

A Study on the Interest Linkage Mechanism of the *Taxus* Industry Chain in Pengshui Miao and Tujia Autonomous County

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Abstract At the *Taxus* base of Pengshui Miao and Tujia Autonomous County, Chongqing, the comprehensive development and utilization of *Taxus* was carried out with seedling cultivation, understory economy, product processing, ecotourism and other aspects as the main line. The benefit linkage mechanism of the operation of the *Taxus* industrial chain was explored and analyzed, so as to extend and supplement the *Taxus* industrial chain. The two models of "company + farmer" and "company + village collective + farmer" are relatively close benefit linkage models, which indirectly promote the increase of farmers' income and smoothly guarantee the operation of the industrial chain, thereby playing a positive role during the development of the *Taxus* industry. This study provides reliable countermeasures and suggestions for the sustained and healthy development of the *Taxus* industry in Pengshui County.

Key words *Taxus*; Development and utilization; Industrial chain; Interest linkage; Mechanism

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The report of the 20th National Congress of the Communist Party of China (CPC) emphasizes the need to "develop rural characteristic industries and broaden channels for farmers to increase their income and become rich". We should adopt measures according to local conditions, including growing crops, raising animals and carrying out forestation according to suitable conditions, and promote the development of rural industries through the integration of rural tourism. Developing the *Taxus* industry and building an industrial chain is an effective way to make scientific and rational use of forest resources and practice that green waters and green mountains are invaluable assets.

Taking ten thousand mu of *Taxus* cultivation resources as the leading factor, a series of research and demonstration were carried out in the *Taxus* base in Pengshui Miao and Tujia Autonomous County, Chongqing (hereinafter referred to as Pengshui County), such as seedling cultivation, underforest breeding, product processing and eco-tourism, in order to extend the industrial chain of *Taxus* in Pengshui County and explore the interest linkage mechanism between enterprises and farmers and the main factors affecting the linkage mechanism. Countermeasures and suggestions on how to improve the interest mechanism between enterprises and farmers were also put forward, which can not only better protect and utilize *Taxus* resources, but also achieve sustainability for enterprises.

General Situation of the *Taxus* Industry in Pengshui County

Distribution of resources

Pengshui County is rich in *Taxus* resources, mainly *Taxus chinensis* and *Taxus wallichiana* var. *mairei* (Lemee & H. Léveillé) L.

From March to November, 2022, our project team collected the resources of *Taxus* in Pengshui County, and conducted a field survey on wild resources with DBH \geq 20 cm and concentrated contiguous cultivated *Taxus* forests.

The survey results showed that there are 29 towns (streets) in Pengshui County distributed with about 838 wild *Taxus* plants. In specific, 126 wild *Taxus* plants were investigated on the spot, mainly distributed in the range of 400–1 500 m above sea level; and there are a total of three ancient *Taxus* trees, distributed in three towns and streets of Dianshui Street, Anzi Town, and Zouma Township. *Taxus* trees, distributed in a single or concentrated manner, are often found in areas with good site conditions or convenient transportation conditions, and most of them were artificially transplanted to the front and back of houses, beside farmland, roadsides, or cemeteries when there were wild young trees. Scattered *Taxus* resources are mainly distributed in broad-leaved forests, coniferous forests, mixed coniferous and broad-leaved forests, and bamboo forests.

Cultivated *Taxus* resources in Pengshui County are mainly concentrated at the boundaries of Puzi Town, Lutang Township and Lianhe Township, with a current preservation area of approximately 627.41 hm². The preserved *Taxus* trees are growing well, with an average tree height of 3.3 m and an average diameter at breast height of 5.2 cm. Currently, some *Taxus* trees are beginning to bear fruit.

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Development and Utilization of Cultivated Resources

Distribution of Cultivated resources Wild *Taxus* resources are scarce, and national laws and regulations prohibit the use of wild *Taxus* as tree species for development and utilization. Therefore, artificially-cultivated *Taxus* resources are the main body for development and utilization. *Taxus* resources artificially cultivated in Pengshui are mainly concentrated at the boundaries of Puzi Town, Lutang Township and Lianhe Township, which is the result of the implementation of the project of returning farmland to forests in 2015. At present, the preserved area is about 627.41 hm².

Table 1 Statistics of cultivated *Taxus* resources in Pengshui County

No.	Towns	Villages	Number of sub-compartments sub-compartments	Area hm ²
Total	3	5	874	627.41
1	Lianhe Township	Tonglian Village	305	281.77
2	Lutang Township	Banli Village	16	6.31
		Poping Village	86	43.83
		Xingguang Village	331	171.29
3	Puzi Town	Fengshan Village	136	124.21

Utilization of resources Through the implementation of the project *Technical Research and Integrated Application of the Taxus Industrial Chain in Pengshui*, focusing on *Taxus* resources, Chongqing Zongshen Tourism Industry Development Co., Ltd. carried out ecological tourism with *Taxus* as its characteristic, and planned a unique *Taxus* forest health base. Meanwhile, they also explored and studied the technologies and processes of *Taxus* seedlings cultivation, developing under-forest economy and processing *Taxus* products, which extend the industrial *Taxus* chain, and now it has taken shape, providing new ideas for the protection and utilization of cultivated *Taxus* resources.

Landscape utilization During the implementation of the project, the landscape property of *Taxus* resources was used to improve the planning of *Taxus* forest health base and enrich the eco-tourism featuring cultivated *Taxus* resources. According to *Guidelines for the Establishment of Chongqing Forest Health Base (Trial)*, the resource conditions, environmental conditions and transportation conditions of the *Taxus* base meet the basic conditions for the construction of Chongqing forest health bases. Some facilities and equipment such as health and wellness trails, signage service systems and supporting facilities have been completed, and the prototype of the forest health base is taking shape.

Seedling cultivation During the implementation of the project, the *Taxus* seedling raising techniques by cutting and seeding were explored, and 50 000 *Taxus* seedlings were cultivated. Meanwhile, the bonsai cultivation techniques of *Taxus* were mastered, and 1 000 pots of *Taxus* were cultivated.

Underforest economy During the implementation of the project, we explored the underforest economic development models of *Taxus*, such as underforest planting (herbs, vegetables and grain) and breeding (poultry, livestock and bees), and an economic

demonstration of 14 hm² was built, which enriched the underforest three-dimensional economy of *Taxus* and achieved good social and economic benefits. During the project implementation period, 0.67 hm² of *Peucedanum praeruptorum*, 3.33 hm² of *Vitex negundo* and 3.33 hm² of *Tagetes erecta* were planted under the forests; 6.67 hm² of cash crops such as tobacco, corn, sweet potato and soybean were planted under the forests; and 5 000 chickens were raised under *Taxus* forests.

Product development The growth rate of *Taxus* is slow. Under the condition of protecting *Taxus* resources, branches, leaves and fruits of *Taxus* are collected reasonably, and a series of products with *Taxus* as raw materials are developed, including handicrafts such as *Taxus* beads and combs, and daily necessities such as *Taxus* pillows, *Taxus* chopsticks and *Taxus* bowls, as characteristic products of Ayilinhai Scenic Area for sale.

Interest linkage mechanism models

During the development of the *Taxus* industry in Pengshui and the implementation of the project, focusing on the development of "rural revitalization", various interest linkage models such as "company + farmers" and "enterprise + village collective + farmers" are used to promote the industrialized development of *Taxus*.

Equity interest linkage models

The company guided the establishment of a joint-stock cooperative interest linkage mechanism, in which farmers take shares with the rights of land, and the company and farmers receive dividends based on the 4 : 6 principle after deducting costs. A total of 446.67 hm² of land has been transferred, involving 2 100 households. The annual collective dividend is 680 000 yuan, involving 60 households.

In the development of the *Taxus* industry, farmers have participated in planting, management and protection, tourism services and other work, and obtained wage income. So far, the company has hired about 30 local farmers and paid a total of approximately 900 000 yuan in labor wages. Some farmers have obtained long-term employment and stable income.

Cooperative interest linkage model

Starting from 2022, led by the company, the development model of "company + collective economy + farmers" has begun. Through the development of the *Taxus* tourism industry, the company has collectively driven farmers in Xingguang Village, Lutang Township to build a 250 m² processing factory for *Taxus* products. The company has developed a series of cultural and creative products such as *Taxus* chopsticks, *Taxus* wine, and *Taxus* sachets. Currently, the company has created an economic benefit of 600 000 yuan, which not only promotes the development of enterprise tourism, but also drives the village collective and farmers to increase their income.

Contract order benefit linkage model

The company signs contracts with farmers to acquire raw

Taxus materials, forming a community of interests. However, due to the limited variety of products currently developed by the company and the lack of large-scale production, the quantity of raw materials purchased by the company is nonmatched, resulting in limited profits for farmers.

Among the three interest linkage models mentioned above, the two closely related models are "company + farmer" and "company + village collective + farmer", which indirectly promote the increase of farmers' income and smoothly ensure the operation of the company, playing a positive role in the development of the *Taxus* industry. The contract order-based benefit linkage model is very unstable, and farmers currently receive relatively little income, which has significant drawbacks.

Problems Faced in the Development of the *Taxus* Industry

The *Taxus* industry in Pengshui County is still in the exploration and development stage, mainly due to insufficient government support, low enthusiasm for enterprise development, small participation of village collectives and farmers, incomplete industrial driving mechanism, and unstable interest linkage.

Insufficient support and financing difficulties

The *Taxus* industry in Pengshui County is in a slow development stage, with insufficient policy guidance and government support, a small number of introduced enterprises, and insufficient capital investment. The *Taxus* industry chain is still in a long-term development stage.

Taxus species characteristics and single product research and development varieties

According to reports, the processing and utilization of *Taxus* mainly focus on raw materials and preparations related to paclitaxel. At present, Pengshui has not yet introduced relevant biopharmaceutical enterprises. *Taxus* is limited by national policies due to its species characteristics. The *Taxus* industry in Pengshui County is mainly guided by ecological and landscape resources, and develops ecotourism. The research and development of *Taxus* products is relatively lagging, with relatively single varieties. The products developed are mainly daily necessities and handicrafts, with a small market audience.

Nonobvious economic benefits and unstable interest linkage

During the development of the *Taxus* industry, various interest linkage mechanisms have been explored and implemented, but the benefits obtained from the interest linkage mechanism between enterprises and farmers are not obvious, and the interest linkage between enterprises and farmers has gradually become unstable. First, the growth cycle of *Taxus* is long. At present, the economic benefits obtained from raw *Taxus* materials or products are less. Farmers mainly obtain economic benefits through under-forest farming, and the benefits obtained gradually decrease due to the growth of *Taxus*. Second, due to limited varieties of *Taxus* products and small market audience, enterprises, village collectives

and farmers have failed to make more profits, and farmers' enthusiasm is not high. Destroying the *Taxus* resources on our own land, the *Taxus* industry in Pengshui will fall into a vicious circle of decreasing *Taxus* resources and shrinking industries, and the development of the *Taxus* industry may fail.

Thoughts and Suggestions on Perfecting the Interest Linkage Mechanism

Top-level design, leading to rural revitalization needs

We should fully understand the national development policy, and do a good job in planning and designing the *Taxus* industrial chain. The government takes the lead in striving for development funds and introducing preferential policies, absorbing and introducing deep processing enterprises, promoting the transformation of *Taxus* from the primary industry to the secondary and tertiary industries, and enriching the types of *Taxus* products including daily chemicals, health products and tea. Meanwhile, we should set up a technical team to provide technical guidance, develop under-forest economy to stabilize interest linkage mechanism between companies and farmers, help rural revitalization, and consolidate the achievements of poverty alleviation.

With the strong support of Pengshui Autonomous County Government, Lutang Township Government can take the lead in laying out the industrial chain construction and improving the planning. Meanwhile, we will guide the start of supporting infrastructure construction, support the improvement and upgrading of industrial infrastructure from the policy point of view, and guide rural revitalization projects to tilt to the construction and development of the *Taxus* industrial chain.

Attracting investment and improving the theme atmosphere

Led by the government, we should attract investment and raise funds through multiple channels, so as to improve facilities such as forest health and wellness, ecological environment, and forest protection in scenic areas and build a distinctive *Taxus* forest health base.

Through resource advantages and market vacancies, we will guide private capital and local entrepreneurs to return to their hometowns, focusing on supporting the *Taxus* ecological industry from the construction of industrial chain branches, such as *Taxus* resource processing, *Taxus* theme catering, *Taxus* theme agriculture and forestry resources protection services.

Focusing on scientific and technological innovation, guiding the input of scientific and technological resources

Scientific research institutes can be guided to take the lead in cooperating with *Taxus* enterprises in depth to build a professional platform for the *Taxus* industry, establish a team of *Taxus* industry experts, attract industrial professionals, solve various technical problems in the production and processing of the *Taxus* industry, and improve the output and quality of *Taxus* products. Led by the Science and Technology Bureau of Pengshui Autonomous County and promoted by township governments, enterprises can cooperate deeply with Chongqing Institute of Forestry Sciences to introduce their forest resource protection team, ancient tree rejuvenation

team, understory economic team, resource utilization team, and forest health and willness team, as well as the traditional Chinese medicine processing team of Chongqing Academy of Chinese Medicine Materia Medica. The understory breeding team of Chongqing Academy of Animal Sciences has also cooperated deeply with enterprises to improve the construction of the industrial chain.

Increasing investment and leading the upgrading of industrial foundation

We should take full advantage of the opportunity for rural revitalization and rely on the characteristic resources of *Taxus* in Pengshui County to develop industries such as underforest planting and aquaculture according to local conditions, and continue to explore a three-dimensional economic model of "forest agriculture", such as forest grain, forest vegetables, forest fungi, forest herbs and forest poultry. The government provides advice and guidance for farmers who transfer land, and enterprises provide technical guidance for business management and underforest economy. Farmers will receive real benefits and utilization, which will increase their enthusiasm for protecting the resources of *Taxus*, which further provide basic guarantees for the sustainable development and utilization of *Taxus* resources in the future. Meanwhile, we will promote the deep integration of *Taxus* with industries such as tourism, health, elderly care and education, develop healthy tourism for *Taxus* in Pengshui County, and create a unique ecological tourism brand for *Taxus*.

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(Continued from page 21)

physiological age of leaves, and this relationship varies depending on mulberry varieties and cutting stages. That is, the net photosynthetic rate of Nongsang 14 was higher than that of hybrid mulberry, which was related to the physiological age of leaves at the same leaf position. Moreover, under the condition of intermediate cutting after harvest of mulberry shoots, the photosynthetic capacity could be significantly improved (Table 2, Pn-NS/Pn-1). Therefore, appropriately increasing the number of harvesting times during the autumn growth period of hybrid mulberry can promote the duration of vigorous growth of hybrid mulberry branches and leaves, which is equivalent to extending the autumn growth period of herbaceous cultivation of hybrid mulberry, which is beneficial for improving mulberry leaf yield.

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Conducting science popularization and education and increasing resource protection efforts

Led by the Pengshui Autonomous County Government and promoted by relevant government departments and local township governments, we should organize standardized management systems and protection measures and strengthen science popularization and publicity to protect existing *Taxus* resources. Meanwhile, enterprises vigorously promote the *Taxus* industry through ecotourism, expand the brand awareness of *Taxus* health care, and promote *Taxus* forest health and willness tourism.

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