

GIAHS Proposal

Xiajin Yellow River Old Course Ancient Mulberry Grove System

Location: Xiajin County, Shandong Province, P.R.China



The People's Government of Xiajin County, Shandong Province

August, 2016

Summary Information

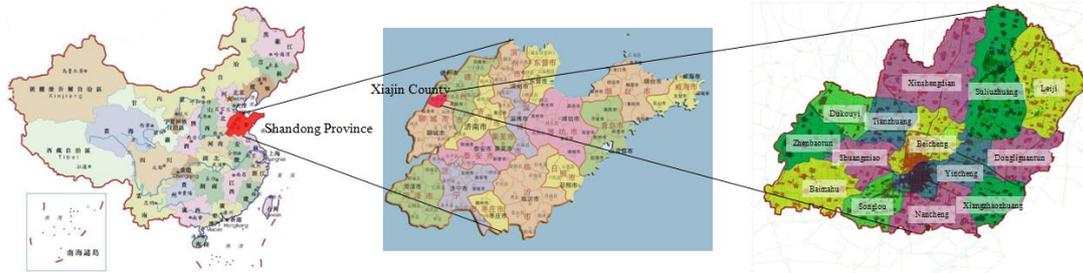
Name/Title of the Agricultural Heritage System:

Xiajin Yellow River Old Course Ancient Mulberry Grove System

Requesting Agency/Organization:

The People's Government of Xiajin County, Shandong Province, P.R.China

Country/location/Site: The heritage system is located in the Suliuzhuang Town, Xiajin County, Shandong. The system lies within longitude $115^{\circ}45'18'' \sim 116^{\circ}16'05''$ E and latitude $36^{\circ}52'38'' \sim 37^{\circ}10'07''$ N.



Accessibility of the site to capital city or major cities: The heritage system is 67 km away from the Dezhou High-Speed Train Station, and 100 km from the Jinan Yaoqiang International Airport. They are connected by an airport express, and the Qingdao-Yinchuan Expressway. The Dezhou-Shangqiu Expressway, still under construction, will be connected with the Qingdao-Yinchuan Expressway. They will form a cross connecting Beijing, Tianjin, Henan, Hebei and Shandong. The crossroad is 10 km away from the heritage system.



Approximate Surface Area: 480.67 hm ²
Agro-Ecological Zone/s: Agri-forestry area on sandy land
Topographic features: The ancient course of the Yellow River is through tableland. The micro-topography is diversified, including channel filled deposits, batture, sand dunes, crevasse fans, and sandy troughs.
Climate Type: Temperate semi-humid monsoon climate
Approximate Population: 51,000
Main Source of Livelihoods: The cultivation and tourism surrounding mulberries and other fruit and their by-products contribute to 67% of the household income.
Ethnicity/Indigenous population: Han people constitute over 99% of the total population.
<p>Summary Information of the Agricultural Heritage System</p> <p>The Xiajin Yellow River Old Course Ancient Mulberry Grove System is located on the sandy land, which is the ancient course left by the Yellow River when its course changed in the Dongzhou Dynasty. The mulberry trees were planted to control the sandstorms, and to provide agricultural products. Their history started in 11 A.D. The heritage system covers an area of more than 400 hectare. Over 20,000 mulberry trees, which are over 100 years old, are living in the heritage site. In addition, there are over 10,000 old persimmon, apricot, hawthorn and pear trees. Silk was once the dominant fabric. But cotton gradually became more important, and replaced silk as the dominant fabric in the area/era. The heritage site, being the witness of these developments, has shown its resilience in the face of socio-economic and environmental change.</p> <p>The heritage system is a model of the coordinated development of desertification control, and society and economy. The soil of the ancient course of the Yellow River is barren. The micro-climate is hostile. The local people plant the resilient mulberry trees with other fruit trees and timber trees, which slow the wind erosion process, stabilize the sand, conserve the water and improve the soil conditions over time. In other words, locals have improved the micro-climate and conditions of the site,</p>

making it possible for planting other crops among the trees. In the woods, crops that can grow on sandy land are planted, such as sweet potato and peanuts. On the grass, livestock are raised. Therefore, the heritage system combines agriculture, forestry and animal husbandry. It not only safeguards ecological security, but also provides the majority of livelihood necessities, including food, clothing, medicine and other daily needs.

The heritage system has witnessed the development of China's sericulture industry, and enjoys rich cultural connotations. It embodies the historic memories and spirits relating to the ancient course of the Yellow River and the mulberry trees. It shows the experience of planting mulberry trees, combining agriculture and forestry, and the rejuvenation of old trees. It also reflects the philosophy of harmonious development of humans and nature, and offers many lessons for modern agriculture and social development.

Since the 1970s and 1980s, the decline of the sericulture industry, urbanization and industrialization, and the pursuit of short-term economic benefits have struck this heritage system. Many old mulberry trees were cleared to plant swift-growing trees and crops, and to build factories. The stability and diversity of the heritage system were damaged. However, the protection and development of the heritage system has become a common cause of the local people. China attaches great importance to ecological protection, leisure agriculture, and the development of the "Silk Road Economic Belt". Another reason is that in 2014 the heritage system was selected as a China National Important Agri-Cultural Heritage System (China-NIAHS).

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1. Characteristics of the Proposed GIAHS

The Yellow River is the second longest river in China. It's famous for being extremely prone to silting, flooding, and course changes. The heritage system is located on the sandy land at the ancient course left by the Yellow River when its course changed in the Dongzhou Dynasty. The mulberry trees were planted to control the sandstorms, and to provide agricultural products. The heritage system presents a sustainable agriculture model. It is a model of the coordinated development of desertification control and economy.

The history of the heritage system can be traced back to 11A.D. In the East Han Dynasty, it became an important silk production base as the Silk Road was developed. Silk was once the dominant fabric in China, but cotton gradually became more important, and replaced silk as the dominant fabric.. The heritage site, being witness to these developments, has shown its resilience and sustainability in the face of socio-economic changes.

At the peak of its history, the heritage system covered an area of over 5,000 hectares. Now, it only covers about 400 hectares. Over 20,000 mulberry trees, which are over 100 years old, are living in the heritage site today. In addition, there are over 10,000 old persimmon, apricot, hawthorn and pear trees. It is known as the “Museum of Deciduous Fruit in the North”, and is a germplasm bank with global significance. The heritage system is made up of mixed woods. There are 55 families, 117 genera and 210 species of plants in the heritage system; and 49 families, 84 genera and 107 species of wild animals.

In the heritage system, there are diversified species from different times. The heritage system is mainly made up old mulberry trees, persimmon, apricot, and pear trees. Other arbors include *Toona sinensis*, *Ailanthus altissima*, poplar, willow and locust. In the woods, crops that can grow on sandy land are planted, such as sweet potato, peanuts and cotton. On the grass, livestock are raised (Fig.1). Therefore, the

heritage system combines agriculture, forestry and husbandry, and is of both economic and ecological value.

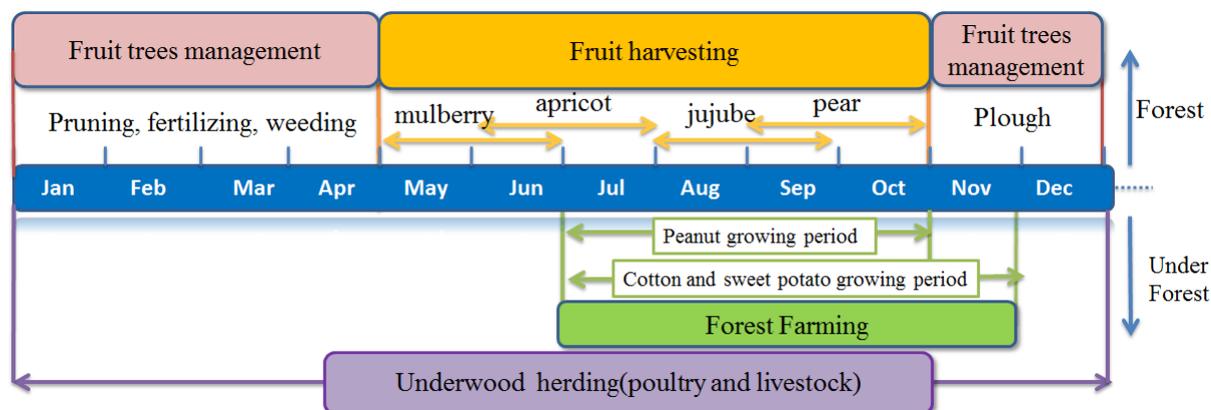


Fig.1 The Seasonal Structure of Agriculture in the Heritage System

1.1 Food and Livelihood Security

1.1.1 Diversified Products

Mulberry trees have long life spans. When they come of age, they are fully productive every year. Even the ones over 1,000 years old are productive. One old mulberry tree produces 400 kg of mulberries per year, and 225 kg of fresh leaves per year. The mulberries can be eaten directly, or be made into dried mulberries, mulberry cakes and mulberry porridge. The leaves, on the other hand, can be used to feed silkworms and other livestock. Leaves can also be made into dishes, porridge and pancakes. The mulberry wood is shiny, without unpleasant odours and patterns like deer spots. It can be made into chairs and tables etc. The branches can be made into small tools, such as the ones used to scratch one's back. The roots, branches and bark of the mulberry trees, and the *phellinus igniarius* are rich in anti-oxidants, and can be made into medicines (Fig.2).

Through intercropping and agro-forestry, the farmers have used the system to improve the site conditions of the ancient course of the Yellow River, and produce agricultural products. By planting peach, apricot, pear, apple, hawthorn and other fruit trees among the mulberry trees, the farmers have grown mixed forests, which provide

various fruits. As to agro-forestry, wheat, green bean, peanut, sweet potato, oilseed rape, green pepper and other crops are planted among the arbours. Chickens, geese, sheep and other livestock are raised in the woods. In this way, the various products of the system have met the subsistence demands of the people (Fig.2).

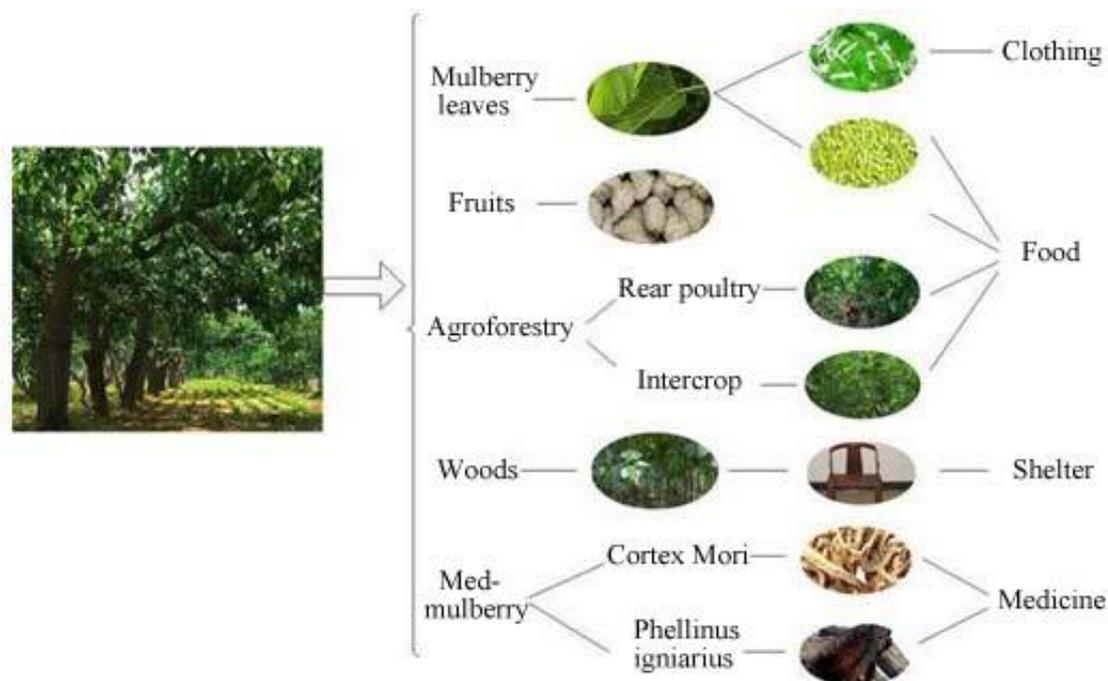


Fig.2 Diversified Products from the Heritage Site

1.1.2 Livelihood Security

The ancient course of the Yellow River is mainly covered by Aeolian sandy soil that is barren. Blowing sand happens frequently. The system is dominated by mulberry trees, which are tolerant and resilient to arid conditions. Many other plants are grown in the system, as well as livestock. This means that the system has both environmental and economic values. It prevents and controls sand blowing, thus improves the micro-environment. The mulberry leaves are used to feed the silkworm, the cocoons of which are made into various silk products. The system produces mulberries and other fruits. The mulberry bark and the *Phellinus igniarius* are made into medicine. These and the other agricultural products from the system meet the local people's needs of clothing, food, housing and medicine.

Mulberry trees have stable yields. Besides they are named “the first spring fruits” because they ripen around Xiaoman (simplified: 小满; literally: grain full; usually begins around May 21 and ends around June 5). At that time of the year, the wheat has not ripened yet. Food is in short supply, making it the most difficult time for farmers. Luckily, the local people harness mulberries to make up the shortage. They also dry the mulberries, which then can be stored for a longer time. According to historical records, mulberries had saved many people at the lower reach of the Yellow River from starving in time of famine.

Nowadays, the system remains important, economically, for local people. Sixty-seven per cent of household income comes from the planting, picking and tourism related to the fruits, mostly mulberries, and their by-products from the system.

1.1.3 Nutritional and Medicinal Values

Phellinus igniarius, which can be found in only certain environments, can be found on many old mulberry trees. As early as the Han Dynasty, which was over 2,000 years ago, the Chinese began to use *Phellinus igniarius*. It was recorded in *Shennong's Herbal Classic*, China's oldest record of plants. The *Compendium of Materia Medica* has also recorded the use of *Phellinus igniarius*. It is said to be beneficial for the internal organs, able to remove gas, even toxic gas, in the digestive system. Modern studies show that *Phellinus igniarius* can help patients with cancer undergoing radiotherapy and chemotherapy, because it can improve the immune system, and ease the side-effects of anti-carcinogens.

Mulberries are very nutritious. Tests show that they contain 18 amino acids, mainly threonine, alanine, valine, isoleucine, leucine, lysine, methionine etc. The analyses of nutrition show that mulberries produced in Xiajin are rich in vitamins and minerals (Tab.1). In addition, they contain remarkably rich antioxidants. Clinical trials show that the extracts from mulberries can prolong human life.

Tab.1 Main Components, Trace Elements and Vitamins in Mulberries

Vitamins (mg/100g)		Minerals (mg/100g)		Main Components (%)	
Vitamin B1	0.169	Iron	3.6	Water	76
Vitamin B2	0.285	Copper	0.0505	Sugar	21
Vitamin C	39	Zinc	0.2108	Dietary Fibre	4.1
Carotene	0.03	Potassium	32	Protein	1.7
Vitamin D	10.2			Fat	0.4

1.2 Biodiversity and Ecosystem Function

1.2.1 Biodiversity

(1) Rich Genetic Resources

The heritage site is known as the “Home of Fruit” because it boasts a long history of planting various fruits, including mulberries, pears, apricots, peaches and jujubes.

● Mulberries

The conditions of the ancient course of the Yellow River are unfavourable for crop cultivation. The soil is mostly Aeolian sandy soil, including acres and acres of sandy hills. Mulberries are adaptive, and resilient to arid and barren soil because of their root systems. Over time, the local people have cultivated many mulberry species. In recent years, some new species have been introduced from outside. Therefore, there is a rich collection of mulberry species in Xiajin (Tab. 2).

More than 20,000 old mulberry trees over 100 years old are living at the heritage site. Dazitian mulberry is a species unique to Xiajin. Its fruit is shaped like a tapering cylindroid. It is slightly crooked. When ripe, the fruit is purple outside, white inside with a sweet flavour and it smells good.

Tab.2 Rich Genetic Resources

Source	Species
Endemic Species	Dazitian, Baizimu, Baishen, Hongzimu, Jiangmishen, Zishenzi, Changbingbai, Xiaocaomei
Introduced Species	Dashi, Hongguo NO.1, Hongguo NO.2

● Other Fruits

The heritage site is located in the temperate deciduous fruit belt. Biodiversity has never left local people's minds when planting mulberry trees at the ancient course of the Yellow River. Considering the water and soil conditions, they have chosen to plant jujube, apricot, peach, hawthorn and plum trees among the mulberries (Tab.3). This practice allows for diversified fruit species and food.

There are over 10,000 old persimmon trees, old apricot trees, old hawthorn trees and old pear trees that are over 100 years old in the heritage site.

Tab.3 Diversified Fruit Species

Species	Area (hectare)	Number of trees	Source	Main Cultivar
Pear (<i>Pyrus</i>)	70	2,000	Endemic	Nashi pear (<i>Pyrus pyrifolia</i>), Mianli pear, Suanli pear, Suli pear
			Introduced	Shuijing pear, Fengshui pear, Xingshui pear, Hongxiangsu pear
Apricot (<i>Armeniaca</i>)	0.67	20	Endemic	Maihuang apricot, Maihuangapricot, Zhibaixing apricot, Yaohedaxing apricot
			Introduced	Hongtaiyang apricot, Hongfeng apricot, Xinshiji apricot, Zhenzhuyouxing apricot
Jujube (<i>Ziziphus</i>)	10	300	Endemic	Dabailing jujube, Luodisu jujube, Yuanling jujube, Tailihong jujube
			Introduced	Zhanhuadongzao jujube, Xuezaos jujube

(2) Agricultural Biodiversity

The old mulberry trees and other fruit trees have created abundant niches at the heritage site, allowing other crops to grow in the system. Thus, the system is blessed with biodiversity.

Investigations show that (Tab.4) there are five species of grain crops in the system, 38 species of economic crops, 15 species of domestic animals and 10 aquatic species. Among them, *Serinus canaria* is an endemic species of Xiajin.

Tab.4 Agricultural Biodiversity

Category	Species
Grain crops	Wheat, corn, sweet potato, rice, sorghum
Economic crops	cotton, peanut, soybean, green bean, sesame, garlic, lotus, rape, potato, yam radix salvia miltiorrhizae, leek, cabbage, carrot, green onion, wild cabbage turnip, pepper, eggplant, tomato, cucumber, watermelon, melon, white gourd, pumpkin, bottle, gourd, courgette, fennel, parsley, celery, lettuce, endive, cowpea, kidney bean, haricot bean, spinach
Domestic animals	Pig, cow, sheep, donkey, mule, chicken, duck, goose, pigeon, quail, wild geese, parrot bee, fox
Aquatic species	Carp, crucian carp, silver carp, bighead carp, grass carp, crayfish, crawfish, shrimp, loach, goldfish, koi carp

(3) Diversified Related Species

Besides agricultural biodiversity, there are many other related plant and animal species. This can be attributed to the complicated topography and diversified systems, such as sandy land, farmland, forest, lakes etc. The two elements lead to abundant niches. At the heritage site, organisms and the environment are in harmony, resulted in diversified botanic and animal resources.

Preliminary statistics show that there are 56 families, 148 genera and 214 species of vascular plants at the heritage site. Among them are 1 family, 1 genus and 2 species of ferns; 2 families, 6 genera and 7 species of gymnosperms; 53 families, 141 genera and 205 species of angiosperms. In addition, there are 11 families, 28 genera and 50 species of arbours that are cultivars. The *Salicaceae* and *Ulmaceae* are windbreak species, while the rest are all fruit species. The herbaceous plants mostly fall into the *Leguminosae*, *Compositae* and *Gramineae* families. The milkvetch, *Astragalus scaberrimus*, *Caragana korshinski*, sweet clover, *Zoysia* grass play an important role in soil and water conservation, important as desertification controls. Please refer to Annex 3 for details.

There are 23 orders, 49 families, 84 genera and 107 species of wild animals at the heritage site, including 12 species of mammals, 83 species of birds, 7 species of reptiles and 5 species of amphibians. Please refer to Annex 3 for more details.

In addition, on many of the old trees wild agaric and *Phellinus igniarius* can be found, which only exist in certain environments. This shows that the system is stable and balanced.

1.2.2 Ecosystem Functions

The environment of the ancient course of the Yellow River is not favourable for agricultural production. Poor water conditions, loose and barren soil, hostile micro-climate, undulating ground, together with low vegetation coverage make the area a victim of soil and water erosion, which causes further environmental degradation. Mulberry trees are extremely vigorous. They have robust roots that can go as deep as four meters. They can survive arid and semi-arid desert conditions, as well as low and high temperatures. Thanks to these features, they play an important role in, sand stabilization and soil conservation, as well as acting as windbreaks

The local people plant the resilient mulberry trees with other fruit trees and timber trees, which slows the Aeolian processes, stabilizes the sand, conserves the water and improves the soil conditions. In other words, they improve the micro-climate and conditions of the site, making it possible for planting other crops among the trees. Thus, the system contributes to human survival and sustainable efforts in controlling desertification. This is because it satisfies local people's demands for clothing, food and daily necessities, and sustains biodiversity in the ancient course of the Yellow River.

(1) Preventing the Aeolian Process

The ancient course of the Yellow River is typical seasonal sandy land. The Aeolian process is the worst in spring (February to May) when the vegetation cover is low. The situation in winter (October to January) is not much better. This is because in winter and spring, the precipitation is low while the evaporation is high (Fig. 3). Another cause is the fast wind speed (6.4m/s, faster than 4m/s, the speed when the wind can carry the sand). Dry weather, together with the monsoon, makes spring and winter the seasons when water and soil erosion caused by the Aeolian process is the worst.

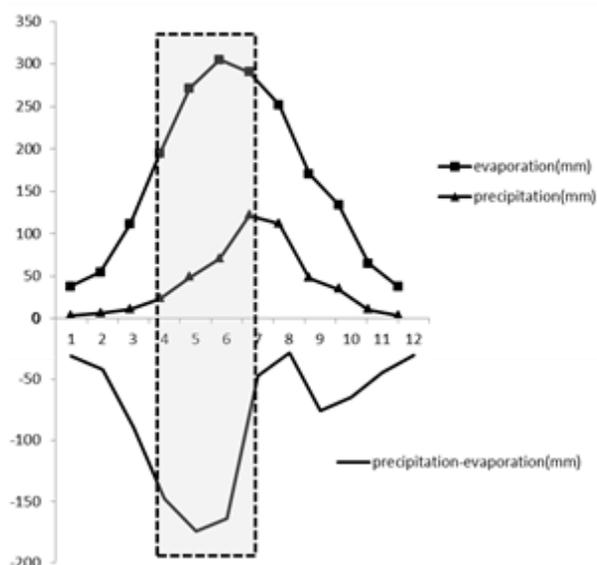


Fig.3 Annual Precipitation and Evaporation

Mulberry trees have big crowns that can help slow the Aeolian process. In the ancient course of the Yellow River, windbreaks are planted around the farmland. The dominant species of the windbreaks is mulberry. Other species include fruits, poplar and willow. Table 5 shows that the windbreaks are effective. Upwind, at a distance of about 3-5 times the windbreak height, the wind speed is slowed by 16.3%. Downwind, at a distance of about 5-20 times the windbreak height, the wind is slowed by 33.3%.

Table 5 The Effects of the Windbreaks on Wind Speed

Shelterbelt Structure	Ventilation Factor (%)	Wind speed without a windbreak (m/s)	Upwind (m/s)		Middle (m/s)	Downwind		
			5H	3H		5H	10H	20H
Sparse	56.5	9.2	7.7	7.7	5.2	4.5	6.5	7.4
Comparing to the wind speed without a windbreak (%)		100	83.7	83.7	56.5	48.9	70.7	80.4

(2) Stabilizing Sand and Conserving Water

Xiajin County is located in the temperate semi-humid monsoon climate zone. It rains a little in winter and spring (January to June). It rains more in summer, but in a relatively short time span (Tab.6). Considering that the area is covered by sandy soil, these features of the precipitation are not conducive for rainwater conservation. Instead,

water and soil erosion is made worse.

Tab.6 Precipitations in Xiajin by Season, 1961-2010

Season	Average Precipitation (mm)	Maximum Precipitation (mm)	Minimum Precipitation (mm)
Spring	78.5	215.1	23.6
Summer	341.3	707.6	87.5
Autumn	97.9	270.8	7.9
Winter	13.7	52.9	0.5

The mulberry trees in the ancient course of the Yellow River are effective in water and soil conservation because their roots can slow runoff and store rainwater. They are deep root arbours, whose taproots go only 1 to 2 meters deep. However their lateral roots can be longer than 9 meters. Seventy-three percent of the horizontal and vertical roots are within 40cm below the land surface (Fig.4). But they cover an area of about 4-8 times the crown area making them effective in holding runoff and storing rainwater. The robust roots store water, ensuring adequate water supply



Fig.4 Roots of the Old Mulberry

for the mulberry trees growing in an arid area with only 250mm to 300mm precipitation per year. What's more, with luxuriant foliage, mulberry trees ease the flushing of rainwater, decrease surface runoff, facilitating rainwater infiltration.

Investigations show that, in one year, one hectare of mulberry trees can store 300m³ more water than land with no trees on it, and reduce soil erosion by 45t. According to this criterion, the old mulberry trees at the ancient course of the Yellow River, compared to land without trees, can store 1.2×10⁵m³ more water per year, and reduce soil erosion by 1.8×10⁴t.

(3) Improving the Soil

The heritage system is located in the sand dune belt, where Aeolian sandy soil is

typical. From the sand profile, one can see that the surface layer is sandy soil, with relatively large porosity. The mix of water, air and heat is not favourable for plants. The soil is not effective in conserving water and fertilizer. The nutrient indexes of the soil are lower than the County's average (Tab.7).

Mulberry trees are effective in easing wind, conserving soil, and are resilient in arid climates. This can be attributed to their roots, which also change the physical and chemical properties, and the structure of the soil. As a result, soil fertility and water retention are improved. Thanks to the heritage system and traditional farming practices, the soil conditions are enhanced (Tab.7).

Tab.7 Comparison of Soil Nutrients

	Organic matter (g/kg)	Total nitrogen (g/kg)	Available P (mg/kg)	Available K (mg/kg)	Hydrolyzable N (mg/kg)
Background of the Yellow River old course	4.0	0.32	2	78.8	49
Average of the system	10.17	0.79	19.73	140.42	-
Average of the County	10.6	0.80	17.6	143	82

(4) Atmosphere Conditioning

Mulberry trees are broad-leaved arbours with active photosynthesis and vitality. They have high biomass and carbon reserves, and are a good choice for carbon sinks. Preliminary estimates have identified that one hectare of mulberry trees absorbs 49.29t of CO₂ per year, or 13.43t of carbon, while the oxygen released per year is 35.85t.

Mulberry leaves are highly resilient to the sulphur dioxide, metal contaminants and dust in the atmosphere. They are effective afforestation trees. One m³ of mulberry woods absorbs 20ml of sulphur dioxide per day. There has been a test of the trees' capacity to absorb lead and cadmium, both of which are atmospheric contaminants. Mulberry trees are the most effective species in absorbing lead, and the second best in absorbing cadmium. The dust retention capacity of mulberry trees can be as high as 4.617 to 6.153 g/m².

An air quality test has been conducted in the old mulberry population, old pear population and old locust wood measuring the concentration of SO₂, NO₂ and PM₁₀.

The result shows that the air quality at the heritage site meets the first grade according to the *GB3095 – 2012 Ambient Air Quality Standards* (Fig.5). In addition, sampling of anion concentration for three consecutive days has been conducted in the old mulberry population, old pear population and old locust wood. According to the test, anion concentration in the old mulberry population is 10,300 anions/ cm^3 , in the old pear population 10,700 anions/ cm^3 , and in the old locust population 13,000 anions/ cm^3 . These are much higher than the World Health Organization's standards which state that fresh air is one with not less than 1,000 – 1,500 anions/ cm^3 .

Monitoring of the micro-climate inside and outside the heritage system shows that in spring and winter, the system slows wind speed by 30%. In June, the temperature in the woods is 3.2°C lower than the control group. Ground temperature at 0-20cm above the surface is 1.7°C lower.

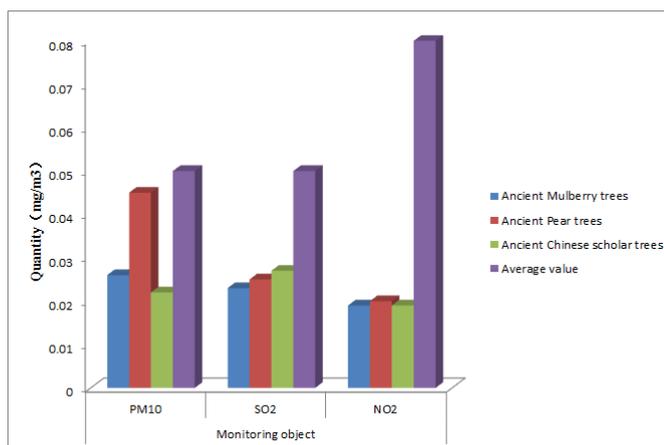


Fig.5 Air Quality

1.3 Knowledge Systems and Adapted Technologies

Sericulture originated in China. With a history of several thousand years, and it has long been an important component of China's agri-culture. Historic records and relics show that our ancestors began to plant mulberries in the Neolithic Age, which was over five thousand years ago. The old mulberry trees in the ancient course of the Yellow River are witnesses of the history of sericulture at the Yellow River Basin. They embody the experience, traditional technologies and the philosophy of harmonious

development between mankind and nature. Modern culture can learn a lot from the system.

1.3.1 Knowledge System

(1) Sapling Cultivation and Grafting

There was a popular saying in Xiajin that goes like this: peach three, apricot four, pear five, and mulberry one. It means that peach trees began to bear fruit at the age of three, apricot trees four, pear trees five, while mulberry trees began to bear fruit in the first year that they were planted. It shows that the farmers at that time planted grafts, instead of saplings.

The grafting of the mulberry trees is described in many ancient books, such as the *Revised Book of Agriculture* (pinyin: wu ben xin shu; simplified: 《务本新书》), *Essentials of Sericulture* (pinyin: nong sang ji yao; simplified: 《农桑辑要》) and *A Comprehensive Book of Agricultural Matters* (pinyin: nong zheng quan shu; simplified: 《农政全书》). The last book records that when grafting, the tissues of the stocks should be joined with the same tissues of the scions, including the phloem and the xylogen. Most importantly, the vascular cambium tissues of the stock and scion plants must be placed in contact with each other.

The grafting usually happens during March and April, before the shoots come out. The branches that are one year old are selected as the scions, while strong roots are selected as the stock. The scions are grafted onto the stocks at the cut. The bark of the mulberry trees are used to bind the rootstock and scions. Cotton is used to protect the cut. Afterward, they are planted into the soil. No watering is needed. All that needs to be done is waiting for the graft to sprout. This method is still used by the farmers.

(2) Pruning

The mulberry trees grow so well that the canopy is too high for the mulberry trees themselves and the plants under the mulberry trees. To improve the ventilation and translucency, it is necessary to control the canopy density. Every year, the farmers will trim the mulberry trees. Those extremely vital branches, branches that droop too much,

and old branches that are weak and long will be cut at the forks that are in good condition. The old, sick and weak branches and those with pests will be removed. The long branches of the full bearing trees and aging trees will also be shortened to let them grow into renewal branches or fruit branches. The overlapping branches, sick branches and dry branches will be removed to lower the density, which will improve the translucency under the canopy. This will help the mulberry trees grow well in the next year. The pruning takes place in the dormant period.

In addition, the farmers often bind the branches with ropes (Fig.6). By doing so, the animals and plants under the mulberry trees can get adequate sunshine without affecting the yields of the mulberry trees. This is a traditional method to control canopy density.



Fig. 6 Controlling the Canopy Density

(3) Rejuvenation of the Old Trees

Old trees are ones over 100 years old. They are valuable natural resources and germplasm resources. The rejuvenation methods used by the farmers on the old trees include layering, breaking the roots while applying fertilizer, tree surgery and pruning.

Layering is the rejuvenation technology with the longest history in Xiajin. It means a stem is covered with soil for rooting. It could prolong the life of the old trees. Another rejuvenation method combines rejuvenation with fertilizer application. When using this method, the surface root is broken to stimulate the growth of new roots. Fertilizer will be put into the holes produced while breaking the old roots to help the new root grow. Every year, the farmers break the roots in different places according to the distribution of the roots. This will help even out the roots.

(4) Proper Close Planting

Planting density is an important factor that affects the biological and economic benefits of the windshields. Judging from the spacing of the old mulberry trees, the farmers that planted them stuck to a planting density (usually 8 m × 10m) and with direct planting (Fig.7).

In an interview, an older farmer in the Dongyanmiao Village shared his experience with the researcher. In one year, he planted 3 lines of mulberry trees on land covering 1.3 mu. In one line, there were 24 mulberry trees. The annual income from selling the mulberries was RMB 3,000. In the following year, he removed ten trees because the density was too high. Instead of dropping, the annual income rose to RMB 3,600. His experience shows the importance of proper close planting.

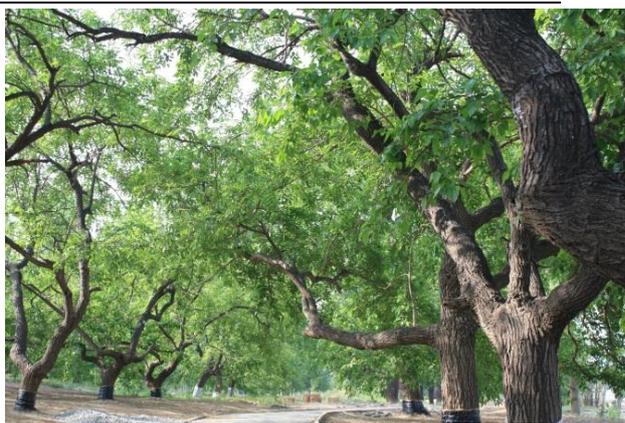


Fig.7 Proper Close Planting

1.3.2 Adapted Technologies

(1) Mixing Fruit Species, Mixing Fruit with Crops

In the heritage system, crops are planted among diversified fruit species. This agricultural mode is the result of a long history of adjusting to local natural and social conditions.

In the heritage system, mulberry, hawthorn, persimmon, apricot, and pear trees are planted together. These are fruit trees. There are also timber trees like *Toona sinensis*, *Ailanthus altissima*, poplar, willow and locust. This arrangement shows the awareness of ecological protection of the people in ancient times, and is of economic value (Fig. 8). It not only makes full use of the space, but also the synergistic effects of the biodiversity in controlling and preventing pests and diseases. In addition, different fruit species bear fruit at different times, which means throughout the year, the heritage system provides different products. As a result, the economic benefits are increased.



The mixed forest had stabilized the mobile sand

Fig.8 Mixed Woods

dunes in the ancient course of the Yellow River, improving the site conditions and the micro-climate. Therefore, crops could be planted, making full use of the sunshine and space. Because the canopy density is relatively high, and the roots are quite developed, the tree species that can be planted together are two to three meters apart, with an age around three years. These include the mulberry trees, apricot trees and peach trees.

When selecting the crops to be planted under the trees, those that would not take up too many nutrients, water, sunshine and space would be selected. After a long time of experimentation, the crops selected are mostly those planted in the summer and harvested in the autumn, such as peanuts, sweet potato, cotton, green beans, wheat, sorghum and maize, etc (Tab.9). In this way, the economic benefits can be guaranteed. In addition, the green manure and the bean crops improve the soil, and also promote the growth of the fruit trees. The uprooted or mown crop parts left in the woods to wither ease the Aeolian process. As a result, the ecological environment of the sandy land is improved.



Fig.9 Inter-planting of Mulberry, Sweet Potato and Peanut

(2) Fertilization

The soil of the ancient course of the Yellow River is mainly sandy soil, lacking organic matter, nitrogen, potassium and phosphorus. To solve this problem, the local people use green manure and farmyard manure. They have also created two fertilizer application methods, including putting fertilizer in the holes, and surrounding the trees with adobes (Fig.10).



Fig.10 Fertilization in the Holes (left), Fertilization with the Adobes (right)

The adobes have been smoldering for a long time, which turns the organic matter into ammonium nitrogen. Some organic phosphorus and mineral potassium have also been turned into available phosphorus and available potassium (Tab.8). Therefore the adobes can not only fertilize the mulberry trees, but also protect the trees from pests and diseases during the blooming and fruit bearing periods.

Table 8 Nutrients in the Adobes

Project	N%	P ₂ O ₅ %	K ₂ O%	Available N (mg/kg)	Available P (mg/kg)	Available K (mg/kg)
AVG	0.28	0.33	0.76	953	58	1485
MAX	0.58	0.73	1.34	1890	110	2500
MIN	0.08	0.09	0.26	50	20	203
Sample number	(20)	(19)	(10)	(7)	(4)	(4)

(3) Picking Mulberries

The mulberries ripen from early May to early June. If the weather is sunny, they will ripen within a short period. Therefore, they must be picked as soon as possible. In early May, picking could happen once every other day. But by early June, the picking must happen every day.

The picking methods vary with the species of the mulberry. The black mulberries are not easy to shake down. They need to be picked by hand from the trees. The white mulberries, however, fall easily. Therefore, they are shaken down onto soft sheets.

There is a local saying that describes this situation. It says that when picking jujubes, people strike the branches with sticks; when picking mulberries, people shake the branches. Soft sheets are held up by bamboo sticks to catch the mulberries falling from the trees. This method does not harm the old trees, and can keep the mulberries clean and in good shape (Fig. 11).

Mulberries can only be stored for a short period of time. For example, under room temperatures, they will begin to change four to seven hours after being picked. After 12 hours, they will begin to rot. Therefore, the farmers usually pick the mulberries in the morning, so that they don't need to store the mulberries overnight.



Fig.11 Mulberry Picking

(4) Dry Mulberries

Fresh mulberries can be dried and stored. This practice has a history of over one thousand years. Actually, dried mulberries have been important provisions for the public and the army during wars in ancient times. The Arts of the People records: when the mulberries are ripe, they were collected and sun dried. In years when the harvest was not good, people could live on dried mulberries. In fact, in the Yellow River basin, dried mulberries had saved many people from starvation during famines.

A considerable number of traditional workshops of dried mulberries still exist in the Suliuzhuang Town of the Xiajin County. There are about ten workshops in one village. One workshop can produce about 500 kg of dried mulberries a year.

1.4 Cultures, Value Systems and Social Organisations (Agri-Culture)

After one thousand years of selection, the mulberry trees in Xiajin are planted for fruit, instead of for the leaves. But the heritage site is an ecological – cultural complex, built by the local farmers after a long history, which integrates nature and culture. It is intertwined with people’s social and cultural life. The physical culture, history, values and culture are already embedded in the social and individual culture and behaviour, such as traditional knowledge, production, festivities, and important rituals of the individuals.

1.4.1 The Ancient Yellow River and the Mulberry Culture

According to the Yellow River Water Conservancy Commission, from 602 B.C. to 1938, the lower reaches of the Yellow River broke its bank 1,590 times. There have been 26 major changes of the course 6 of which had great impacts. Several of the changes took the Yellow River back to Xiajin and away again. After each change, an ancient course was left with relics.

Historical materials record that the first major change happened in the fifth year of the reign of Emperor Ding of Dongzhou (602 B.C.). After the change, the Yellow River ran across Xiajin from southwest to northeast. The local people called it the “Great River”. In 11 A.D., the second major change moved the course 80 km towards the east. The course left in Xiajin is known as the ancient course of Dongzhou. It is covered with sand dunes, which is described by a folk song. It goes like this: when the wind stops, one meter of sand covers the ground; when the wind starts, the sand is all over the place; one has to close the door and cover their pans; even so, one swallows the rice with sand”.

(1) Sand Control and the Sericulture

The ancient course of the Yellow River took shape in the Dong Zhou Dynasty. Mulberry trees were then planted on the sandy land in the ancient course by the people

at the middle and lower reaches of the Yellow River, especially in Shandong. The mulberry leaves were used to feed silkworms, the cocoons of which are made into silk. This meant that the mulberry trees not only prevented sand storms, but also promoted an economy. There are many descriptions of sericulture in Qing and Lu, two states, in historic records, such as the *Commentary of Guliang*, the *Writings of Master Guan* and the *Commentary of Zhuo*. It is an educated guess that sericulture in Shandong during the Spring and Autumn Period, and the Warring State Period was quite developed. Shandong is also known as Lu, so the mulberry in Shandong is known as “Lu Mulberry”. The *Arts for the People* recorded that “there were black and yellow mulberries”. The *Collection of Essays on Sericulture* states that “mulberry was originated in Shandong.” It can be seen that Lu Mulberry has a prominent position in the evolution of the mulberry.

Qin Shi Huang, the First Emperor of Qin, unified China, ending the separation of states. The Han Dynasty inherited the policies of the Qin Dynasty. It advocated agriculture and the planting of mulberries. It also encouraged the development of trade and commerce, made economic, trade and cultural exchanges between China and neighbouring countries, including those in West Asia and South Asia, more frequent. As a result, the world renowned Silk Road was built. During the Qin and Han dynasties, which lasted for four and five hundred years, the mulberry and sericulture industries achieved great progress. Shandong and the other places in the lower reach of the Yellow River were where these industries were the most developed.

During the Sui Dynasty, the country was unified and the emperors attached great importance to agriculture, including the silkworm and mulberry industry. The country was strong and prosperous in the early Tang Dynasty. During the reign of Emperor Xuanzong of Tang (714 A.D. – 741 A.D.), the Tang economy reached its zenith. The silk production technologies of the Yellow River basin were in a leading position in the country. The *Book of Agriculture* was written by WANG Zhen in 1313, from which one can see the attention paid by people in early Yuan Dynasty to the mulberry and sericulture industries.

Throughout history, the demands for silk rose and foreign trade bloomed in prosperous times, promoting the development of the mulberry and sericulture industries in the ancient course of the Yellow River. In return, these industries resulted in abundant provisions of goods for the Silk Road. Therefore, they had made important contributions to the culture and economic exchanges between the West and the East, and in disseminating Chinese culture.

(2) Mulberry Evolution and Livelihood Provisions for People at the Yellow River Old Course

Throughout history, the mulberry and sericulture industries in north China, including the ancient course of the Yellow River would decline during wars. But the mulberry leaves and fruit were valued as food in these times. Sometimes, they were the source of food that stopped people from starving. This, to some extent, helped the mulberry trees to live on.

At the beginning of the Republic of China (1912-1949), sericulture suffered from the planting of cotton. However, the local people of the ancient course of the Yellow River continued to plant mulberry trees for they could also reduce sand storms. It was difficult for them to shift to herbaceous plants. They just shifted the mulberry cultivars that produce fruit, can tolerate dry climate and barren soil in the area with serious desertification. The size of the mulberry woods was even increased in this period.

After hundreds of years' selection, the main mulberry species in the ancient course of the Yellow River are those that produce good fruit, instead of those favourable to sericulture. The area they cover also keeps changing. The changes in the number of the mulberry trees and their usage are closely linked to the rise and fall of the mulberry and silkworm culture in ancient China.

1.4.2 Value Systems

Spirits: The time-honoured old mulberry woods are passed down from generation to generation. They are the witnesses of history. They have witnessed the fight of the ancestors against floods, wind and sand. They have also witnessed the adaption

between humans and nature. The farmers have developed affection for the old mulberry trees. The old mulberry trees embody the spirit of people living in the ancient course of the Yellow River. These people have never stopped fighting in the hostile environment. The old mulberry trees reflect the essence of their spirit, and are of profound historic and cultural value. The healthy trunks and branches, the vitality, and the stable yields of the old mulberry trees give a sense of history, make people proud and give them a sense of belonging. To sum up, local people have found spiritual sustenance in the old mulberry trees.

Memory: The mulberry culture, drum culture, culture of the Yellow River and folk culture make up a cultural system that has been passed down generation after generation. The mulberry culture has been embedded in every aspect of people's lives, including food, clothing, and accommodation and trading. For the local people, mulberry trees are not just trees, but also a spiritual presence. ZHU Guoxiang was a magistrate famous for his contribution in controlling desertification. In the memorial hall of ZHU Guoxiang, the bowls made of mulberry leaves, mulberry wood carts, mulberry wood carrying poles, mulberry wood buckets and mulberry wood animal-drawn seed ploughs (Fig.12) used at that time are exhibited. According to local elderly people, they used shoulder poles like the ones exhibited to carry water to plant mulberry trees.



Fig.12 Mulberry Leave Bowls, Mulberry Wood Carrying Poles and Buckets

Values: In traditional Chinese culture, mulberry symbolizes filial piety for one's

ancestors and hometown. It's written in the *Book of Poetry · Minor Odes of the Kingdom Xiao Bian* that “one must be respectful for the mulberry trees and Chinese catalpa trees”. This is because these trees were usually planted by their ancestors. If they were not respectful of these trees, they were not respectful towards their ancestors. Meanwhile, the mulberry trees and Chinese catalpa trees were usually planted around their houses. In the Dong Han Dynasty, they were used to refer to hometown. For example, ZHANG Heng, a poet in the Dong Han Dynasty, had written a poem named the Ode to Nandu. It said that “I'm filial all my life. I have moved to the south and I miss my hometown. When I see a mulberry tree, it's like I see my hometown again.” Even nowadays, the farmers of Xiajin often plant mulberry trees around their house. One mulberry tree is enough to bring back their memory of hometown. If one is said to have brought good fortune to Sangzi (Simplified: 桑梓; pinyin: sangzi; literally: mulberry trees and Chinese catalpa trees), one has contributed to one's hometown.

Folk art: Xiajin enjoys rich agri-cultural atmosphere. Historic cultural activities and art, such as drumming, Madi Chui Qiang (local opera) and folk songs (also known as “xiao diao zi”) all have close links to agricultural activities of the area. Drumming has been popular for over 600 years. At the beginning, drumming was used in worshipping of gods when there were droughts or other natural disasters. Later, it became a form of entertainment. The drums, with other percussion instruments like gongs and cymbals, become a set of percussion instruments (Picture 13). Madi Chui Qiang is an ancient opera. It has a history of over 170 years in the Madi Village. During this period, the villagers passed on this art without using written documents. The art has been passed down for nine generations until now. Xiajin folk songs are also full of local features. For example, the Zhuguantun folk songs combine monologue with singing. They are humorous and funny. There is a local saying describing the charm of the Zhuguantun folk songs. It says that “when one is listening to the folk songs, one would not even answer the invitation for meals”. Da Hang Song was a song sang when laboring. At the same time, the local people have incorporated their affection for mulberry trees into indigenous folk arts of the Yellow River Basin, such as paper cuts

(Fig. 13).



Fig.13 Xiajin Drumming and Paper Cutting

Literatures: Many poems and songs have been written about the mulberry trees. Following are some of the examples. “Walking in Jin along the ancient path, I think about the past long gone. Among the mulberry trees and Chinese catalpa trees, we talk about agriculture affairs and the history”. “The mulberries are soft and fresh. They are red, white or purple. They look like strawberries and longan, but with various colors. What a cheerful sight these wonderful fruits show in the ancient course. ” CHEN Xuehai, a magistrate lived during the reign of Emperor Yongzheng of the Qing, wrote that “The mulberry trees are the foundation of people’s life. All are happy for the harvest is good. ”

1.4.3 Social Organizations

An enclosed small-peasant economy and extended families were important features of Chinese people’s lives during the feudal era, which lasted for a long time.

The small-peasant economy was self-sufficient, which meant that most farmers had to produce what they needed in daily life. Therefore, they planted various fruits in the old woods dominated by mulberry trees. The mulberry leaves were used to feed silkworms, the cocoons of which were made into silk. All sorts of coarse cereals and vegetables were planted under the fruit trees. Livestock were raised in the woods too. As a result, complicated/complex and stable old mulberry woods were formed, the

products of which were able to meet the families' demands of food, clothing and daily necessities.

Because of social institutions like the clan philosophy and the extended family structure, the old mulberry woods were important heritages and were passed on as a place where the families lived and worked.

1.5 Remarkable Landscapes, Land and Water Resources Management Features

The old mulberry trees at the ancient course of the Yellow River were originally planted to ease sandstorms. They lived on, evolved and became a system endowed with agricultural biodiversity, traditional knowledge and technologies, as well as unique ecological and cultural landscapes.

1.5.1 Landscape Features

Sandy Land in the ancient course of the Yellow River : The topography of the area is diversified. It constitutes channel-filled deposits, battures, sand dunes, crevasse fans, and sandy troughs. These micro-topographies, presenting diversified landscapes, form an undulating topography which is rare in plains (Fig.14).



Fig. 14 Sandy Land and Mulberry Trees

Vertical Landscapes: The old mulberry trees have improved the natural environment, creating abundant vertical niches. The farmers use intercropping extensively, and raise poultry in the woods, using natural resources efficiently such as sunshine, heat, water and soil (Fig.15).

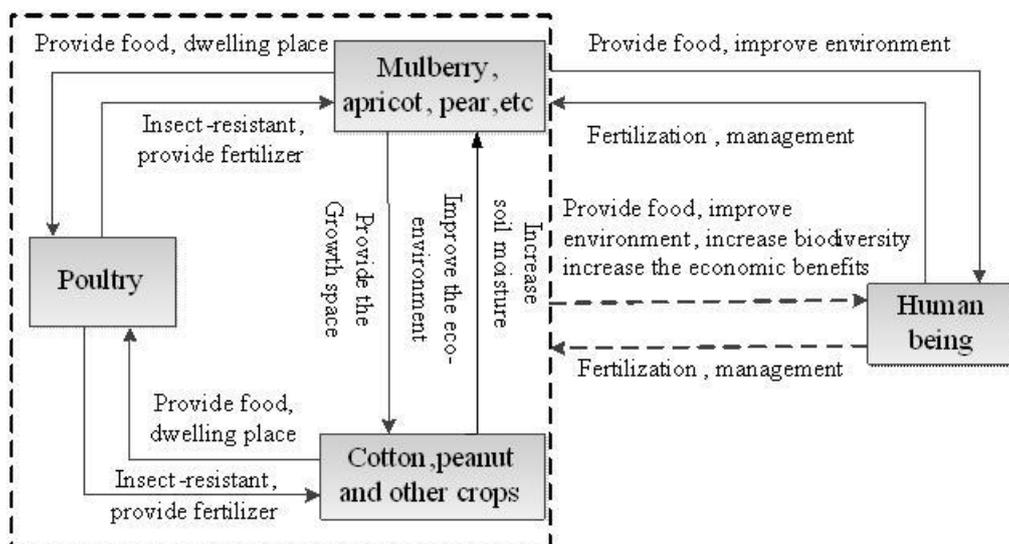


Fig.15 Vertical Landscapes and Functions

The mulberries, apples, peaches, apricots, hawthorns and other fruit trees, as well as poplars, locust trees and other arbors are planted in mixed formations. They are able to prevent sand storms, enrich biodiversity, provide diversified habitats, prevent and control pests and diseases. In short, they present a suitable environment for crops. As to the herb layer, crops like sweet potatoes, peanuts, beans, rapeseed and other crops are planted. At the same time, geese, chickens, sheep and other livestock are raised in the woods.

Different landscapes in different seasons. In spring, the woods are full of life as the new shoots of the old mulberry trees come out. In summer, mulberries of different shades hang on the branches, radiating fragrance into the air. When autumn comes, the gold leaves form a spectacular scene. In winter, the mulberry trees are turned into ice sculptures, which are sacred and beautiful. The peach, apricot and pear trees scattered in the woods add to their beauty, which has different attractions in different seasons (Fig.16).



Fig.16 Landscapes in Different Seasons

1.5.2 Land and Water Resources Management

The locals have accumulated experience of water and soil conservation through practice. For sandy land with relatively obvious rises and falls, farmers build “smaller grids and wider wind shields”. In the grids, fruit trees, crops and grasses are planted together. For farmland and undulating sandy land, they build “medium-sized grids and narrow wind shields”.

In addition, they build weirs that help with soil and water conservation (Fig.17) by storing surface runoff from rain. These weirs are also useful in maintaining and improving the fertility of the lands by easing water and soil erosion. Thanks to these efforts, the mulberry yields are high and stable.

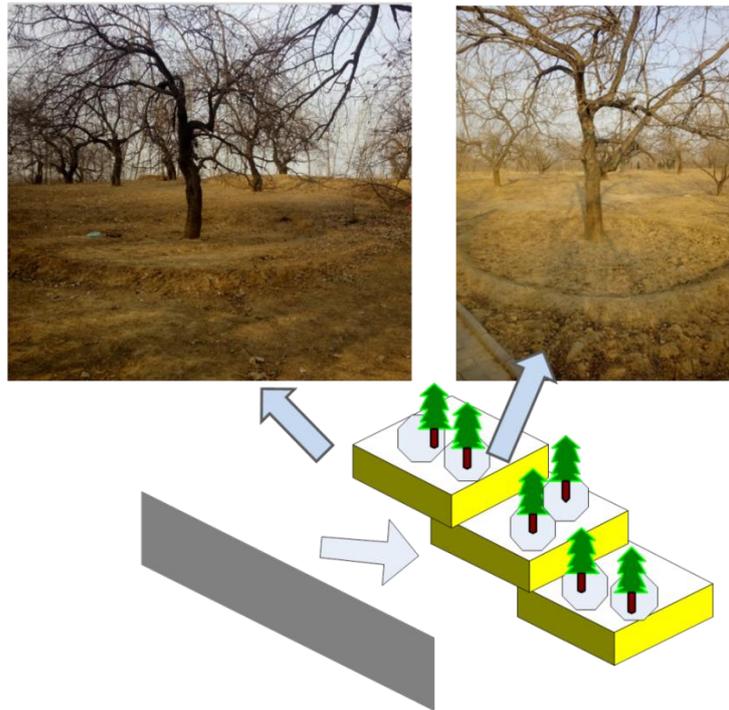


Fig.17 Weirs that Help with Water and Soil Conservation

2. Historic Relevance

In terms of adapting to a hostile natural environment, the heritage site is a model of desertification control in the floor area in the Luxibei Plain, and of sustainable development. The modes one sees in the heritage site are demonstrations of harmony between humans and nature, including “preventing and controlling desertification by planting mulberry trees”, and “combining forestry and agriculture”. Planting pioneer trees such as mulberries and other species which can tolerate hostile site conditions, improves the micro-environment. This makes it possible for other crops to grow. The mixed forests and the combination of forestry and agriculture protect biodiversity. What’s more, they make the structure of the ecosystems more robust, giving full play to their functions.

The heritage site has shown its resilience in the face of socio-economic changes. It has evolved as the Silk Road, and as the silkworm and mulberry industry evolved. When the silk industry was in a prosperous period, the farmers planted mulberries favorable to the silk industry. In war times, they planted mulberries to produce better fruit, so that they could be sources of food. When silk was the dominant fabric, farmers mainly planted mulberries. But cotton gradually became more important. Accordingly, farmers switched to planting mulberry trees that produced better fruit. Below the mulberry trees, they planted cotton. This development fully demonstrates how the heritage site adapts to ensure livelihood security.

2.1 An Outstanding Representative of the Agro-Culture at the Ancient Course of the Yellow River

The heritage site has pooled the essence of China’s traditional agro-culture. It demonstrates the philosophy of “harmony between the nature and human”. The sandy land of Xiajin was the result of the flooding of the Yellow River. The heritage site is not only representative of the mulberry culture in the Yellow River basin, but also an

achievement of the local people's efforts in controlling desertification.

The system is an artificial ecosystem built in a natural environment. To fight desertification, people have chosen mulberry trees because they can tolerate drought and barren soil, are effective wind breaks, and have economic value. The mulberry leaves are used to feed silkworms, the cocoons of which are made into silk. The mulberry fruit are dried and are food for local people, as well as sources of income.

To make better windbreaks and to control pest and diseases, farmers plant other trees in the mulberry woods, such as peach, apricot, pear, persimmon and hawthorn, as well as bushes and herbaceous plants. Different species make the communities, dominated by mulberries, more stable, more effective in soil and water conservation, and more economically beneficial. The environmental resources are used most efficiently and reasonably.

2.2 An Important Industrial Base along the Silk Road

The silkworm and mulberry culture, with a history of several thousand years, originated in China and was an important component of China's agro-culture. The world famous "Silk Road" was formed as the time honored silkworm industry developed. The Silk Road not only made trade between Asia and Europe possible, but also allowed Chinese civilization to spread and interact with the Western culture.

According to the historic records and relics, ancestors of the Chinese had begun to plant mulberries and raise silkworms in the neolithic age, more than five thousand years ago. In ancient times, Xiajin County was part of Yangzhou. The *Tribute of Yu*, written in the Warring State Period, recorded that "as the flood passed, places favorable for planting mulberries could begin to raise silkworm; people who had moved to higher places could build their home on the plains again". This shows that as early as the Warring State Period, the people of Xiajin had chosen to plant mulberries and had developed the silkworm and mulberry industries.

During the reign of Emperor Wu in West Han Dynasty, ZHANG Qian, an imperial envoy, started the Silk Road. During the East Han Dynasty, BAN Chao managed the

western areas and lengthened the Silk Road. It was the first time that China's trade route extended to Europe and Africa. The Silk Road connected the Western Countries with the Han Dynasty. It was more than a trade channel. It was also a bridge that connected China with European and Asian countries along the route, and a bridge that enabled cultural exchange and friendship. The most typical goods that China sold along the route were silk products, which was how the Silk Road derived its name. At that time, the silkworm and mulberry industries of Xiajin had been developing for five or six hundred years. It had the most developed silkworm and mulberry industries in the north. Therefore, it became an important silk production base on the Silk Road.

During the Sui Dynasty, the country was unified and the emperors attached great importance to agriculture, including the silkworm and mulberry industry. The country was strong and prosperous during the early Tang Dynasty. During the reign of Emperor Xuanzong of Tang (714 A.D. – 741 A.D.), Tang's economy reached the summit. The ancient course of the Yellow River remained an important production base during this period. This was because the silk production technologies of the Yellow River basin were in a leading position in the country. In addition, the area was closed to Chang'an (the beginning point of the Silk Road) (Fig.18).



Fig.18 The Silk Road in the Tang Dynasty**2.3 A Witness of China's Silkworm and Mulberry Culture**

The heritage site witnessed the origination and prosperity of the Silk Road and the silkworm and mulberry culture. It also witnessed their decline as cotton took the dominant place of silk, and farmers switched from mulberry species favourable to the silkworm industry to ones that produced better fruit.

In the middle of the Yuan Dynasty, planting cotton became popular in the Yangtze River basin and spread to the Yellow River basin. Simpler production and higher yield per unit area meant that cotton was less pricy than silk. As a result, people used more cotton products. Silk floss was replaced by cotton.

In the Ming Dynasty, silk and cotton both took up 50% of the market in Xiajin. According to the tribute record in the Ming Dynasty, in Hongwu 24th year (1391), Xiajin paid the summer tax with “21.328 kg of silk floss” and autumn tax with “49.6 kg of cotton” (Fig.19). According to the earliest historic record of the Xiajin County, written during the reign of the Emperor Jiajing of Qing, this had been the case from the tenth year of Yongle to the tenth year of Jiajing (Fig.19).

At the end of the Ming Dynasty and the beginning of the Qing Dynasty, capitalism and the handicraft industry bloomed. Cotton quickly took the market shares of silk. The silk industry died out. In the 13th year of the Reign of Emperor Kangxi of Qing (1674), ZHU Guoxiang, the county magistrate, paid a visit to the ancient course of the Yellow River. He saw a “desolate place half desert, which was not suitable for growing crops”. As a result, he “ordered people to plant fruit trees that would function as windbreak and could yield economic returns”. Following his order, the local people planted mulberry trees, making the same choice as their ancestors. The choice had been proven wise by more than a thousand years planting trees to control desertification. But instead of mulberry trees favourable for the silkworm industry, mulberry trees that produced better fruit were chosen. By the 1920s, the planting of mulberry trees in Xiajin reached a peak. According to incomplete statistics, the mulberry trees covered an area larger

than 5,000 hectares. It is said that “one can walk for over 1,000 meters in the mulberry woods”.

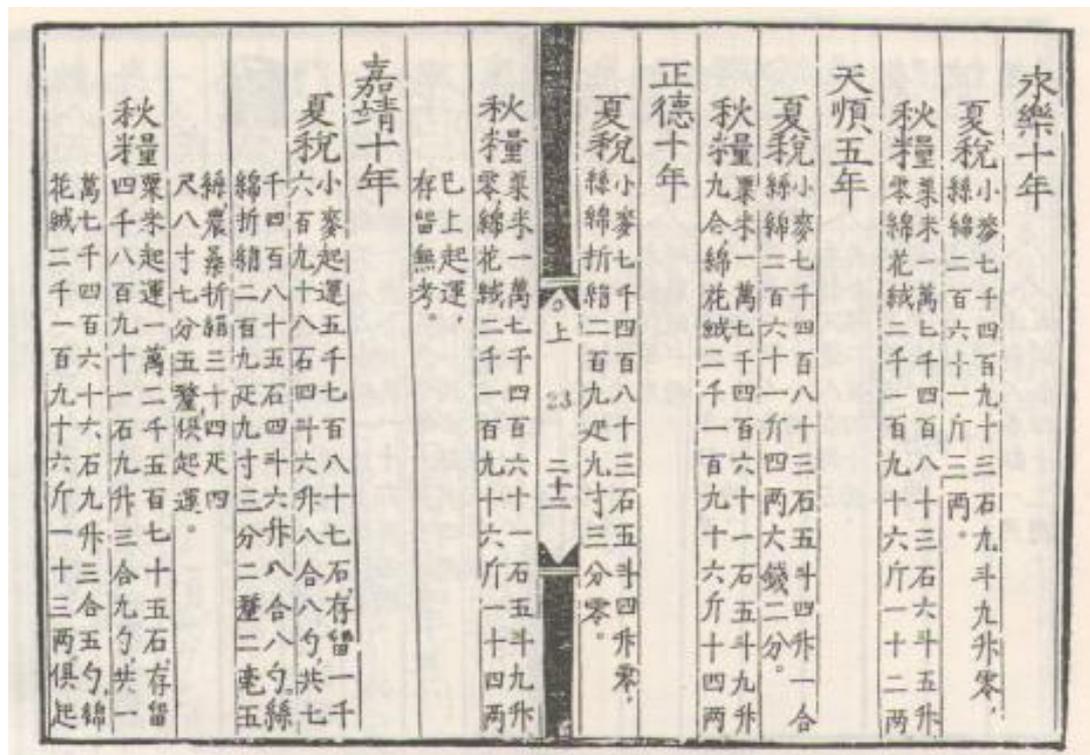
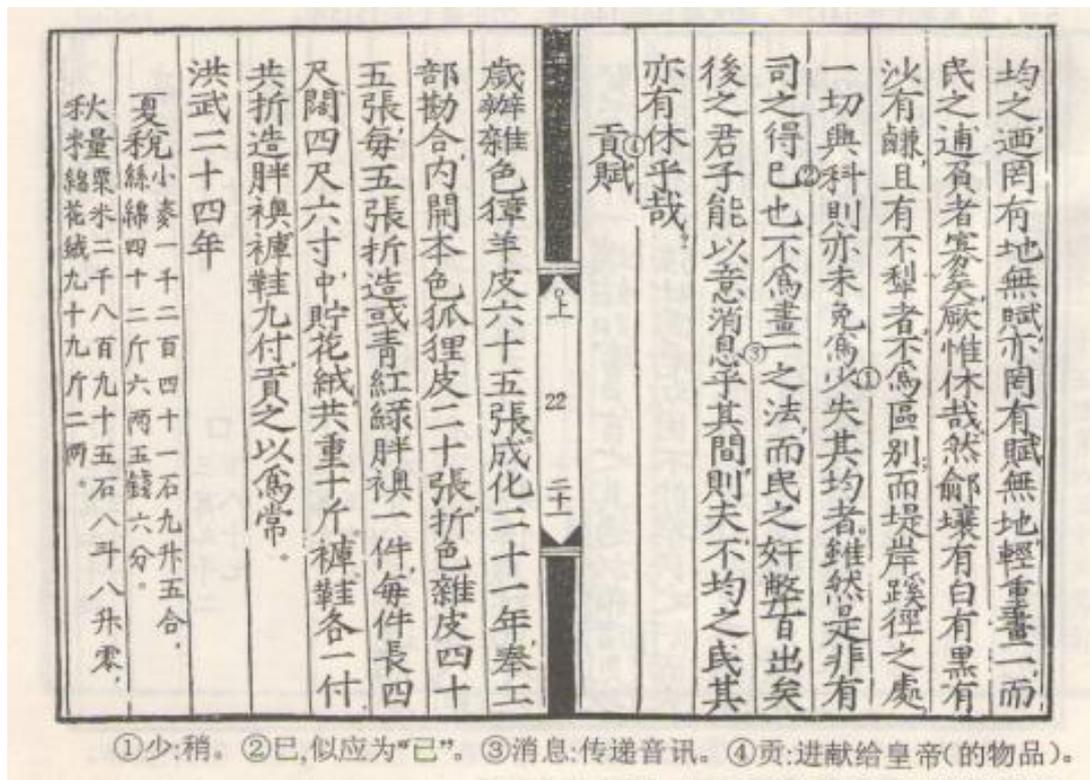


Fig.19 Tax Records of the Ming Dynasty

3. Contemporary Relevance

In 2014, the system site entered into the second list of “China National Important Agricultural Heritage Sites (Chian-NIAHS)” released by the Ministry of Agriculture. This can be attributed to its eco-functions, including preventing and reducing sandstorms, protecting biodiversity, utilizing biological resources, and maintaining agricultural landscapes. The heritage site is a model for obtaining economic gains while improving the environment of sandy land. Lessons learnt from the heritage site can be applied in developing multi-function agriculture, which is the current trend. The heritage site also contributes to scientific research and food security.

3.1 Obtaining Economic Gains while Improving the Environment of Sandy Land

The old mulberry woods are located in the sandy land which was once the course of the Yellow River in the Dongzhou Dynasty. They boast a history longer than 2,000 years. For many years, rampant sandstorms made life difficult at this place. But thanks to the people’s consistent efforts in planting trees, the place was covered with trees by mid Qing Dynasty.

The mulberry trees, an important component of China’s silkworm and mulberry culture, were chosen because they could live in an unfavorable environment and barren sandy land. Another reason was that they could ease sandstorms while meeting livelihood demands, leading to harmony between the nature and human beings. The Tenglong Mulberry Tree (tenglong means a flying Chinese dragon) and the Wolong Mulberry Tree (wolong means a lying Chinese dragon) are more than 1,000 years old. The other old mulberry trees are more than several hundred years old. Judging from the ages of the mulberry trees, local people had never stopped fighting the sandstorms. Their choice of the mulberry trees, which have great economic and ecological performance, shows their wisdom and vision. The mulberry trees are resilient. They

have robust roots that can go as deep as 4 meters below the surface. They can grow in arid and semi-arid deserts, and are resilient in low and high temperatures, and to salt and alkali. They make effective windbreaks. These features make them outstanding choices in controlling the sandstorms in the north. On the other hand, the mulberry leaves are food for the silkworm, the cocoon of which is used to make silk. The mulberry trees are important for the local economy and society. As the Silk Road developed and prospered, the silkworm and mulberry culture and industries in Xiajin experienced a prosperous period.

In addition, the agro-cultural heritage site demonstrated dynamic adaptability which sustained the win-win mode. Hit by cotton production, wars, and depredated national strength, the silkworm industry in Xiajin shrunk. To adapt to this change, farmers switched from species that were favorable for the silkworm industry to the ones that produced better fruit. Therefore, livelihood was sustained. The mulberry trees have long life spans. They are still productive even when they are 1,000 years old. What's more amazing is that their yields remain high once they enter fruiting periods. They are especially important for food security during famines.

3.2 A Model of Multi-Function Modern Agriculture

The old mulberry woods at the ancient course of the Yellow River prevent sandstorms, help with water and soil conservation, and contribute to the forestation of the barren mountains. In addition, they can adapt to various types of soil and climate. They are easy to grow. Therefore, it is not difficult to promote the mulberry trees. The traditional pattern of the mulberry industry is using the leaves to feed silkworms. This pattern can yield high returns within a short time. Normally, the farmers can expect to have economic returns in the same year that they grow and plant the saplings, raise the silkworms, and graft.

The old mulberry trees, even though several hundred years old, still have robust roots and luxuriant leaves. Even those more than 1,000 years old are still productive. They not only conserve water and resources, but also produce 400 kg of mulberries and

225 kg of leaves per tree. No wonder the farmers call them the “sweet fruit”. The mulberry fruit can be dried and stored. They are important provisions in times when the yields are decided by the weather. At present, they are still important as they are a new growth point in leisure sight-seeing.

With a long history and profound cultural connotations, the old mulberry woods at the ancient course of the Yellow River have become a distinct tourist site. The mulberry picking festival is held during mid-May and late July when the mulberries ripen. The fruit of different mulberry species have different colours. The tourists can freely pick and taste different kinds of mulberries in the woods. Statistics show that tourism contributes 7% of the County’s GDP, while agro-cultural tourism contributes 60% of the tourism income. It can be noted that agro-cultural tourism is important for Xiajin’s economy (Fig.20).

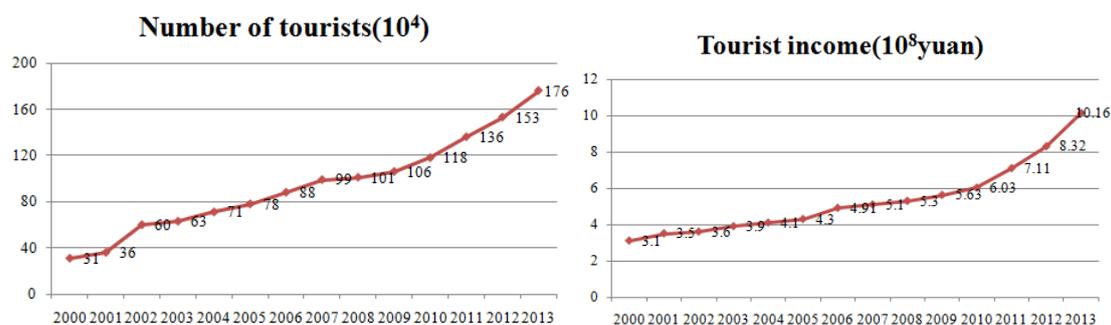


Fig.20 Tourist Number and Tourist Income of the Xiajin County

What’s more, the value chain of the mulberry industry is extending because of developments in science and technology. The leaves, branches, bark, and roots of mulberry and *Phellinus igniarius* are made into food and medicines, some of which are in short supply, such as the mulberry wine and powder made from the leaves. Meanwhile, intercropping and livestock raised in the woods make efficient use of the resources, increasing the production and economic benefits of the woods. As a result, the farmers’ income has been increased.

3.3 Important Germplasm Repository

The main plant of the heritage site is mulberry. Other species include pear, jujube,

apricot, peach, hawthorn, persimmon and plum. These mixed forests, together with the complicated topographies of the area, have created diversified habitats, which make biodiversity possible. Preliminary investigations show that there are a total of 56 families, 148 genera, and 214 species of vascular plants. Among them, five species are grain crops, and 38 species are economic crops. There are 15 species of livestock, and 10 are fishery products. There are 23 orders, 49 families, 84 genera, and 107 species of wild animals. In addition, wild agaric, *Phellinus igniarius* and other fungi can be found on many old trees.

What's more, more than 20,000 mulberry trees that are more than 100 years old are living in the heritage site. They fall into 8 endemic species, including Dazitian, Baizimu, Baishen, Hongzimu, Jiangmishen, Zishenzi, Changbinbai and Xiaocaomei. In addition, there are more than 10,000 old persimmon, apricot, hawthorn and pear trees. There are important germplasm resources for the mulberry and related fruit industries.

3.4 A Platform Integrating Production, Education and Research

The old mulberry trees at the ancient course of the Yellow River are valuable materials for the study of the natural environment, social changes, and history. This is because they have recorded the changes of climate and other geographic factors, and the evolution of botanic physiology. They are also direct and indirect documents of social changes. Meanwhile, the rise and fall of the Silk Road, and silkworm and mulberry culture, can be seen in the development of the mulberry industry. Silk was once the dominant fabric, but cotton has gradually become more important today. The heritage site, being the witness of these developments, has profound cultural connotations. In addition, the old mulberry trees present outstanding research materials for improving the environment of the sandy land in the north, and for restoring the ecosystem.

The heritage site is an important platform for production, education, and research

relating to the industries and culture of silkworm and mulberry, and prevention and control of sandstorms. Cross-disciplinary cooperation will promote research on gene technologies of silkworm and mulberry, as well as product development and mulberry cultural industries. The production, education, and research associations will develop the technology innovation capacity, accelerating the application of science and technology achievements. These efforts will promote the brand of the Xiajin mulberry to the other parts of China, and the world.

4. Threats and Challenges

(1) Threats to Nature and Humans

As do other agricultural systems, the old mulberry woods face threats posted by the nature (ecosystem evolution, climate change, pests and disease) and human (inappropriate management, over-exploitation). For example, 2014 saw the yield of mulberry leaves reduced by whiteflies, which caused loss to local farmers.

Second, urbanization and industrialization mean that human activities affect a larger area. Driven by economic pursuit, some old mulberry trees have been replaced by swift-growing poplars, crops, or factories. These have harmed the old mulberry woods themselves and the environment surrounding them. The stability and diversity of the system are harmed.

Third, tourism has been a double-edged sword. Old mulberry trees are a key contributor to tourism at the ancient course of the Yellow River. On one hand, the increase of tourists has injected vitality into the heritage system. On the other hand, they have caused environmental pollution and degradation with inappropriate actions, such as climbing the trees, shaking the tree branches too hard and breaking the saplings. Tourism is a new threat to the heritage system.

(2) Impacts Posed by Modern Agricultural Technologies

Modern agricultural technologies have exerted grave impacts on traditional agricultural modes as people are driven by economic pursuits. Old trees are replaced by new species, which would yield direct economic benefits in short-terms. However, this arrangement would not only destroy the genetic resources of Xiajin, but also damage the historic and cultural values carried by the old mulberry trees. Therefore, this arrangement is not rational in the long term.

In addition to modern agricultural technologies, pesticides and fertilizers have posted threats to the stability of the old mulberry woods. This is because of the effectiveness of pesticides and fertilizers even though traditional agricultural practices

are environmentally friendly. On top of this, the system is threatened by the agricultural production on nearby farmland.

(3) Reduction of Workforce

Urbanization has accelerated as society and economy become more developed. An increasing number of young people are seeking a career in the cities, which reduces the labor force of appropriate age in the rural areas. This widespread issue in China is also hampering the conservation of the agricultural heritage of the old mulberry trees at the ancient course of the Yellow River. This is because fewer young people are willing to work in agriculture, which requires heavy physical labor. They are not interested in traditional agricultural production and technologies relating to the old mulberry trees.

Sampling surveys show that among the people that are willing to work in the mulberry industry, 68.3% of them are more than 55 years old, 19.5% are 45 to 54 years old. Only 4.9% are between 25 and 34 (Fig.21). It can be noted that the younger they are, the less willing they are to work in the mulberry industry.

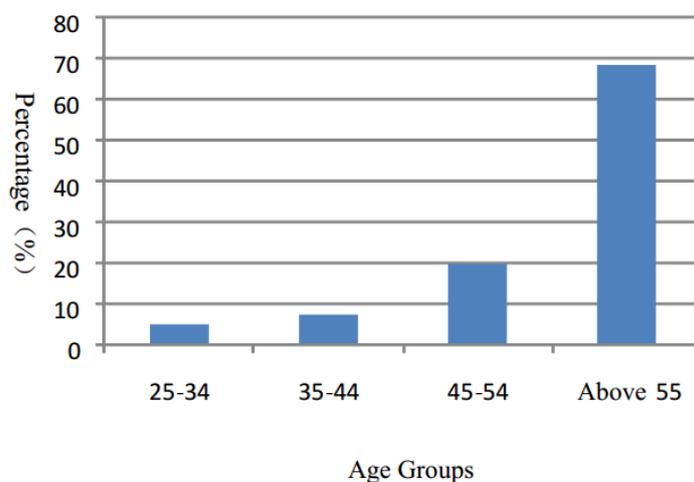


Fig.21 Ages of the Practitioners of the Mulberry Industry

(4) Unsound Protection Measures

The Xiajin County Government attaches great importance to protecting the old mulberry trees at the ancient course of the Yellow River. However, a designated organization and management methods are still lacking. Lacking organizational support and leadership, it is challenging for some areas to protect the agricultural

heritage.

Protection of agricultural heritage asks for strong technology capability, which is not available for Xiajin at present. The tourism bureau of Xiajin is in charge of this campaign. But they lack expertise and adequate resources to undertake the difficult tasks of protecting and developing agricultural heritage. In particular, not enough work has been done to study and protect the culture at the ancient course of the Yellow River and the mulberry-silkworm culture. A large amount of resources need to be designated to the collecting, sorting, documenting, archiving, protecting and transmitting of the cultural heritage.

(5) Cut-Throat Competition, Lacking Brand Effects

Due to the fact that the mulberry industry is a time-honored one in China, there are relatively mature industrial chains, of both mulberries for fruit and for silkworm, in many areas. The mulberry industry of Xiajin is still in transition from the traditional agriculture mode to the modern agriculture mode. It has a small scale with a low industrialization level and few industrial organizations. The problems of this stage include low efficiency of resources utilization, weak resilience against market risks, and low added values. Therefore, it is an urgent matter that the mulberry industry in Xiajin build up its brand, using its advantages in production bases, mulberries and culture, which will help put it in a favorable position in China's mulberry industry.

Another problem that makes the local mulberry industry less competitive is the lack of leading enterprises, which would boost the local mulberry industry by giving full play to the brand effects, and by industrialization and scientific and technological innovation. Besides, non-governmental organizations, such as industrial associations, have not made many contributions. They can help through exchanges and agreements.

(6) Short Length of Preservation

The mulberry fruit is a juicy berry without peel or core. It's soft and delicious, but cannot last, especially not through long-haul transportation. It's a typical seasonal fruit that is available only during a short period of time. This is also why many old mulberry trees were once leveled off.

Difficulties of preservation and transportation are still problems facing mulberry farmers. These problems, coupled with concentrated mature periods, backward transportation facilities, and lack of refinement processing enterprises, have prevented the income of mulberry farmers from increasing, even though the mulberry yields are high.

5. Practical Considerations

5.1 Ongoing Efforts to Promote GIAHS

(1) Adopting Protection Measures

First, Xiajin County has conducted surveys on the old trees to learn about the numbers and owners of the old trees, and has recorded basic parameters of the trees, such as height, diameter, crown and location. In addition, the County has begun to put tags on the old trees which signify that they are under protection (Fig.22).

Second, analyses have been conducted on the current system. The analyses show that the old mulberry trees at the ancient course



Fig.22 Tags on the Old Trees

of the Yellow River were planted across a wide span of time. There are 2 trees more than 1,000 years old and 550 trees between 700 and 800. The rest are more than 100 years old. There are also more than 10,000 old trees of other species, such as apricot, pear, persimmon, and hawthorn.

Third, function zones have been designated for the protection and development of the heritage system. There are five of them, namely: the protection zone of old mulberry trees, the zone for developing the mulberry industry, the zone for developing featured economic woods, the comprehensive development zone at the middle, and the zone for the recovery of eco-functions. This arrangement is made considering the features of the old mulberry woods, the principles of the protection and development

efforts, and the current situations of the Xiajin County and its advantages.

(2) Formulating Protection Policies

A high-level workshop was held. In July 2014, the Xiajin County convened the “Seminar on Protecting and Developing the Agro-Culture Heritage of the Old Mulberry Woods at the Ancient Course (Xiajin) of the Yellow River”. More than 50 experts on agro-cultural heritage, the mulberry and silkworm industries attended the seminar, including LI Wenhua, XIANG Zhonghuai, SU Huairui, the academicians of the China Academy of Engineering. They gave helpful advice on protecting and developing agro-cultural heritage, building a modern agricultural system, extending the value chain of the mulberry culture industry, and various usages of the old tree resources. The *Advices on Furthering the Protection and Development of the Agro-Cultural Heritage of the Old Mulberry Trees at the Ancient Course of the Yellow River* was submitted to the Shandong Provincial Government following the meeting, and got the attention of the Provincial Government. Thanks to the seminar, stronger measures have been adopted to protect the resources and promote the mulberry industry. It’s of benefit in integrating production, education, and research.

The Planning of Protecting and Developing the Agro-Heritage of the Old Mulberry Trees at the Ancient Course (Xiajin) of the Yellow River has been formulated. In 2014, the Xiajin County Government entrusted the China Academy of Science and other research institutions to form a high-level cross-disciplinary expert team. The team conducted field investigation, literature research and consultations, the results of which have been used to formulate the planning, which is in line with the basic requirements of protecting and developing agro-cultural heritage and the situation of Xiajin. The planning has clarified the scope of the heritage system and the function zones. Other content in the planning includes: a stringent action plan to protect the agricultural ecosystem, culture and landscape, practical measures of developing eco-agricultural products and sustainable tourism, and a capacity development plan that focuses on culture, decision making, operation, and management capabilities.

(3) Building related Brands

The county has made great efforts to develop eco-tourism, which resulted in the Ancient Yellow River Course Forest Park. In 2006, the Park was put on the list of municipal forest parks by the Dezhou Forestry Bureau. In 2009, it was put on the list of provincial forest parks, and in 2015 on the list of national forest parks. Since 2006, several tourist sites have been built, such as the Yishou Garden, the Xingwu Garden, the Xiangxue Garden, the Huailin Shengwu Garden, and the Ping'an Lake Wetland. Activities like the Pear Flower Festival, the Picking of Mulberries, and the Picking of Pear have been held since 2008. All these efforts have resulted in the eco-tourism brand, "Visit the Ancient Course of the Yellow River, Taste the Fruit of Mulberry Trees over 1,000 years old". More than 1.3 million tourists per year visit the park.

Many efforts have been made in becoming a NIAHS and GIAHS. In 2014, the system was named a NIAHS by the Ministry of Agriculture. In 2015, the county has been working with the Institute of Geographic Sciences and Natural Resources Research of the China Academy of Science on the proposal of GIAHS.

The mulberry industry is promoted by different measures. The "Xiajin Mulberry" has been registered as a product of geographic indication. Investment has been introduced into several cultural, leisure, and resort projects surrounding the forest park, such as the Oriental Mulberry Cultural Industrial Park, the Wanjing Health Care and Nursing Base, and the Deba Hot Spring Resort.

(4) Setting up Platforms of Production, Education and Research

Xiajin County has been building platforms of production, education, and research through which research is used to protect and develop the old mulberry woods. Following are some examples. The county and the Institute of Geographic Sciences and Natural Resources Research of the China Academy of Science have entered into a framework agreement of cooperation in areas such as agro-cultural heritage protection, sustainable tourism, and regional development. A framework agreement has been signed between the county and the State Key Laboratory of Silkworm Genome Biology

on topics including silkworm gene sequencing and protection, multiple utilization of silkworms, and the development of the silkworm industry.

5.2 Potentials and Opportunities for Sustainability and Management of GIAHS

(1) Developing the “Silk Road Economic Belt”

The world famous Silk Road was formed as the time honored silkworm industry as China spread. The Silk Road not only made trade between Asia and Europe possible, but also allowed the Chinese civilization to spread and interact with Western culture. In September 2013, XI Jinping, the General Secretary, visited the four countries of Central Asia and put forward a strategic idea, or the “Development of the Silk Road Economic Belt”. In the opening ceremony of the Boao Forum for Asia, Premier LI Keqiang stressed the development of “One Belt and One Road”. The concept refers to the “Silk Road Economic Belt” and the “21st Century Maritime Silk Road”. The “Development of the Silk Road Economic Belt” would fully rely on a bilateral and multilateral mechanism between China and the other countries in the area, and would promote cooperation in trade, industry, investment, energy and resources, finance, and environmental protection.

In 2013, the *Opinions of the Ministry of Commerce, National Development and Reform Commission, and Ministry of Technology on Further Promoting the Healthy Development of the Silk Industry* was released. In February 2014, the Shandong Province released the *Shandong Province’s Development Planning of the Silkworm Industry (2014 – 2020)*. These policies show that the Central Government and local governments attach great importance to the silkworm industry.

The old mulberry woods at the ancient course of the Yellow River, an important silk production base on the Silk Road, witnessed the origin and fall of the silkworm culture in China. They are about to witness the revitalization of the silkworm industry

brought about by the above-mentioned developments. The industrial chain would be expanded. New growth points would be cultivated. The silkworm industry would create more jobs for local people and contribute to sustainable development.

(2) Recognition of Agro-Cultural Heritage

Since the GIAHS was initiated by the FAO in 2002, the multiple functions and values of agro-cultural heritage and the GIAHS brand have won widespread international recognition. This presents a vital opportunity for the Chinese GIAHS sites to sell their products in the international market and to attract international investment.

XI Jinping, the General Secretary, pointed out in the rural work meeting of the Central Government that “agro-culture is precious treasure of China and is a vital component of China’s culture; and that it must be carried forward.” The Ministry of Agriculture initiated the China – NIAHS in 2012, which presents valuable opportunities and a platform for protecting and developing agro-cultural heritage.

In 2014, the Shandong Provincial Government gave instructions based on the *Advices on Furthering the Protection and Development of the Agro-Cultural Heritage of the Old Mulberry Trees at the Ancient Course of the Yellow River*. The advice was formulated by experts in agro-culture and the silkworm industry. A package of supporting policies was also released following the instructions.

(3) Recognition from the Public on Protecting the Old Mulberry Trees and Developing the Mulberry Industry

Old mulberry trees have been the main source of livelihood since ancient times. There are more than 3,000 households whose income comes mainly from the mulberry trees. The fact that local governments have stepped up the protection, development, and utilization of the mulberries mean that they have become the driver of local economy. What’s more, the old mulberries are used to develop leisure agriculture, which improves industrial structure and rapidly increases agricultural income. In recent years, there have been more research on products relating to old mulberry trees as they become more famous. This research aims to integrate the components and links in the

agricultural system of the old mulberry trees, and to integrate the industries, the production and deep processing of agricultural products. This integration would result in efficient and practical eco-agriculture in line with the ecological, natural, economic, social, and market conditions of Xiajin. The locals would be beneficiaries, and would come to see the importance of protecting and developing the old mulberry woods. They would join in the course with more enthusiasm.

5.3 Action Plan

(1) Protecting the Agro-Ecology

Protecting the ecosystem of the heritage site would focus on four aspects, namely biodiversity, old tree resources (famous old trees), ecosystem and environment, and eco-agricultural technologies (Fig.8).

In the immediate future, surveys of old tree resources will be completed, which would result in a database. Measures would be taken to improve the health of trees whose trunks have seriously rotted. Traditional eco-agricultural technologies would be studied. Traditional species would be brought back on the condition that they would not sabotage biodiversity. Eco-agricultural technologies would be popularized in the core conservation area. A network would be put up to monitor the germplasm resources and the environment of the heritage system.

In the future, the experience of the demonstration sites of eco-agriculture would be promoted to other areas. Efficient water conservancy facilities would be built. Agricultural machines would be used. Farming would be reduced or even stopped to restore and maintain soil fertility. Eco-agricultural technologies would be promoted in the heritage site to contain pollution caused by agriculture and the rural areas. This would further improve the structure of the heritage system.

(2) Protecting the Agro-Culture

The protection of agro-culture focuses on two aspects, namely the tangible and intangible cultural heritage (Tab.8). The former include both fixed tangible heritage and

mobile tangible heritage.

In the immediate future, the survey on mulberry culture in the heritage site would be completed. The survey aims to have a fresh understanding of the mulberry culture values by collecting tangible and intangible cultural heritages. The survey would give a clear depiction of the history of the mulberry culture in Xiajin, and would constitute the foundation for further protecting and developing the mulberry culture. Policies on protecting the heritage system have been improved. Education campaigns are being organized. The county is also proposing to become a GIAHS. These efforts would allow more to be learned about the heritage site.

Based on the efforts mentioned before, more actions would be taken to protect the mulberry culture. For example, a brochure on the mulberry culture would be compiled. Researches on the mulberry culture would be published. Documentaries would be made. Festivals of mulberry culture would be held regularly. Museums would be constructed, as well as theme parks. These would restore the valuable folk customs and demonstrate the inheritance, protection, and development of the mulberry culture in a comprehensive and systematic way.

(3) Protecting the Agricultural Landscape

The agricultural landscape protection covers farmland, forests, villages, agricultural production and rural environment (Tab.8).

The survey and assessment of the farmland, forest, village and agricultural production landscapes will be completed soon. The results will be used to designate landscape protection areas. On the other hand, efforts will be made to improve the rural environment. For example, facilities for agricultural production, sewage processing and solid waste processing will be set up so that the non-hazardous disposal ratio of domestic waste and production waste would significantly increase. In addition, the appearance and the air will be improved through landscaping. More efforts will be made in improving the environment and landscapes of the heritage site.

On top of the actions mentioned above, an organization will be designated to

monitor and manage the agricultural landscapes. An advertisement and education campaign will be carried out to improve the habitants' understanding of the landscapes' values. The ancient buildings will be renovated. Buildings in modern styles will be adjusted to be in line with the landscapes. Through these planning and guiding efforts, the core conservation area will have landscapes where the old mulberry trees, sand dunes, rivers and villages coexist in harmony.

(4) Developing Agricultural Products

Efforts in developing eco-agricultural products would focus on the following aspects: eco-products related to the old mulberry trees, production base, production and processing, brands, product certification, market development, and the industrial chains (Tab.8). The key to these efforts is to improve the processing technologies and capacity of existing processing companies through science and technology supports as well as policy supports.

Following are the focuses in the near future. Efforts will be made to develop eco-products. An eco-agricultural production base will be built for which green product is the minimum standard. Processing enterprises that enjoy a good reputation, robust foundation, multiple brands, and strong innovation capacity will receive more support. New production modes will be developed, such as the “enterprises+bases+associations+farmers” , “leading enterprises+cooperatives+farmers” and household farmland.

Working on the achievements of the actions mentioned above, the production mode of eco-products will be promoted to more than 80% of the heritage site. This will drive the development of agricultural, forestry, and fishery processing companies in the heritage site. The production and processing of eco-agricultural products and related industries will increase the income of local people.

(5) Developing Leisure Agriculture

Leisure agriculture will be promoted by improving the tourism routes, tourism products and brands, management and service system, and infrastructure construction

(Tab.8).

Tab.8 Protection and Development Action Plan

Object	Program	Action
Agro-Ecology	Protecting agricultural biodiversity	Surveys and monitoring of old tree resources at the heritage site
		Building a system to protect the old trees at the heritage site
	Protecting the ecology and environment of the heritage site	Building a system to protect the biodiversity of the heritage site
		Building a germplasm repository of northern economic trees
		Building a germplasm repository of old mulberry trees
		Monitoring the environment of the heritage site regularly
Protecting and developing eco-agricultural technologies	Utilization of tradition eco-agricultural technologies	
	Promoting the eco-agriculture modes Modern eco-agriculture projects	
Agro-Culture	Inheriting and developing the mulberry culture	Surveys and researches of mulberry culture Applying for the GIAHS
		Restoring the customs of the mulberry culture
	Presenting and advertising the mulberry culture	Selecting people to carry forward the operation and management techniques of the old mulberry woods
		Renovating the old villages and buildings
		Building a mulberry culture museum
		Building a theme park of mulberry culture
Protecting tourism landscape resources	Publishing books on the protection of agro-cultural heritages	
	Advertising the mulberry culture	
Agricultural Landscape	Improving rural environment	Building a center for the inheritance and promotion of the silkworm and mulberry culture
		Building and maintaining the landscapes of the Ancient Yellow River Course Forest Park
	Improving rural environment	Investigating and protecting the rural landscapes for tourism
		Domestic waste disposal project
Improving rural environment	Improving rural environment	Improving the landscapes of the villages
		Disposing of agricultural pollutions
		Improving key landscapes

Eco-Products	Creating harmonious landscapes	Improving the layout of the agricultural production landscape Education of agricultural landscape protection Monitoring and managing the improvement of rural landscapes Building a mulberry product base
	Developing and promoting eco-products	Developing eco-products, promoting refined processing Obtaining certifications for the eco-products of the heritage sites and enhancing related advertisement Supporting the leading enterprises and building brands
	Policy guidance and support for the mulberry industry	Enhancing the cooperation with the higher education institutions and research institutes Providing more capital supports for the mulberry industry Attracting enterprises and investments
	Building operation modes and the service system	Developing cooperation modes of agricultural production Improving the logistic system
Leisure Agriculture	Developing tourism products and brands in the heritage site	Integrating the tourism resources of the heritage site and designing tourism routes Developing tourism products with different themes and characteristics at the heritage site Building a tourism brand of the agro-cultural heritage site Attracting investment to developing eco-tourism at the heritage site
	Developing and management leisure agricultural products	Developing leisure agriculture products Developing agro-tourism and leisure farms Building a management and service system of leisure agriculture
	Infrastructure construction	Infrastructure construction

Immediate actions include developing tours that include sight-seeing in the old mulberry woods and production sites with local characteristics, tasting of feature products, shopping for organic foods produced at the heritage sites, and rural cultural entertainments. The number of tourist attractions will be improved by creating leisure farms, demonstration farms, agricultural sight-seeing sites, folk cultural festivals and agricultural production festivals, etc. In addition, construction of infrastructure and service facilities will be accelerated.

Additionally, several long-term actions will be taken. A couple of high-quality

leisure agricultural projects will take into consideration the current situations of leisure agriculture and the market changes. The agriculture structure will be bettered. The leisure agriculture belt and

clusters with reasonable arrangement and structure, good services, prominent features, and normative management will take shape. The special resources of the heritage site will be made the core in developing the leisure agriculture. The position of agriculture will improve noticeably. The service facilities will be improved by renovating old residences and buildings, by building roads, etc.

5.4 Expected Impacts of GIAHS on Society and Ecology

Becoming a GIAHS will bring more opportunities for protecting and developing the old mulberry woods. Following are the expected impacts of the GIAHS on the society and ecology.

(1) Increasing Rural Income, Promoting Local Economy

Take the price of the mulberries as an example: it has increased from RMB 2.5/kg in 2012 to RMB1-2/kg in 2015. The companies pay the farmer RMB 1/kg for the mulberries. These increases can be attributed to the advertising effects of becoming a NIAHS. The old mulberry trees will be known by an even larger amount of people if they form a GIAHS. This means that they would have even higher market values, which will attract more companies to invest in the mulberry and silkworm industries, expanding and extending the value chains of the mulberry fruit industry. As a result, more jobs will be created. The farmers' income will increase. In short, the local economy will be pushed forward.

(2) Promoting the Culture, Enhancing Local People's Sense of Identity

When applying for the GIAHS, activities of different forms will be held, which will advertise the culture of the mulberry and of the ancient Yellow River. These activities will improve the local people's understanding and recognition of the culture.

Surveys and research about the culture, as well as about related knowledge and technologies, will allow the people a comprehensive and thorough understanding of the folk culture, the theme of which is the cultivation of mulberries for silkworm and for fruit, and the old mulberry trees. They would be proud of the agro-cultural heritage, and would have a sense of belonging. In short, the efforts will enhance emotional resonance.

(3) Enhancing Local People's Awareness of Ecological Protection

The old mulberry trees at the ancient course of the Yellow River were originally planted to improve the environment of the sandy land and ease blowing sand. During the years of natural disasters, the old mulberry trees save many people from starving. However, in recent history, many disasters struck the old mulberry woods, sparing only those in villages with complicated topography and many sand dunes. They had gone through even graver hardship at the beginning of the 21st century. A large number of old mulberry trees were levelled off to grow crops as agricultural machines became more popular and the irrigation facilities were improved. The situation was made worse by the fact that high yields of mulberries could not bring high returns because mulberries were hard to store and the transportation facilities were backward. All in all, the area of the old mulberry woods shrunk quickly. In the end, there were only a little more than 400 hm². This, however, caused the degradation of the sandy land and harmed agricultural production. As dusty weather visits more frequently, people have begun to see the importance of the old mulberry trees to ecological stability. The application of the GIAHS will enhance this awareness and promote the sustainable development of the sandy land at the ancient course of the Yellow River.

(4) Protecting Biodiversity and Endemic Species

The old mulberry trees at the ancient course of the Yellow River not only present the majority of livelihood provisions, but also play a vital role in maintaining local environment, protecting biodiversity, and maintaining a balanced ecosystem. Especially, they are of great importance to preventing wind erosion, conserving soil and

water, improving the soil, and atmosphere conditioning. Applying for the GIAHS means that protection of the old mulberry woods will be enhanced, thus maintaining and improving both ecological and economic benefits.

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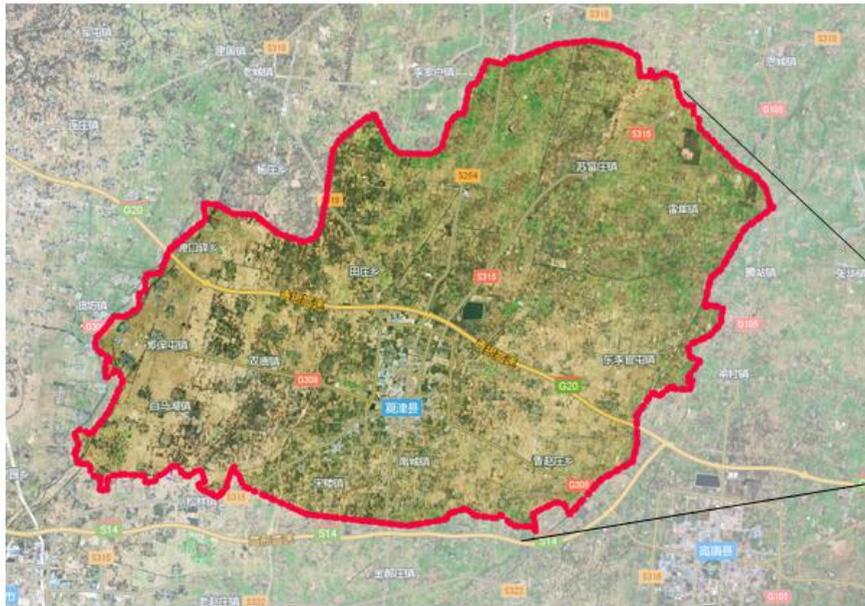
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Annexes 1: Maps



Region of Xiajin Yellow River Old Course Ancient Mulberry Grove System

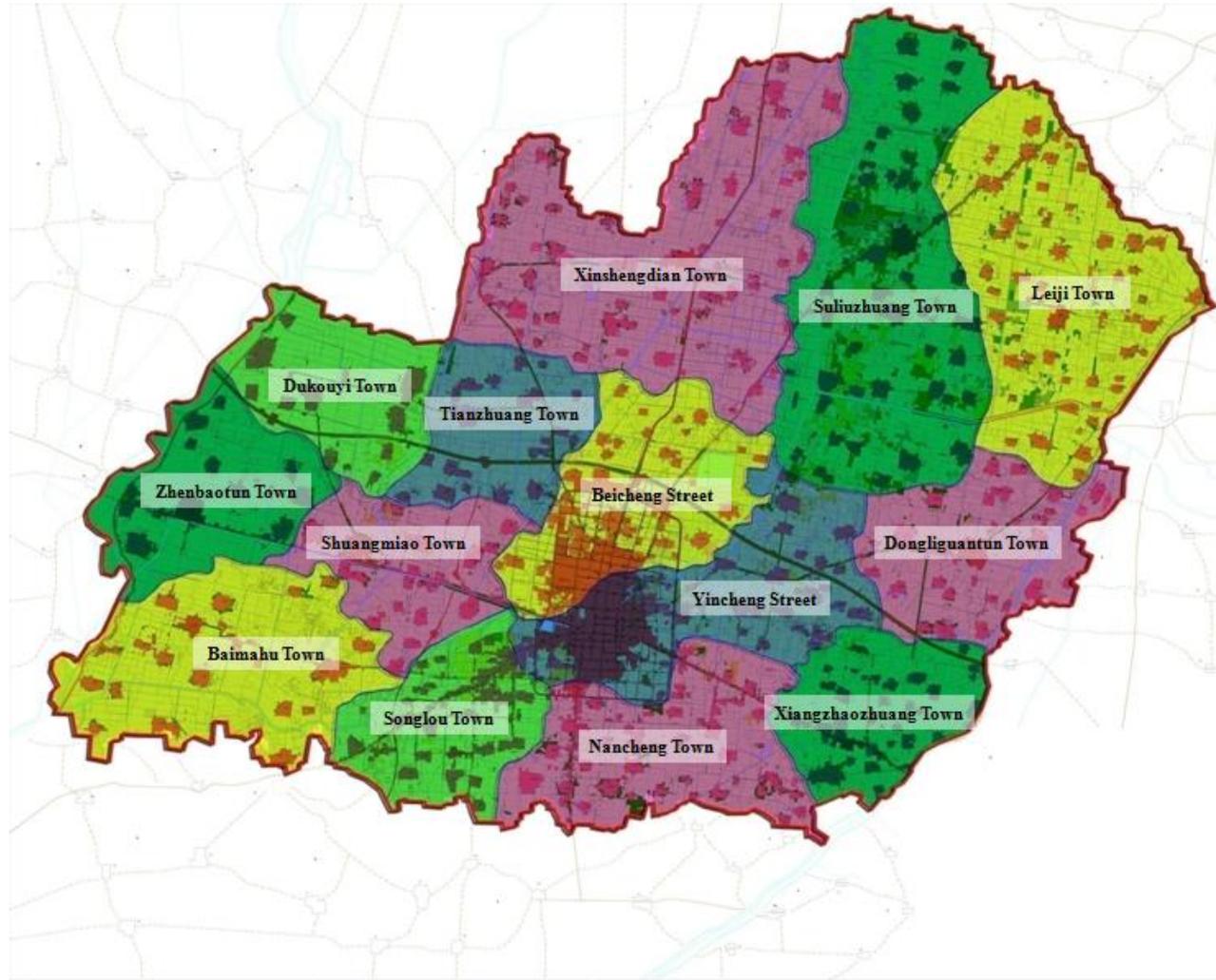


Shandong Province in China

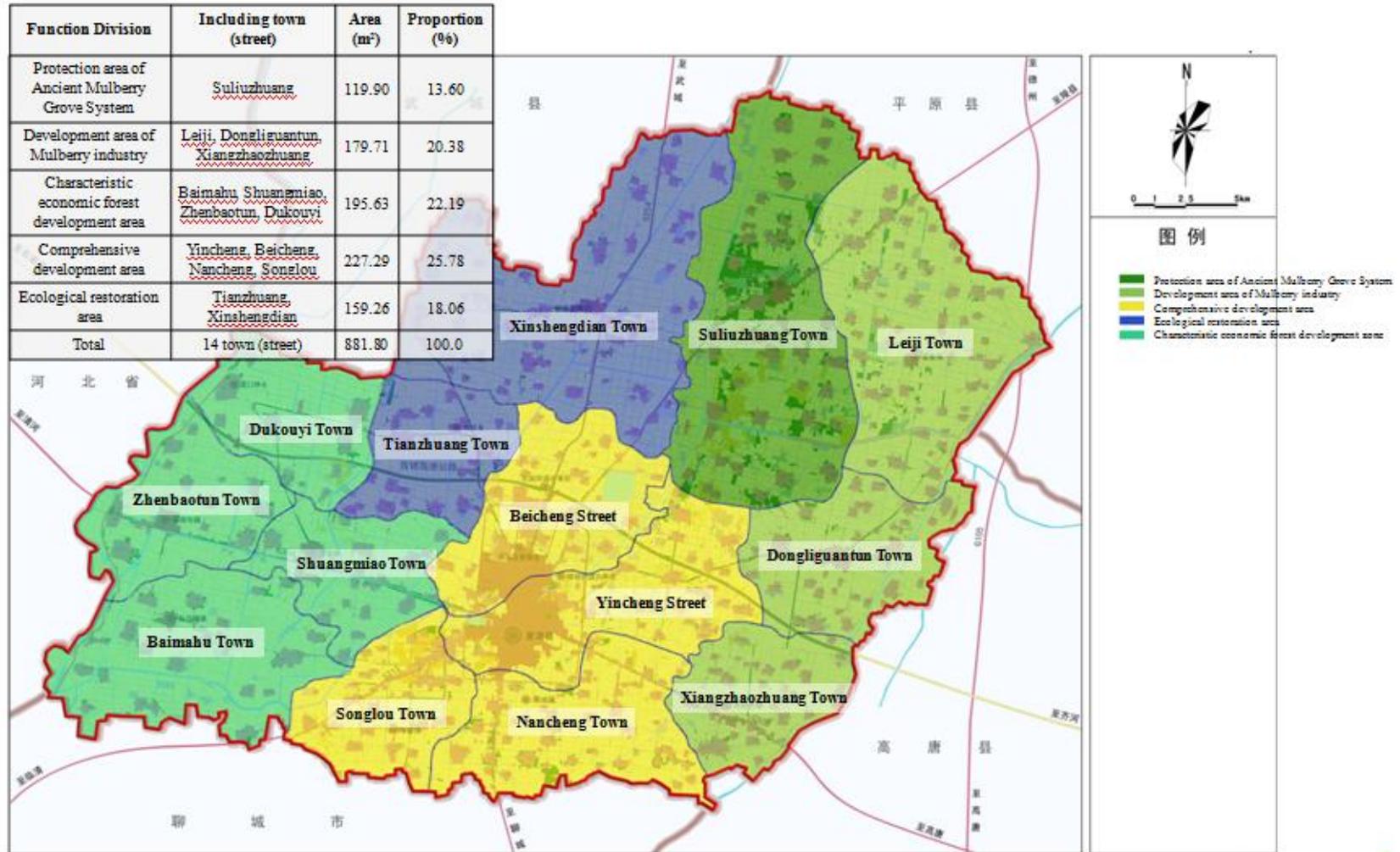


Xiajin County in Shandong Province

Location



Region



Function Division

Annexes 2: Photos











Annexes 3: Biodiversity

List of vascular plants

序号 NO.	科名 FAMILY NAME	属名 GENUS NAME	种名 SPECIES NAME	种拉丁学名 LATIN NAME	说明 NOTE
一 蕨类植物门 PTERIDOPHYTA					
1	木贼科 EQUISETACEAE	木贼属 Equisetum	节节草 Commelina diffusa	<i>Equisetum ramosissimum</i>	
2			问荆 Meadow pine	<i>Equisetum arvense</i>	
二 裸子植物门 GYMNOSPERMAE					
3	松科 PINACEAE	冷杉属 Abies	冷杉 Fir	<i>Abies fabri</i>	栽培 Cultivation
4		松属 Pinus	樟子松 Mongolian scotch pine	<i>Pinus sylvestris</i>	栽培 Cultivation
5		雪松属 Cedrus	雪松 Cedrus	<i>Cedrus deodara</i>	栽培 Cultivation
6	柏科 CUPRESSACEAE	圆柏属 Sabina	北美圆柏 Juniperus virginiana	<i>Sabina virginiana</i>	栽培 Cultivation
7			圆柏 China Savin	<i>Sabina chinensis</i>	栽培 Cultivation
8		刺柏属 Juniperus	刺柏 Juniperus formosana	<i>Juniperus formosana</i> Hayata	栽培 Cultivation
9		侧柏属 Platycladus	侧柏 Chinese Arborvitae	<i>Platycladus orientalis</i>	栽培 Cultivation
三 被子植物门 AUGIOSPERMAE					
I 双子叶植物 DICOTYLEDONS					
10	杨柳科 SALICACEAE	杨属 Populus	加杨 Canadian poplar	<i>Populus X canadensis</i>	栽培 Cultivation
11			新疆杨 Populus bolleana lauch	<i>Populus alba</i>	栽培 Cultivation
12			小叶杨 Simon poplar	<i>Populus simonii</i> Carr	栽培 Cultivation
13			北京杨 Beijing poplar	<i>Populus beijingensis</i>	栽培 Cultivation

序号 NO.	科名 FAMILY NAME	属名 GENUS NAME	种名 SPECIES NAME	种拉丁学名 LATIN NAME	说明 NOTE
14			沙兰杨 Sacrau poplar	<i>Populus P. X canadensis</i>	栽培 Cultivation
15			健杨 Robusta poplar	<i>Populus X canadensis</i>	栽培 Cultivation
16			抱头毛白杨 Populus tomentosa	<i>Populus tomentosa</i>	栽培 Cultivation
17			青杨 Cathay Poplar	<i>Populus cathayana</i>	栽培 Cultivation
18			毛白杨 Chinese white poplar	<i>Populus tomentosa</i>	栽培 Cultivation
19		柳属 Salix	旱柳 Corkscrew Willow	<i>Salix matsudana</i>	栽培 Cultivation
20			龙爪柳 Dragons claw Willow	<i>Salix matsudana var. matsudana f. tortuosa</i>	栽培 Cultivation
21			杞柳 Osier	<i>Salix integra</i>	栽培 Cultivation
22			筐柳 Salix linearistipularis	<i>Salix linearistipularis</i>	栽培 Cultivation
23			沙柳 salix mongolica	<i>Salix cheilophila</i>	栽培 Cultivation
24			线叶柳 Salix wilhelmsiana	<i>Salix wilhelmsiana</i>	栽培 Cultivation
25			黄柳 Yellow willow	<i>Salix gordejvii</i>	栽培 Cultivation
26			垂柳 Weeping Willow	<i>Salix bagylonica</i>	栽培 Cultivation
27			榆科 ULMACEAE	榆属 Ulmus	榆树 Ulmus pumila
28	桑科 MORACEAE	桑属 Morus	鲁桑 Morus multicaulis	<i>Morus alba var. multicaulis</i>	栽培 Cultivation
29			裂叶桑 M.aiba var bitoba	<i>Morus trilobata</i>	栽培 Cultivation
30			桑 Mulberry	<i>Morus alba</i>	栽培 Cultivation
31		柘属 Cudrania	柘树 Silkworm thorn tree	<i>Cudrania tricuspidata</i>	栽培 Cultivation
32		构属 Broussonetia	构树 Paper mulberry	<i>Broussonetia papyrifera</i>	栽培 Cultivation
33		榕属 Ficus	无花果 Fig tree	<i>Ficus carica</i>	栽培 Cultivation
34	蓼科 POLYGONACEAE	蓼属 Polygonum	习见蓼 Polygonum antiquity	<i>Polygonum plebeium</i>	
35			酸模叶蓼 Persicaria lapathifolia	<i>Polygonum lapathifolium</i>	

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36			扁蓄 Herba Polygoni Avicularis	<i>Polygonum aviculare</i>		
37			两栖蓼 Water persicaria	<i>Polygonum amphibium</i>		
38	藜科 CHENOPODIACEAE	藜属 Chenopodium	刺藜 Aristate goosefoot	<i>Chenopodium aristatum</i>		
39			尖头叶藜 Acuminate goosefoot	<i>Chenopodium acuminatum</i>		
40			藜 Goosefoots	<i>Chenopodium album</i>		
41		虫实属 Corispermum	烛台虫实 candelabra tickseed	<i>Corispermum candelabrum</i>		
42			绳虫实 Declinate tickseed	<i>Corispermum declinatum</i>		
43		沙蓬属 Agriophyllum	沙蓬 Agriophyllum squarrosum	<i>Agriophyllum squarrosum</i>		
44		碱蓬属 Suaeda	灰绿碱蓬 Suaedaglauca Bunge	<i>Suaeda glauca</i>		
45		地肤属 Kochia	地肤 Bassia scoparia	<i>Kochia scoparia</i>		
46		猪毛菜属 Salsola	无翅猪毛菜 Salsola	<i>Salsola komarovii</i>		
47			猪毛菜 Common Russianthistle Herb	<i>Salsola collina</i>		
48		苋科 AMARANTHACEAE	苋属 Amaranthus	反枝苋 redroot pigweed	<i>Amaranthus retroflexus</i>	
49				凹头苋 Amaranthus ascendens	<i>Amaranthus lividus</i>	
50	北美苋 Prostrate Amaranth			<i>Amaranthus blitoides</i>		
51	马齿苋科 PORTULACACEAE	马齿苋属 Portulaca	马齿苋 Purslane	<i>Portulaca oleracea</i>		
52	石竹科 CORYOPHYLLACEAE	蝇子草属 Silene	麦瓶草 Silene conoidea L.	<i>Silene conoidea</i>		
53	罂粟科 PAPAVERACEAE	角茴香属 Hepecoum	角茴香 Root of erect hypecoum	<i>Hepecoum erectum</i>		
54	毛茛科 RANUNCULACEAE	毛茛属 Ranunculus	茴茴蒜 Chinese buttercup	<i>Ranunculus chinensis</i>		

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55	十字花科 CRUCIFERAE	芥属 <i>Capsella</i>	芥 Shepherd's purse	<i>Capsella bursa-pastoris</i>	
56		芝麻菜属 <i>Eruca</i>	芝麻菜 Arugula	<i>Eruca sativa</i>	
57		糖芥属 <i>Erysimum</i>	小花糖芥 Wallflower	<i>Erysimum cheiranthoides</i>	
58		独行菜属 <i>Lepidium</i>	独行菜 Cress	<i>Lepidium apetalum</i>	
59		涩芥属 <i>Malcolmia</i>	涩芥 <i>Malcolmia africana</i>	<i>Malcolmia africana</i>	
60		焯菜属 <i>Rorippa</i>	风花菜 <i>Rorippa palustris</i>	<i>Rorippa globosa</i>	
61		盐芥属 <i>Thellungiella</i>	小盐芥 <i>Thellungiella halophila</i>	<i>Thellungiella halophila</i>	
62		播娘蒿属 <i>Descurainia</i>	播娘蒿 <i>Sisymbrium sophia</i>	<i>Descurainia sophia</i>	
63		悬铃木科 PLATANACEAE	悬铃木属 <i>Platanus</i>	一球悬铃木 <i>Platanus occidentalis</i> occidentalis American sycamore	<i>Platanus occidentalis</i>
64	二球悬铃木 <i>Platanus hispanica</i> Muenchh			<i>Platanus acerifolia</i>	栽培 Cultivation
65	三球悬铃木 <i>Platanus orientalis</i> Oriental plane			<i>Platanus orientalis</i>	栽培 Cultivation
66	蔷薇科 ROSACEAE	桃属 <i>Amygdalus</i>	桃 Peach	<i>Amygdalus persica</i>	栽培 Cultivation
67		李属 <i>Prunus</i>	山桃 Wild peach	<i>Prunus davidiana</i>	栽培 Cultivation
68			李子 Plum	<i>Prunus salicina</i>	栽培 Cultivation
69			红叶李 Redleaf Cherry Plum	<i>Prunus Cerasifera</i>	栽培 Cultivation
70			樱桃 Cherry	<i>Cerasus pseudocerasus</i>	栽培 Cultivation
71		杏属 <i>Armeniaca</i>	杏 Apricot	<i>Armeniaca vulgaris</i>	栽培 Cultivation
72		梨属 <i>Pyrus</i>	杜梨 Birch-leaf pear	<i>Pyrus betulifolia</i>	栽培 Cultivation
73			白梨 Chinese white pear	<i>Pyrus bretschneideri</i>	栽培 Cultivation
74			沙梨 Nashi Pear	<i>Pyrus serotina</i>	栽培 Cultivation

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75		山楂属 Crataegus	山楂 Hawthorn	<i>Crataegus pinnatifida</i>	栽培 Cultivation	
76		苹果属 Malus	沙果 Crab apple	<i>Malus asiatica</i>	栽培 Cultivation	
77			苹果 Apple	<i>Malus pumila</i>	栽培 Cultivation	
78			海棠 Chaenomeles speciosa	<i>Malus spectabilis</i>	栽培 Cultivation	
79			木瓜属 Chaenomeles	木瓜 Pawpaw	<i>Chaenomeles sinensis</i>	栽培 Cultivation
80		贴梗海棠 Fructus chaenomeli		<i>Chaenomeles speciosa</i>	栽培 Cultivation	
81		樱属 Cerasus	毛樱桃 Tomentosa cherry	<i>Cerasus tomentosa</i>		
82		蔷薇属 Rosa	玫瑰 Rose	<i>Rosa rugosa</i>		
83		委陵菜属 Potentilla	朝天委陵菜 Potentilla supina	<i>Potentilla supina</i>		
84			委陵菜 Potentilla chinensis	<i>Potentilla chinensis</i>		
85		豆科 LEGUMINOSAE	合欢属 Albizia	合欢 Silktree siris	<i>Albizia julibrissin</i>	栽培 Cultivation
86			黄耆属 Astragalus	沙打旺 Erect milkvetch	<i>Astragalus adsurgens</i>	
87				糙叶黄芪 Astragalus scaberrimus Bunge	<i>Astragalus scaberimus Bga</i>	
88			锦鸡儿属 Caragana	柠条 Caragana microphylla	<i>Caragana intermedia</i>	
89	紫荆属 Cercis		紫荆 Chinese redbud	<i>Cercis chinensis</i>		
90	红豆属 Onobrychis		红豆草 Saifoin	<i>Onobrychis viciaefolia</i>		
91	大豆属 Glycine		大豆 Soybean	<i>Glycine max</i>	栽培 Cultivation	
92	落花生属 Arachis		落花生 Peanut	<i>Arachis hypogaea</i>	栽培 Cultivation	
93	米口袋属 Gueldenstaedtia		米口袋 Gueldenstaedtia verna	<i>Gueldenstaedtia verna</i>		
94			狭叶米口袋 Gueldenstaedtia stenophylla Bunge	<i>Gueldenstaedtia stenophylla</i>		

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95		鸡眼草属 Kummerowia	长萼鸡眼草 Kummerowia stipulacea	<i>Kummerowia stipulacea</i>	
96		胡枝子属 Lespedeza	兴安胡枝子 Lespedeza davurica	<i>Lespedeza daurica</i>	
97		苜蓿属 Medicago	紫花苜蓿 Alfalfa	<i>Medicago sativa</i>	
98		草木樨属 Melilotus	白花草木樨 White sweet clover	<i>Melilotus albus</i>	
99			草木樨 Sweetclover	<i>Melilotus suaveolens</i>	
100		银背藤属 Argyreia	葛藤 Kudzu	<i>Argyreia seguinii</i>	
101		车轴草属 Trifolium	红三叶 Red clover	<i>Trifolium pratense</i>	
102		大豆属 Glycine	野大豆 Wild soybean	<i>Glycine soja</i>	
103		紫穗槐属 Amorpha	紫穗槐 Amorpha fruticosa	<i>Amorpha fruticosa</i>	栽培 Cultivation
104		槐属 Sophora	槐 Sophora japonica	<i>Sophora japonica</i>	栽培 Cultivation
105			龙爪槐 Chinese pagoda tree	<i>Sophora japonica var. japonica f. pendula</i>	栽培 Cultivation
106			刺槐 Locust	<i>Robinia pseudoacacia</i>	栽培 Cultivation
107		刺槐属 Robinia	毛刺槐 Robinia hispida	<i>Robinia hispida</i>	栽培 Cultivation
108	牻牛儿苗科 GERANIACEAE	牻牛儿苗属 Erodium	牻牛儿苗 Erodium stephanianum Willdenow	<i>Erodium stephanianum</i>	
109	蒺藜科 ZYGOPHYLLACEAE	蒺藜属 Tribulus	蒺藜 Caltrop	<i>Tribulus terrester</i>	
110	芸香科 RUTACEAE	吴茱萸属 Tetradium	吴茱萸 Evodia	<i>Tetradium ruticarpum</i>	
111		花椒属 Zanthoxylum	花椒 Wild pepper	<i>Zanthoxylum bungeanum</i>	
112	苦木科 SIMAROUBACEAE	臭椿属 Ailanthus	臭椿 Tree of heaven	<i>Ailanthus altissima</i>	
113	楝科	香椿属 Toona	香椿 Chinese mahogany	<i>Toona sinensis</i>	栽培 Cultivation

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114	MELIACEAE	楝属 Melia	苦楝 Melia azedarach	<i>Melia azedarach</i>	
115	大戟科 EUPHORBIACEAE	铁苋菜属 Acalypha	铁苋菜 Copperleaf herb	<i>Acalypha australis</i>	
116		大戟属 Euphorbia	乳浆大戟 Euphorbia esula Linn	<i>Euphorbia esula</i>	
117	远志科 POLYGALACEAE	远志属 Polygala	西伯利亚远志 Polygala sibirica	<i>Polygala sibirica</i>	
118			远志 Polygala amflra	<i>Polygala tenuifolia</i>	
119	漆树科 ANACARDIACEAE	盐肤木属 Rhus	火炬树 Torch tree	<i>Rhus Typhina</i>	
120	葡萄科 VITACEAE	葡萄属 Vitis	葡萄 Grapevine	<i>Vitis vinifera</i>	
121		地锦属 Parthenocissus	地锦 Humifuse euphorbia herb	<i>Parthenocissus tricuspidata</i>	
122	无患子科 SAPINDACEAE	栾树属 Koelreuteria	栾树 Goldenrain tree	<i>Koelreuteria paniculata</i>	
123		文冠果属 Xanthoceras	文冠果 Shinyleaf Yellowhorn	<i>Xanthoceras sorbifolia</i>	
124	鼠李科 RHAMNACEAE	枣属 Ziziphus	枣 Jujube	<i>Ziziphus jujuba</i>	栽培 Cultivation
125			酸枣 Zizyphus jujube tree	<i>Ziziphus jujuba var. spinosa</i>	
126	锦葵科 MALVACEAE	木槿属 Hibiscus	芙蓉麻 Chingma	<i>Hibiscus cannabinus</i>	
127			木槿 Hibiscus	<i>Hibiscus syriacus</i>	
128			野西瓜苗 Hibiscus trionum Linn	<i>Hibiscus trionum</i>	
129		苘麻属 Abutilon	苘麻 Piemaker	<i>Abutilon theophrasti</i>	
130	柽柳科 TAMARICACEAE	柽柳属 Tamarix	柽柳 Tamarix	<i>Tamarix chinensis</i>	
131	堇菜科 VIOLACEAE	堇菜科 Viola	早开堇菜 Serrate violet	<i>Viola prionantha</i>	
132	瑞香科 THYMELACEAE	草瑞香属 Diarthron	草瑞香 Diarthron linifolium Turcz	<i>Diarthron linifolium</i>	
133	胡颓子科	沙棘属 Hippophae	沙棘 Seabuckthorn	<i>Hippophae rhamnoides</i>	

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134	ELAEAGNACEAE	胡颓子属 <i>Elaeagnus</i>	沙枣 Wild olive	<i>Elaeagnus angustifolia</i>	
135	山茱萸科 CORNACEAE	山茱萸属 <i>Macrocarpium</i>	车梁木 <i>Cornus walteri wanger</i>	<i>Macrocarpium Cornus walteri</i>	
136	报春花科 PRIMULACEAE	报春花属 <i>Primula</i>	点地梅 <i>Herba Androsacis</i>	<i>Androsace umbellata</i>	
137	白花丹科 PLUMBAGINACEAE	补血草属 <i>Limonium</i>	二色补血草	<i>Limonium bicolor</i>	
138	柿科 EBENACEAE	柿属 <i>Diospyros</i>	柿树 Persimmon tree	<i>Diospyros kaki</i>	栽培 Cultivation
139			君迁子 <i>Dateplum</i>	<i>Diospyros lotus</i>	栽培 Cultivation
140			黑枣 <i>Dateplum persimmon</i>	<i>Diospyros lotus</i>	栽培 Cultivation
141	夹竹桃科 APOCYNACEAE	罗布麻属 <i>Apocynum</i>	罗布麻 Bluish dogbane	<i>Apocynum venetum</i>	
142	紫草科 BORAGINACEAE	附地菜属 <i>Trigonotis</i>	钝萼附地菜 <i>Trigonotis amblyosepala</i>	<i>Trigonotis amblyosepala nakai</i>	
143			附地菜 <i>Trigonotis</i>	<i>Trigonotis peduncularis</i>	
144		鹤虱属 <i>Lappula</i>	鹤虱 <i>Fructus Carpesii</i>	<i>Lappula myosotis</i>	
145		砂引草属 <i>Messerschmidia</i>	砂引草 <i>Messerschmidia sibirica</i>	<i>Messerschmidia sibirica</i>	
146	木犀科 OLEACEAE	梣属 <i>Fraxinus</i>	白蜡树 Chinese ash	<i>Fraxinus chinensis</i>	
147			绒毛白蜡 <i>Fraxinus velutina</i>	<i>Fraxinus velutina</i>	
148	萝藦科	萝藦属 <i>Metaplexis</i>	萝藦 <i>Metaplexis japonica</i>	<i>Metaplexis japonica</i>	
149	ASCLEPIADACEAE	鹅绒藤属 <i>Cynanchum</i>	地稍瓜 <i>Cynanchum thesioides</i>	<i>Cynanchum thesioides</i>	
150	旋花科	旋花属 <i>Convolvulus</i>	田旋花 Field bindweed	<i>Convolvulus arvensis</i>	
151	CONVOLVULACEAE	菟丝子属 <i>Cuscuta</i>	欧洲菟丝子 <i>Cuscuta europea</i>	<i>Cuscuta europaea</i>	

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152			菟丝子 <i>Cuscuta chinensis</i>	<i>Cuscuta chinensis</i>	
153		打碗花属 <i>Calystegia</i>	打碗花 <i>Ivy Glorybind</i>	<i>Calystegia hederacea</i>	
154		牵牛属 <i>Pharbitis</i>	牵牛 <i>Morning glory</i>	<i>Pharbitis nil</i>	
155		番薯属 <i>Ipomoea</i>	番薯 <i>Sweet potato</i>	<i>Ipomoea batatas</i>	栽培 <i>Cultivation</i>
156	唇形科 LABIATAE	夏至草属 <i>Lagopsis</i>	夏至草 <i>Lagopsis supina</i>	<i>Lagopsis supina</i>	
157	茄科 SOLANACEAE	曼陀罗属 <i>Datura</i>	曼陀罗 <i>Jimsonweed</i>	<i>Datura stramonium</i>	
158		枸杞属 <i>Lycium</i>	枸杞 <i>Wolfberry</i>	<i>Lycium chinense</i>	
159	玄参科 SCROPHULARIACEAE	泡桐属 <i>Paulownia</i>	兰考泡桐 <i>Paulownia elongate</i>	<i>Paulownia elongata</i>	
160		柳穿鱼属 <i>Linaria</i>	柳穿鱼 <i>Linaria vulgaris</i>	<i>Linaria vulgaris</i>	
161		通泉草属 <i>Mazus</i>	通泉草 <i>Mazus reptans</i>	<i>Mazus japonicus</i>	
162		地黄属 <i>Rehmannia</i>	地黄 <i>Rehmannia Root</i>	<i>Rehmannia glutinosa</i>	
163	紫葳科 BIGNONIACEAE	角蒿属 <i>Incarvillea</i>	角蒿 <i>Chinese incarvilla herb</i>	<i>Incarvillea sinensis</i>	
164	忍冬科 CAPRIFOLIZCEAE	忍冬属 <i>Lonicera</i>	忍冬 <i>Honeysuckle</i>	<i>Lonicere gaponica</i>	
165			金银花 <i>Honeysuckle</i>	<i>Lonicera japonica</i>	
166	车前科 PLANTAGINACEAE	车前属 <i>Plantago</i>	车前 <i>Plantain</i>	<i>Plantago asiatica</i>	
167			大车前 <i>Greater plantain</i>	<i>Plantago major</i>	
168			平车前 <i>Plantago depressa</i>	<i>Plantago depressa</i>	
169	茜草科 RUBIACEAE	茜草属 <i>Rubia</i>	茜草 <i>Rubia cordifolia</i>	<i>Rubia cordifolia</i>	
170	菊科 COMPOSITAE	蒿属 <i>Artemisia</i>	蒙古蒿 <i>Artemisia mongolica</i>	<i>Artemisia mongolica</i>	
171			猪毛蒿 <i>Artemisia scoparia</i> Waldst. et Kit.	<i>Artemisia scoparia</i>	
172			黑蒿 <i>Black carraway</i>	<i>Artemisia palustris</i>	

序号 NO.	科名 FAMILY NAME	属名 GENUS NAME	种名 SPECIES NAME	种拉丁学名 LATIN NAME	说明 NOTE	
173			野艾蒿 Artemisia lavandulaefolia	<i>Artemisia lavandulaefolia</i>		
174			艾蒿 felon herb	<i>Artemisia argyi</i>		
175		白酒草属 Conyza	小蓬草 Conyza canadensis	<i>Conyza canadensis</i>		
176		蓟属 Cirsium	刺儿菜 Cephalanoplos segetum	<i>Cirsium setosum</i>		
177		狗娃花属 Heteropappus	阿尔泰狗娃花 Heteropappus altaicus(Willd.) Novopokr	<i>Heteropappus altaicus</i>		
178		旋覆花属 Inula	旋覆花 Inula flowers	<i>Inula japonica</i>		
179			沙地旋覆花 Sand inula flowers	<i>I.salsoloides (Turcz.)Ostenf</i>		
180		苦苣菜属 Sonchus	苦苣菜 Common sow thistle	<i>Sonchus oleraceus</i>		
181		蒲公英属 Taraxacum	戟片蒲公英 T.asiaticum var.lonchophyllum	<i>Taraxacum asiaticum</i>		
182			蒲公英 Herba taraxaci	<i>Taraxacum mongolicum</i>		
183		苍耳属 Xanthium	苍耳 Siberian cocklebur	<i>Xanthium sibiricum</i>		
184		鳢肠属 Eclipta	鳢肠 Eclipta prostrata	<i>Eclipta prostrata</i>		
185		泥胡菜属 Hemistepta	泥胡菜 Hemistepta lyrata	<i>Hemistepta lyrata</i>		
186		莴苣属 Lactuca	蒙山莴苣 Mulgedium tatarica	<i>Lacyuca tatarica(L.)C.A.Mey.</i>		
187		鸦葱属 Scorzonera	蒙古鸦葱 Scorzonera mongolica Maxim	<i>Scorzonera mongolica Maxim.</i>		
II 单子叶植物 monocotyledonous plant						
188		香蒲科 TYPHACEAE	香蒲属 Typha	狭叶香蒲 Typha angustifolia	<i>Typha angustifolia</i>	
189	小香蒲 Typha minima Funk			<i>Typha minima</i>		
190	禾本科 GRAMINEAE	芦苇属 Phragmites	芦苇 reed	<i>Phragmites australis</i>		

序号 NO.	科名 FAMILY NAME	属名 GENUS NAME	种名 SPECIES NAME	种拉丁学名 LATIN NAME	说明 NOTE
191		拂子茅属 Calamagrostis	拂子茅 calamagrostis epigejos	<i>Calamagrostis epigeios</i>	
192		画眉草属 Eragrostis	小画眉草 Eragrostis minor	<i>Eragrostis minor</i>	
193		穆属 Eleusine	牛筋草 eleusine indica	<i>Eleusine indica</i>	
194		虎尾草属 Chloris	虎尾草 Chloris virgata	<i>Chloris virgata</i>	
195		狗牙根属 Cynodon	狗牙根 Bermuda grass	<i>Cynodon dactylon</i>	
196		刚竹属 Phyllostachys	淡竹 henon bamboo	<i>Phyllostachys glauca</i>	
197		马唐属 Digitaria	升马唐 digitaria ciliaris	<i>Digitaria ciliaris</i>	
198		狗尾草属 Setaria	金色狗尾草 Setaria glauca Beauv	<i>Setaria glauca</i>	
199			狗尾草 green bristlegrass	<i>Setaria viridis</i>	
200		碱茅属 Puccinellia	碱茅 puccinellia tenuifolra	<i>Puccinellia distans</i>	
201		三芒草属 Aristida	三芒草 aristida adscensionis	<i>Aristida adscensionis</i>	
202		白茅属 Imperata	白茅 cogongrass	<i>Imperata cylindrica</i>	
204		结缕草属 Zoysia	中华结缕草 chinese zoysia	<i>Zoysia sinica</i>	
205		水蔗草属 Apluda	水蔗草 Apluda mutica	<i>Apluda mutica</i>	
206		莎草科 CYPERACEAE	蔗草属 Scirpus	扁秆蔗草 Scirpus planiculmis	<i>Scirpus planiculmis</i>
207	苔草属 Carex		卵穗苔草 Carex duriuscula	<i>Carex duriuscula</i>	
208			白颖苔草 white caryopsis sedge	<i>Carex rigescens</i>	
209	莎草属 Cyperus		头状莎草 Cyperus glomeratus	<i>Cyperus glomeratus</i>	
210			香附子 Cyperus rotundus	<i>Cyperus rotundus</i>	
211	灯心草科 JUNCUS	灯心草属 Juncus	灯心草 Rush	<i>Juncus effusus</i>	

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212	百合科 LILIACEAE	萱草属 Hemerocallis	黄花 wreath goldenrod	<i>Hemerocallis citrina</i>	
213		天门冬属 Asparagus	兴安天门冬 asparagus dauricus	<i>Asparagus dauricus</i>	
214	葱科 ALLIACEAE	葱属 Allium	晶头 Allium chinense	<i>Allium chinense</i>	

List of Wild Animals

类别 CATEGORY	目名 ORDER NAME	科名 FAMILY NAME	属名 GENUS NAME	种名 SPECIES NAME	种拉丁学名 LATIN NAME
兽类 MAMMALS	食虫目 Insectivora	刺猬科 Erinaceidae	猬属 Erinaceus	刺猬 Hedgehog	Heterothermic
		鼯鼠科 Soricidea	麝鼠属 Crocidura	小麝鼠 Crocidura suaveolens	Crocidura suaveolens
	翼手目 Chiroptera	蝙蝠科 Vespertilionidae	伏翼属 Pipistrellus	普通伏翼 Pipistrellus pipistrellus	Pipistrellus pipistrellus
			蝙蝠属 Vespertilio	东方蝙蝠 Asian Particolored Bat	superans
	兔形目 Lagomorpha	兔科 Leporidae	兔属 Lepus	野兔 Hare	<i>Lepus capensis</i>
	啮齿目 Rodentia	鼠科 Muridae	姬鼠属 Apodemus	黑线姬鼠 Apodemus agrarius	<i>Apodemus agrarius</i>
		仓鼠科 Circetidae	短耳仓鼠属 Allocricetulus	仓鼠 Hamster	<i>Cricetidae</i>
	食肉目 Carnivora	犬科 Canidae	狐属 Vulpes	狐 Fox	<i>Vulpes</i>
鼬科 Mustelidae		鼬属 Mustela	黄鼬 Weasel	<i>Mustela sibirica</i>	
鸟类 BIRDS	鸊鷉目 Podicipediformes	鸊鷉科 Podicedidae	小鸊鷉属 Tachybaptus	小鸊鷉 Little Grebe	<i>Tachybaptus ruficollis</i>
	鹤形目 Ciconiiformes	鹭科 Ardeidae	鹭属 Ardea	苍鹭 Heron	<i>Ardea cinerea</i>
			池鹭属 Ardeola	池鹭 Chinese pond-heron	<i>Ardeola bacchus</i>
			鹭属 Ardea	草鹭 Purple Heron	<i>Ardea purpurea</i>

类别 CATEGORY	目名 ORDER NAME	科名 FAMILY NAME	属名 GENUS NAME	种名 SPECIES NAME	种拉丁学名 LATIN NAME
			白鹭属 Egretta	白鹭 Egret	<i>Little Egret</i>
			苇鳉属 Ixobrychus	紫背苇鳉 Von Schrenck's Bittern	<i>Ixobrychus eurhythmus</i>
			麻鳉属 Botaurus	大麻鳉 Botaurus stellaris	<i>Botaurus stellaris</i>
		鹤科 Ciconiidae	鹤属 Ciconia	黑鹤 Black Stork	<i>Ciconia nigra</i>
				白鹤 White stork	<i>Ciconia ciconia</i>
		雁形目 Anseriformes	鸭科 Anatidae	天鹅属 Cygnus	大天鹅 Whooper Swan
	雁属 Anser			鸿雁 Swan Goose	<i>Anser cygnoides</i>
	麻鸭属 Tadorna			赤麻鸭 Ruddy Shelduck	<i>Tadorna ferruginea</i>
	鸭属 Anas			绿头鸭 Mallard	<i>Anas platyrhynchos</i>
	秋沙鸭属 Mergus			普通秋沙鸭 Common Merganser	<i>Mergus merganser</i>
中华秋沙鸭 Mergus squamatus				<i>Mergus squamatus</i>	
隼形目 Falconiformes	鹰科 Accipitridae	鹰属 Accipiter	鸢 mivus korschum	<i>Aquila</i>	
			苍鹰 goshawk	<i>Accipiter gentilis</i>	
	隼科 Falconidae	隼属 falcons	红隼 Falco tinnunculus	<i>Falco tinnunculus</i>	
鸡形目 Galliformes	雉科 Phasianidae	鹌鹑属 Coturnix	鹌鹑 quail	<i>Coturnix coturnix</i>	
鹤形目 Gruiformes	鹤科 Gruidae	鹤属 cranes	灰鹤 grey crane	<i>Grus grus</i>	

类别 CATEGORY	目名 ORDER NAME	科名 FAMILY NAME	属名 GENUS NAME	种名 SPECIES NAME	种拉丁学名 LATIN NAME
		秧鸡科 Rallidae	黑水鸡属 Gallinula	黑水鸡 Common Moorhen	<i>Gallinula chloropus</i>
			骨顶属 Fulica	骨顶鸡 Eurasian Coot	<i>Fulica atra</i>
		鸨科 otididae	鸨属 Otis	大鸨 Great bustard	Otis tarda
	鸨形目 Charadriiformes	鸨科 Charadriidae	麦鸡属 Vanellus	凤头麦鸡 Vanellus vanellus	<i>Vanellus vanellus</i>
			鸨属 Charadrius	金眶鸨 Charadrius dubius	<i>Charadrius dubius</i>
				红胸鸨 Charadrius asiaticus	<i>Charadrius asiaticus</i>
				环颈鸨 Charadrius alexandrinus	<i>Charadrius alexandrinus</i>
		鹬科 Scolopacidae	鹬属 Tringa	林鹬 Wood Sandpiper	<i>Tringa glareola</i>
			三趾鹬属 Crocethia	三趾鹬 Sanderling	<i>Calidris alba</i>
	反嘴鸭科 Recurvirostridae	长脚鹬属 Recurvirostra	黑翅长脚鹬 Black-Winged Stilt	<i>Himantopus himantopus</i>	
	鸥形目 Lariformes	鸥科 Laridae	鸥属 Larus	黑嘴鸥 Saunders's Gull	<i>Larus saundersi</i>
	鸠鸽目 Columbiformes	鸠鸽科 Columbidae	斑鸠属 Streptopelia	山斑鸠 Oriental turtle dove	<i>Streptopelia orientalis</i>
				灰斑鸠 Eurasian Collared Dove	<i>Streptopelia decaocto</i>
				珠颈斑鸠 Spotted Dove	<i>Streptopelia chinensis</i>
鹬形目 Cuculiformes	杜鹃科 Cuculidae	杜鹃属 Rhododendron	四声杜鹃 Indian Cuckoo	<i>Cuculus micropterus</i>	
			大杜鹃 Eurasian Cuckoo	<i>Cuculus canorus</i>	
鸮形目	鸮科 Strigidae	耳鸮属 Asio otus	长耳鸮 Long-eared Owl	<i>Asio otus</i>	

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	STRIGIFORMES			短耳鸮 Short-eared Owl	<i>Asio flammeus</i>	
			雕鸮属 <i>Bubo bubo</i>	雕鸮 Eurasian Eagle Owl	<i>Bubo bubo</i>	
			小鸮属 <i>Athene</i>	纵纹腹小鸮 little owl	<i>Athene noctus</i>	
	雨燕目 APODIFORMES	雨燕科 Apodidae	雨燕属 <i>Apus</i>		楼燕 hawk swallow	<i>Apus apus</i>
					白腰雨燕 Pacific Swift	<i>Apus pacificus</i>
	佛法僧目 Coraciiformes	翠鸟科 Alcedinidae	翠鸟属 <i>Alcedo</i>		普通翠鸟 Common Kingfisher	<i>Alcedo atthis</i>
		戴胜科 Upupidae	戴胜属 <i>Upupa</i>		戴胜 Hoopoe	<i>Upupa epops</i>
	鸛形目 piciformes	啄木鸟科 Picidae	啄木鸟属 <i>Picus</i>		黑枕绿啄木鸟 <i>Picus canus zimmermanni</i>	<i>Picus canu</i>
					大斑啄木鸟 Great Spotted Woodpecker	<i>Dendrocopos major</i>
					棕腹啄木鸟 <i>Picoides hyperythrus</i>	<i>Dendrocopos hyperythrus</i>
					星头啄木鸟 <i>Picoides canicapillus</i>	<i>Dendrocopos canicapillus</i>
	雀形目 Passeriformes	百灵科 Alaudidae		短趾百灵属 <i>Calandrella</i>	小沙百灵 <i>Calandrella rufescens</i>	<i>Calandrella rufescens</i>
				凤头百灵属 <i>Galerida</i>	凤头百灵 Crested Lark	<i>Galerida cristata</i>
云雀属 <i>Alauda</i>				云雀 Skylark	<i>Alauda arvensis</i>	
鹎科 Pycnonotidae		鹎属 <i>Pycnonotus</i>		白头鹎 Light-vented Bulbul	<i>Pycnonotus sinensis</i>	

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		燕科 Hirundinidae	燕属 <i>Hirundo</i>	家燕 Barn Swallow	<i>Hirundo rustica</i>	
				金腰燕 Red-rumped Swallow	<i>Hirundo daurica</i>	
		鹊鸂科 Motacillidae	山鹊鸂属 <i>Dendronanthus</i>	山鹊鸂 Forest Wagtail	<i>Dendronanthus indicus</i>	
				鹊鸂属 <i>Motacilla</i>	灰鹊鸂 Grey Wagtail	<i>Motacilla cinerea</i>
					白鹊鸂 White Wagtail	<i>Motacilla alba</i>
		伯劳科 Laniidae	伯劳属 <i>Lanius</i>	红尾伯劳 Brown Shrike	<i>Lanius cristatus</i>	
				虎纹伯劳 Tiger stripes borlaug	<i>Lanius tigrinus</i>	
				棕背伯劳 Long-tailed Shrike	<i>Lanius schach</i>	
		黄鹂科 Oriolidae	黄鹂属 <i>Oriolus</i>	黑枕黄鹂 Black-naped Oriole	<i>Oriolus chinensis</i>	
		卷尾科 Dicruridae	卷尾属 <i>Dicrurus</i>	黑卷尾 Black Drongo	<i>Dicrurus macrocercus</i>	
		椋鸟科 Sturnidae	椋鸟属 <i>Sturnus</i>	灰椋鸟 White-cheeked Starling	<i>Sturnus cineraceus</i>	
		鸦科 Corvidae	灰喜鹊属 <i>Cyanopica</i>	灰喜鹊 Azure-winged Magpie	<i>Cyanopica cyanus</i>	
				喜鹊属 <i>Pica</i>	喜鹊 Magpie	<i>Pica pica</i>
				寒鸦属 Jackdaws genera	寒鸦 Western Jackdaw	<i>Corvus monedula</i>
				鸦属 Ravens	大嘴乌鸦 Jungle Crow	<i>Corvus macrorhynchos</i>
		鹎科 Muscicapidae	歌鹎属 <i>luscinia</i>	红点颏 <i>Luscinia calliope</i>	<i>Luscinia calliope</i>	
鹎属 <i>Tarsiger</i>	红胁蓝尾鹎 Red-flanked Bluetail		<i>Tarsiger cyanurus</i>			

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			红尾鸫属 <i>Phoenicurus</i>	北红尾鸫 Daurian Redstart	<i>Phoenicurus aureus</i>
			斑鸠属 <i>Streptopelia</i>	斑鸠 Turtle dove	<i>Streptopelia turtur</i>
			苇莺属 <i>Acrocephalus</i>	大苇莺 Great Reed Warbler	<i>Acrocephalus arundinaceus</i>
			柳莺属 <i>Phylloscopus</i>	极北柳莺 Arctic Warbler	<i>Phylloscopus borealis</i>
				暗绿柳莺 Greenish warbler	<i>Phylloscopus trochiloides</i>
			鹟属 <i>Muscicapa</i>	乌鹟 Dark-sided Flycatcher	<i>Dark-sided Flycatcher</i>
		山雀科 <i>Paridae</i>	山雀属 <i>parus</i>	大山雀 Great Tit	<i>Parus major</i>
		绣眼鸟科 <i>Zosteropidae</i>	绣眼鸟属 <i>Zosterops</i>	暗绿绣眼鸟 <i>Zosterops japonica</i>	<i>Zosterops japonicus</i>
		文鸟科 <i>Ploceidea</i>	麻雀属 <i>Passer</i>	麻雀 Sparrow	<i>Passer montanus</i>
		雀科 <i>Paridae</i>	燕雀属 <i>Fringilla</i>	燕雀 Brambling	<i>Fringilla montifringilla</i>
			金翅雀属 <i>Carduelis</i>	金翅雀 Grey-capped Greenfinch	<i>Carduelis sinica</i>
			锡嘴属 <i>Coccothraustes</i>	锡嘴雀 Hawfinch	<i>Coccothraustes coccothraustes</i>
		鹑科 <i>Emberizidae</i>	鹑属 <i>Emberiza</i>	三道眉草鹑 Meadow Bunting	<i>Emberiza cioides</i>
				小鹑 Little Bunting	<i>Emberiza pusilla</i>
		爬行类	龟鳖目 <i>Chelonia</i>	鳖科 <i>Trionychidae</i>	鳖属 <i>Amyda</i>

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REPTILES	有鳞目 Squamata	壁虎科 Gekkonidae	壁虎属 Gekko	无蹼壁虎 Gekko swinhonis	<i>Gekko swinhonis</i>
		蜥蜴科 Lacertian	麻蜥属 Eremias	丽斑麻蜥 Eremias argus	<i>Eremias argus</i>
		游蛇科 Colubridae	游蛇属 Natrix	黄脊游蛇 Hierophis spinalis	<i>Coluber spinalis</i>
			颈槽蛇属 Rhabdophis	虎斑游蛇 Natrix tigrina	<i>Rhabdophis tigrina</i>
			链环蛇属 Lycodon	赤练蛇 Crimson Snake	<i>Lycodon rufozonatus</i>
			锦蛇属 elaphe	白条锦蛇 Elaphe dione	<i>Elaphe dione</i>
两栖类 AMPHIBIANS	无尾目 Anura	蟾蜍科 Bufonidae	蟾蜍属 <i>Bufo</i>	中华蟾蜍 Asiatic toad	<i>Bufo gargarizans</i>
				花背蟾蜍 Mongolian toad	<i>Bufo raddei</i>
			蛙属 Rana	泽蛙 Fejervarya limnocharis	<i>Rana limnocharis</i>
				黑斑蛙 Rana nigromaculata	<i>Rana nigromaculata</i>
			狭口蛙属 Kaloula	北方狭口蛙 Boreal Digging Frog	<i>Kaloula borealis</i>