteristics. In general, grape cultivation is less affected by natural conditions now. Thanks to the development of science and technology, grapes are now widely grown in southern regions such as Guangxi, where the temperature and humidity are high. Grape cultivation is mountains and hill oriented. This doesn't mean that the plains are not suitable for planting grapes, but that the plains have to ensure China's grain rations first rather than fruits. The

farmland in the mountainous and hilly areas is relatively fragmented, so it is relatively more suitable for grape cultivation. The density of the vitivinicultural sector is obviously city-oriented. Although large-scale grape plantations can be located far away from cities, some enterprises such as table grape vineyards, winery chateaus, grape-picking tourism attractions, and wine consumption places that can meet the needs of the market nearby are densely distributed around big cities. There are spatial differences in grape industrial types. If the cultivation of table grapes and wine grapes is classified as the primary industry, the production of wine and the processing of grape juice and musts and dried grapes as the secondary industry, and the wholesale and retail of wine and grape tourism as the tertiary industry, the proportion and integration degree of these three industries in different provinces are different. The proportion of primary industry in the western region is higher, and the proportion of tertiary industry in the eastern region is higher. The integration of primary and secondary industries in the northern region is closer, and the integration of primary and tertiary industries in the southern region is closer. The industry gravity center has shifted to the west and southwest. From the perspective of natural and technical conditions, most of the traditional grape producing areas in China are located in the north and northeast, but in terms of agricultural production, there are more choices in the north and northeast, so the vitivinicultural sector fluctuates significantly in these places, and the status of the Yellow River Old course producing area even declines. With the weakening of natural and technological constraints, and with China's emphasis on the three rural issues and the implementation of the rural poverty reduction and Rural Revitalization Policy, the rural economy has developed rapidly, and the vast western and southwestern regions of China choose the grape industry as the direction of development. However, how to do a good job of industrial integration in the three industries and increase the added value of the grape industry is the next problem facing these areas. In terms of trend, Xinjiang, Yunnan, Shaanxi, Henan, Jiangsu and other provinces occupy an important position in China's vitivinicultural sector and maintain continuous growth for 20 years. Shandong, Liaoning,

Hebei and other provinces account for a large share of China's vitivinicultural sector, but fluctuate sharply. Guangxi, Zhejiang, Sichuan, Guizhou, Ningxia, Hunan, Anhui, Gansu, Hubei, Shanxi and other provinces maintained a small and stable growth.

Generally speaking, China is a huge market with a large and continuous demand for agricultural products such as grains and grapes. This trend will not change. Because of the limited farmland, the main responsibility of the Chinese government is to achieve basic self-sufficiency in grain food based on the domestic supply. Grape products are not a necessity for China, and they are replaceable whether as fruit or as wine. However, it is a fact that the production and consumption of grape products in China have been growing for more than 20 years, which shows that the cultivation of vitivinicultural sector consumer market is becoming more and more mature. At the same time, China's rural land ownership in not private. At present, farmers only have the right to use their farmland for 30 years. So, industries like wine industry, which need a hundred years or more to form a brand, are unlikely to form a scale in China in the short term. The proportion of imported wine in China's wine consumption is greater than 30%, and China's wine dependence on imports will exist for a long time.

6 Discussions

Due to the current data conditions and other objective factors, this research needs to be further conducted. The main problems include: whether the real-time data extracted from Baidu Maps ' grape Points of Interest (POI) can reflect the panorama of grape data in China; how to do data verification more scientifically; how to analyze the grape cultivation conditions more detailed, for example, the influence factors of soil can be added; whether the grape cultivation can be studied by cultivars; whether the domestic grape statistical data can be refined, etc. Because of the author's interest in this topic and the understanding of the significance of the study, this paper only makes some assumptions and preliminary analysis, hoping to be able to conduct more in-depth, more comprehensive and more systematic research in the future.

References

AN, M. M., WANG, J. M., CHENG, D., SHI, Y., QIAO, F., LI, J. H., & YU, G. F. (2019). Development status of grape industry in Shandong province. *Bulletin of Agricultural Science and Technology*(09), 208-210. (in Chinese)

ANONYMOUS. (2011a). Top ten grape producing areas in China (I). *Practical technology and information on fruit trees*(07), 45-46. (in Chinese)

ANONYMOUS. (2011b). Top ten grape producing areas in China (II). *Practical technology and information on fruit trees*(08), 45-46. (in Chinese)

AURAND, J.-M. (2015). *State of the vitiviniculture world market.* Paper presented at the 38th OIV World Congress of vine and wine.

CAO, W. J. (2009). The development course and prospect of Chinese grape industry in the past 60 years. *Sino-Overseas Grapevine & Wine*(09), 56-60. (in Chinese)

CHEN, Q. Q., ZHAO, D. Y., YANG, Q., YANG, J. Y., & ZHAO, X. (2017). Life cycle stage identification and peak forecast of China's wine industry. *Arid Land Geography, 40*(04), 866-874. (in Chinese)

COUNCIL, G. O. o. t. S. (2016). The General Office of the State Council Guidance on Promoting the Integration of Primary, Secondary and Tertiary Industries in Rural Areas. *Gazette of the State Council of the People's Republic of China*(2), 41-45. doi:10.3969/j.issn.0546-9503.2016.02.007 (in Chinese)

FANG, C. L. (2014). Progress and the future direction of research into urban agglomeration in China. *Acta Geographica Sinica, 69*(08), 1130-1144. (in Chinese)

FOCUS, F. (2016). Table and dried grapes. *Nonalcoholic products of the vitivinicultural sector intended for human consumption*.

GUO, B. L. (1992). Characteristics and dynamics force of pathway of centre of gravity of grain distribution in China. *Acta Agriculturae Shanghai*(01), 68-74. (in Chinese)

LI, H., LI, J. G., & YANG, H. C. (2009). Review of grape and wine industry development in recent 30 years of China's reforming and opening-up. *Modern Food Science and Technology, 25*(04), 341-347. (in Chinese)

LUO, G. G. (2003). The challenges and countermeasures of grape industry after china ' s

accession to WTO. *Sino-Overseas Grapevine & Wine*(05), 8-12. (in Chinese)

LUO, S. Y. (2017). *Grape industry and the tourism development in China.* (MSc.), Hubei University, Available from Cnki (in Chinese)

LV, Q. F. (2013). *Research on modern China's wine industry development.* (PhD.), Northwest A&F University, Available from Cnki (in Chinese)

OIV. (2017). 2017 World vitiviniculture situation: OIV statistical report on world vitiviniculture.

OIV. (2019). 2019 Statistical Report on World Vitiviniculture. *International Organisation of Vine and Wine Intergovernmental Organisation. http://oiv. int/public/medias/6782/oiv-2019-statistical-report-on-world-vitiviniculture. pdf. Accessed on 4 Nov 2020*.

PENG, D. H. (1995). *Introduction to wine brewing technology*: China Light Industry Press. (in Chinese)

PU, S. H., ZHANG, J. F., DING, F., & MA, X. Q. (2013). Development status and research emphases of the grape industry in Xinjiang. *Northern Horticulture*(13), 200-203. (in Chinese)

SHAO, F. (2007). *The research on development strategy of China wine industry.* (MSc), Central China Normal University , Available from Cnki (in Chinese)

SONG, R. G. (2002). The present and problems of grape protected cultivation in the northeast. *Sino-Overseas Grapevine & Wine*(05), 19-22. (in Chinese)

SU, J. (2015). Glamour purple crystal pearls — grapes. *China Fruit & Vegetable, 34*(11), 46-51. (in Chinese)

TIAN, S. F. (2009). Situation analysis of grape industry in China. *Sino-Overseas Grapevine & Wine*(01), 64-66. (in Chinese)

TIAN, S. F. (2018). The development of grape industry and technology in China. *Journal of Agriculture, 8*(01), 135-139. (in Chinese)

VINE, I. O. O., & WINE. (2017). 2017 World vitiviniculture situation: OIV statistical report on world vitiviniculture.

WANG, J. J., YANG, X. X., SHI, T. H., & WANG, Z. X. (2011). Problems and countermeasures of grape industry development in Ningxia. *Ningxia Journal of Agriculture and Forestry Science and Technology, 52*(10), 65-67+105. (in Chinese)

WANG, X. C., WU, W. M., ZAHO, M. Z., WANG, Z. W., & QIAN, Y. M. (2015). Present situation,

existing problems and countermeasures of grape industry in Jiangsu province. *The Journal of Hebei Forestry Science and Technology*(04), 109-111. (in Chinese)

XI, D. Z., LIU, W. Z., MENG, Q., & JIA, Y. L. (2008). Status in quo and development trend of China's wine industry. *China Brewing*(18), 10-11. (in Chinese)

XI, J. P. (2015, 2015-10-17). Working together to eradicate poverty for common development, p. 002.

YANG, H. C., & XUE, H. C. (2008). Development characteristics, path dependence and strategic choice of grape wine industry in China. *Liquor-Making Science & Technology*(12), 126-128. (in Chinese)

ZHAI, H., DU, Y.-P., SUN, Q.-H., WANG, Z.-S., PEI, C.-G., & WANG, Z.-y. (2007). On the development situation of Chinese grape industry. *Journal of Fruit Science, 6*.

ZHANG, W., ZHANG, Y. H., LU, X. Y., BAI, M. D., KONG, W. X., MA, C. H., SHA, Y. C. (2015). Research on the present situation and countermeasure of grape industry development in Yunnan. *China Tropical Agriculture*(04), 25-28. (in Chinese)

ZHANG, Y., & ZHU, J. Y. (2009). Present status & existed problems & development trend of grape wine industry in China. *Liquor-Making Science & Technology*(11), 128-131. (in Chinese)

ZHAO, Q. S., & GAN, S. L. (2020). Country analysis and development trend of China's import wine market. *China Brewing, 39*(10), 216-219. (in Chinese)