Guardians of the Mother Lake: How Technological Cooperation Empowers Rural Revitalization in Dali, Yunnan, China

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"The Erhai Dilemma"—A Global Challenge Reflected in a Chinese Lake

In the early morning, a thin mist veils the surface of Erhai Lake like gauze. The distant mountains are like a dark jade and white egrets fly gracefully. This highland pearl, known for generations by the Bai people (Bai are one of China's ethnic minorities) as the "Mother Lake," is not only Dali's ecological shield and cultural root but also the source of life for two million people. However, this tranquility was once nearly shattered. A pollution crisis at the end of the last century led to two blue-algae blooms in Erhai, causing a sharp decline in water quality. Agricultural non-point source pollution[1] was a significant factor in this problem. This is a common dilemma faced by many lakes worldwide.

Erhai Lake during a blue-algae bloom. Source: Douyin [2]

To save Mother Lake, the local government implemented the strictest "Three Prohibitions and Four Promotions"[3] policy in its history. This policy prohibited the use of chemical fertilizers and pesticides, the cultivation of crops requiring heavy fertilization, and large-scale livestock and poultry farming. At the same time, it promoted green planting, the resourceful use of agricultural waste, water-saving measures, and ecological compensation. However, under these strict environmental measures, how were farmers who had lost their traditional farming methods to make a living? With all the land within three kilometers of Erhai's perimeter being transferred, how would villagers who had farmed for generations adapt to new roles? This difficult choice, known as the "Erhai Dilemma," tested the wisdom of all parties involved.

To address the "Erhai Dilemma," various parties—including the government, universities, businesses, communities, and individuals—built consensus and worked together. The government promoted pollution control throughout the entire basin. Universities established the Science and Technology Residence to conduct research. Businesses participated in the recycling of organic waste. Communities organized residents to sort garbage and raised environmental awareness, while individuals actively cooperated with environmental protection actions. The innovative cooperation model, represented by Gusheng Village near Erhai, has proven that a win-win situation for both ecological protection and economic development is entirely achievable through technological empowerment, talent support, the ecological development of industries and the industrialization of ecology, and multi-party collaboration.

The scenery of Erhai Lake after treatment. Source: Dianping [4]

The Gusheng Village Science and Technology Residence

On February 14, 2022[5], the Gusheng Village Science and Technology Residence in Dali, Yunnan province, jointly established by China Agricultural University(CAU), Yunnan Agricultural University and the Dali Bai Autonomous Prefecture Government, was officially inaugurated. Professor Zhang Fusuo, an academician of the Chinese Academy of Engineering and Dean of the National Academy of Green Agricultural Development at CAU, led his team to move their laboratory to the fields. He, along with Jin Kemo, an associate professor at the College of Resources and Environmental Sciences at CAU and the head of the Gusheng Village Science and Technology Residence, led teachers and students to put down roots in the countryside[6], eating, living, and working alongside the villagers, creating an entirely new model of scientific research.

As a "3.0+" version[7] of the Science and Technology Residence, the Gusheng Village Residence breaks through the limitations of a single discipline by integrating multiple fields such as ecology, agronomy, and social sciences. Upholding the principle of "equal dialogue," it transforms farmers from passive recipients of technology into active participants and co-creators of innovation. Today, there are 18 Science and Technology Residences[9] in the Erhai basin, focusing on vegetables, green and high-value crops, and Erhai rice[8], among others. Gusheng Village alone hosts 12 of them. More than 150 teachers and students, predominantly female, are stationed there long-term, writing a

new chapter of rural revitalization with their youth and hard work. This service model of "zero distance, zero time difference, zero threshold, and zero cost" has allowed technology to truly integrate into this Bai village of just over 400 households and fewer than 2,000 people[10].

The Residence adopted a detailed division of labor: it is responsible for guiding small-scale farmers in the cultivation of fine crops like rice, while bulk crops such as corn and soybeans are managed by enterprises through unified contracting. The teachers and students of the Residence, together with local farmers, have organically combined the traditional farming wisdom of the Bai people with modern technology. While protecting traditional crop varieties like the water willow (Ottelia acuminata), they have promoted green planting techniques and mechanized operations, and established a pollution monitoring network covering the entire basin. According to an estimate from a teacher at the Residence, the mechanization rate for farming among surrounding households has reached 90%. The green planting techniques promoted have achieved remarkable results, even under the strict regional ban on chemical fertilizers and pesticides: a 30% reduction in fertilizer use, a 31% increase in rice yield, a 50% decrease in phosphorus runoff, and a 15%-30% reduction in the nitrogen and phosphorus pollution load entering the lake[11]. These high-quality agricultural products have also found high-end markets—the rice is sold in premium supermarkets like Sam's Club, and the vegetables are even exported overseas, turning ecological value into tangible economic benefits.

Even more valuable is that the Science and Technology Residence focuses not only on technological innovation but also on human development. It is estimated that the Residence has trained over 200 new-type farmers. By offering courses such as e-commerce training and embroidery skill inheritance, it has helped stay-at-home elderly and women master new life skills and has established a start-up base for young farmers. For the villagers whose lives were changed by the land transfers, the younger generation has moved to coastal cities for development opportunities, while the older generation engages in work such as field patrol and maintenance within the village. Everyone has found their place in this transformation.

Cultural and creative products designed by the teachers and students of the Residence. Photo by Ma Chenye

The Circular Economy Practice of Shunfeng Erhai Company

The Erhai basin produces 1.34 million tons of organic waste annually, with livestock and poultry manure accounting for 42.1%, crop straw for 12.7%, and kitchen waste for 9.6%[12]. Traditional disposal methods are not only costly but can also cause secondary pollution. This systemic problem urgently requires an industrialized solution.

Yunnan Shunfeng Erhai Environmental Technology Corp.,Ltd[13] keenly seized the market opportunities brought by the new environmental policies. The company utilizes organic waste such as livestock manure and kitchen garbage from the Erhai basin for resource recovery. It has built a circular economy system of "full coverage, full collection, full treatment, and full utilization." Shunfeng Erhai has established 27 organic waste

collection stations, 6 organic fertilizer processing plants, and 27 production lines across 18 towns in the Erhai basin, forming a complete waste treatment network[14]. The annual processing capacity for organic waste can reach 4 million tons.

Shunfeng Erhai's big data monitoring platform for kitchen waste. Photo by Ma Chenye

Shunfeng Erhai employs advanced anaerobic digestion technology, producing over 30 million cubic meters of biogas annually, which supplies clean energy for 1,500 taxis. The company also specializes in aerobic fermentation technology, producing 100,000 tons of organic fertilizer per year. Under the strict ban on chemical fertilizers and pesticides in the Erhai basin, these high-quality organic fertilizers not only secure agricultural production but also achieve an astounding resource utilization rate for waste of over 95%[15].

The deep integration of industry, university, and research is the core competitiveness of Shunfeng Erhai. The company and the Residence have jointly established the Erhai Organic Recycling Engineering Center. The Residence focuses on the research and development of organic waste recycling technology, while Shunfeng Erhai is responsible for converting these technological achievements into large-scale production. Through continuous technological innovation, they have truly achieved the circular economy goal of "turning waste into treasure." This model of deep integration between industry, university, and research enables a seamless connection between the innovation chain and the industrial chain.

Digital Erhai · A Big Data System for All-Spatial Governance. Photo by Ma Chenye

The Multi-Party Collaborative Ecosystem

The success of Gusheng Village is no accident; it is the result of the synergistic efforts of the government, universities, businesses, communities, and individuals. The government plays a leading role, implementing the "four ones" system[16]: adhering to "one core" (taking water as the core goal), controlling "one source" (agricultural non-point source pollution in the dam area, urban and rural domestic sources, etc.), building "one channel" (a clean water channel into the lake), and constructing "one cycle" (a virtuous ecological cycle of production, life, and ecology). This has shifted the focus in the Erhai basin from "the governance of one lake" to "the governance of the entire region and the system as a whole". The Science and Technology Residence, as a hub for technological innovation and talent cultivation, not only continuously provides technology but also trains a new generation of talent who understand agriculture and love the countryside. Companies like Shunfeng Erhai undertake the tasks of industrial operation and market promotion, converting ecological value into economic benefits. Although the identity of community farmers has changed, they have achieved active participation, co-creation, and benefit-sharing through land rent, employment in enterprises, and technical training.

Party-building has played a key role in this collaborative system. The Party organization coordinates resources from all parties to ensure smooth and efficient cooperation. Party members who are technical experts act as pioneers and role models, encouraging farmers to adopt new technologies and ideas. The Communist Youth League has mobilized young volunteers, especially university students from the Residence, to

actively carry out over 20 environmental awareness campaigns and technology promotion activities, instilling the concept of ecological civilization deep in people's hearts. This combination of a "red engine" and "green development" has injected strong momentum into rural revitalization.

Gusheng Village Mural—Illustrating the Core Socialist Values [17]. Photo by Ma Chenye

The revitalization has yielded significant and multi-faceted results. Economically, farmers have diversified their income sources through land transfer rent, wages from employment in enterprises, and sales of high-end agricultural products. According to an estimate from a teacher at the Residence, the average annual income of farmers has increased by 35%. Socially, although the form of the traditional village has changed, community cohesion has actually strengthened through skills training and cultural activities, and villagers' emphasis on their children's education has also significantly increased. Ecologically, the water quality of Erhai Lake has been consistently maintained at the Class II standard[18], restoring the poetic scenery described as "The Cangshan Mountains are a timeless painting without ink, and Erhai Lake is an eternal zither without strings".

Gusheng Village Mural—All ethnic groups in China should hold together tightly like the seeds of a pomegranate. Photo by Ma Chenye

Local Roots, Global Vision

The practice in Gusheng Village proves that even under strict environmental requirements, a new path of ecological priority and green development can be forged through a combination of institutional innovation, technological empowerment, and industrial drive. The core of this model lies in resolving the "environment-development" dilemma through deep community engagement and strong government-industry-university-research cooperation, advancing technological innovation to overcome resource and environmental constraints, and adopting industrialized operations to achieve sustainable development.

The Erhai model contributes Chinese wisdom to the world. In the face of severe environmental challenges, by having the courage to reform, the skill to innovate, and the dedication to cooperate, it is possible to find invaluable assets in lucid waters and lush mountains, making sustainable development a tangible reality that benefits the people.

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