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GIES Case Study on Hunjiang *Schisandra Chinensis* in Valley Terraces of Sandaogou Town

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Abstract: Sandaogou Town, Hunjiang District, Baishan City, Jilin Province, covers an area of 426.62 km^2, administers 6 administrative villages, and has a total population of 2,812. The region is characterized by a temperate continental monsoon climate with pronounced seasonal variation, abundant precipitation, and sufficient sunshine. Soil is fertile and meet national standards for soil environmental quality and the control of agricultural land soil pollution. Irrigation water is sourced from precipitation and tributaries of the Yalu River; meets the Class I standards of the national environmental quality standards for surface water and the standards for drinking water quality, supporting optimal growth conditions for *Schisandra chinensis*. In 2024, the cultivated area reached 450.8 ha. Schisandra produced in Sandaogou Town has a schisandrin content (dried weight) exceeding the standards set by the Pharmacopoeia of China, and contains abundant flavonoids and amino acids, indicating high medicinal value and product quality. Based on scientific data, this case study summarizes a model for the conservation and sustainable development of the valley terrace habitats of *Schisandra chinensis* in Sandaogou Town, Hunjiang District. This case dataset comprises 5 components: (1) boundary data of the case area; (2) physical geography data; (3) characteristic data of *Schisandra chinensis*; (4) industrial development and management operations; (5) photos. The dataset is archived in .shp, .docx, .jpg, .tif and .xlsx formats, and consist of 88 data files with data size of 37.8 MB (compressed into one file with 29.4 MB).

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Dataset Availability Statement:

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1 Introduction

The Schisandraceae family belongs to the Magnoliidae subclass and the Magnoliales order, comprising the *Schisandra* genus (*Schisandra* Michx.) and the *Kadsura* genus (*Kadsura* Kaempf. Ex Juss). Globally, 39 species of Schisandraceae have been identified, with 29 species native to China, making it the region with the most concentrated distribution of Schisandraceae plants[1]. Schisandraceae plants are primarily distributed in North China, Northeast China, Inner Mongolia, and Henan Province within China, with additional occurrences in the Russian Far East, the Korean Peninsula, Japan, and India. In China, the primary sources for the commonly used medicinal Schisandra are the dried mature fruits of *Schisandra chinensis* (Northern Schisandra) and *Schisandra sphenanthera* (Southern Schisandra). These fruits are named for their distinctive taste profile, including sour, sweet, pungent, bitter, and salty[2]. *Schisandra chinensis*, primarily produced in northeastern China. Its fruits are large with thick flesh, ranging in color from deep red to purplish black. They contain high levels of medicinal components and exhibit potent therapeutic effects[3]. In contrast, *Schisandra sphenanthera* is primarily cultivated in Hubei, Henan, Shaanxi, Shanxi, Gansu, and other provinces, produces smaller fruits with comparatively lower medicinal efficacy[4].

Figure 1 *Schisandra Chinensis* of Sandaogou Town, Hunjiang District

Sandaogou Town, Hunjiang District, is located in the southeastern part of Jilin Province at the foot of the Changbai Mt. It features a temperate continental monsoon climate with distinct seasonal changes, abundant precipitation, and sufficient annual sunshine. These environmental characteristics provide suitable conditions for the cultivation of *Schisandra chinensis* (Figure 1). Currently, Changbai Mt. Schisandra is a nationally recognized geographical indication product. Sandaogou Town falls within the protected geographical indication production area of this geographical indication product and is authorized to use the "Geographical Indication of China" of Changbai Mt. Schisandra.

This study compiled and analyzed data regarding the ecological environment of Sandaogou Town in Hunjiang District and the characteristics of *Schisandra chinensis* products. It developed the GIES case dataset on Hunjiang *Schisandra Chinensis* in valley terraces of Sandaogou Town, aiming to provide scientific support for the habitat conservation and sustainable development of *Schisandra chinensis* products from Sandaogou Town.

2 Metadata of the Dataset

The metadata of the GIES case dataset on Hunjiang District *Schisandra chinensis* mountain valleys in Sandaogou Town[5] is summarized in Table 1. It includes the dataset full name, short name, authors, year of the dataset, data format, data size, data files, data publisher, and data sharing policy, etc.

Table 1 Metadata summary of the GIES case dataset on Hunjiang District *Schisandra chinensis* mountain valleys in Sandaogou Town

Items	Description
Dataset full name	GIES case dataset on Hunjiang District *Schisandra chinensis* mountain valleys in Sandaogou Town
Dataset short name	HunjiangSchisandraChinensisCase30
Authors	Lu, H. W., Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, luhw@igsnrr.ac.cn Xu, D., People's Government of Hunjiang District, Baishan City, Jilin Province, 781482619@qq.com Yang, S., Hunjiang Sub-district Office, Baishan Municipal Administration for Market Regulation, 59330666@qq.com Zhang, M. Y., Hunjiang Sub-district Office, Baishan Municipal Administration for Market Regulation, 554286240@qq.com Yang, Y. F., Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, yangyunfei24@mails.ucas.ac.cn Zhang, H. Z., Institute of Data Science and Agricultural Economics, Beijing Academy of Agriculture and Forestry Sciences, zhanghuizhi@baafs.net.cn Xue, Y. X., Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, xueyx.20b@igsnrr.ac.cn Lei, H., Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, leihong251@mails.ucas.ac.cn Cui, Y. W., Sandaogou Town, Hunjiang District, Baishan City, Jilin Province, 18743919177@139.com Wang, L., Sandaogou Town, Hunjiang District, Baishan City, Jilin Province, 13943938898@139.com Zhang, F. S., Sandaogou Town, Hunjiang District, Baishan City, Jilin Province, 58823121@qq.com Peng, L. D., Sandaogou Town, Hunjiang District, Baishan City, Jilin Province, 13943911515@139.com Feng, H., Hunjiang Sub-district Office, Baishan Municipal Administration for Market Regulation, 329900785@qq.com Gu, P. C., Sandaogou Qiangnong Cooperative Union, Ditai Village, Sandaogou Town, Hunjiang District, Baishan City, Jilin Province, 16604392777@139.com Wang, X., Erdaogou Village, Sandaogou Town, Hunjiang District, Baishan City, Jilin Province, 13843903983@139.com Lu, G. Y., Jilin Jiuxiancao Agricultural and Sideline Products Processing Co., Ltd, jljxc2025@126.com Pan, H. G., Baishan Debaicai Ecological Technology Co., Ltd, 178920576@qq.com Wang, S. J., Jilin Agricultural Science and Technology College, 172975673@qq.com
Geographical region	Sandaogou Town, Hunjiang District, Baishan City, Jilin Province: 41°29′50″N–41°48′10″N, 126°22′41″E–126°41′18″E
Year	2025
Data format	.xlsx, .shp, .tif, .jpg, .docx
Data size	37.8 MB (compressed to 29.4 MB)
Data files	Boundary data of the case area; Physical geography data; Characteristic data of *Schisandra chinensis*; Industrial development and management operations, etc.
Foundation	Jilin Provincial Administration for Market Regulation (2025)
Data publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	(1) *Data* are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use *Data* subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute *Data* subject to written permission from the GCdataPR Editorial Office and the issuance of a *Data* redistribution license; and (4) If *Data* are used to compile new datasets, the "ten percent principle" should be followed such that *Data* records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[6]
Communication and searchable system	DOI, CSTR, Crossref, DCI, CSCD, CNKI, SciEngine, WDS, GEOSS, PubScholar, CKRSC

3 Case Dataset Development

3.1 Case Area

Hunjiang District, located at the foot of the Changbai Mt. in southeastern Jilin Province, is bordered Tonghua County of Tonghua City to the west, Liuhe County to the north, Ji'an City to the south, and Jiangyuan District and Linjiang City to the east. To the southeast, it faces the Democratic People's Republic of Korea across the river, with a border length of 45 km. The district administers 8 subdistricts and 4 towns (Figure 2)[1]. Currently, the district's total area dedicated to specialty agriculture reaches 20.67 km^2, with 8 km^2 allocated to medicinal herb cultivation and over 30 varieties are cultivated.

The case area is situated in Sandaogou Town, southern Hunjiang District, Baishan City, Jilin Province (41°29′50″N–41°48′10″N, 126°22′41″E–126°41′18″E). It faces North Korea's Cicheng County across the river to the east, borders Ji'an City's Qingshi Town to the south, connects with Hongtuya Town to the west, and adjoins Linjiang City's Weishahe Town to the north. The town has a border length of 45 km, an administrative area of 426.62 km^2, and a total population of 2,812, comprising 6 administrative villages (Figure 2). Currently, Sandaogou Town is the primary cultivation zone for Sandaogou *Schisandra chinensis*, with 4.51 km^2 under cultivation and an annual fresh fruit production of approximately 6,956 t.

3.2 Ecological and Environmental Data

3.2.1 Topography

The case area is situated in the low-mountainous regions of the Longgang and Laoling ranges with terrain gradually sloping from north to south and is characterized by undulating ridges, dense forests, layered peaks, and intersecting ravines. Major mountain ranges include Laohu Ridge, Laotudingzi Ridge, Dahainanpo Ridge, Laoliangzi Ridge, Toudaoyangcha Ridge, and Bugedonggou Ridge. The dominant topography within the study area comprises low- to-medium undulating mountains, medium-undulating low mountains, and medium-undulating mountains. Among these, medium-undulating mountains cover 390.54 km^2 (91.54%) and represent the most prevalent topographic type. Low-to-medium undulating mountains cover 18.04 km^2 (4.23%) and occur in the northwest, medium-undulating low mountains occupying the same area in the southeast[2]. Based on the SRTM 3 90-m elevation data[3] and slope analysis, the elevation of the study area ranges from 283 m to 1,512 m (Figure 3), the highest point occurs on Laohu Ridge and the lowest along the banks of the Yalu River. Slopes range from 0° to 55.8° (Figure 4). The river valley region features flat terrain, with an average elevation of 424.88 m and a slope of 9.67°, and constitute the principal cultivation areas

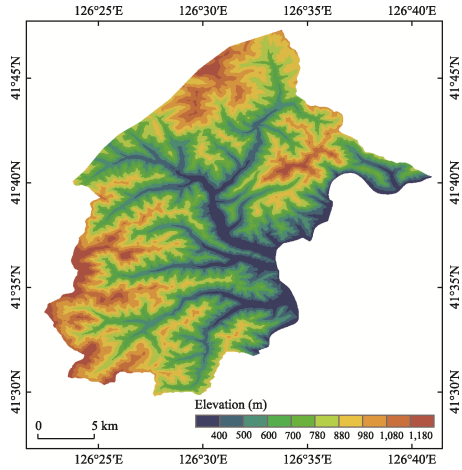
Figure 2 Geo-location and the administrative divisions map of Sandaogou Town

[1] Resource and Environmental Science Data Platform. https://www.resdc.cn/data.aspx?DATAID=333.

[2] Resource and Environmental Science Data Platform. Spatial Distribution Dataset of 100 million Geomorphic Types in China. https://www.resdc.cn/data.aspx?DATAID=124.

[3] NASA, NIMA. https://earthexplorer.usgs.gov/.

for *Schisandra chinensis*.



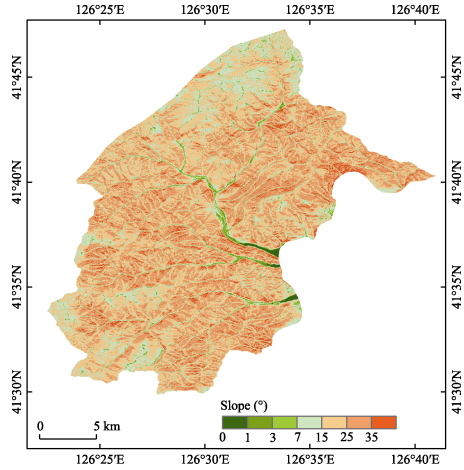


Figure 3 Elevation classification map of Sandaogou Town**Figure 4** Slope classification map of Sandaogou Town

3.2.2 Climatic Conditions

Sandaogou Town of Hunjiang District is situated in the mid-temperate zone, and is characterized by a distinct mid-temperate continental monsoon climate with pronounced seasonal variation. The four seasons are clearly defined. Summers are mild and rainy, while springs and winters are cold and dry, and diurnal temperature fluctuations are significant, with large annual and daily temperature ranges. Based on long-term monitoring data (1985–2024) from the Baishan Meteorological Station (No.54371) within Hunjiang District, the case area recorded a mean annual temperature of 5 ℃, with recorded extremes of 36.5 ℃ and–35.1 ℃. Annual precipitation averages 888.9 mm, with a highly uneven distribution, exceeding 50% in summer and less than 5% in winter, demonstrating typical rain-heat synchronization. The region also exhibits a mean relative humidity of 71%, a frost-free period of 115–140 d, a mean wind speed of 1.8 m/s, and an annual sunshine duration of 2,181.5 h. The region receives abundant annual sunshine, distributed relatively uniformly throughout the year (Figure 5 and 6). This climate, characterized by large diurnal temperature variations, rain-heat synchronization, and abundant sunlight, provides an exceptionally suitable habitat for dry matter accumulation and moisture supply in *Schisandra chinensis* cultivation in Sandaogou Town.

3.2.3 *Schisandra Chinensis* Cultivation Areas and NDVI

Schisandra chinensis cultivation areas were identified through visual interpretation of

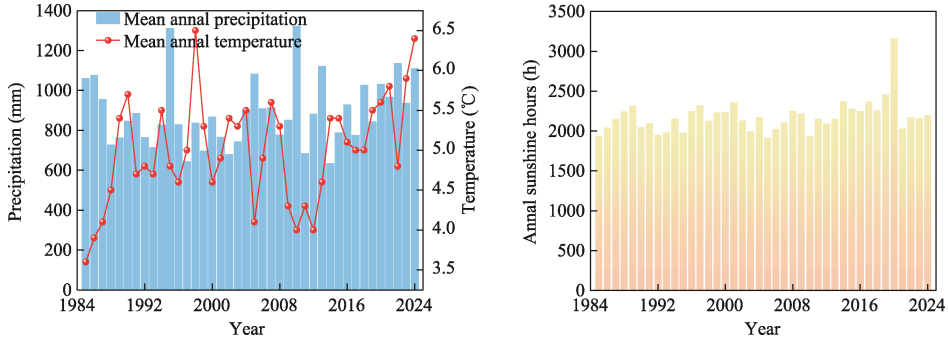


Figure 5 Changes in mean annual temperature, mean annual precipitation, and mean annual sunshine hours in Hunjiang District (1985–2024)

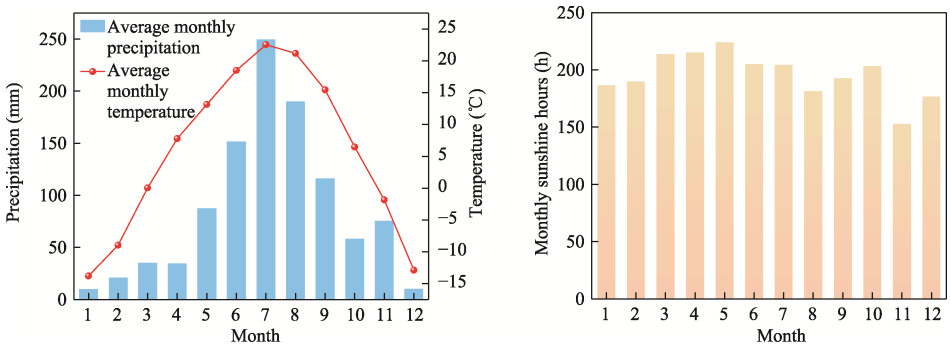


Figure 6 Distribution of average monthly temperature, average monthly precipitation, and average monthly sunshine hours in Hunjiang District over the past 5 years

Google Earth remote sensing imagery (Figure 7). Comparison with a 30 m resolution national land cover dataset[7] indicated that the distribution of *Schisandra chinensis* cultivation areas closely aligns with that of local farmland. These areas are primarily concentrated in the valleys and river basins of the central and eastern regions, characterized by lower elevations and gentler slopes. Furthermore, an analysis of vegetation cover in the study area based on 2024 TM satellite imagery[4] revealed that the region possesses abundant forest resources. The spatial distribution of the Normalized Difference Vegetation Index (NDVI) is highly consistent with forest cover, indicating excellent overall vegetation condition and a stable ecosystem (Figure 8). This provides an optimal ecological environment for the cultivation and growth of *Schisandra chinensis*, thereby supporting the potential for its sustainable development.

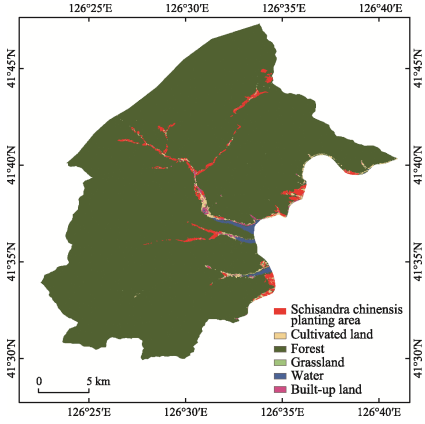


Figure 7 Map of land use and *Schisandra chinensis* planting areas in Sandaogou Town

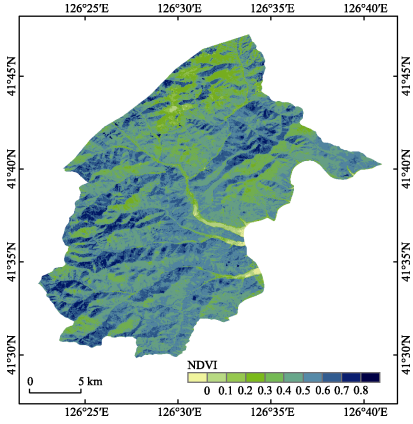


Figure 8 Distribution map of NDVI in Sandaogou Town (2024)

3.2.4 Soil Conditions

The predominant soil type in the case area is dark brown forest soil, which typically develops under temperate humid monsoon climates and mixed coniferous-broadleaf forests and is widely distributed across Northeast China. This soil is characterized by accumulated organic matter in the topsoil and a moderately to slightly acidic pH profile, providing favorable conditions for *Schisandra chinensis* growth. To evaluate the current soil status in the case area, 15 soil sampling sites were established across the primary cultivation areas of 6 villages (Figure 9). Soil samples were collected at 20 cm intervals, resulting in 57 samples, with

[4] Earth Resources Observation and Science (EROS) Center. Landsat 4-5 Thematic Mapper Collection 2 Level-2. U.S. Geological Survey, 2024. https://data.usgs.gov/datacatalog/data/USGS%3AEROS5e83d1193824e4fc.

sampling depths ranging from 40 to 100 cm (averaging 80 cm). The 57 soil samples were analyzed by the Physical and Chemical Analysis Center, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences (CMA-certified) for soil fertility indicators including pH, organic matter, total nitrogen, total potassium, available potassium, available phosphorus, as well as soil heavy metal concentrations, specifically mercury (Hg), arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), zinc (Zn), copper (Cu) and nickle (Ni).

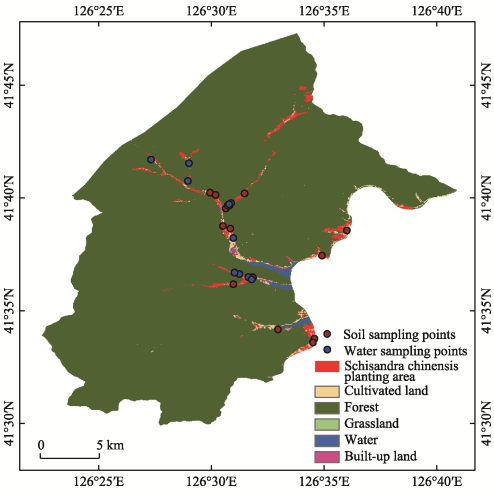


Figure 9 Distribution map of soil and water sampling sites in Sandaogou Town

The soil fertility test results are presented in Figure 10. Soil pH ranged from 4.02 to 7.95 (averaging 5.88), indicating slightly acidic to neutral conditions. Although existing literature typically defines the optimal pH for *Schisandra chinensis* as 5.5–6.5, over a decade of local cultivation has shown that growth and fruit phenotypic indicators at sites exceeding the optimal pH range (e.g., pH > 7) do not differ significantly from those within the optimal range. This adaptation may be attributed to the region's high soil organic matter content and relatively high background fertility, which can buffer pH-related stress and mitigate its effects on plant growth. Such buffering capacity may enhance the ecological adaptability of *Schisandra chinensis* to variable soil pH conditions. Across the sampling sites, soil organic matter, total nitrogen, total potassium, available phosphorus, and available potassium concentrations ranged from 4.36–84.38 g/kg, 0.46–3.88 g/kg, 15.99–30.20 g/kg, 7.9–238.3 mg/kg and 46.83–1,512.3 mg/kg, respectively. Analysis of the 15 sampling sites revealed that, across different soil layers at various locations, the 0–20 cm layer exhibited higher levels of soil organic matter, total nitrogen, total potassium, available phosphorus and available potassium, ranging from 22.78–84.38 g/kg, 0.92–3.88 g/kg, 18.02–25.34 g/kg, 11.5–237 mg/kg and 123.33–1512.3 mg/kg, respectively, with mean values of 42.09 g/kg, 1.87 g/kg, 21.36 g/kg,

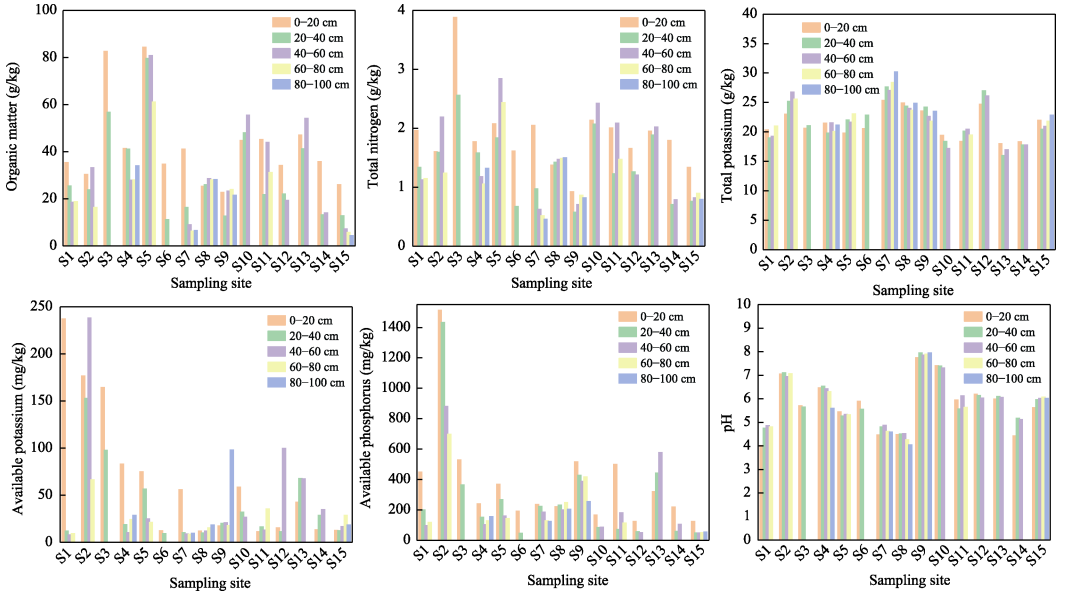


Figure 10 Soil fertility test results in Sandaogou Town

65.9 mg/kg and 380.79 mg/kg, with standard deviations of 18.37 g/kg, 0.65 g/kg, 2.47 g/kg, 71.46 mg/kg and 343.23 mg/kg, respectively. These levels align with the "Abundant" category (Grade II) of the National second soil census soil nutrient classification standards[8].

The heavy metal content results for the case area are shown in Table 2. Across all soil layers, the concentration ranges for Cr, Zn, Hg, As, Ni, Cu, Cd, and Pb were 34–130 mg/kg, 48.5–152 mg/kg, 0.017–0.52 mg/kg, 4.3–21 mg/kg, 3.88–61.32 mg/kg, 2.09–43.36 mg/kg, 0.0098– 0.294 mg/kg, and 3.47–59.44 mg/kg, respectively. Comparing the heavy metal indicator test results from the case area with the soil pollution risk screening values specified in the Soil environmental quality risk control standard for soil contamination of agricultural land (Trial) (GB 15618—2018)[9], all measured concentrations fell well below the designated agricultural land pollution risk screening values. This indicates that the soil environmental quality in the case study area is favorable, with no evidence of heavy metal contamination.

3.2.5 Water Conditions

The case area is situated on the northern bank of the Yalu River, forming part of the Yalu River basin. The primary watercourses within its boundaries comprise the Yalu River mainstem and the Hunjiang River. The mainstem section extends 48.5 km with a catchment area of 420.6 km^2, receiving inflows from 6 first-order tributaries, 5 second-order tributaries, and 3 third-order tributaries. These tributaries, supplemented by natural precipitation, constitute the primary irrigation sources for the *Schisandra chinensis* cultivation zones. Consequently, 12 surface water samples were collected from rivers adjacent to these cultivation areas (Figure 9). A total of 48 parameters were analyzed in accordance with the Environmental quality standards for surface water (GB 3838—2002)[10] and the Standards for drinking water quality (GB 5749—2022)[11]. These indicators included pH, dissolved oxygen (DO), biochemical oxygen demand (BOD_5), total nitrogen, total phosphorus, Cd, Co, Ni, Cu, and other conventional water quality parameters, along with heavy metals and mineral elements. The water quality results are presented in Table 3. Surface water in the case study area exhibited a slightly alkaline pH ranging from 7.86–8.20 and DO levels between 11.13 and 11.35 mg/L, with all parameters falling within permissible limits. Notably, heavy metals such as As, Cd, and Co were not detected. According to the Surface water environmental quality evaluation measures (Trial), all test results met the standards for Class I water specified in the Environmental quality standards for surface water (GB 3838—2002) and complied with the limit requirements for tested indicators specified in the Standards for drinking water quality (GB 5749—2022). This indicates that the irrigation water quality for *Schisandra chinensis* in the case area is excellent, providing an optimal hydrological environment for its cultivation.

Table 2 Statistical testing result of soil heavy metal content in Sandaogou Town Unit: mg/kg

	Cr	Zn	Hg	As	Ni	Cu	Cd	Pb
Maximum detectable value	130	152	0.52	21	61.32	43.36	0.294	59.44
Corresponding pH	5.96	7.41	7.39	6.20	6.01	7.05	7.05	4.48
Limits[9]	150	250	2.4	40	70	100	0.3	70

3.3 Product Characteristics Data

3.3.1 Product Characteristics

Schisandra chinensis is a perennial deciduous woody vine with stems reaching up to 8 m in length. The undersides of young leaves are typically pubescent, with membranous blades that vary in shape from broadly elliptic and ovate to obovate or nearly circular. The flowers are pale pink or pink and oblong to elliptic-oblong. The flowering period occurs from May to July, followed by fruiting from July to October. The berries are small, red, and spherical or obovoid, with inconspicuous glandular dots on the pericarp; they turn deep red when ripe

Table 3 Statistical testing result of river water quality in Sandaogou Town

Test item	Water sample test results	Limits[10]	Limits[11]
pH	8.03	6–9	6.5–8.5
DO (mg/L)	11.24	≥7.5	/
CODMn (mg/L)	1.79	≤2	3
COD (mg/L)	13	≤15	/
BOD_5 (mg/L)	2.49	≤3	/
Ammonia nitrogen (mg/L)	0.1	≤0.15	0.5
P (mg/L)	0	≤0.02	/
Cu (mg/L)	0	≤0.01	1.0
Zn (mg/L)	0	≤0.05	1.0
F^- (mg/L)	0.2445	≤1	1
Se (mg/L)	0.0004	≤0.01	/
As (mg/L)	0	≤0.05	0.01
Hg (mg/L)	0.00004	≤0.00005	0.001
Cd (mg/L)	0	≤0.001	0.005
Cr (mg/L)	0.00065	≤0.01	0.05
Pb (mg/L)	0.00335	≤0.01	0.01
Cyanide (mg/L)	< 0.002	≤0.005	0.05
Volatile phenol (mg/L)	0.0003	≤0.0002	/
Sulfide (mg/L)	0.01	≤0.05	/
Total coliforms (MPN/100mL)	ND	≤200	Not detectable
Al (mg/L)	0.0051	/	0.2
Fe (mg/L)	0.00005	/	0.3
Mn (mg/L)	0	/	0.1
SO_4^{2-} (mg/L)	6.069	/	250
NO_3-N (mg/L)	1.786	/	10
Escherichia coli (MPN/100mL)	ND	/	Not detectable
Total colony count (CFU/mL)	60	/	< 100
Color	< 5	/	15
Turbidity (NTU)	< 0.5	/	1
Taste and Odor	Without	/	Free from any foreign or abnormal odors
Visible matter	Without	/	Without
Chloride (mg/L)	1.62	/	250
TDS (mg/L)	52	/	1,000
Total hardness of water (mg/L)	28	/	450

Note: ND indicates not detected; / indicates no corresponding standard limit.

and become wrinkled upon drying. *Schisandra chinensis* prefers cool, moist climates and is cold-tolerant but sensitive to waterlogging. It requires moderate shade, particularly during the seedling stage, to prevent damage from intense sunlight. It thrives in loose, fertile, humus-rich soil and is propagated by row sowing or broadcast sowing. While wild *Schisandra chinensis* is typically found in ravines, streamside areas, and on hillsides, its natural resources have severely diminished. Consequently, it is classified as a Grade III Key Protected Medicinal Plant Species in the National List of Rare and Endangered Medicinal Animal and Plant Species. Since the 1970s, researchers have conducted domestication studies on wild Schisandra cultivars. Systematic mastery of domestication and cultivation techniques has been achieved, enabling large-scale artificial cultivation. The species cultivated in the case area is *Schisandra chinensis*, a nationally recognized geographical indication product, entitled to bear the "Geographical Indication of China". Although wild *Schisandra chinensis* still occurs in the surrounding mountains in limited quantities, local cultivation has reached a significant scale, supported by in-house seedling propagation for

both replanting and expansion.

3.3.2 Product Composition Characteristics and Medicinal Value

The chemical constituents of *Schisandra chinensis* primarily include lignans, volatile oils, organic acids, terpenoids, flavonoids, polysaccharides, and inorganic elements (Table 4). Lignans are the primary active component and are largely responsible for the pharmacological properties of *Schisandra chinensis*[12]. They constitute 2%–8% of the fruit and effectively reduce serum alanine aminotransferase (ALT) levels in patients with hepatitis. Schisandrin exhibits significant hepatoprotective, anti-HIV, antioxidant, and central nervous system protective functions[13,14]. Polysaccharides constitute another vital active component, comprising approximately 7% to 11% of the fruit. Primarily composed of galactose and glucose monosaccharides, they exhibit hepatoprotective, sedative-hypnotic, and immunemodulating effects[15]. Volatile oils constitute 5% to 6% of the fruit and are predominantly composed of terpenoid compounds. These volatile oils exert effects on the central nervous system, enhancing the body's defense against non-specific stimuli[16]. However, toxicological studies indicate that these volatile oils possess certain toxic potential, warranting careful pharmacological consideration[17]. Additionally, *Schisandra chinensis* contains organic acids (including unsaturated fatty acids), essential amino acids, flavonoids, and trace elements, all of which contribute to its significant medicinal value.

Table 4 Statistical summary of Schisandra components and their content

Ingredients	Content range	Discription
Lignans	2%–8%	Schisandrin is the primary active ingredient in *Schisandra chinensis*
Volatile oil	5%–6%	The main components include citral, ylangene, and others
Polysaccharides	7%–11%	Primarily found in the pulp of Schisandra berries, including rhamnose, glucose, arabinose, and galactose, among others
Organic acids	The specific acid content varies	Mainly includes citric acid (3.2%–3.32%), malic acid (1.09%–1.17%), and shikimic acid (0.52%–0.54%)
Flavonoids	The content varies depending on the variety and fruit parts	Including quercetin, apigenin, myricetin, kaempferol, and luteolin
Amino acids	The content varies depending on the variety and fruit parts	There are approximately 16 amino acids, including 6 essential amino acids for the human body
Trace elements	Low content	Mainly including iron, manganese, silicon, and phosphorus

3.3.3 Product Quality

As a traditional Chinese medicinal herb, the quality of *Schisandra chinensis* is closely linked to its pharmacological efficacy; therefore, analyzing its product quality is of great significance. This study evaluated the quality of *Schisandra chinensis* fruits collected from Dalu Village within the case area. It determined the sensory characteristics, moisture content, total ash, schisandrin content and impurity levels of the air-dried fruits (collected in 2024, based on dry weight). Additionally, the moisture content, total ash, schisandrin, flavonoids, organic acids, and amino acids were measured in fresh fruits (collected in 2025, based on fresh weight), along with heavy metals (Cu, Zn, Pb, Cr, Cd, Hg, and As) and pesticide residues (carbofuran and omethoate). The results of the *Schisandra chinensis* fruit quality analysis are presented in Tables 5 and 6. The Sandaogou *Schisandra chinensis* fruits appear as shrivelled spherical granules with a dark red surface; the pulp is plump, oily, and glossy, featuring a reticulated shrivelled texture and a white bloom. The flavor is sour and sweet, and its sensory characteristics comply with the standard requirements defined in the Product of geographical indication—Changbaishan Wuweizi (DB22/T 2168—2020)[18]. Regarding physicochemical indicators, the moisture content, total ash, schisandrin, and impurities in the dried state all met the criteria specified in the aforementioned standard. Notably, the

schisandrin content significantly exceeded the 0.4% threshold established by the Pharmacopoeia of China[19]. In the fresh fruit, the water content, total ash content and flavonoid content reached 83.9%, 5.6%, and 41.1 mg/kg, respectively. As shown in Table 7, heavy metals were all below the limit of detection (LOD). No pesticide residues of carbofuran and omethoate were detected. All parameters met the requirements for heavy metals and pesticide residues in *Schisandra chinensis* as stipulated in the Pharmacopoeia of China, remaining well below the relevant standard limits. These results demonstrate that Sandaogou *Schisandra chinensis* possesses high medicinal value and product quality.

Table 5 Morphological characteristics and quality testing results of dried Schisandra fruit

Test item	Unit	Testing result	Limits[18]
Shape	–	Shrunken spherical granules	Shrunken spherical granules
Color	–	Dull red	Purple-red or dull red
Appearance	–	The flesh is thick, oily and lustrous, with a network of wrinkles and a white bloom	The flesh is thick, oily and lustrous,with a network of wrinkles and a hoar-frost
Flesh odor	–	Sour in taste	Sour in taste
Moisture content	%	14.5	≤16.0
Total ash	%	5.3	≤7.0
Schisandrin	%	0.534	≥0.45
Impurity	%	0.4	≤1

Note: – indicates no corresponding data.

Table 6 Statistical testing result of fresh weight Schisandra fruit quality

Test item	Unit	Sample test results	Note
Water content	%	83.9	Fresh weight
Total ash	%	5.6	Fresh weight
Schisandrin	%	0.52	Dried weight ("Pharmacopoeia of China: 2025 Edition" standard limits≥0.4)
Flavonoids	mg/kg	41.1	Fresh weight
Tartaric acid	g/kg	0.97	Fresh weight
Malic acid	g/kg	25	Fresh weight
Citric acid	g/kg	45	Fresh weight
Tryptophan	mg/kg	3.7	Fresh weight
Phenylalanine	mg/kg	1.2	Fresh weight
Methionine	mg/kg	0.35	Fresh weight
Lysine	mg/kg	0.68	Fresh weight
Isoleucine	mg/kg	3.0	Fresh weight
Leucine	mg/kg	3.3	Fresh weight
Threonine	mg/kg	0.48	Fresh weight
Valine	mg/kg	1.2	Fresh weight

4 Management of the *Schisandra chinensis* Industry

4.1 Socioeconomic Development of Sandaogou Town

Demographic data for the permanent resident population of Sandaogou Town[5] indicates that between 2021 and 2025, the total population initially increased before declining, while the total number of households exhibited a continuous declining trend (Figure 11). Based on the age structure in 2025, among the total population of 2,812, the population aged 60 and over accounted for 30.16%, with those aged 50 and over cumulatively exceeding 56%. In contrast, the core working-age population (30–50 years) represented only 26.49%, suggesting

[5] Data was cited from the People's Government of Sandaogou Town, Hunjiang District, Banshan City, Jilin Province.

Table 7 Statistical testing result of heavy metals and pesticide residues in Schisandra fruit

Test item	Unit	Sample test results	Note	Limits[19]
Carbofuran	mg/kg	ND	The limit of quantification is 0.01 mg/kg	0.02
Omethoate	mg/kg	ND	The limit of quantification is 0.01 mg/kg	0.05
Cu	mg/kg	0.35	The limit of detection is 0.05 mg/kg, and the limit of quantification is 0.2 mg/kg	20
Zn	mg/kg	Below the limit of quantification	The limit of detection is 0.5 mg/kg, and the limit of quantification is 2 mg/kg	/
Pb	mg/kg	Below the limit of detection	The limit of detection is 0.02 mg/kg, and the limit of quantification is 0.05 mg/kg	5
Cd	mg/kg	Below the limit of detection	The limit of detection is 0.002 mg/kg, and the limit of quantification is 0.005 mg/kg	1
Cr	mg/kg	Below the limit of detection	The limit of detection is 0.05 mg/kg, and the limit of quantification is 0.2 mg/kg	/
Hg	mg/kg	Below the limit of detection	The limit of detection is 0.001 mg/kg, and the limit of quantification is 0.003 mg/kg	0.2
As	mg/kg	Below the limit of detection	The limit of detection is 0.01 mg/kg, and the limit of quantification is 0.03 mg/kg	2

Note: ND indicates not detected; / indicates no corresponding standard limit.

increasing demographic pressure on the local labor force (Figure 12). An analysis of the ethnic composition in 2025 indicates that the local population is predominantly Han (97.69%). The ethnic minorities include Manchu, Korean, Hui, and Mongolian ethnic groups. Despite these demographic challenges, the case area has demonstrated robust socio-economic development. In recent years, *Schisandra chinensis* cultivation has been significantly scaled up, establishing a pillar industry based on a comprehensive industrial chain. From 2021 to 2025, the total output value reached 864 million CNY, serving as a primary driver for increasing local farmers' incomes and advancing rural revitalization.

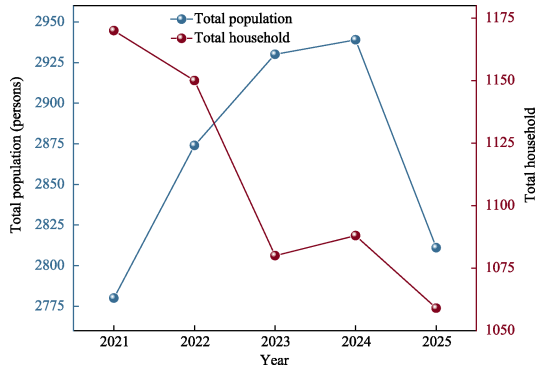


Figure 11 Population change chart of Sandaogou Town (2021–2025)

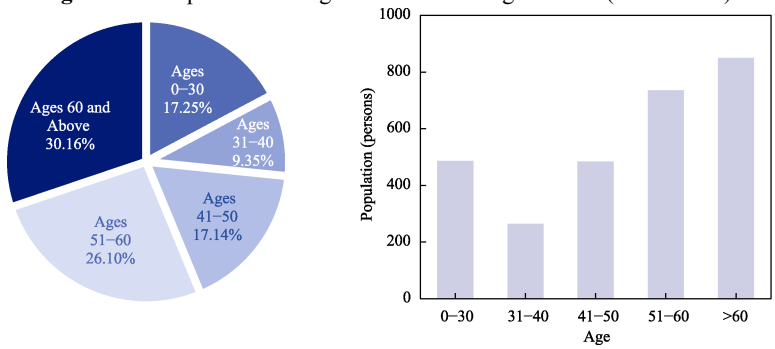


Figure 12 Population age structure of Sandaogou Town (2025)

4.2 Cultivation Management

The *Schisandra chinensis* cultivated in Sandaogou has developed a distinctive management system integrating specialized irrigation, fertilization, and plant protection protocols. In terms of irrigation, natural rainfall serves as the primary water source, supplemented by tributaries of the Yalu River, with an annual water consumption of approximately 180,000 m^3. This has led to the establishment of a water resource management system characterized by "centralized allocation and time-segmented irrigation", which supplements irrigation based on precipitation levels. By scientifically planning irrigation schedules and water allocation, seasonal water supply issues have been effectively resolved, significantly improving water resource utilization efficiency and ensuring rational distribution. Fertilization management adopts a synergistic blending model of organic and inorganic fertilizers, with precision fertilization carried out across five distinct periods throughout the year. These periods serve the following purposes: flower promotion in late May, fruit retention in early June, vine strengthening in late June, fruit enlargement in early July, and nutrient accumulation in mid-August. An average of 30,000 kg of decomposed farmyard manure is applied per ha, supplemented by 750 kg of NPK compound fertilizer to meet the nutritional requirements of *Schisandra chinensis* during its various growth stages. Concurrently, the case area has evolved a three-tiered plant protection framework consisting of "biological, physical, and chemical" controls. Specifically, biological control involves soil disinfection using *Bacillus subtilis* in late April to disrupt pathogen transmission. Physical control is implemented by deploying 150 pheromone traps per ha to interrupt pest reproductive cycles. From May onwards, control is achieved by spraying biological pesticides such as matrine, while strictly adhering to a 14-d pre-harvest interval to ensure pesticide residues comply with standards.

4.3 Production Management

In order to enhance the quality, profitability and market competitiveness of *Schisandra chinensis* products from Sandaogou, a "Three Unifications" standardized management model has been implemented across the industrial chain, enabling improved control from cultivation to harvest. First, seedling standardization was implemented prior to production. Initially, professionals established strict seedling selection criteria, and high-quality northern *Schisandra chinensis* seedlings were procured from the Ji'an *Schisandra chinensis* Seedling Cultivation Base for large-scale planting, ensuring the consistency of the plants seed source in the early stages. Through years of localized cultivation and acclimatization, a comprehensive set of independent seedling propagation standards has been gradually established, enabling the selection and breeding of superior one-year-old seedlings. The area has now achieved self-sufficiency in seedling propagation, capable of meeting local needs for replanting and new plantings. This has resolved, at source, the issues of variety contamination and inconsistent quality previously caused by small-scale, household-based cultivation, thereby ensuring the quality of *Schisandra chinensis* varieties within the project area and effectively preventing the risks of low yields and pest and disease outbreaks caused by inferior seedlings. Second, agricultural inputs have been standardized. The town government centrally procures bio-organic fertilizers and highly effective, low-toxicity pesticides that are certified by authoritative bodies and comply with green standards. Strict regulations governing the distribution of agricultural inputs and the supervision of pesticide use have been established to ensure that *Schisandra chinensis* growers apply bio-organic fertilizers and pesticides scientifically in accordance with uniform protocols. This has significantly reduced the risk of pesticide residues in *Schisandra chinensis* products and effectively safeguarded the overall quality of the fruit. In addition, benefiting from local micro-environmental conditions influenced byof the Yunfeng Reservoir, the case area enjoys a longer frost-free period, which effectively extends the fruit harvest period and creates

favorable conditions for the accumulation of schisandrin. This has gradually led to the establishment of a standardized harvesting model. The harvest period is strictly fixed between 15 August and 10 October each year, and a "two-stage" harvesting method is adopted. This effectively avoids the loss of unripe *Schisandra chinensis* berries and the waste of overripe ones caused by traditional harvesting methods, significantly increasing the proportion of high-quality berries and overall harvesting efficiency, thereby achieving the synergistic optimization of *Schisandra chinensis* quality and total yield.

Through implementing the "Three Unifications" standardized management model, the case area successfully transitioned *Schisandra chinensis* cultivation from initial small-scale, unplanned household-based farming to large-scale, standardized collective-led production. This approach has not only elevated the product quality of Sandaogou *Schisandra chinensis* but also reduced cultivation costs and increased planting returns. Moreover, the superior *Schisandra chinensis* products have significantly enhanced market competitiveness, supporting the sustained and healthy development of the Sandaogou *Schisandra chinensis* industry.

4.4 Operational Management and Industrialization Development

The cultivation of *Schisandra chinensis* in Sandaogou commenced in 2010. Initially, local farmers transplanted wild plants from shrub forests into courtyards for small-scale cultivation. During this early phase, management practices were rudimentary, planting areas were limited, yields were low, and economic returns were modest. In addition, cultivation lacked unified organization and planning. Cultivation remained predominantly a household-based activity, with growers relying on market traders to purchase fresh berries door-to-door. Prices fluctuated significantly, sales channels were relatively limited, and market risks remained high. In 2017, Baishan Debaicai Ecological Technology Co., Ltd was established. The company focuses on the research and development of cutting-edge products such as plant extract deep processing, nutritional supplements, Chinese herbal enzymes, and health beverages. The company developed Schisandra-based products including Schisandra herbal pillows, Schisandra calming incense, and Schisandra wellness hammers. This initiative has established a comprehensive industrial chain encompassing cultivation, research, processing, and sales, significantly advancing the industrialization of *Schisandra chinensis* production in Sandaogou region. In 2023, a *Schisandra chinensis* drying plant was established in Xianrendong Village within the case area. This effectively addressed challenges in storing and transporting fresh fruit, extending the industrial chain from cultivation to processing and enhancing product value. In 2024, the village collective established an economic cooperative, local *Schisandra chinensis* cultivation expanding to 4.51 km^2, with an annual fresh fruit production of 6,956 t.

Currently, the *Schisandra chinensis* industry in Sandaogou has formed a relatively complete industrial chain encompassing cultivation, processing, and sales. The establishment of *Schisandra chinensis* drying facilities and a "micro-industrial park" has effectively driven industrial upgrading. Technological support primarily relies on the "Science and Technology Courtyard" jointly established with Jilin Agricultural Science and Technology College to research methods for increasing *Schisandra chinensis* yield. Regarding industrial integration, tourist experience programs such as *Schisandra chinensis* picking and processing plant tours have been introduced, actively exploring the "*Schisandra chinensis* + cultural tourism" integration model to promote the construction of an integrated industry-academia-research-tourism collaborative system.

4.5 Ecological Environment Traceability for Schisandra

The sustainable development of the *Schisandra chinensis* industry in Sandaogou Town relies heavily on robust support from modern technology. To this end, a GIES ground station

(Figure 13) has been established in Xianrendong Village within the case area. This station conducts real-time, round-the-clock monitoring of the ecological environment in the *Schisandra chinensis* cultivation zone, tracking key indicators including: air negative oxygen ion concentration, phenology, wind speed, wind direction, precipitation, air quality, temperature, relative humidity, soil temperature and moisture, atmospheric pressure, and soil electrical conductivity. These real-time monitoring data reflect the optimal growth environment for *Schisandra chinensis* and provide scientific, precise data support for cultivation management. This further drives the transformation of the Sandaogou *Schisandra chinensis* industry toward smarter, more scientific, and sustainable cultivation practices.

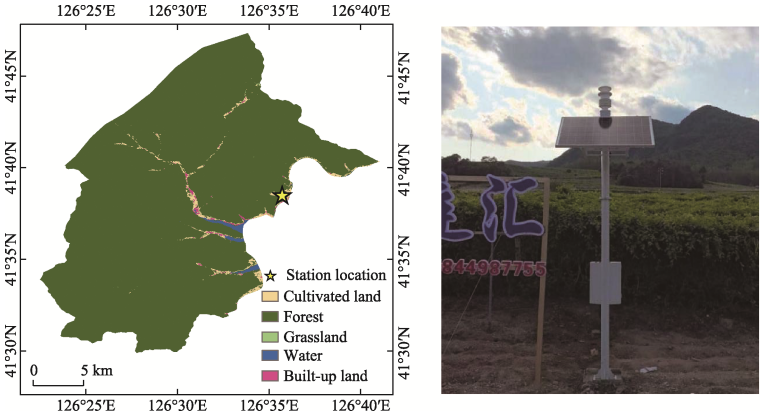


Figure 13 Location map and facility of the GIES ground station

5 Discussion and Conclusion

The case area is situated in the moderately undulating mountains region at the foot of the Changbai Mt., occupying the northern bank of the Yalu River, within the Yalu River watershed. The combination of weakly acidic to neutral soil conditions, significant diurnal temperature variation, rain-heat synchronization, abundant sunlight, and unique small watershed geography collectively nurtures the regionally distinctive Sandaogou *Schisandra chinensis* products. *Schisandra chinensis* possesses exceptional medicinal value, and its derivative products, such as Schisandra herbal pillows, Schisandra calming incense, and Schisandra wellness hammers, and show tremendous development potential with broad prospects. Nevertheless, the Sandaogou *Schisandra chinensis* industry confronts a series of challenges that require urgent research and resolution.

5.1 Population Decline and Ageing Challenges

In recent years, population ageing in the case area has intensified annually, posing a formidable challenge to labor force sustainability. Effectively addressing the issues of rural depopulation and accelerating ageing is a core challenge in achieving rural revitalization and ensuring that farmers can live and work in peace and contentment. At present, the *Schisandra chinensis* industry in Sandaogou Town remains focused on the upstream cultivation stage, while the downstream deep-processing sector has developed relatively late and at a slower pace. To address the ongoing challenges of an ageing population, future efforts should focus on exploring cultivation models suitable for mechanized production, such as wide-row, high-density planting. The town should actively introduce mechanized and intelligent technologies to continuously reduce reliance on labor in the cultivation process and consistently improve planting efficiency. At the same time, efforts should be made to gradually strengthen the branding and market promotion of Sandaogou *Schisandra*

chinensis and its derivative products, continuously enhancing the market influence and visibility of these products, and gradually expanding sales channels. Through the comprehensive development of the *Schisandra chinensis* industry chain in the case area, an industrial framework comprising smart cultivation, automated production, intelligent processing, efficient transport and digital management will gradually take shape. This will generate more jobs and employment opportunities across multiple stages of the industry chain, injecting new vitality into local residents' incomes, providing more options for migrant workers to return home to work or start businesses, and offering a novel solution to alleviate population outflow and ageing in the case area.

5.2 Weak Brand and Intellectual Property Awareness

Currently, *Schisandra chinensis* produced in the Sandaogou Town has yet to establish a proprietary brand endowed with regional distinctiveness or substantial market influence. *Schisandra chinensis* products from this region exhibit limited market recognition and diminished competitiveness. Additionally, owing to historically weak awareness of intellectual property rights among certain producers, premium *Schisandra chinensis* products from the case area failed to achieve their inherent market value, resulting in limited benefits for farmers. In the future, the region should leverage its core advantage of superior *Schisandra chinensis* quality by actively registering a distinctive brand exclusive to the case area. Concurrently, multi-channel and multi-format brand promotion campaigns should be implemented to continuously enhance brand recognition. By elevating brand value, product value will be consistently improved, enabling participating farmers to secure more substantial benefits.

5.3 The potential of Science and Technology Courtyards Remains to be Tapped

Although the demonstration area has established a joint "Science and Technology Courtyard" with Jilin Agricultural Science and Technology College to provide technical support for *Schisandra chinensis* research, the courtyard remains in an incipient phase overall. Its capacity to drive industrial upgrading has yet to be fully realized. In the future, the platform of the "Science and Technology Courtyard" should be fully leveraged to further harness its collaborative strengths in industry-academia-research partnerships. Efforts should concentrate on facilitating the dissemination of research and the implementation of outcomes, with a particular emphasis on technology-driven empowerment. This will involve continuously optimizing the *Schisandra chinensis* cultivation management system to progressively enhance both the intrinsic and visual qualities of the fruit. Ultimately, this strategy will facilitate the selection of superior produce, thereby providing sustained scientific support to fortify the core competitiveness of the *Schisandra chinensis* industry within the case area.

5.4 Cultural Tourism Brands Require Further Developed

Although the case area has initiated exploration of an integrated "*Schisandra chinensis* + cultural tourism" model, gradually building a *Schisandra chinensis* cultural tourism brand and launching initiatives such as *Schisandra chinensis* picking and the display and sale of Schisandra herbal pillows, a systematic cultural tourism brand has yet to be established. In the future, full advantage should be taken of the G331 border tourism corridor and the region's border tourism assets to embed the *Schisandra chinensis* industry firmly within the border tourism circuit. By integrating regional landscape resources and the advantages of the border location, we can promote the transformation of *Schisandra chinensis* from a traditional agricultural industry into one that is integrated with cultural tourism. Building upon the sales of *Schisandra chinensis* berries and their derivatives, the *Schisandra chinensis* industry chain should be extended to encompass sightseeing and picking during

the cultivation phase, factory tours and hands-on experiences in the processing phase, as well as the promotion of Schisandra's medicinal history and wellness culture. This will create a *Schisandra chinensis* cultural tourism brand that integrates ecological sightseeing, picking experiences, handicrafts, and health and wellness. Ultimately, through the profound integration of "*Schisandra chinensis* + cultural tourism", the dual imperatives of promoting agriculture through tourism and strengthening agriculture via tourism can be realized, thereby providing sustained momentum for rural revitalization in the case area.

Author Contributions

Lu, H. W. oversaw the overall design of this case study; Lu, H. W., Xue, Y. X., Xu, D., Yang, S., Zhang, M. Y., Feng, H., Cui, Y. W., Wang, L., Zhang, F. S., and Peng, L. D. participated in field investigations and the construction of the GIES ground station; Xue, Y. X., Yang, Y. F., and Lei, H. completed soil and water sample collection and testing; Zhang, H. Z., Gu, P. C., Wang, X., Lu, G. Y., Pan, H. G., and Wang, S. J. provided industrial development and enterprise management data; Xue, Y. X. and Yang, Y. F. completed the drafting and revision of the manuscript.

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Conflicts of Interest

The authors declare no conflicts of interest.

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