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Mechanisms and Effects of New Quality Productive Forces in Enabling the Sustainable Development of Agricultural Heritage Systems

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Abstract: In 2002, the Food and Agriculture Organization of the United Nations (FAO) launched the Globally Important Agricultural Heritage Systems (GIAHS) initiative at the World Summit on Sustainable Development to address global challenges confronting family farming and traditional agricultural systems, including climate change, population displacement, and biodiversity loss. To date, the FAO has designated 102 GIAHS sites across 29 countries. China accounts for 25 of these sites, ranking first globally, owing to its rich and long-standing agricultural civilization. Consequently, China plays a pivotal role in promoting the conservation and development of GIAHS, formulating long-term strategies to support these systems, and unlocking their productive potential. This study investigates the economic, ecological, and social outcomes of the sustainable development of agricultural heritage systems under the empowerment of new quality productive forces, with the aim of providing a scientific basis for the conservation and modern integrated development of agricultural heritage. First, it identifies the key pathways through which new quality productive forces affect the conservation, utilization, and transmission of agricultural heritage systems. Second, it evaluates the effects of new quality productive forces on income generation, ecological restoration, and cultural continuity in heritage sites. Third, it proposes differentiated strategies for leveraging new quality productive forces according to the characteristics of different types of agricultural heritage systems, thereby avoiding a one-size-fits-all approach to their development.

Keywords: New quality productivity; Agriculture; Sustainable development

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1. Introduction

1.1. Background and significance of the study

Since 2005, the Food and Agriculture Organization of the United Nations (FAO) has formally promoted efforts to assist farming communities in conserving traditional agricultural systems and their associated landscapes, agricultural biodiversity, knowledge systems, and cultural heritage. The designation of Globally

Important Agricultural Heritage Systems (GIAHS) is based on five core criteria: (1) food and livelihood security; (2) agrobiodiversity; (3) local and traditional knowledge systems; (4) cultures, value systems, and social organizations; and (5) landscape and seascape features. Numerous countries around the world have undertaken extensive research on agricultural heritage systems. Agricultural heritage systems are not merely historical "fossils" or tourism "icons"; rather, they embody three irreplaceable forms of value. First, they constitute gene pools of biological and cultural diversity. Traditional agricultural systems conserve a wide range of locally adapted crop varieties, livestock and poultry breeds, and associated wild flora and fauna, while also embodying rich local knowledge, agricultural rituals, and community-based organizational institutions. Second, they serve as living models of sustainable agriculture. Over thousands of years, these heritage sites have maintained agricultural productivity through circular resource use, complementary resource utilization, and ecological self-regulation, thereby providing valuable insights for the development of modern ecological agriculture. Third, they offer potential solutions to global challenges. Against the backdrop of intensifying climate change, growing water scarcity, and accelerating biodiversity loss, the drought-resistant crop varieties, water-saving technologies, and soil conservation practices embedded in agricultural heritage systems can provide valuable and directly applicable knowledge for enhancing global food security and ecological security.

1.2. Literature review

Research in Europe has primarily focused on analyzing the characteristics of GIAHS sites and identifying potential heritage sites, with particular emphasis on the historical continuity and cultural uniqueness of Mediterranean agricultural landscapes. Marta Arnés García et al. (2020) conducted a qualitative analysis of the application documents of six GIAHS sites in Europe [1]. Based on the five core criteria of GIAHS, they developed 24 sub-criteria applicable to European GIAHS and evaluated their effectiveness. The findings revealed three common characteristics shared by European agricultural heritage sites: the historical continuity of cultural landscapes, the adaptive transmission of traditional knowledge, and the synergy of social organizations. Cintya Elizabeth Manrique Anticona et al. (2023) conducted research on potential heritage sites in Spain using a combination of literature review, GIS-based spatial analysis, and expert evaluation [2]. Among 173 candidate sites, they identified 50 sites that met the GIAHS criteria. These sites encompassed a variety of agricultural systems, including grape cultivation, livestock farming, and rice cultivation, many of which demonstrated a high level of development, with 15 sites reaching the highest evaluation level. These sites were geographically distributed across different regions of Spain, laying a foundation for establishing the first national agricultural heritage network in Europe. Csaba Centeri et al. (2021) argued that Hungarian agricultural heritage systems, including forested pastures, orchard grasslands, and sustainable agricultural farms, demonstrate synergies among ecological, economic, and cultural functions, thereby providing practical examples of realizing the value of ecological products [3].

Asia has become a major global research region for agricultural heritage, with China and Japan serving as two representative countries. Their research places greater emphasis on dynamic conservation and multifunctional development, highlighting the coordinated relationship between human activities and the environment. Min Qingwen et al. (2019) systematically reviewed 15 years of research on China's nationally important agricultural heritage systems and proposed an overall framework of dynamic conservation and adaptive management [4]. They argued that a benefit-sharing mechanism involving government leadership,

scientific research support, enterprise-driven development, community participation, and collaboration with social organizations should be established to achieve a balance between conservation and development. Wen Zhao et al. (2021) developed a sustainability evaluation framework for GIAHS based on the United Nations Sustainable Development Goals (SDGs), using the Kuaijishan Ancient Chinese Torreya Community in Zhejiang as a case study to quantify its economic, social, and environmental values [5]. Research in Japan has primarily focused on heritage monitoring and community participation. Sheryl Rose C. Reyes et al. (2020) reviewed the application documents of 11 GIAHS sites in Japan and found that heritage conservation places considerable emphasis on the application of the Socio-Ecological Production Landscapes and Seascapes (SEPLS) framework, based on which they proposed corresponding monitoring indicators [6]. In addition, China, Japan, and the Republic of Korea have conducted regional exchanges and collaborative activities within the East Asia Research Association for Agricultural Heritage Systems (ERAHS), exploring approaches to agricultural heritage conservation across different geographical contexts.

Research on agricultural heritage in the Americas is still at an early stage and generally relies on traditional approaches and locally based conservation practices for systematic identification and protection. Raphael Ocelli Pinheiro et al. (2022) compared agricultural heritage programs in Brazil and Italy and found that Brazil promotes its Brazilian Nationally Important Agricultural Heritage Systems (B-NIAHS) through a bottom-up approach, with particular emphasis on the conservation of Indigenous knowledge. However, challenges remain, including insufficient research investment and limited international cooperation. Italy, by contrast, adopts a top-down policy-driven approach to its Italian Nationally Important Agricultural Heritage Systems (I-NIAHS), emphasizing alignment with the European Union's Common Agricultural Policy (CAP) to enhance the economic sustainability of agricultural heritage [7].

Research examining the relationship between traditional agriculture and food security in Africa has identified distinctive characteristics in systems such as the terraced agricultural system in Simien Mountains National Park, Ethiopia, and rainfed agriculture in northern Malawi. However, due to constraints related to funding, technology, capacity building, and knowledge dissemination, most conservation and development initiatives rely heavily on support from international organizations.

Research on new quality productive forces initially emerged in 2009, when the President of the CPC first proposed the concept during an inspection visit to Heilongjiang. New quality productive forces differ from traditional productive forces in their reliance on technological and institutional innovation to transcend conventional production models, with innovation serving as their core driving force. Existing research on the empowerment mechanisms of new quality productive forces has primarily focused on three dimensions: regional development, forms of civilization, and rural revitalization. Qianbin Di et al. examined 23 resource-based cities in Northeast China and, through empirical analysis, found that new quality productive forces promote high-quality development through three major mediating channels: technological innovation, industrial structure upgrading, and optimization of resource factor allocation [8].

2. Spatial distribution characteristics based on geographic information systems

2.1. Spatial clustering

Within the administrative boundaries of China, the light-yellow areas represent land that is not covered by GIAHS sites. GIAHS sites are primarily distributed in the middle and lower reaches of the Yangtze River and along the southeastern coast, with these regions accounting for approximately 40% of the total number

of GIAHS sites in China. The middle and lower reaches of the Yellow River exhibit a relatively dispersed distribution, accounting for approximately 36% of the sites. The Qinghai–Xizang Plateau and the arid regions of northwestern China have no GIAHS sites. The spatial distribution of GIAHS sites in China is highly uneven and exhibits a distinct pattern of spatial clustering. This pattern is primarily attributable to substantial regional differences in climatic conditions, as the middle and lower reaches of the Yangtze River and the southeastern coastal regions are characterized by a temperate monsoon climate with abundant heat and water resources. It is also closely associated with the long-standing agricultural civilization developed through traditional rice cultivation, tea cultivation, and fishery systems in these regions.

2.2. Strong topographic dependence

In plain areas, sites such as the Xinghua Duotian Agricultural System in Jiangsu and the Mulberry-Dyke Fish Pond System in Huzhou, Zhejiang, exemplify traditional agricultural wisdom based on the synergistic use of water and soil resources. In mountainous and hilly areas, systems such as the Honghe Hani Rice Terraces in Yunnan and the Ziquejie Rice Terraces in Hunan demonstrate traditional agricultural wisdom in utilizing resources through vertically differentiated agricultural practices in mountainous environments. In plateau meadow areas, only two GIAHS sites—the Aohan Dryland Farming System and the Ar Horqin Grassland Nomadic System in Inner Mongolia—are located in this region, highlighting the scarcity and distinctiveness of agricultural systems in arid and semi-arid environments.

2.3. Strong association with river basins

Most GIAHS sites are distributed within the basins of major rivers, including the Yangtze, Yellow, and Pearl rivers. The ancient mulberry tree clusters of Xiajin along the ancient course of the Yellow River, for example, represent an agricultural heritage system characterized by the sandy-land agriculture of the Yellow River region. The natural resources provided by river basins constitute the fundamental basis for the functioning and sustainability of agricultural systems.

2.4. Construction of agricultural heritage belts

Based on the analyses of spatial clustering, topographic dependence, and river-basin associations, and in conjunction with the kernel density distribution of GIAHS sites in China shown in **Figure 1**, this study further identifies three major high-density clustering regions. To promote coordinated conservation and interconnected development among heritage sites and move beyond the existing isolated, site-based conservation model, this section proposes the establishment of three thematic agricultural heritage belts, thereby creating a networked framework for conservation and utilization that integrates “points, lines, and areas.”

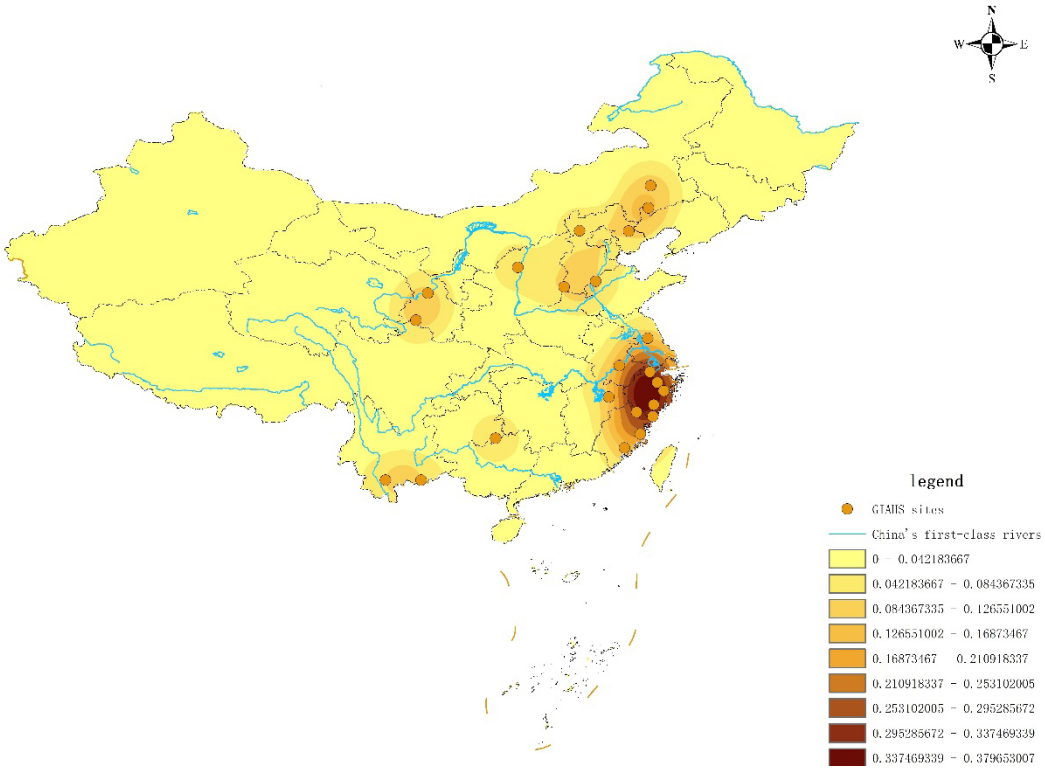

Figure 1. Kernel density distribution of GIAHS sites in China

2.4.1. Jiang–Sea cultural heritage belt

This heritage belt is primarily distributed across the middle and lower reaches of the Yangtze River and the southeastern coastal regions, corresponding to the areas with the highest kernel density values in **Figure 1**, where density values generally exceed 0.210 and locally exceed 0.337. It represents the most concentrated distribution of GIAHS sites in China, accounting for approximately 40% of the national total. Representative heritage systems include the Xinghua Duotian Traditional Agricultural System in Jiangsu, the Mulberry-Dyke Fish-Pond System in Huzhou, Zhejiang, the Qingtian Rice-Fish Culture System in Zhejiang, and the Fuzhou Jasmine and Tea Cultural System in Fujian. The defining characteristic of this belt is an integrated spatial configuration of water, agricultural land, villages, and coastal areas, reflecting the convergence and integration of rice-farming and maritime civilizations. Most of these heritage systems have developed in densely interconnected river-network plains and coastal areas, where well-developed hydrological networks have supported distinctive forms of ecological agriculture, including mulberry-dyke fish pond systems, rice-fish co-culture, and tidal irrigation. The establishment of the Jiang–Sea Cultural Heritage Belt would integrate the agricultural wisdom of water–land co-adaptation embodied in these heritage sites and facilitate cross-regional cooperation in water-resource management, biodiversity conservation, and the development of ecological agricultural products, thereby creating an ecological and cultural corridor extending from the Yangtze River to the southeastern coast.

2.4.2. Southern mountainous rice-terrace heritage belt

This heritage belt is located in the mountainous and hilly areas extending along the Nanling Mountains–Wuyi Mountains–Yunnan–Guizhou Plateau corridor, corresponding to the medium- to high-density clustering

areas surrounding the southeastern hills shown in **Figure 1**, with density values ranging from 0.126 to 0.295. Representative heritage systems include the Honghe Hani Rice Terraces System in Yunnan, the Ziquejie Rice Terraces System in Xinhua, Hunan, the Hakka Rice Terraces System in Chongyi, Jiangxi, and the Longji Rice Terraces System in Longsheng, Guangxi. The defining characteristic of this belt is a vertically integrated spatial structure comprising mountains, forests, terraced fields, villages, and water resources, which reflects the sophisticated resource-utilization strategies developed by mountain communities in response to limited land availability. The terraced systems follow contour lines and form a complete ecological circulation chain extending from water-source forests at higher elevations through villages and terraced fields to river valleys. In addition to supporting agricultural production, these terraces provide important ecosystem services, including water conservation, soil and water conservation, and microclimate regulation. The establishment of the Southern Mountainous Rice-Terrace Heritage Belt aims to facilitate knowledge exchange and technological cooperation among rice-terrace heritage sites, establish an interprovincial ecological monitoring network for terraced landscapes, and jointly address common challenges such as labor outmigration, the degradation of traditional crop varieties, and excessive tourism development.

2.4.3. Northern dryland farming and nomadic heritage belt

This heritage belt is primarily distributed across the middle and lower reaches of the Yellow River and the eastern Inner Mongolia Plateau, corresponding to the transition zone between high-density and medium-to-low-density areas in **Figure 1**, where density values are generally no higher than 0.126. Representative heritage systems include the Aohan Dryland Farming System and the Ar Horqin Grassland Nomadic System in Inner Mongolia, the Ancient Jujube Orchards in Jiaxian, Shaanxi, the Traditional Vineyards of Xuanhua, Hebei, and the Ancient Mulberry Tree Clusters along the Ancient Course of the Yellow River in Xiajin, Shandong. The defining characteristic of this belt is its ecological transitional nature, characterized by the interweaving of dryland farming and pastoralism and representing a distinctive pattern of human–environment adaptation under semi-humid, semi-arid, and arid climatic conditions. The heritage systems exhibit a pronounced dual structure: the middle and lower reaches of the Yellow River are dominated by drought-tolerant crops and have developed dryland farming techniques such as rainwater harvesting, supplemental irrigation, and sand-mulching, whereas the Inner Mongolia Plateau is characterized by nomadic systems that follow water and pasture resources and maintain a dynamic balance between grassland ecosystems and livestock populations. The establishment of the Northern Dryland Farming and Nomadic Heritage Belt would strengthen coordinated actions in germplasm resource conservation, grassland ecological restoration, and the documentation and transmission of traditional pastoral knowledge, while exploring pathways toward the sustainable persistence of agricultural heritage systems in arid and semi-arid regions.

3. Theoretical analysis and research hypotheses

3.1. Direct effects of new quality productive

Forces on the Sustainable Development of Agricultural Heritage Systems Regional theory of human–land relationships posits that natural, economic, and social subsystems interact to form an integrated system, within which human society and the natural environment engage in continuous and dynamic interactions. Agricultural heritage systems are affected by unsustainable farming practices and land-use patterns, which in turn have implications for global food security, rural livelihoods, and cultural values. With innovation

as its fundamental driving force, new quality productive forces seek to unlock previously underutilized productive potential. The introduction of new quality productive forces enables a renewed understanding of human–land relationships within agricultural heritage systems. Globally Important Agricultural Heritage Systems (GIAHS) represent the outcomes of the co-evolution of human societies and their environments. New quality productive forces emphasize the conservation and rational utilization of resources rather than their excessive exploitation, thereby contributing positively to the conservation of traditional knowledge, biodiversity, and agricultural landscapes. In terms of human activities, the conventional reliance on relatively homogeneous and unsustainable modes of production can be transformed into a development model driven by technological innovation. For example, technological approaches can be employed to improve traditional crop varieties, thereby enhancing agricultural productivity in heritage sites, while digital technologies can improve the precision and effectiveness of heritage conservation. By integrating innovative resources to enhance production efficiency and promote high-quality development, new quality productive forces are closely aligned with the pursuit of sustainable development pathways for GIAHS.

Accordingly, the following hypothesis is proposed: Hypothesis 1: New quality productive forces have a positive effect on the sustainable development of Globally Important Agricultural Heritage Systems (GIAHS).

3.2. Heterogeneous effects of new quality productive forces on the sustainable development of GIAHS

The effects of new quality productive forces on GIAHS are heterogeneous due to differences in geographical location, development stage, and the composition of new quality productive forces. In terms of geographical location, natural environmental conditions vary considerably across heritage sites, including differences in climate, hydrology, soil, and biological resources. Warm and humid environments are generally more conducive to crop growth, whereas cold and dry environments tend to impose greater constraints on agricultural production. Regional disparities in economic development are also substantial. Factors such as higher per capita disposable income and better infrastructure can significantly influence the formation and development of new quality productive forces through pathways such as industrial integration and technological innovation. Heritage sites with relatively mature development foundations can prioritize the application of new quality productive forces to industrial upgrading, thereby enhancing the sustainability of their economic development. By contrast, heritage sites with relatively limited development foundations and weaker infrastructure may initially focus on basic infrastructure development supported by new quality productive forces, thereby laying the foundation for subsequent sustainable development. The 25 existing GIAHS sites in China can be broadly classified into three types: plain-based agricultural heritage systems, mountainous and hilly agricultural heritage systems, and plateau meadow agricultural heritage systems.

Hypothesis 2: The effects of new quality productive forces on the sustainable development of GIAHS exhibit heterogeneity in terms of geographical location, development stage, and heritage-system type.

3.3. Pathways through which new quality productive forces affect the sustainable development of GIAHS

New quality productive forces do not affect the sustainable development of GIAHS solely through a direct effect, but also operate through three primary mediating pathways: technological innovation, industrial integration, and factor optimization.

3.3.1. Technological innovation pathway

The technological innovation pathway enables new quality productive forces to promote the modernization of traditional technologies, the genetic exploration and innovative utilization of germplasm resources, and the enhancement of the resilience of traditional crop varieties, thereby improving the efficiency of agricultural production in heritage sites.

3.3.2. Industrial integration pathway

The industrial integration pathway enables new quality productive forces to facilitate the integrated development of primary industries, such as crop cultivation, secondary industries, such as agricultural processing, and tertiary industries, such as cultural tourism, thereby breaking away from traditional single-sector production models. The promotion of agricultural products through online platforms can expand market access and increase sales, while cultural and creative products can extend the value chain and product life cycle.

3.3.3. Factor optimization pathway

The factor optimization pathway refers to the process through which new quality productive forces facilitate the concentration and efficient allocation of production factors, including capital, human resources, and data, in heritage sites.

Hypothesis 3: New quality productive forces affect the sustainable development of GIAHS through three pathways: technological innovation, industrial integration, and factor optimization.

4. Evaluation of the correlation effects of new quality productive forces on the sustainable development of agricultural heritage systems

4.1. Evaluation dimensions and indicator selection

This study focuses on the multifunctionality and sustainable development of agricultural heritage systems and establishes an evaluation framework for the effects of new quality productive forces from three dimensions: economic, ecological, and social effects. The framework integrates a set of indicators that capture key functions and outcomes within heritage sites to provide a comprehensive assessment.

4.1.1. Economic effects

The economic dimension primarily examines the extent to which new quality productive forces promote industrial value creation and household income growth in heritage sites. Three indicators are selected: the growth rate of per capita disposable income, the rate of increase in the added value of specialty agricultural products, and the proportion of revenue generated by cultural tourism and related industries. The growth rate of per capita disposable income reflects improvements in local livelihoods. The rate of increase in the added value of specialty agricultural products captures the additional value generated through technological innovation and processing upgrades, while the proportion of revenue generated by cultural tourism and related industries reflects the outcomes of integrated development across agriculture, culture, and tourism.

4.1.2. Ecological effects

The ecological dimension focuses on ecological conservation and the green transformation of heritage sites.

Drawing on the evaluation framework developed by García et al. for assessing the ecological functions of European GIAHS, three indicators are selected: the biodiversity index, the reduction rate of fertilizer and pesticide use, and the area of ecological restoration. New quality productive forces can reduce agricultural non-point source pollution through green technologies, digital monitoring, and circular agricultural practices, while contributing to the conservation of native species and traditional ecological landscapes and thereby enhancing ecosystem stability. Among these indicators, the biodiversity index serves as the core ecological indicator in this study and encompasses three levels.

First, species diversity. Agricultural heritage systems function as natural reservoirs of traditional crop varieties and wild relatives. For example, the Hani Rice Terraces in Yunnan conserve hundreds of traditional local rice varieties, while the Aohan Dryland Farming System preserves dozens of traditional millet varieties. New quality productive forces can help curb the loss of traditional varieties by establishing germplasm resource repositories, promoting ecological cultivation of traditional varieties, and preventing the uncontrolled spread of genetically modified varieties.

Second, genetic diversity. Different local varieties of the same crop contain substantial genetic variation, providing valuable genetic resources for disease-resistant breeding and climate-adaptive crop improvement. New quality productive forces employ modern biotechnologies, such as gene sequencing and molecular markers, to systematically document and analyze the genetic backgrounds of traditional varieties, thereby providing scientific support for subsequent varietal improvement and germplasm innovation.

Third, ecosystem diversity. Agricultural heritage systems themselves constitute complex mosaic landscapes composed of multiple ecosystem types, including croplands, forests, water bodies, villages, and grasslands. For example, southern mountainous rice-terrace systems form a vertically structured ecological sequence of "forest–village–terraced fields–river valley," whereas the Jiang–Sea Cultural Heritage Belt exhibits a gradient ecological pattern extending from freshwater to saltwater and intertidal zones.

4.1.3. Social effects

The social dimension refers to three major outcomes: the number of participants involved in heritage conservation, the transmission of cultural heritage, and employment generation. New quality productive forces can enhance community participation, increase the number of heritage practitioners and knowledge bearers, generate local employment opportunities, and strengthen the capacity for sustainable development in heritage sites through digital dissemination, skills training, and the innovation of new business models.

4.2. Significant positive driving effect

The development level of new quality productive forces is significantly and positively correlated with economic, ecological, and social effects. Through three mediating pathways—technological innovation, industrial integration, and factor optimization—new quality productive forces promote the greening of production practices, modernization of industrial chains, and digitalization of governance in heritage sites, thereby facilitating the coordinated improvement of economic, ecological, and social benefits. These findings provide empirical support for the positive driving effect proposed in Hypothesis 1.

From an economic perspective, new quality productive forces have facilitated the industrialization, specialization, and advanced processing of traditional agricultural products, thereby increasing the value of specialty agricultural products. Meanwhile, new forms of integrated agriculture, culture, and tourism have continued to emerge, contributing to a gradual increase in the income levels of both urban and rural residents.

From an ecological perspective, green pest and disease control, precision agriculture, and ecological circular technologies have been increasingly adopted, resulting in substantial reductions in the use of chemical fertilizers and pesticides, improvements in biodiversity, and an expansion of the area undergoing ecological restoration. At the community level, residents have become increasingly engaged in local cultural activities, while the number of practitioners inheriting traditional agricultural techniques has grown. Emerging industries and business models have also created numerous employment opportunities for local communities, contributing to improvements in local social cohesion, cultural vitality, and community life.

4.3. Heterogeneous effects: Differentiation between mature and potential heritage sites

The effects of new quality productive forces on the sustainable development of agricultural heritage systems exhibit significant heterogeneity across different development stages, with substantial differences between mature and potential heritage sites, thereby supporting Hypothesis 2.

Mature heritage sites, represented by the Honghe Hani Rice Terraces in Yunnan, generally have well-developed infrastructure, comprehensive industrial systems, and high levels of market recognition. In these sites, new quality productive forces primarily promote high-end development, refined management, and digital transformation. Economic effects are particularly evident, with deeper integration of agriculture, culture, and tourism accompanied by substantial increases in added value and income levels. Ecological effects remain stable, with ecosystem service values being effectively translated into economic and social benefits. Social effects continue to improve, reflected in high levels of community participation and well-established heritage transmission systems. Overall scores are predominantly within the high-level range, demonstrating characteristics of high-quality development.

Potential heritage sites refer to emerging agricultural heritage systems that have recently been identified as having development potential. This category partially overlaps with sites that remain under assessment and have not yet received formal recognition. Such sites have neither been clearly evaluated nor excluded from conservation considerations, and their eligibility for potential heritage designation has yet to be determined [9–10].

These sites are generally at an early stage of conservation and development, characterized by relatively weak infrastructure and short industrial value chains. Accordingly, new quality productive forces primarily serve to strengthen basic development capacity and ecological conservation. The effects of ecological restoration and biodiversity conservation tend to emerge relatively quickly, whereas economic benefits are released more gradually. Community participation and heritage transmission gradually improve, while employment generation remains concentrated in relatively low-skilled and primary-level positions. Although their overall scores generally fall within the medium-to-low range, these sites possess considerable growth potential and substantial scope for the application of new quality productive forces.

4.4. Regional and typological differences

Across the three major heritage belts, the Jiang–Sea Cultural Heritage Belt benefits from its economic and technological advantages, resulting in more pronounced economic and social effects. The Southern Mountainous Rice Terrace Heritage Belt has a strong ecological foundation and extensive application of green technologies, resulting in the highest ecological effect scores. The Northern Dryland Farming and Nomadic Heritage Belt has achieved notable progress in ecological restoration and germplasm resource

conservation, while its economic and social effects have improved steadily. Because heritage sites differ substantially in their resource endowments and dominant industries, the structure of their development effects also varies considerably. These differences are closely associated with their spatial distribution patterns and geographical contexts.

5. Conclusion

New quality productive forces have injected new vitality into the sustainable development of agricultural heritage systems while providing technological support for their long-term conservation and development. This study examined the underlying mechanisms and multidimensional effects through which new quality productive forces empower agricultural heritage systems. The findings demonstrate that new quality productive forces can promote economic growth, ecological conservation, and cultural heritage transmission in heritage sites through three pathways: technological innovation, industrial integration, and factor optimization. These effects also exhibit significant regional and typological heterogeneity. The study indicates that integrating the new productivity paradigm with dynamic conservation of agricultural heritage can help address the traditional imbalance that places greater emphasis on conservation than development, thereby achieving a more effective integration of heritage conservation and utilization.

Agricultural heritage systems constitute an important component of Chinese civilization, and their long-term sustainability is closely connected with the transmission of cultural heritage and the broader strategy of rural revitalization. Given the differences in resource endowments and development foundations among different agricultural heritage belts, differentiated approaches should be adopted according to local conditions, with efforts to promote technological, industrial, and model innovation. By leveraging digital empowerment and green development, agricultural heritage systems can achieve high-quality and sustainable development, thereby establishing a pathway toward high-quality and sustainable development of agricultural heritage systems with Chinese characteristics.

Disclosure statement

The author declares no conflict of interest.

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