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Analysis on Protection of GI Product Hanyuan Chinese Prickly Ash and Suggestions of its Industrial Development

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Abstract Hanyuan Prickly Ash is a type of GI products with very deep cultural essence. From such humanistic factors as name origin, historical origin, fame, cultivation technology, and management measure, and such natural factors as climatic environment and soil conditions, this paper analysis key factors for protection of GI product Hanyuan Prickly Ash. Then it discusses about industrial development of Hanyuan Prickly Ash from suitable planting areas and climate. It proposes that we should gradually raise safety and hygienic indexes, revise and implement local standards, strengthen popularization of harmless production technologies and quality control of product, promote "enterprise + base" industrial model, and implement government marketing of brand and industry.

Key words Hanyuan Prickly Ash, Geographic Indication, Industrial development

By now, Hanyuan Prickly Ash has had over 2000 years of cultivation history. It is mainly planted in southern foot of Daxiang Mountain Ranges of Qionglai Mountain. Prickly Ashes from Hanyuan County of Yaan City in Sichuan Province are famous for their slightly deep red color, big particle, and spicy but fragrant taste. Hanyuan Prickly Ash is also called Li Pepper, Hanyuan tribute pepper, Qing pepper, baby pepper, and Xuanzang pepper, etc. In *Annals of Hanyuan County*, it states that Li pepper tree like cornel has thorns. Hanyuan County is rich in this plant. Each particle has a child particle, just like mother and child, so it is called mother-child pepper. *Annals of Yuanhe, Comprehensive Geography of the Great Qing Dynasty* and many other historical documents have records of prickly ash as article of tribute. After paying tribute every, the prickly ash is packed in small bag, and any one who get it will regard it as valuable product. Hanyuan Prickly Ash is a flowering plant in the family Rutaceae. It is one of several species of *Zanthoxylum*. Its major composition is volatile aromatic oil, so it is a type of famous spices and oil trees. As a type of important condiment, it enjoys the laudatory title of "King of Sichuan Flavor Prickly Ash".

To effectively protect this traditional product with historical and cultural background and further promote sustainable development of Hanyuan Prickly Ash industry, Hanyuan County government launched the protection of GI product Hanyuan Prickly Ash in September, 2003. On February 4th, 2005, General Ad-

ministration of Quality Supervision, Inspection and Quarantine of the People's Republic of China officially approved the application for protection of GI product Hanyuan Prickly Ash. The protection region is administrative areas under the jurisdiction of Hanyuan County.

1 Relevant concepts of Geographic Indication production protection

Geographical Indication (GI) products refer to those products originated from specific region and designated with geographical name, and quality, reputation or other special nature of these products depend on natural and humanistic factors of this region. Most GI products are agricultural products, foods, arts and crafts products. A GI is a quality mark, and its property system is firstly originated from France for special protection of alcohol products^[1]. In 1883, *Paris Convention for the Protection of Industrial Property* initially provided legal protection for geographical indication from the point of anti-unfair competition. With over a century of theoretical development and application practice of GI product protection, a series of international conventions have been signed, such as *Madrid Agreement for the Repression of False or Deceptive Indications of Source on Goods* (1891), *The Stresa Convention* (1951), *Lisbon Agreement for the Protection of Application and Their International Registration* (1958), and *Agreement on Trade-related Aspects of Intellectual Property Rights* (Trips Agreement, 1986). So, the international GI protection system framework has been established. With GI protection, the product will have an increase of 20% in economic benefits.

There are generally two types of GI products. One type is planting and cultivation products from local areas, and the other is products produced and processed in accordance with local special process and raw materials wholly or partly from local or

Received: December 5, 2011 Accepted: March 9, 2012

Supported by Science and Technology Program Project of General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (2011IK054 and 2009IK296) and Scientific Research and Technological Development Program Project of Guangxi Province (0992015-7).

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other areas. The essence of GI product protection is the concrete manifestation of origin designation system in economy^[2].

A famous, special, and excellent product should generally possess four elements: geographical name (designated with the origin), special quality, reputation, natural and humanistic factors. Special quality is the basis for GI protection, and the connection between natural factor and/or humanistic factor and special quality is the key to GI protection. Natural factors mainly include soil, terrain, climate, and water quality; humanistic factors include social factor and cultural factor, mainly historical tradition, special production process, formula, etc. The quality or other special features of most agricultural type GI products are decided by natural factors; the quality of arts and crafts GI products depends on humanistic factors; and the quality of food type GI products is determined jointly by natural and humanistic factors.

2 Name, historical origin and fame of Hanyuan Prickly Ash

2.1 Name and historical origin of Hanyuan Prickly Ash

In ancient times, Hanyuan Prickly Ash was called Li Pepper and Tribute Pepper. From Yuanhe Period (806 to 820 AD) of Tang Dynasty to Guangxu Period (1903) of Qing Dynasty, Hanyuan Prickly Ash had been paid as article of tribute for over 1 083 years. This tribute pepper is mainly produced in Qingxi County (now Hanyuan County), so it is called Qing Pepper. Qing Pepper fruit has 1 to 3 pure "meat" particles, like mother and child embraced together, so it also has the name of "Mother-child Pepper" or "Baby Pepper". There is a folk story of Xuanzang's Journey to the West. It tells that Xuanzang had spent the night in Lizhou after his return from the West. His cane was changed to a living thing (*i. e.* the Prickly Ash), so it is also called Xuanzang Pepper. Qing Dynasty scholar Nie Zhenchun composed the Li Pepper Poem to eulogize the Li Pepper.

*"Person who passes on Li Pepper we not know,
Perhaps it originates from Xuanzang inserting his cane.
Green leaves suffered from rain and dew,
who can count such scarlet fruit, no one.
Even full of thorns on branches, deep rooted and mother-child hugged shape,
As well as spicy flavor, No wonder it had been paid as tribute in Yuanhe."*

2.2 Fame Cultivation of Hanyuan Prickly Ash has a long history. In ancient times, Hanyuan was called Zhadu. In the 6th year of Yuanding Period, the Emperor Wu Di of the Han Dynasty suppressed the rebellion in southwest areas and set Li Prefecture. In Sui Dynasty (607 AD), it was firstly called Hanyuan County. Later, it once was called Qingxi County. Since the Republic of China, it has been named Hanyuan County. As early as the 6th year of Yuanding Period (111 BC) in Han Dynasty, there were records of Prickly Ash planting, indicating the Prickly Ash Planting has a history of over 2 100 years. In 2001, Hanyuan County was named "home to Chinese Prickly Ash" by State Bureau of Forestry. In 2002, it was

called home of "Hanyuan Prickly Ash" by Sichuan Specialties Association. In 2008, it ranked the first in "Top Ten GI Products" in Sichuan Province. In recent years, Hanyuan Prickly Ash and its deep processing products are sold in all parts of the country, America, Japan, and Southeast Asian countries and regions.

3 Correlation between quality and protection regions of Hanyuan Prickly Ash

Output and quality of Hanyuan Prickly Ash are subject to such factors as climate, soil and cultivation management measures. Good quality and high output of prickly ash requires proper climatic conditions, soil conditions, and topography. Climatic conditions include temperature, annual hours of sunshine, and rainfall; soil conditions are mainly soil structure, fertility, water and pH value; the topography mainly includes slope aspect, slope and height above sea level. In the growth of prickly ash, dense planting, fertilization application, pruning, antifreezing, and picking are key management measure^[4].

3.1 Climatic environment and soil conditions of Hanyuan Prickly Ash production regions

3.1.1 Climatic environment conditions. The climate in Hanyuan County is typical dry and hot valley climate. The main producing regions of prickly ash has mean annual temperature of 12 °C, 300 days of frost-free period, 1500 hours of sunshine time, 745 mm average annual rainfall, and 1300mm evaporation amount (the ratio of evaporation to rainfall up to 1.7). The rainfall is mainly in June to August (about 80%). The rainfall in these three months account for 65% of the whole year rainfall. The relative humidity in the whole year is 69%. The dry and hot characteristics are distinct, vertical change is significant. The winter is not cold, the summer is not scorching, sunshine is abundant, and rainfall is adequate. Besides, there is a clear distinction between dry and wet seasons. In the mature period (July to September), the average day-and-night temperature difference is 12 °C. Hanyuan County makes great achievements in protection of ecological environment. The water quality and environment quality in Hanyuan reach the first level of national Category III, and the air quality is close to national first level.

3.1.2 Soil conditions. Soil types in Hanyuan County mainly include alluvial soil, purplish soil, and yellowish-brown. In main producing regions of Hanyuan Prickly Ash, the soil is mountain soil with pH value at 6 to 8. Due to limitations of natural conditions and human activities, the soil takes on vertical distribution, the relative height difference is about 3 471 m from the valley bottom to the peak.

3.2 Relation between climate, soil and production and growth of Hanyuan Prickly Ash Hanyuan Prickly Ash prefers cool, dry and sunny climate. It is not cold-resistant. The average temperature is 8 to 16 °C, and the most suitable place for planting should have temperature of 10 to 14 °C. It is suitably planted in leeward, sunny, and warm place with sunshine hours over 1 600 h. The soil pH value should be within 6.5 to 8. Its adaptability to soil is high. The preferred soil should have

deep soil layer, wet sandy soil and mountain calcium soil. The root system of prickly ash is shallow, but the lateral root is well developed, so the water demand is not high, it is highly drought-resistant. Excessively wet soil is harmful to growth of prickly ash. However, in the early and middle growth periods, it still needs certain amount water. If aridity in these periods, it will severely affect the output. The prickly ash should be planted in a place with annual rainfall of 400 to 700 mm, and the height above sea level of 1 150 to 1 700 m. The annual sunshine hours should exceed 1 600 h, especially in flowering period and mature period, the sunshine shall be sufficient. The soil requirement is not strict for prickly ash, but it should have good aeration and be loose in texture, and too high water content or bad drainage will influence growth and fruiting of prickly ash^[5-6].

Hanyuan Prickly Ash is mainly produced in southern foot of Daxiang Mountain Ranges of Qionglai Mountain. Compared with other production regions of prickly ash, the climate in Hanyuan is greatly superior, particularly cool and dry, adequate sunshine in growth period, as well as gifted soil conditions. In recent years, many regions introduce Hanyuan Prickly Ash, but the change of growth environment leads to bad growth of pure small particle of prickly ash.

4 Cultivation technologies, management measures and picking methods

Unique quality of Hanyuan Prickly Ash is inseparable from special cultivation and management technology. It takes full advantages of natural resources, brings into full play the production capacity of soil and prickly ash, in addition to reasonable, scientific cultivation technology, management measures, and picking method, the superior quality of Hanyuan Prickly Ash is guaranteed.

4.1 Cultivation technologies

4.1.1 Nursery and garden selection. The nursery should be situated in sunny, leeward, and flat place with deep and fertile soil, high gas permeability. Garden should have sufficient sunshine, the height above sea level within 1 150 to 1 700 m, average temperature at 8 to 16 °C, the pH value of soil is in 6.5 to 8, and the gas permeability and water drainage are good.

4.1.2 Seed selection, seed production, and seedling raising. It is required to select pure, strong, and high output prickly ash trees free of plant diseases and insect pests as seed tree. Pick the seeds on fine days after they are fully mature. Put the mature seed in ventilated area for drying till the seed vessel is cracked and seeds come out. Rub them with hands or slightly strike them with wood stick. After screening, use water to separate again (1:13 salt solution). Take out plump seeds, add warm water and some alkaline substance to wash, remove the surface oil, and sterilize with plant ash. There are many methods for seed storage, for example, caking storage method. Add 4 times dry fine soil into seed and mix uniformly, then add fresh cow dung to make them to cakes. In the period between the Waking of Insects (the 3rd solar term) and the Spring Equinox of the next year, beat the cakes to pieces and mix with

soil, then sow them at seedbed. The seedbed should be applied with farm manure and phosphorus fertilizer. After sowing, cover certain thickness of fine soil, additional cover a layer of straws, spray sufficient water, regularly uncover straws and apply fertilizer, and properly supplement seedlings, conduct weeding and prevent plant diseases and insect pests.

4.1.3 Grafting and seedling raising. The rootstock mainly adopts Dahongpao Pepper, Chinese wild pepper, Gaojiao-huang Pepper, and Yunnan Green Pepper. The scion is selected from maternal plant or picked from superior, strong, high output mature prickly ashes. The branches for scion should be substantial in tissue and free of plant diseases and insect pests. The grafting is generally conducted during the first ten days of March to the first ten days of April. Major grafting methods include cut grafting, complex grafting and T-shaped bud grafting. After grafting, regularly inspect the survival conditions and timely remove binding and supplement grafting.

4.1.4 Transplanting. Pure prickly ashes may be planted in a garden, or mixed with other types of crops. For pure prickly ash garden, the row spacing should be 1.5 × 2m; for mixed types, the row spacing should be 1.5 × 4m. The preferred planting direction is the east-west direction. The mixed crops can be leguminous plant. Field planting should be in spring and autumn. The nursery stock for field planting should be 1 to 2 years old, strong, and over 30 cm high, with complete root system. The rhizome should be thicker than 0.5 cm. The pit for planting should be 60 cm in length and width, and 40 cm deep, and be sterilized. If planted in mountainous areas, the pit should be excavated in accordance with contour. The pit should be back filled into a form of hillock (after sinking, it will be flat with the ground). At the top of hillock, excavate a pit for field planting, and irrigate (cover with plastic film in case of water shortage).

4.2 Management measures It is required to take care of management, timely fill water, strengthen soil, apply fertilizer, manage water, and prevent and control plant diseases and insect pests. Besides, it is proposed to improve soil through deep plough, expand pits, and take winter protection measures. Also, proper fertilizing should be ensured. In spring, apply fertilizer for ensuring flowering; in summer, apply fertilizer for ensuring strengthening fruit; in autumn, apply fertilizer for enhancing nutrition. Furthermore, it is recommended to prune in time. Preferred shapes of prickly ash include natural open center shape and multiple main branch open center shape. Pruning should focus on cultivating and adjusting backbone branches. Prevention and control of diseases and insect pests mainly include root rot, *Clytus validus* Fairmaire, *Embrik* – *Strandia bimaculata* (White), Coccidae, etc. It is required to focus on prevention, and integrated control, adopt such methods as physical, biological, and chemical prevention and control.

4.3 Picking technologies Prickly ashes become mature in August and September. When prickly ashes take on bright red and plump in oil, it is preferred to pick. Picking should be conducted in fine days (or in days not rainy). Hold prickly ashes in left hand and pick them in thumb and forefinger of right hand,

never press down tightly. Picked prickly ashes should be put into bamboo basket for air drying and screening. Air drying is the key step for their quality. The thickness for air drying should be 10 to 13 cm. Expose prickly ashes in open air for several days (in fine days, preferred air dried in one days). Do not stir hot prickly ashes. If there are no fine days for a long time, it is allowed to dry through anthracite fire, but such method may influence seed sprouting. Store the dry prickly ashes in well-ventilated areas, and pack them in braided bags or sacks. Before sales, rub prickly ashes with hands to separate kernels, and clean out branches.

5 Quality characteristics of Hanyuan Prickly Ash

Hanyuan Prickly Ash is small in size. Shapes mainly include natural open center shape and multiple main branch open center shape. The mature period is in August to September, and the growth period spans about 5 months.

5.1 Appearance characteristics of Hanyuan Prickly Ash

Hanyuan Prickly Ash has big particle, red color (from slightly deep red to purple). The cross-section of peel is about 1 mm thick. Oil sacs are dense and plump. The inner skin is smooth and yellowish. Most are separate from pulp, and there are 1 to 3 particles of pure pulp prickly ashes.

5.2 Size and quality characteristics of Hanyuan Prickly Ash

Every 1 000 Hanyuan Prickly Ash particles weigh about 14.5 g. Hanyuan Prickly Ash contains much oil, strong fragrance, and spicy taste. The main content is volatile aromatic oil. Other contents such as phytosterol and undersaturated organic acid are helpful for human body, and both the skin and seed can be used as medicine. According to sampling analysis of Zhongnan Agricultural College, the content of volatile aromatic oil is up to 8.56%, which is greater than that of other types of prickly ashes (3 to 5%). And the ash content is only 4.18%, which is lower than that of other types of prickly ashes. Hanyuan Prickly Ash contains much oil, has slightly deep red color, and spicy and aromatic taste.

6 Thinking on development of Hanyuan Prickly Ash industry

6.1 Problems influencing quality and industrial development of Hanyuan Prickly Ash

In 2004, the total output of Hanyuan Prickly Ash in the whole Hanyuan County reaches 850 tons, the output value is nearly 60 million yuan. In 2010, the planting area of Hanyuan Prickly Ash reaches 6 670 hm². Over 17 million prickly ashes are planted, and the total output exceeds 10 000 tons. Calculated at 100 yuan/kg, the total output value is up to 100 million yuan. Prickly ash farmers have a net income of about 66.53 million yuan. It indicates that prickly ash has become a major source for economic income of local farmers, and deep processing industry has become one of pillar industries of Hanyuan County^[7].

The development of Hanyuan Prickly Ash industry provides a new approach to increase of local farmers' income. Maintenance

of core of Hanyuan Prickly Ash industry relies on maintenance of its unique quality and protection of GI product. Hanyuan Prickly Ash becoming GI protection product gives credit to its unique quality, which is closely connected with unique climate and soil and other natural factors of Hanyuan County. Becoming GI protection product not only provides legal weapon for its property protection, but also provides a regional industrial brand platform for its resource concentration.

However, in the development of Hanyuan Prickly Ash, there are following problems influencing further development of prickly ash industry. Firstly, according to analysis and research of climatic adaptability and production distribution of Hanyuan Prickly Ash, the suitable areas should have a height above sea level of 1 150 m to 1 700 m, but there are only 10 000 hm² such areas, limiting further raising output of Hanyuan Prickly Ash. Secondly, the climate in Hanyuan County is typical dry and hot valley climate. In this area, the sunshine is abundant, but the water loss and soil erosion are serious. The ecology is extremely weak, natural disasters such as freezing, drought, wind, insect pests, weeds and fires, are prominent. Bad weather may lead to decrease of output of Hanyuan Prickly Ash. In 2010, such problem of bad weather leads to serious decrease of output of prickly ashes. Thirdly, although it has formulated *Harmless Agricultural Products – Technical Specifications for Hanyuan Prickly Ash Production* and *Harmless Agricultural Products – Standard for Hanyuan Prickly Ash*, and it has established demonstration base, the separate prickly ash farmers are in large quantities, and there is still blind points in supervision of residues of pesticides, which is not incorporated into supervision of harmless agricultural products, thus there are certain risks of security and health. Consequently, it may result in domino effect of Hanyuan Prickly Ash industry.

6.2 Suggestions for industrial development of Hanyuan Prickly Ash

To promote further development of Hanyuan Prickly Ash industry and keep collective property of GI property, we suggest taking following measures and establishing appropriate systems. In the first place, we should gradually raise safety and hygienic indexes of Hanyuan Prickly Ash, revise and implement local standard *GI Product Hanyuan Prickly Ash*, to promote the overall safety level of the industry. Secondly, it is proposed to bring into play functions of trades society, strengthen popularization of harmless production technologies and quality control of product, promote "enterprise + base" industrial model, and control the pesticide from the source. Next, it is recommended to perfect and standardize the system for using GI product Hanyuan Prickly Ash, and set up independent government supervisory authority to strengthen supervision of Hanyuan Prickly Ash regional brand and industry. In addition, it is preferred to set up industrial popularization platform and carry out government marketing of brand and industry. Since the land suitable for cultivation of Hanyuan Prickly Ash and its output are limited, marketing may bring higher industrial profits and speed up gathering of capital, technologies, talents and brand of Hanyuan Prickly Ash.

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tion in multi-period distributed lag model, but the effective impact of the conduction of market prices on production behavior still exists. We can also use the substitution effect and the income effect to explain the mechanism of action of this variable. According to the substitution effect, after the food prices increase, farmers will shift to agricultural production, therefore, it will increase the growing area. However, according to the income effect, when food prices rise, the income of farmers will increase, therefore, they are likely to further enjoy their leisure, thereby reducing crop acreage. From the empirical results, the substitution effect is greater than the income effect, and thus the crop acreage increased.

In terms of "external social networks and geographic factors", "whether in 2007", "whether in 2008", "Duilongdeqing County" and other variables have inconspicuous impact on the total planting area, indicating that for the three regions overall, the environmental changes over the past few years are not large, and the climate, environment and other external factors are not the main factors influencing the planting area; "dummy variable of Xigaze City" has significant positive impact on the planting area. In comparison with Nagqu County, in Xigaze City, different endowments of per capita arable land and geographical environment determine that the planting area is bigger after controlling a series of variables, and such regional differences are prominent.

4 Conclusions

This paper conducts systematic analysis of the basic characteristics and influencing factors of typical farmer and herdsman's operating behavior in crop production in the Tibetan areas, using the sampling survey data from fixed observation spot in rural areas of the Ministry of Agriculture. In general, we draw the following conclusions.

First, the factors representing the basic characteristics of rural households, "whether cadre or party member household" and "the amount of household labor forces" have obvious impact on the planting area. Cadres, as an alternative career, reduce the planting area, and abundant labor forces will naturally increase the planting area.

Second, young labor forces and highly educated labor forces cannot obtain scale returns in the small-scale production, and these labor forces flow out and depart from agriculture

in a large number, thus variables of "the number of migrant workers" and "the average level of education", have little effect on the planting area.

Third, the benefit of "original value of fixed assets for production purpose at the end of year", "whether having agricultural machinery or not" (as the substitute of labor), is greater than the cost in the existing per capita arable land area, and the two variables have significant positive impact on the planting area.

Fourth, since "household borrowing" expands the production possibility curve and farmers' ability to resist risks, the planting area is increased, but due to unsound financial markets and constraints of the current land system, "the original value of the farmers' houses" can not provide financing, having inconspicuous impact on the planting area.

Fifth, "the product of average price of food and whether selling or not" representing the market price, has significant impact on the planting area, indicating that in farmers' expectation of the price in the next period, the price in the previous period has a quite remarkable effect.

Sixth, "major food consumption all the year around" has multi-path impact on the planting area, and it is vulnerable to the impact of the relative price of food, thus the total effects of it on the planting area is uncertain.

Seventh, in dummy variables, due to resource endowment and other factors, there is an obvious difference between Xigaze City and Nagqu County; there is no obvious regional difference between Duilongdeqing County and Nagqu County; the time variables of the year 2007 and 2008 also have no obvious effects.

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