Soil and Water Conservation, Ecological Reconstruction, and Spatial Transformation of Tea Industry in Xinyang City (1952 - 2000)

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Abstract The water conservancy construction and soil and water conservation projects in New China have reshaped the tea industry landscape in Xinyang City of Henan Province from multiple dimensions. In terms of hydraulic technology, engineering systems represented by the Nanwan Irrigation District redefined the watershed irrigation pattern, while the application of modern agricultural technologies such as sprinkler and electric irrigation accelerated the shift from traditional experience to scientific management in tea garden practices. Ecologically, systematic soil and water management significantly improved growing conditions, making it possible for tea cultivation to break through the traditional geographical limitation of "tea does not grow north of the Huai River." This integrated governance model not only laid the foundation for the northward expansion of Xinyang's tea industry across the Huai River but also facilitated the transition toward scale and intensification through improved irrigation infrastructure and the breeding of cold-resistant tea varieties. Ultimately, driven by the tripartite interactive mechanism of "engineering governance - ecological improvement-spatial expansion," the tea industry in Xinyang achieved a historic leap from traditional production to modern intensive development.

Key words Huai River basin, Xinyang region in Henan Province, Soil and water control, Tea industry

0 Introduction

Xinyang region in Henan Province has a long history of tea planting. In March 1952, the Ministry of Agriculture and the Ministry of Trade jointly instructed the tea production in 1952: "According to the needs of the international and domestic markets, we need to increase the production of black tea as well as green tea"[1]. This policy provides an opportunity for the development of tea producing areas in the Huai River Basin, which is absolutely dominated by green tea.

1 Water control and tea planting: water control project and tea industry construction in Xinyang tea region

The water conservancy projects in the Huai River Basin had a profound impact on tea production. In the 1950s, the central government launched the Huai River Control Project, which integrated comprehensive development such as irrigation and power generation while addressing flood disasters, thereby reshaping the production and lifestyle of the people along the river[2]. Taking the construction of the Nanwan Reservoir in the Xinyang region as an example, as a key upstream control project, it directly facilitated the reorganization of the population and industry in the tea-growing areas. From 1954 to the spring of 1955, the government organized the relocation of reservoir area migrants to six major tea mountains, including Dongjiahe Mount Cheyun and Mount Jiyun, and established five tea production cooperatives[2]. The transition of migrants from grain cultivation to specialized tea production completely transformed the traditional production model[3]. Under the leadership of the local government, measures such as technical training and housing construction significantly improved the production and living conditions of the migrants[4]. Within the cooperatives, a mutual assistance mechanism was formed, enabling new migrants to gradually master techniques for tea garden management, harvesting, and processing[5].

The transformation of the tea industry, characterized by the reorganization of immigrant labor and the adoption of intensive production methods, represented an early application of the Huai River Harnessing Project within the agricultural sector. During the late 1950s, with the implementation of national water conservancy initiatives such as the Nanwan Irrigation Area, the tea industry within the river basin gradually developed an intensive production model supported by irrigation infrastructure. From the 1960s onward, the Huai River Basin established four major irrigation systems, encompassing reservoirs, ponds, rivers, lakes, mechanized wells, and irrigation zones supplied by the Yellow River. These significantly improved water conservancy conditions in the Xinyang region[6]. Following the completion of the South Bend Irrigation Area, tea farms such as the Ershiwuligang Tea Farm actively developed water conservancy facilities, forming an integrated and complementary irrigation network. In 1970, the tea farm proposed the strategy of "building reservoirs in the mountains, storing floodwater, and irrigating to protect tea plantations," which was later systematized and promoted as a model practice[7]. By constructing ponds to store water, tea farms ensured the survival of tea seedlings during droughts and facilitated the intercropping of tea and grain crops, achieving positive ecological outcomes[8-9].

However, some irrigation districts constructed during the Great Leap Forward and Cultural Revolution period suffered from low engineering standards and poor quality, resulting in suboptimal performance, with some tea plantations even requiring secondary lift irrigation[10]. To address this issue, water-saving technolo-

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gies such as sprinkler irrigation were gradually promoted in the Xinyang tea region starting from the 1970s – 1980s. In 1981, Xinyang County implemented pilot sprinkler irrigation projects covering 53.33 ha at tea plantations including Qunlong Mountain and Jiyun, achieving remarkable drought resistance results[11]. For instance, in 1982, the sprinkler-irrigated tea plantations at Jiyun Tea Brigade saw an increase of 52.5 kg/ha, while the Red Flag Tea Plantation also achieved significant success[10]. Given these outcomes, Xinyang County converted the Red Flag Tea Factory into a breeding station for improved tea varieties and allocated special funds for this purpose[11]. In 1987, it was proposed that water conservancy infrastructure in tea regions should be strengthened, including the widespread construction of ponds and the installation of sprinkler irrigation systems[11]. This experience was quickly extended to neighboring counties and cities: in 1987, Guangshan County mandated the implementation of sprinkler irrigation across 133.33 ha of low-yield tea plantations, equipped with 10 sprinkler irrigation machines. In 1988, the county further purchased 30 additional sprinkler irrigation machines and built lift irrigation stations and laboratories[12]. For tea plantations where sprinkler irrigation was not feasible, Xinyang had already proposed alternative soil and water conservation measures, such as trenching for water retention, as early as 1982[13]. The adoption of sprinkler irrigation technology not only revolutionized irrigation methods but also played a pivotal role in transitioning the tea industry toward modernized and high-efficiency practices.

Although the Xinyang tea region receives abundant precipitation, summer and autumn droughts are frequent. Relying solely on natural rainfall often leads to reduced yields. During the 1970s and 1980s, the construction of electric irrigation stations in river and lake irrigation areas significantly enhanced irrigation infrastructure. For example, in 1978, an electric irrigation station was built at the Silkworm Tea Farm in Luoshan County[14]. Between 1982 and 1984, the Xinyang County Tea Seed Farm established a two-stage electric irrigation system along with supporting ditches, which were further repaired and upgraded in 1985. By 1987, five sprinkler irrigation machines had been added, boosting the level of irrigation mechanization[15]. Similarly, in 1982, Gushi County carried out an expansion project at the Qianshan River Electric Irrigation Station[16]. As critical infrastructure, these electric irrigation stations helped tea-growing areas overcome natural constraints, improve drought resilience, increase production, and thereby lay a solid foundation for the development of the "Xinyang Maojian Tea" brand.

In summary, the Huai River Control Project has profoundly reshaped the production pattern of Xinyang tea industry through resettlement, irrigation system construction and water-saving technology promotion, promoted its transformation to water conservancy, intensification and modernization, and highlighted the effectiveness of coordinated development of water conservancy projects and agricultural economy.

2 Soil conservation and enhanced tea production: soil and water conservation projects and ecological transformation of tea plantations in the Xinyang tea region

Soil and water conservation in the Xinyang region is one of a key factor for high tea yields. The area experiences uneven seasonal rainfall, with intense erosive force during the wet season. Tea plants, being shallow-rooted crops, have limited soil retention capacity. Additionally, tea gardens are mostly located in high mountains and hilly areas, making them highly susceptible to erosion[17]. Prior to the establishment of the People's Republic of China, poor management led to severe soil erosion in tea plantations[18]. Since 1949, systematic soil and water management was implemented in the Xinyang tea region.

In 1956, Xinyang County systematically introduced three soil and water conservation measures: terracing transformation—converting sloping tea gardens into terraced fields to channel rainwater efficiently; excavation of drainage ditches to divert floodwater around plantations, reducing erosion; use of the "semi-mulching grass method" for vegetative soil stabilization. Steep-slope tea gardens also required stone revetments for slope protection[19].

By 1959, technical standards were further refined: drainage ditches were to be constructed approximately every 10 m, with a width of 0.33 m and a depth of 0.5 m, aligned along the natural contour of the mountains[19]. This system was later promoted in counties such as Shangcheng and Gushi, which focused respectively on improving ditch systems (1965) and advancing terracing works (1972)[20-21].

In the 1980s, Guangshan County took the lead in implementing classified rehabilitation of old tea plantations: converting "soil-eroding land" (where water, soil, and fertilizer run off) into "soil-conserving land" (where water, soil, and fertilizer are retained); and densifying understocked areas through replanting. Slope gradient determined the treatment: areas with $< 5°$ were converted into level terraces; those with $5° - 25°$ were transformed into contoured terraced fields; and slopes $> 30°$ were reinforced with stone-walled terraces while preserving original tea bushes. Planting density standards were raised to 66 – 86 bushes/ha to achieve the "Five Standardizations."

Xinyang's soil and water conservation emphasized "combining storage with drainage": steep slopes underwent "terracing," while concave and flat tea plantations were trenched with perimeter and cross-ditches (approx. 60 cm deep and wide) for drainage and waterlogging prevention. The optimal period for renovation was July – September, taking advantage of soil weathering and root growth[24].

The drainage system was designed to "irrigate in drought and drain in waterlogging," incorporating four types of ditches: longitudinal ditches (utilizing natural gullies or laid diagonally, with silt traps); transverse ditches (along contours); boundary ditches (along the upper borders and property lines); intercepting ditches (at the lower edge where tea gardens meet farmland)[22]. Follow-

ing reform and opening-up, to develop "nationally renowned premium tea," Xinyang promoted the construction of dwarf, dense, rapid-establishment, and high-yield tea plantations. This required enhanced soil/water conservation and irrigation, high-density planting (*e. g.*, 533 plants/ha), and tree planting around tea gardens[23].

Guangshan County promoted green manure cultivation and intercropping (especially legumes), which conserved soil and water while increasing organic matter[24-25]. Government investment provided crucial support: in 1986, Shangcheng County received a loan of 130 000 yuan for soil/water conservation, improved variety promotion, and mechanization[26]; in 1992, Xinyang County invested 250 000 yuan, implementing terracing and densification at a cost of 3 750 yuan/ha[27].

3 Crossing the boundary and reshaping: the practice of "introducing tea from south to north" in Xinyang region

In 1958, Mao Zedong put forward the instruction of "opening up tea plantations on hillsides", which promoted tea cultivation to the national strategic level, thus transforming the Huai River from a natural geographical barrier to a political symbol that needs to be "conquered". In the traditional Chinese agricultural cognition, the Huai River, as a climate transition zone between the north and the south, is known as the saying that "tea does not cross the Huai River". In the 1950s and 1970s, the movement of "introducing tea from the south to the north" reconstructed this natural boundary through technical means and political mobilization. Based on the initial achievements in soil and water control in Xinyang region, the development goal of "tea trees crossing the Huai River" was clearly put forward in 1960, which not only aimed at breaking through geographical constraints, but also fully reflected the determination and ability to transform nature in the period of socialist construction.

Xinyang is located in the northern edge of tea planting in China, vulnerable to the attack of cold air from the north. The main stream of Huai River passes through its south. The core tea area is located in the northern foot of Tongbai Mountain - Dabie Mountain in the south of Huai River, which belongs to the north - south climate transition zone. The extreme low temperature in winter can reach below -15 ℃, which often leads to the freezing injury of tea trees. In order to cope with the cold and uneven precipitation, Xinyang has accumulated rich experience in cold and drought resistance of tea plants, which provides an important basis for "Huai River" of tea plants. In 1959, the People's Committee of Xinyang County explicitly instructed: "The climate in our county is cold, and there has been freezing damage over the years. All production brigades should seal roots and earth up to ensure the safe overwintering of tea trees "[28], and require "pruning frozen branches to promote the growth of leaf buds" in spring[29].

In September 1958, when Mao Zedong visited Shucha People's Commune, he called for "more tea plantations on the hillside in the future" and formally opened the process of tea moving northward. Traditionally, due to the lack of cold-resistant breeding, irrigation facilities and soil improvement technology, tea trees are difficult to grow in north of Huai River. Studies have shown that tea trees are prone to freeze injury due to water loss of organs during overwintering[31]. However, the experience of tea planting in the Soviet Union in the 1930s confirmed that tea trees could be cultivated in the frigid zone. In addition, the Huai River control project gradually improved the regional environment, which provided objective conditions for the northward movement. In the 1960s, due to the food difficulties and the loss of agricultural labor force caused by the "Great Leap Forward", the contradiction between supply and demand of tea became increasingly prominent, and many parts of the country carried out the "introduction of tea from south to north". In 1960, Xinyang County put forward the idea of "expanding tea plantations to the north of the Huaihe River to achieve Huai River" of tea plants"[32], but most of the initial attempts failed due to neglect of scientific support. Even the antifreeze of the tea area south of the Huai River is not yet perfect, and the promotion of more to the north is only of political significance[33].

In the 1970s, Xinyang County revived this initiative and achieved significant progress, building upon long-term accumulated practices in cold and drought resistance. Within two years starting from 1968, the county developed 73.33 ha of new tea gardens, accounting for 27.5% of the total tea cultivation area at the time[9]. Expansion was also widely promoted in the hilly regions of the central and northern parts of the county. As a model for tea cultivation north of the Huai River, the Hongqi Tea Plantation successfully reclaimed rocky and soil-based uplands since its establishment in 1968. By 1974, it had developed 53.33 ha of tea gardens, producing tea that met the quality standards of "Xinyang Maojian," with plans for further expansion.

In 1962, Xinyang County conducted a national appraisal of improved tea varieties, identifying Guizhou Taicha, Qimen Zhuyezhong, and Fu'an Dabaiha as highly cold-resistant and adaptable, thereby laying the foundation for tea cultivation beyond the Huai River. By 1980, the number of tea-growing communes and brigades in Xinyang had increased substantially, and tea gardens transitioned from scattered plots to concentrated, contiguous development. The Li'an region also successfully bred a cold-resistant variety, "Shuchazao"[31].

Xinyang's "Northward Expansion of Tea Cultivation" combined local experience with technological innovation, forming a unique techno-managerial approach. This endeavor not achieved a geographical breakthrough but also embodied the socialist construction ethos of "humans conquering nature". Supported by river management projects in the Huai River Basin, it facilitated the scaling-up and improved-variety transformation of tea production.

4 Conclusions

The development of the tea industry in the Huai River Basin empirically demonstrates the innovative practices of socialist agricultural modernization in an ecological transition zone. Beginning with the Huai River Control Project, water conservancy facilities such as the Nanwan Irrigation District not only effectively managed flooding in the basin but also reshaped agricultural production spaces through systematic soil-water conservation and resettlement programs. From the 1950s through the reform and opening-up period, the continuous expansion of irrigation infrastructure facilitated the transition from collectivized to scaled agricultural production. The adoption of modern technologies such as sprinkler irrigation and electric pumping stations transformed tea garden management from traditional experience-based methods to scientific cultivation.

During the 1970s and 1980s, the promotion of water-saving irrigation technologies alleviated water constraints on tea growth and spurred technological advancement across the entire industry chain. Meanwhile, ongoing innovations in soil and water conservation broke through natural limitations from terracing reforms in 1956 to the remediation of "soil-eroding land" in the 1980s, particularly through the successful breeding of cold-resistant tea varieties, which ultimately enabled the historic breakthrough of tea cultivation north of the Huai River.

From the 1980s to the 1990s, supported by systematic soil-water management projects and large-scale tea planting practices, the Xinyang region established a solid industrial foundation for building the "Xinyang Maojian" brand. This trajectory vividly illustrates the distinctive development pathway of "Controlling Water-Revitalizing Tea – Enriching the People" pioneered by the Chinese Communist Party in the Huai River Basin, successfully transitioning the region from an underdeveloped area into a clustered industrial zone.

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temperature increased, indicating their higher sensitivity to thermal stress among soil microbial communities. This differential sensitivity directly contributes to the alteration of soil microbial community structure, as reflected in the principal component analysis (Fig. 3).

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