

Discovering Grapes and Wine in the Far North of China

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Grapegrowing in China goes back at least 3000 years. The first *Vitis vinifera* grapes were probably first grown in the imperial city of Xian from seed brought to China in 128 BC by General Zhang Qian who was returning from Tashkent. Chinese claim that this event predates the arrival of *Vitis vinifera* vines in France by 200 years. The General is still honored as the father of the Chinese wine industry by a statue at the Dynasty Winery in Tianjin. Over the centuries, many more grape varieties arrived from the Middle East via the Silk Road, the influence of which is still apparent today in some of the local Chinese varieties.

As China has become increasingly prosperous and Western customs more popular, the demand for Western-style grape wines has boomed. Even a tiny percentage of 1.3 billion people is a lot of wine drinkers. China's 90 wineries don't come close to meeting the current, much less the future demand. It is a growth industry.



Currently, almost all of China's wineries are located in mild climate regions southeast or southwest of Beijing. Good climates for volume but not necessarily quality. However, since 1985, the Chinese government has been fostering large-scale vineyard and winery experiments in more northern parts of China, particularly the Yellow River Basin in Inner Mongolia. Here the conditions may be more conducive to

quality—hot days and cool nights over a short season, intense sunlight and low humidity. The only problem is the extreme, dry, snowless cold winter and a short growing season constrained by frost in spring and fall. This has resulted in a flurry of grape research related to problems of winter hardiness and short growing season.

In early September, 2003 we traveled around the grape regions of northern China for seven days. Our travels covered the Yellow River grape region of Inner Mongolia, as well as Heilongjiang and Jilin Provinces in the extreme northeast of China (formerly known as Manchuria). Our goal was to exchange information and research findings on cold hardiness and on cultural methods that foster winter survival and early ripening.

INNER MONGOLIA

Our travels in China began in the Inner Mongolia Autonomous Region and Hohhot, its capital. Hohhot is located about 300km northwest of Beijing on the edge of the great Mongolian grasslands. The Huang He or Yellow River flows through the southwestern part of Inner Mongolia. North of the river are broad grasslands that rise suddenly into mountains that still have their snow caps in May, providing dramatic and beautiful scenery. The climate is semi-arid, with around 30 cm of precipitation a year. Inner Mongolia has blistering summer heat but a short frost free season, only 130 days in the grapegrowing region around the city of Bāotóu. Winters are cold with -30°C being the norm. With no snow cover in this arid region, the soil freezes extremely deep.

Centuries ago, this was the home of the great Khans, Ghengis and his son, Kublai, and their Golden Horde. Today, it is mostly a Chinese province, but with great appreciation for traditional Mongolian food and arts. Twice a day we dined on traditional Mongolian dishes made from grassland-grazed lamb and mutton, truly the best in the world.

Inner Mongolia University of Agriculture-Hohhot

On our travels around Inner Mongolia and its Yellow River grape region we were accompanied by our wonderful host, Professor Wang Li Xue, and her associate professors, Li Lianguo and Li Xiaoyan. Director Yan Shao Yong and Mde. Lizhen Zhang, from the Agriculture Department of Inner Mongolia rounded out the entourage. This provided us a chance to discuss grape varieties under cultivation in the area. They also discussed their research on physiology of cold hardiness. Prof. Wang's lab has focused on changes in starch molecules in grapevine cells during the winter. They have found that the quantity and dynamic changes in starch grains in grape shoots were closely correlated with cold hardiness. In winter hardy species, such as *Vitis amurensis*, the starch grains were smaller, formed earlier in the fall and in larger quantity, and disappeared later in the spring. Grafting to hardy rootstocks increased the starch contents of shoots on the scion varieties and was beneficial for hardiness.

Prof. Wang is famous among northern China grapegrowers for developing deep ditch cultivation techniques for grapes. Deep ditch cultivation makes it possible for growers in Inner Mongolia to raise premium table and wine grapes despite the challenge of

extremely cold temperatures deep in the soil. In deep ditch cultivation, vines are planted in trenches that are 1-1.5 meters deep. Each year, about 30cm of soil are added to the trench until it is nearly filled. The result is that the major roots of the vine are located 1-1.5 meters deep and deeper. The roots resist the damage caused by subzero soil temperatures in the more shallow layers of soil.

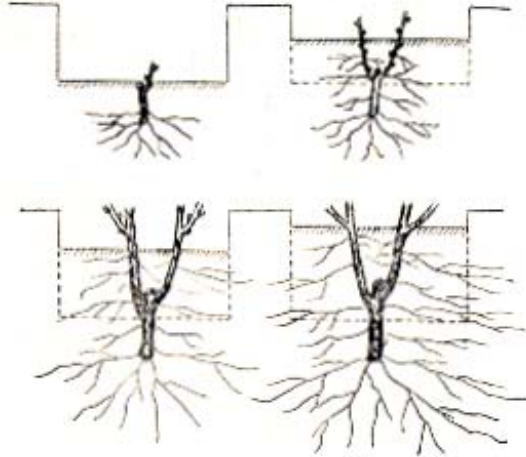


Figure 1. Deep ditch cultivation of vines. Development of root system in years one through four after planting (Wang, 1985).



Figure 2. Mature vines under deep ditch cultivation in late spring

High density planting of vines is another tactic pioneered by Prof. Wang to combat crop loss due to winter injury. Vines in the Bāotóu /Shamujia area are planted at very close spacing, only 50cm apart, yielding vineyards with 4,000 vines per hectare (about 1600 vines per acre). We noted that each individual vine is cropped to produce only 4-5 clusters of fruit. So if even a few dormant buds on each vine survive the winter, there is a full crop in the vineyard simply by virtue of the vast number of vines per hectare. The large number of vines per hectare provides a kind of insurance. Four-meter long vertical cordons are used to make this close spacing possible. Cluster thinning is used to reduce production to 4-5 clusters per vine. Green pruning during the growing season reduces the potential problem of the vines shading each other.



Figure 3. Close vine spacing (left) and long vertical cordons on sloping trellis (right).

Meng Gen Vineyard, Tuo Xian County, Inner Mongolia

For 300 years, vines have been cultivated in Meng Gen's vineyard on the hillsides along the north bank of the Yellow River. For the past 100 years this vineyard has cultivated a local variety of *Vitis vinifera* named for the county, Tuo Xian. Tuo Xian is a seeded table grape variety, pink in color with elliptical pink berries, and noted for its huge long clusters. The clusters we saw in Meng Gen's vineyard were up to 15" in length and weighed 2-4 pounds. This variety ripens rather early, around 10 September in a typical year. Tuo Xian is sold as a fresh table grape in China. However, at nearby In the Clouds Winery, we also tasted very pleasant wines produced from Tuo Xian. Tuo Xian (the grape variety) represents one of the more winter hardy *Vitis vinifera* we have encountered. Its impressive cluster size and beauty make it an attractive variety for use in breeding here in Minnesota.

At Meng Gen's vineyard we also encountered a local invention called the funnel trellis. The funnel trellis resembles a structure right out of Mad Max Beyond the Thunderdome. The trellis is built in a circle about 20-30 meters in diameter. The outside rim of the trellis is very high, 12-15 feet. This slopes at a 30-45 degree angle to a height of 4 feet in the middle of the circle. This creates a gigantic funnel. The vines are planted in a circle around the center of the funnel and trained to very long vertical cordons that grow up the sides of the funnel. The height of the trellis helps the vine avoid the late spring and early frosts that are so common in this area. Summer care of the vines such as cluster thinning and green pruning are done by simply walking under the trellis. Likewise, the clusters are easy to reach for harvesting.

Inner Mongolia Grapes and Flowers Cultivation Technique Research and Development Center, Wūhǎi

During our visit to the Yellow River viticulture region in Inner Mongolia, it became evident that the Wūhǎi region, 300 km southwest of Bāotóu on the Yellow River is a rapidly expanding vineyard and winery region due to its slightly more favorable climate than Huhhot and Baotou. Two of the foremost researchers from this region, Professor Lin Shouren and Li Guo Feng, traveled to Hohhot and briefed us on their grape and winery development project in Wūhǎi that has been underway since 1985. They are working with selections that they claim can survive -30 to -40 °C. They have named and released for production one super hardy grape variety named Red Wine #1. This appears to be a technical breakthrough for their breeding program in terms of the level of winter hardiness achieved in this variety. It results from a backcross of *V. amurensis* x *V. vinifera* to *V. amurensis*. The team has several other winegrape selections from their program that are in second testing, Red Dry #2 and Inner Mongolia #1 and #2.

In the Clouds Winery, Tuo Xian County, Inner Mongolia

This winery in Tuo Xian County makes wine from locally-grown grapes, with several styles of wine produced from the local variety, Tuo Xian. Part of this winery facility is constructed within an ancient city wall, and many smaller storage vats are actually built into the interior of the earthen wall, providing temperature control for the stored

white wines. Most of the wine, however, is held in 25,000 liter underground concrete holding tanks. There were 20 such tanks in the main storage room, holding almost all red wine. Although some of the equipment is outdated and causes some flaws in the wines, this winery would likely improve greatly if it received some investment to upgrade its facilities. Production is about 200,000 liters per year.

We tasted three wines at the In the Clouds Winery. The first was a simple white wine produced from the Tuo Xian grape. It was cleanly made with light fruit and finished at 12% alcohol and 2% residual sugar. The second was a red wine, also said to be made from the Tuo Xian grape variety by fermenting seven days on the skins. This wine was light in color and body and had been through a secondary (malolactic) fermentation. It was a bit high in alcohol, light in tannin, and also slightly oxidized in flavor. It is unlikely that this red wine was produced entirely from the pink-skinned Tuo Xian. There was most likely an addition of a *vinifera-amurensis* hybrid such as Beichun to enhance the color.

This winery also introduced us to a rare and special Chinese beverage, white grape wine infused with fresh flowers of *Osmanthus fragrans*. The flower from the *Osmanthus fragrans* shrub has been used to flavor wine since at least 1300 AD and was considered an imperial treasure of China. The infusion results in a wine with strong floral-cherry aroma that is typically served as an aperitif or dessert wine. The wine is produced by adding fresh *Osmanthus* flowers to the wine after fermentation is complete and steeping them in the wine for 6 to 12 months. The wine was finished at 15% alcohol and 12% residual sugar.

Viction Winery, Shamuji County

This winery is the result of a 12 million RMB investment by a Hong Kong-based food processing firm that includes 5 million RMB of capital equipment. Primary wine production is from Cabernet Sauvignon and Chardonnay grapes produced in the Wūhǎi region. Most of the grapes arrive at this winery with a sugar content of 18-20 °Brix which, to us, means not quite ripe. We tasted several of the wines at the winery and later they were also served with lunch. The Cabernet was uncharacteristically light in color and body, but with good fruit, dry with medium tannin, and clean finish. It was 12% alcohol and had not been aged or treated with oak. The style was skillfully adapted to the ripeness of the fruit available. The Viction Winery Chardonnay was another example of skilled northern winemaking. It was rather light in body and alcohol, crisp and clean on the palate with good acidity, and with characteristic Chardonnay aromatics. It had not been oaked. Both the Cabernet and Chardonnay at Viction Winery were very different from the dull, cloying overcooked whites we tasted from more southern parts of China. These light crisp wines cut through the high fat dishes at lunch really well.

Also at Viction Winery, we encountered our second *Osmanthus*-flavored wine which was made by a different infusion technique. Fresh *Osmanthus* flowers are steeped in grape brandy to extract the aroma. The *Osmanthus*-flavored brandy then is infused into the white wine to produce an intensely aromatic floral dessert wine. It had a

strong straw color, good fruit-flower flavor intensity. We were told it had 4% residual sugar, but tasted much sweeter than that, and had an alcohol listed at 15%. It had only been bottled for about one week when we tasted it.

Shamujia County Vineyards

Bāotóu lies about 100 miles west of Hohhot, on the northernmost reaches of the Huáng Hé (Yellow River). We were welcomed and met with 10 local officials of the district including the director, vice-director, and sub-director of agriculture for the city, the director of the local horticulture research institute, mayor of the township, and directors of the horticultural research and technology center. We were told that grapes have been cultivated as a main agricultural crop since 1960 with about 1300 hectares now in cultivation generating 25 million RMB per year, which is about 45% of the agriculture production for the community. Quite a few different grape varieties are grown here including Dragon Eyes (Long Yan), White Milk (Bai Niu nai), Rizamat (a Russian variety), Red Globe (Hong Ti Qui), Victoria (Wei Duo Li Ya), August (Ao gu si te), Pink Honey (Pink Ya Du Mi), Good Seedless (You Wei He), Beautiful Finger (Mei Ren Zhi), Harvest (Feng Hou), Green Globe (Lü Di Qiu) and a Red Globe variant. The vineyard we visited was planted densely with 4,000 vines per hectare and used deep ditch cultivation.

HEILONGJIANG AND JILIN PROVINCES

Heilongjiang He is the Chinese name for the Amur River which forms the boundary between China and the Siberian frontier of Russia. Harbin is a very cosmopolitan city of nine million people situated along the Song River, a tributary of the Amur, just 300 miles from the border with Russia. Harbin still has a beautiful Russian sector with blocks of renovated buildings in classic turn-of-the-century Russian style and the onion-domed St. Sophia's Orthodox Church. It is the sister city of St. Paul, Minnesota with whom it shares an almost identical climate--hot summers with a short growing season and severely cold winters. On average, winter in Harbin is even colder than Minnesota and the growing season about ten days shorter. The vast farmlands south of Harbin resemble southern Minnesota, as fields of corn and soybeans grow on rolling plains as far as one can see. Nels Hansen, plant explorer extraordinaire, visited Harbin in 1924 to collect seed of local Asian pears and other fruits. We felt privileged to follow in his footsteps 75 years later.

Heilongjiang Academy of Agricultural Sciences Horticultural Research Academy, Harbin

The Horticultural Research Academy of Heilongjiang in Harbin is a national center of excellence for breeding of grapes, Asian pears, and plums. Also, it recently has become the main research center in northern China for greenhouse and unheated plastic house culture of flowers, vegetables, and grapes.

Prof. Dianyi Jin leads the grape research program at the institute. To date, the program has focused on breeding table grapes. However, the Institute has a new charter to develop wine grapes and begin an experimental winery. Breeding has used

Vitis vinifera, *Vitis amurensis* and *Vitis labrusca* and has resulted in selections such as Mizhi and Hongxiangshui. Both are high in quality, but winter tender, e.g. they assume that the vines will be protected during the winter.

The Horticulture Research Academy also has a new venture in agro-tourism. The entire campus is being renovated to accommodate tourists. The new campus includes a wide range of educational displays, a very fine restaurant, and a hotel.

Our hosts in Harbin also took us to a fantastic book store where we loaded up on Chinese cook books and Chinese books on grapegrowing (unfortunately all in Chinese). We figure that we now must have the largest collection of Chinese viticulture books in the U.S. Reading them is the problem.

Chinese Academy of Agricultural Sciences

Institute of Special Economic Wild Animal and Plant Sciences, Zuoja-Jilin

About 200km south of Harbin is Jilin Province. In Jilin, the low rolling hills and plains give way to bigger hills and small mountains covered with deciduous forest. On average, Jilin is milder in winter than Harbin, but still is accustomed to lows of -35 °C in most winters. In Jilin, we visited this special CAAS Institute of Special Economic Wild Animal and Plant Sciences. Research is conducted here on improving the disease-resistance and cold-hardiness of fruits through breeding cultivated varieties with superior selections of wild species. Besides fruits, work is also directed towards cultivation and breeding of wild animals and Chinese herbs. They have released dozens of varieties of plants in recent years, including two hawthorne and eight *Vitis amurensis* grape varieties.

Most importantly for us, this CAAS Institute is home to the Chinese National Repository for *Vitis amurensis*, the hardy native grape species of northern China and Siberia. Some 360 selections of *Vitis amurensis* collected from all around the far north of China are grown in the collection here. The collection includes a broad range of traits within this species including selections that are resistant to mildew, some super hardy selections, some with lower than typical acidity, and some with larger than typical berry and cluster size. In 2003, this site was stuck by two late spring frosts of -5 to -10°C during the first ten days of May, the first such event there in at least 20 years. These freeze incidents destroyed virtually all the emerging grape flowers. Therefore there was practically no fruit for us to taste and evaluate this fall in this collection. However, we were able to review the log book for the collection and see photographs of the many *Vitis amurensis* selections. We also discussed their grape breeding work at the Institute which recently produced its first winter hardy wine grape selection, "Zuojia Red Amurensis #1" from a cross of (*Vitis amurensis* x *Vitis vinifera*) x *Vitis amurensis*. They are currently making selections from their first round of F3 seedlings.

During this visit to the CAAS Institute in Jilin, we also learned that there is a whole industry in Jilin and Heilongjiang centered around the commercial production of selected *Vitis amurensis* grapes for making grape juice and spirits. Grape production

is surprisingly good for the most superior wild *amurensis* grape selections, typically 12-15 tons per hectare, but as high as 18 tons/hectare. Cluster weights on the commercially grown selections are typically 100 grams or greater. Titratable acidity ranges from 1.35 to 3.0 at harvest, with sugar levels from 12% to 21%.

At this institute we also were treated to an incredible lunch of Chinese dishes made entirely from wild meats, fruits, mushrooms, and vegetables harvested from the surrounding forest and mountains. We were served a special wine produced at the institute's experimental winery from fruit of the native *Schizandra chinensis* vine. Schizandra berries have the highest natural concentration of ascorbic acid of any fruit in the world. Healthy for sure, but a real winemaking challenge. The wine we tasted with lunch had successfully tamed all that acid. It was finished sweet which allowed the natural strawberry-cranberry aroma and cranberry flavor of the Schizandra fruit to come out. It was delicious, especially with some of the spicy dishes served at lunch.

Tonkin Ltd. Dong Jin Group, Harbin

At Tonkin Ltd. outside of Harbin, we toured what their vice president, Dr. Zhandong Wang, stated was the largest greenhouse grape production facility in the world. The current operation has 1,200 greenhouses, each 12m (width) x 50m (length) x 3.2m (height) with 480 grapevines per house. By 2005, the operation will have expanded to 6,000 greenhouses situated on 400 hectares of land. This is their third year of production.

The greenhouses at Tonkin, Ltd. are inexpensive unheated plastic hoop houses. They serve only to avoid spring and fall frost and to increase the heat needed for vine development and fruit ripening in this traditionally cool and short frost-free season area. In the winter, these houses are not heated. The winter temperature inside the greenhouses drops to the same severe low temperatures as those outside.

All the vines grown at Tonkin are premium vinifera table grapes. Ninety-five percent of the production is the UC-Davis variety, "Red Globe". Other varieties grown are UC-Davis's "Centennial Seedless" and premium tetraploid varieties such as "Ju Feng". They are shipped around China as well as South Korea and Japan. When the project is fully developed, grapes will probably be shipped to Europe and the US, as well.

We learned a lot about how such an operation is established and maintained. The vines are planted at close spacing, about 0.6m between vines. Rows are 2.3m (7.5 feet) apart. Vines are trained straight up on wires as vertical cordons. The vines are severely pruned, with only five buds allowed to produce fruit (in contrast to a normal 20-30 buds in outdoor cultivation). Each of these five shoots is allowed to produce only one cluster of grapes. Cluster thinning is used to achieve this. Lateral shoots that attempt to sprout during the growing season are removed during one of five rounds of green pruning during the season. The result is extremely large and attractive berries and clusters that sell for a premium price on the produce market. Gibberellic acid treatment of the clusters is used shortly after fruit set to further enhance the size of the fruit.

These greenhouse vines require special protective measures to survive the severe winters around Harbin. First, all vines are grafted on hardy rootstocks, with the old Minnesota grape variety, Beta, being the rootstock of choice. Vines are covered with 20cm of soil, covered with 6-7cm of rice straw and then topped with plastic. Water is added around the vines late in the season to provide warmth as well as saturate and seal the soil for the winter. Given the high density of the plantings, only five buds per vine need to survive the winter, which is more than adequate for the small vine structure needed in the greenhouse. With the protection provided these vines, at least five buds routinely survive.

BEIJING

Gordon stayed on in China for four days after Tom and Mark departed. Gordon took advantage of his extra Sunday in China to visit to the China Academy of Science, Institute of Botany with our Beijing friend, Dr. Chen Zhao.

At the Botanical Garden, Gordon met Liu Huaifeng, a PhD student in viticulture. The Institute has 200 different varieties of grapes in the vineyard that are used for breeding of table and wine grapes. This effort has been going on for 15 years. Twenty-five percent of the grapes grown in China are from varieties developed here, including some very famous ones like Bei Chun, Bei Hong, and Bei Mei. They are also known in China for breeding table grape varieties with super large berries. Their variety, Super Beijing, has berries ranging from 13-20g in size (for comparison, the berry of Swenson Red is around 2.5 or 3g). Gordon tasted grapes from a number of named varieties. Most of the grapes were way past their prime with many shriveled berries and wasps present in the clusters. However, he still was able to taste fruit from Beijing Excellent, a white table grape that ripens late July to early August. Another was Jing Xiu, which is pink in color and ripens about July 25. Another is Yan 73 a black wine grape. All are selections of *Vitis vinifera* or *Vitis vinifera* x *Vitis amurensis* hybrids. These hybrids have moderate hardiness, surviving the winter low temperatures of -25°C to -28°C in Beijing.

Gordon also visited the laboratory at the Institute which included an experimental winery and many large glass jars containing clusters of at least a hundred different grape varieties in what looked like formaldehyde.

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