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李华　主编

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Proceedings of the Seven International Symposium on Viticulture and Enology

（2011）

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前　言

中国葡萄酒拥有 9000 多年历史，是世界公认的葡萄与葡萄酒起源中心，有过很多辉煌。汉唐时期，是中国国力鼎盛时期，也是中国葡萄与葡萄酒产业的大繁荣时期。进入元代，由于战争等多方面原因，经济日益衰败，葡萄酒产业也随之下滑。明代是中国农耕文明最发达的时期，但由于赋税制度等一系列问题，葡萄酒产量继续下滑，葡萄酒产业走入了低谷。正因为此，中国葡萄酒历史出现了断层。此时，西欧葡萄酒产业则迅速发展，产量快速上升。

明末清初至中华人民共和国成立前这一阶段，中国葡萄酒一直不稳，步履蹒跚。新中国成立后，由于国家经济基础薄弱，人民生活处于贫困线上，亟待解决温饱问题，葡萄与葡萄酒产业仍然在很低的水平上徘徊，直到 1980 年，葡萄酒产量才缓慢上升至 7.8 万吨。

中国葡萄酒产业的真正起步是在改革开放之后。随着改革开放政策的实行，经济开始全面复苏，人民生活水平也逐步提高，对葡萄酒的需求日渐旺盛，客观上促进了葡萄种植与葡萄酒生产的发展和繁荣，特别是进入 20 世纪 90 年代后，中国葡萄酒产业进入了快速发展阶段。到 2010 年，中国葡萄酒从名不见经传到现在世界上占有很高的地位，年产量跃升至 108.88 万吨，是 1980 年产量的 14 倍。中国葡萄酒在世界上的声誉正在日益提升，地位正在不断提高，2009 年，中国葡萄酒产量已上升至世界第 6 位，消费量上升至世界第 5 位（OIV，2010）。中国已经成为世界葡萄酒产业发展最快的国家，赢得了世界葡萄酒国家和消费者的赞叹和高度关注。

在快速发展、赢得一片赞叹声的同时，我们也要静下心来仔细思考一下，中国葡萄酒产业发展的今天，是否还有什么问题或是需要我们去思考的东西？回答是肯定的，有，有很多问题需要我们去思考。

中国葡萄酒走过了漫长的发展历史，期间出现了很多概念，至今我们很多人还记忆犹新，绿色葡萄酒、无公害葡萄酒、有机葡萄酒、低碳葡萄酒、年份葡萄酒、庄园葡萄酒、地理标志葡萄酒、品牌葡萄酒，……这每一个概念的背后都有相关的机构和认证体系。然而，到底执行得怎么样呢？是否按照最初构想的那样在一步一步地稳步前行呢？虽然有一些地区是在踏踏实实、稳稳当当地前行，但是，就全国葡萄酒产业整体而言，浮躁远远超过踏实。这种盲目的、浮躁的产业快速发展的背后，所暴露的问题是消费者的不成熟、生产者的盲目跟风以及监管措施的缺失和滞后。

我国葡萄酒产业所面临的另一个突出矛盾是：国内葡萄酒产业的生产能力不能满足内部消费能力日益增长的需求。以 2010 年为例，我国葡萄酒出口量为 1361.4 吨，出口额为 2378.04

万美元；而同期进口量为 28.34 万吨，进口额为 77004.40 万美元。进口量、进口额分别是出口量、出口额的 208 倍和 32.38 倍。这组数据表明，我国葡萄酒行业目前面临的主要问题是如何满足国内消费市场的需求。

因此，如何克服葡萄酒产业发展中出现的问题，促使我国葡萄酒产业健康、快速地发展是我们亟待讨论解决的重大课题。为此，第七届国际葡萄与葡萄酒学术研讨会将邀请国内外葡萄与葡萄酒行业的各方专家，围绕“有机与低碳葡萄酒产业”主题，深入探讨葡萄酒产业发展的前沿及热点问题，共同推动葡萄与葡萄酒行业的健康、有序和可持续发展。

大会秘书长、西北农林科技大学副校长、葡萄酒学院终身名誉院长
OIV 亚洲葡萄与葡萄酒科技发展中心主任 李 华

2011 年 3 月 26 日

Preface

China is recognized worldwide as one of the centers of origin of viticulture. And the history can be dated back to 9,000 years ago. China had its heyday in the Han and Tang dynasties, so did viticulture and enology. Entering the Yuan dynasty, however, the wine industry began to decline due to recession of economy out of years' of wars. The Ming dynasty saw the highly development of agriculture, but wine production was on constant decline, and moved to its nadir because of the onerous tax systems and series of other problems. Hence, China's wine history was disrupted. In contrast, wine industry was rapidly developing in Western Europe, and its production increased rapidly.

From the late Ming dynasty and the early Qing dynasty to the establishment of the People's Republic of China, wine industry came to a standstill and faltered. After the founding of PRC, grapes and wine industry still fluctuated at a low level because of the weak economic development and people's low living standard. Wine production increased slowly and reached 78 thousand tons till 1980.

The real rapid development of Chinese wine industry started after the adoption of reform and opening up policy. With the implementation of the policy, the economy began to recover fully, people's living standard was gradually improved, and people had more and more demand for wine. This promoted the development and prosperity of grapes growing and wine production. Especially when entering into 1990, both of them experienced a rapid development. By 2010, China's wine industry, little known to the outsiders before, is now gaining a higher status in the word, with an annual output leaping to 1088.8 thousand tons, 14 times of that in1980. According to the statistics of the international Organization of Vine and Wine, China's wine production has scaled to the world top sixth, and its consumption ranked fifth in 2009. At present, China has become the world's fastest growing country in wine industry, and a focus by wine producing countries and consumers in the world.

At the same time, we must clearly realize that wine industry is a sun-rising trade whose rapid development follows the advance of economy and the improvement of people's living standard. Theory of wine production originates from original vineyard, in which no chemical synthesis fertilizer and pesticides are to be applied, the natural growth patterns are to be followed, cleaner production is to be implemented. Also good safety production rules and recycling production pattern should be observed integrating organic concept with low-carbon views to avoid environmental deterioration. The concept of green, pollution-free, and organic wine production and so on is formed thereafter. Based on this idea, sustainable production and management pattern for wine production is to be explored. The development of small wineries into big industry becomes a trend in the domestic field of food production. More and more enterprises have advocated the "low carbon" concept by using various technologies and methods. However, the reality is not at all optimistic. Production in some areas can practice the concept seriously, while that in some other regions is more impetuous and blundering. This kind of blindness and flippancy is caused by people's blind following of the trend, lack of regulatory measures and immaturity of consumer psychology.

Another prominent contradiction China is confronted is that the productive capacity of the domestic wine can not meet the growing needs of domestic consumption. Taking the year of 2010 as an example, the export volume of China's wine was 1361.4 thousand liters, and the export value 23780.4 thousand dollars. At this same period,

imports volume amounted to 28.34 thousand liters, imports value 77004.4 thousand dollars. The volume and value of import were respectively 208 and 32.38 times to those of the export. It is shown that the major problem that China's wine confronts is trade-dumping and sustainable development.

Therefore, how to overcome the questions in wine development and promote the healthy and fast development of it becomes a major issue which we need to discuss and resolve urgently. For this reason, the seventh international symposium on viticulture and enology will invite domestic and foreign experts in grape and wine to discuss the front and hot issues of wine industry development concerning the subject of "organic and low-carbon wine industry" in depth, and to promote the healthy, orderly and sustainable development of the grape and wine industries.

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Vice-President of Northwest A & F University, Honorary Dean of College of Enology
Director of Sci-Tech Development Centre of Vitiviniculture in Asia, OIV

Dr. Li Hua
Mach 26th，2011

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The System of Climatic Index for Chinese Viticulture Zoning

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Abstract This study analyzes firstly the climatic index systems used in the viticulture zoning and the climatic characteristics in China. It is shown that all climatic zoning index systems were based on the Mediterranean and para -Mediterranean climatic conditions, therefore, not necessarily suitable for the climate conditions in China, which are dominant with continental features. According to the climatic characteristics in China and the grapevine growing requirements, the thermal index and water index for viticulture climatic zoning in China were studied. A new zoning index system is established, with Frost-Free Days (*FFD*) as the first index, Dryness Index (*DI*=ETC/P) of growth season (1st, April-30th, September) as the secondary index and bury line (mean lowest temperature below−15℃) as the tertiary index. By applying this zoning system and using the daily climatic data of the past 30 years (from 1971 to 2000) provided by CMA through ARCGIS software, China could be subdivided into 12 viticulture zones, which reflects well the actual viticulture regions in China.

Key words Grapevine Viticulture Climatic zoning *FFD* *DI* Bury line

1 Intr oduction

The zoning for grapevine cultivation is a scientific method for determining the suitable areas, based on the results of integrated analysis comprising firstly evaluating roundly the ecological, social and economic conditions; secondly analyzing the historical and actual viticulture condition in detail; thirdly comparing the positive and negative factors and production potential as well as the problems existing [1]. In specific geographical area, climate is the key parameter to decide the suitability of grapevine cultivation and the category of wine (sweet wine, sparking wine, dry red and dry white wine). Hence, the premise of scientific and reasonable grapevine cultivation zoning is to set up a suitable climatic zoning index system adapting to Chinese climatic characteristic.

2 Chinese climatic characteristics

Affected by the layout of terrain, atmospheric circulation, the latitude situated and state of ground, the

*Corresponding author

Chinese climate presents three characteristics: significant monsoon characteristic, notable continental climate and multiple climatic types.

2.1 Significant monsoon characteristic

In the winter, China is prevailing of northwester and north-lean wind, while in the summer southeaster and southwester from the sea dominant. Because the current from continent brings dry air and the current from sea brings humid air, so most of the precipitation takes place from Match to September. The characteristic of monsoon not only reflects on the changes of wind direction, but also on the variation of dry and humid periods in China[2].

2.2 Notable continental climate

Compared to the areas of the same latitude, Chinese one is the coldest in winter, the average January temperature of northeast is 15℃~20℃ lower than other areas of the same latitude; while in Huanghe River and Huaihe River watershed is 10℃~15℃ lower; the southern of Changjiang River is 6℃~10℃ lower; Southern China costal areas are 5℃ lower. But as summer referred, the temperature is much higher than those areas of the same latitude (the desert areas are of exception), the average temperature of July in northeast is 4℃ higher, north China is 2.5℃ higher, the mid-downstream of Changjiang river is 1.5℃~2℃ higher[2].

Influenced by the continental climate, most area of China located at latitude of temperate zone or semitropical zone, and the landform varies, always sunny and clear in spring and autumn, the daily range of temperature is great, cold current is of high frequency. The process of spring warming up is fast, but not stable, the cold air invades frequently and brings spring frost. The process of winter monsoon draws back and summer monsoon northing last a long time, and repeats several times, which makes the spring temperature varies greatly, and frost always takes place. As autumn referred, the temperature descents quickly [3].

2.3 Multiple climatic types

China, with a vast territory, reaching 53°N at Mohe in north, which belongs to cold-temperate zone, and 3°N at Nansha Islands in south, which belongs to tropical zone, has many high mountains, deep valleys, hills and basins. The area above 4500 m from sea leveling in Qingzang plateau is in winter all year long, but the islands in South China Sea is always in summer, as the areas in central Yunnan Province referred, it's always in spring, but in the other parts of China, we can distinguish the four season clearly[2].

3 The construction of thermal indexes

Suitable thermal accumulation is the basal requirement of plant survival. Grapevine is thermophilous plant, which has high thermal requirement. Thermal conditions influence not only the length of phenophase, but also the growth and the quality of grape and related products [4]. Therefore, thermal index is one of the decisive parameters in climatic zoning for grapevine cultivation. The thermal parameter should first guarantee the suitability and then the profitable viticulture in a specific area.

3.1 The analysis of thermal indexes

Now, there are 6 indexes (Tab.1) employed in grapevine cultivation zoning. After analysis the marginal grapevine cultural regions using these index (Tab.2), we found that the index of accumulated temperature、index of Branas、index of Huglin、LTI and index of mean temperature of the warmest month can't ideally distinguish if these area could grow grapevine economically and effectively. The index of Branas of the four region analyzed in table 2 exceed 4.2, the index of Branas of Qiqihaer, Datong, and Huhehaote surpass 4.5, which inferred that the late-harvest variety could be cultured; in these areas, both the accumulated temperature and the average temperature of the hottest month surpass the minimum margin, which inferred that grapevine could be cultured.

According to the standard of LTI, Harbin and Qiqihaer of Henongjiang Province is excluded from grapevine-cultivable areas, but Datong in Shanxi Province and Huhehaote in Inner Mongolia was considered suitable for viticulture[5].

Table 1 Summarization of thermal indexes

Index	Founder	Formula	Note
Index of Branas	Branas	$I(Rt) = X \cdot H \times 10^{-6}$	X :The summation of temperature when daily average temperature surpass 10℃ H: Illumination hours of the same time
Index of Huglin	Huglin	$IH = \sum \{[(T_{mj} - 10) + (T_{xj} - 10)] \div 2\} \times K$	T_{mj}: average daily temperature surpass 10℃;T_{xj}: The highest temperature of the same time; K: (if latitude is among 40－50, the K value is among 1.02－1.06)
LTI *	Jackson	$LTI = T_{mean} \times (60 - N)$	T_{mean}: average temperature of the warmest month; N: value of latitude
$\sum T_a$ *	Davitaya	T=($t \geqslant 10$)℃	Date length: Apr. 1th- Sep. 30th
TWM*	Coombe	T_{max}	July in most areas of China, August in Costal area.
$\sum T_a{}^1$ *	Amerine and Winkler	$T' = \sum [(t \geq 10) - 10]$	Date length: Apr. 1st—Sep. 30th

*∑Ta: sum of active temperature; TWM: mean temperature of the warmest month; ∑Ta1 sum of effect temperature. LTI: latitude temperature index.

Table 2 Comparison of thermal indexes in boundary regions of grapevine

Indexes	The boundary	Harbin	Qiqihaer	Datong	Huhehaote
$\sum T_a$ *	2800	2852.3	2822.4	2983.2	3025.8
$\sum T_a{}^1$ *	945	1252.3	1222.7	1375.6	1421.4
TWM*	18	23	23.1	22	22.6
Index of Branas	2.6	4.2	4.5	4.5	4.9
Index of Huglin	1500	1820	1813	1923	1884
LTI*	380	327.75	291.445	437.8	433.54

*$\sum T_a$: sum of active temperature; $\sum T_a{}^1$ sum of effect temperature; TWM: mean temperature of the warmest month; LTI: latitude temperature index.

But the results of studies on Frost-free period (*FFP*), Last frost day and Fist frost day of Huhehaote and Datong in the past 30 years showed that, although the *FFP* of these two area surpass 150d, but 12 of Last frost day appeared after 1th May in Huhehaote and 16 for Datong, in last 30 years, which is too late as the buds, bursting at 20th April in northern China, suffer from frost (Fig.1, Fig.2). In fact, these four areas mentioned above are not suitable for viticulture.

The existing zoning climatic indexes adopt on the accumulated temperature as thermal index. But accumulated temperature is just the accumulation of temperature, as the summer in China is relatively hot comparing to other areas of the same latitude, the variation of accumulated temperature with those areas of the same latitude is not significant, and even superior to those. But it conceals the characteristic of continental climate

of China, under which the temperature varies furiously in spring and fall, a relatively short frost-free season and severe winter. So, it's not suitable to use accumulated temperature to show the thermal condition of specific area in China. For example, Harbin, locating at a higher latitude than Strasbourg (in France) (Fig.3), has a higher accumulated temperature than Strasbourg, because the temperature in Harbin from May to August is higher than that of Strasbourg. But at the same time, there are only 5 month whose average temperature surpasses 0℃ in Harbin, as Strasbourg referred, the average month temperature surpass 0℃ yearlong with exception of January, February and December. Strasbourg. Strasbourg is a famous wine region in France, but Harbin, which have lower latitude and higher accumulated temperature, can't grow grapevine economically.

The study on these above-mentioned indexes shown that, these international widely used indexes, such as accumulated temperature indexes, index of Branas, index of Huglin, LTI and average temperature of the warmest month, can't effectively distinguish if those areas could culture grapevine economically or not.

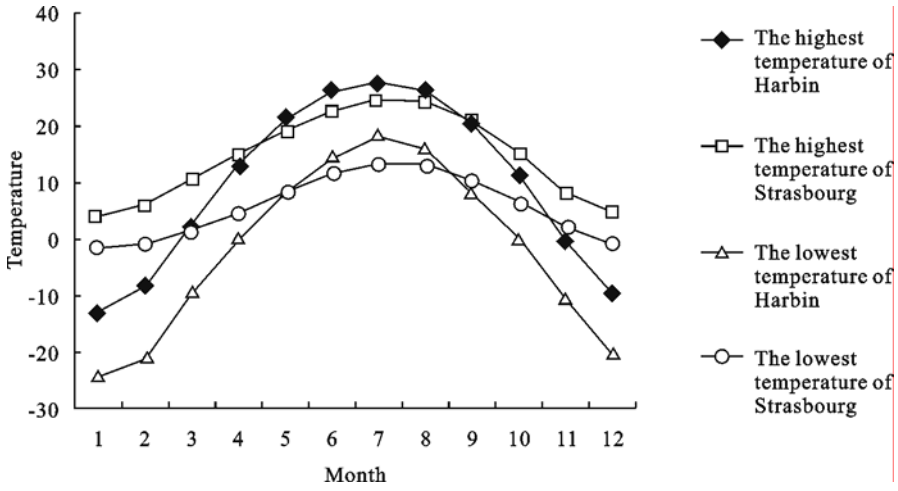

Fig.1 Comparison of mean month highest and lowest temperature between Harbin and Strasbourg.

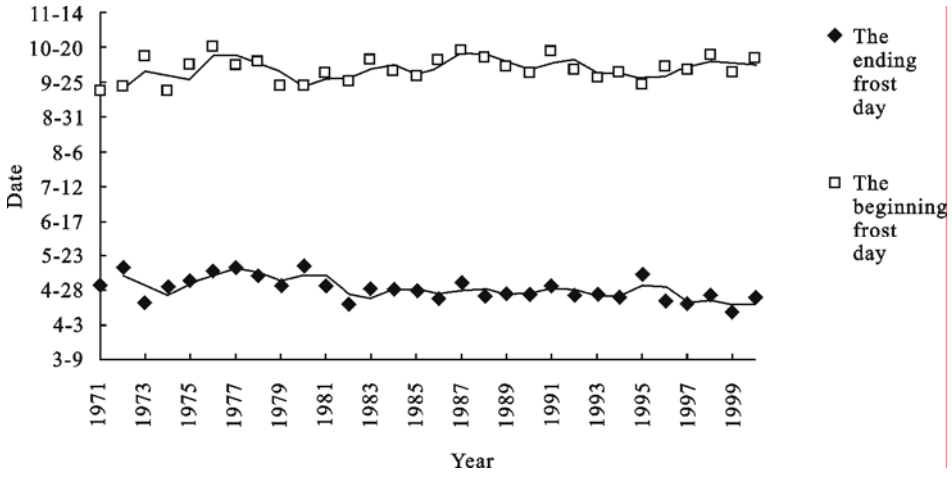

Fig. 2 Distributing chart of the early and the end frost day of Huhehaote.

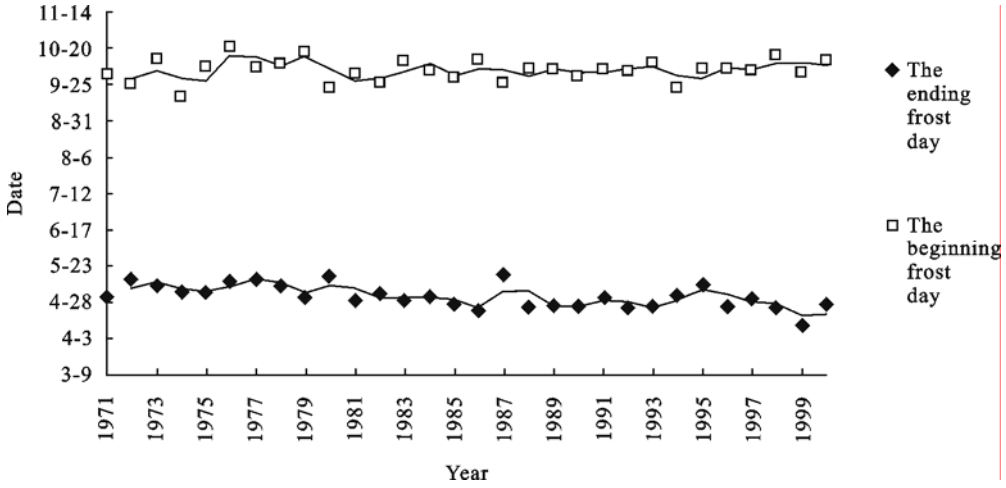

Fig.3 Distributing chart of the early and the end frost day of Datong.

3.2 The new thermal index—Frost-free period (*FFP*)

FFD is the interval between the last occurrence of 0℃and the first occurrence of 0℃in autumn. The length of *FFD* could decide if grapevine is suitable to plant and if the berries could fully matured. The accumulation of carbohydrate in root, trunk and perennial organ after harvest is good for the plant withstand the winter coldness and benefit the yield of next year. If the *FFD* is too short, the buds will suffer in spring frosts, and eventually affect the grape berry set. The sharp decline of temperature in fall will reduce the synthesize capability of carbohydrate and also affect the maturity of the berries. Early frost, which will make the leaves fall off earlier rather than the natural step, declines the accumulation of sugar in berries and perennial canes. Sufficient frost-free season is the guarantee of berries maturity, nutrition accumulation and safely live through the winter[6]。The length of *FFD* directly decides the length of growing season and the utility of thermal recourse.

The natural grapevine growing season should not shorter than 150d, and the late harvest varieties claim even longer growing season. This study defined that the average *FFD* should not less than 150d, and the occurrences of *FFD* shorter than 150d should not surpass 3 times in the past 30 years. Applied this standard to study the suitability of viticulture in those 4 region, we found that the *FFD* could preferably distinguish the suitability of viticulture (Tab.3). Based on the climatic data of China, the Software ARCGIS was adopted to map the distribution of *FFD* in China. According to the map we find that the frontier of *FFD* is accord with northern limit of Chinese viticulture (Fig.4). Each thermal index has its suitable climate type, as the continental monsoon climate of China referred, *FFD* is the best thermal index to define the suitability of viticulture.

In our zoning, we subdivide the Chinese regions, by the values of *FFP*, into 5 zones, that is, zone unsuitable to viticulture (*FFP*＜160d) and zones suitable to viticulture (I, 160d≤*FFP*≤180d; II, 180d≤*FFP*≤200d; III, 200d≤*FFP*≤220d; IV, 220 d<*FFP*). Among the zones suitable to viticulture, Zone II and III are he optimum viticulture areas.

Table 3 Comparison of thermal indexes in boundary regions of grapevine

Indexes	The boundary	Harbin	Qiqihaer	Datong	Huhehaote
Frost-free period (d)	150	154.8	156.1	154.6	157.1
frequency of frost-free period <150d(times)	3	13	9	8	6