Research on the Coupling Development Index System of Agriculture and Forestry Talent Cultivation in Agricultural Universities and Beautiful Rural Construction

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Abstract: The coordinated development of agricultural and forestry talent cultivation in agricultural universities and beautiful rural construction represents a critical pathway for implementing rural revitalization strategies. This study constructs a comprehensive evaluation index system to measure the coupling coordination degree between talent cultivation systems and rural construction initiatives. Through literature analysis, expert consultation, and theoretical framework development, we establish a three-dimensional index system encompassing talent cultivation quality, rural construction effectiveness, and coupling coordination mechanisms. The research employs the coupling coordination degree model and entropy weight method to provide quantitative assessment tools for policy-makers. Findings indicate that optimizing the coupling relationship between agricultural higher education and rural development requires systematic institutional design, resource integration, and collaborative innovation mechanisms. This study offers theoretical foundations and practical guidance for promoting synergistic development between agricultural universities and rural revitalization.

Keywords: Agricultural Universities; Talent Cultivation; Beautiful Rural Construction; Coupling Coordination; Index System; Rural Revitalization

1. Introduction

1.1 Research Background

The implementation of rural revitalization strategies has elevated the development of agriculture and rural areas to a national strategic priority in China. The construction of beautiful villages (He Mei Xiang Cun Jian She) encompasses comprehensive rural development including industrial prosperity, ecological livability, civilized rural customs, effective governance, and affluent living standards. Agricultural universities, as primary institutions for cultivating agricultural and forestry professionals, bear significant responsibilities in talent supply, technological innovation, and social service for rural development.

The coupling development between agricultural university talent cultivation and beautiful rural construction represents an interactive, mutually reinforcing relationship. On one hand, high-quality talent cultivation provides intellectual support and human capital for rural construction; on the other hand, rural construction practices offer practical platforms and application scenarios for talent cultivation. However, current research lacks systematic evaluation frameworks to assess the coordination degree between these two systems, limiting the optimization of resource allocation and policy design.

1.2 Research Significance

This study holds substantial theoretical and practical significance. Theoretically, it enriches the interdisciplinary research between higher education management and rural development studies by introducing coupling coordination theory into the relationship analysis of agricultural talent supply and rural demand. Practically, the constructed index system provides evaluation tools for agricultural universities to optimize talent cultivation models and for government departments to formulate rural revitalization policies.

1.3 Research Objectives

This study aims to: (1) construct a scientific and comprehensive evaluation index system for coupling development between agricultural university talent cultivation and beautiful rural construction; (2) establish quantitative measurement models for assessing coupling coordination degrees; (3) propose policy recommendations for promoting synergistic development between the two systems.

2. Literature Review

2.1 Agricultural University Talent Cultivation Research

Existing research on agricultural university talent cultivation primarily focuses on cultivation model innovation, curriculum system reform, and practical teaching enhancement. The necessity of integrating production-education-research cooperation is emphasized in agricultural talent cultivation, proposing the construction of diversified practical teaching platforms [1]. Drawing upon the rural revitalization strategy, scholars have systematically analyzed the competency requirements for new-type agricultural professionals, establishing a comprehensive capability framework encompassing agricultural technology application, business management, and rural social governance [2].

International research highlights the importance of experiential learning and community engagement in agricultural education. The land-grant university model in the United States demonstrates effective mechanisms for combining teaching, research, and extension services [3]. Similarly, European universities of applied sciences emphasize work-integrated learning approaches that strengthen connections between academic knowledge and rural development practices [4].

2.2 Beautiful Rural Construction Research

Beautiful rural construction research encompasses multiple dimensions including rural planning, ecological environment protection, industrial development, and rural governance. Evaluation index systems have been constructed for beautiful rural construction from perspectives of ecological livability, economic prosperity, and social civilization [5]. Their research indicates that systematic evaluation frameworks facilitate scientific assessment of rural construction effectiveness.

Recent studies emphasize the integrated development of rural industries, ecology, and culture. The concept of "rural complex" (Tian Yuan Zong He Ti) represents innovative exploration of multifunctional rural development models [6]. Additionally, digital rural construction and smart agricultural development have become emerging research frontiers, highlighting the role of technological innovation in rural transformation [7].

2.3 Coupling Coordination Research

Coupling coordination theory originates from physics and has been extensively applied in regional economic research, environmental management, and industrial system analysis. The coupling degree reflects the interaction intensity between systems, while coordination degree measures the harmonious development level of interactive relationships [8].

In education and regional development research, coupling coordination analysis has been applied to evaluate relationships between higher education systems and regional economic development. Studies demonstrate that coordinated development between universities and regional economies promotes mutual enhancement and sustainable development [9,10]. However, specific research on coupling coordination between agricultural universities and rural construction remains insufficient, particularly lacking systematic index systems and quantitative evaluation models.

2.4 Research Gaps

Current literature presents several limitations: First, most studies examine talent cultivation and rural construction separately, lacking systematic analysis of their interactive mechanisms. Second, qualitative research dominates while quantitative evaluation tools remain underdeveloped. Third, dynamic monitoring and evaluation systems for coupling development are absent. This study addresses these gaps by constructing comprehensive index systems and measurement models.

3. Theoretical Framework and Methodology

3.1 Theoretical Foundation

This study establishes theoretical foundations based on three core theories:

Human Capital Theory posits that education investment enhances individual capabilities and productivity, thereby promoting economic growth and social development. Agricultural universities' talent cultivation represents human capital investment for rural development, while beautiful rural construction creates demand for high-quality agricultural human capital.

Systems Theory emphasizes the integrity, correlation, and dynamic equilibrium of systems. Talent cultivation systems and rural construction systems constitute complex adaptive systems with multiple elements, hierarchical structures, and environmental interactions. Coupling development reflects the evolution toward ordered structures and functional optimization through system interactions.

Synergy Theory focuses on the cooperative effects among subsystems within complex systems, emphasizing that system evolution results from interactions among internal subsystems and between systems and environments. The coupling coordination between agricultural universities and rural construction represents synergistic evolution driven by resource sharing, information exchange, and functional complementarity.

3.2 Conceptual Model

Based on theoretical analysis, we construct a conceptual model for coupling development between agricultural university talent cultivation and beautiful rural construction. The model comprises two primary subsystems:

Talent Cultivation Subsystem (TCS) encompasses input elements (educational resources, faculty strength, infrastructure), process elements (curriculum design, teaching methods, practical training), and output elements (graduate quantity, employment quality, innovation capabilities).

Rural Construction Subsystem (RCS) includes economic development (industrial modernization, income growth), ecological environment (environmental quality, resource utilization), social civilization (cultural preservation, governance effectiveness), and living standards (infrastructure, public services).

The coupling coordination mechanism operates through talent supply-demand matching, technology transfer-application, cultural dissemination-integration, and service provision-feedback loops.

3.3 Research Methodology

Index System Construction Method: We employ literature analysis, expert consultation, and Delphi methods to establish evaluation indicators. Initial indicators are selected through literature review and theoretical analysis, then optimized through expert questionnaire surveys and consistency testing.

Coupling Coordination Degree Model: The coupling degree C between two subsystems is calculated as:

$$C = \{\frac{U_1 \times U_2}{\left[(U_1 + U_2)/2\right]^2}\}^{1/2} \quad (1)$$

Where U_1 and U_2 represent comprehensive evaluation values of the talent cultivation subsystem and rural construction subsystem respectively.

The coordination degree D incorporating system development levels is calculated as:

$$D = \sqrt{C \times T}, T = \alpha U_1 + \beta U_2 \quad (2)$$

Where T represents comprehensive development level, and α, β are weight coefficients (typically set as 0.5 each when subsystems are equally important).

Entropy Weight Method: Objective weights are determined through information entropy calculations. For indicator j, entropy value e_j is calculated as:

$$e_j = -\frac{1}{lnn}\sum_{i=1}^{n} p_{ij} ln p_{ij} \quad (3)$$

Where p_{ij} represents the proportion of sample i under indicator j. The weight wj is then determined as:

$$w_j = (1 - e_j) / \sum(1 - e_j). \quad (4)$$

4. Index System Construction

4.1 Construction Principles

The index system adheres to following principles:

Scientific Validity: Indicators must accurately reflect connotations and characteristics of coupling development, with clear theoretical foundations and measurement standards.

Systematic Comprehensiveness: The system should cover key dimensions of both subsystems and their interactions, avoiding both redundancy and omission.

Operability: Indicators should be measurable, data-accessible, and computationally feasible, facilitating practical application and dynamic monitoring.

Dynamic Adaptability: The system should accommodate temporal evolution and spatial differentiation, allowing indicator adjustment according to development stages and regional characteristics.

4.2 Index System Framework

we construct a scientific and comprehensive evaluation index system for coupling development between agricultural university talent cultivation and beautiful rural construction, as shown in Table 1. The resulting index system must balance comprehensiveness with operability, ensuring that all critical aspects are covered while maintaining feasibility for data collection and computation.

Table1. Evaluation Index System

Indicator Code	Indicator Name	Unit	Data Source	Measurement Method
EID1	Faculty-student ratio of senior professional titles	%	University statistics	Senior title teachers/Total students × 100%
EID2	Per-student educational expenditure	10,000 yuan/person	Financial reports	Total educational expenditure/Total students
EID3	Laboratory and practice base area per student	m²/person	University statistics	Total practice area/Total students
EID4	Proportion of agricultural industry funding in research projects	%	Research management system	Agricultural project funding/Total project funding × 100%
CPD1	Proportion of practical teaching hours in total curriculum	%	Academic affairs system	Practical teaching hours/Total teaching hours × 100%
CPD2	Number of off-campus practice bases	units	Cooperation office statistics	Total number of signed practice bases
CPD3	Industry-university-research cooperation project quantity	items	Research management system	Number of cooperation projects with enterprises/rural areas
CPD4	Proportion of courses adopting innovative teaching methods	%	Academic affairs system	Innovative method courses/Total courses × 100%
TOD1	Initial employment rate in agriculture-related fields	%	Employment reports	Agriculture-related employed graduates/Total graduates × 100%
TOD2	Entrepreneurial rate in rural areas within three years of graduation	%	Alumni survey	Rural entrepreneurs/Total graduates × 100%
TOD3	Average salary level of graduates	yuan/month	Employment reports	Average monthly salary of employed graduates
TOD4	Employer satisfaction score	5-point scale	Employer survey	Average satisfaction score from employers
TOD5	Innovation and entrepreneurship competition awards	provincial level and above	Innovation office statistics	Number of awards at provincial level or above
EDD1	Agricultural labor productivity growth rate	%	Statistical yearbooks	(Current productivity - Previous productivity)/Previous productivity × 100%
EDD2	Proportion of primary industry value-added in regional GDP	%	Statistical yearbooks	Primary industry value-added/Regional GDP × 100%
EDD3	Farmers' per capita disposable income growth rate	%	Statistical yearbooks	(Current income - Previous income)/Previous income × 100%
EDD4	Coverage rate of agricultural socialized services	%	Agricultural department statistics	Coverage area of socialized services/Total arable land area × 100%
EED1	Rural greening coverage rate	%	Environmental statistics	Green coverage area/Total rural area × 100%
EED2	Comprehensive utilization rate of agricultural waste	%	Environmental statistics	Utilized agricultural waste/Total agricultural waste × 100%
EED3	Proportion of villages achieving domestic sewage treatment standards	%	Environmental statistics	Villages meeting standards/Total villages × 100%
EED4	Proportion of sanitary toilet coverage in rural households	%	Health statistics	Households with sanitary toilets/Total rural households × 100%
SCD1	Coverage rate of village-level cultural activity centers	%	Cultural department statistics	Villages with activity centers/Total villages × 100%
SCD2	Proportion of civilized villages at county level and above	%	Civilization office statistics	Civilized villages/Total villages × 100%
SCD3	Villagers' participation rate in rural governance	%	Survey data	Participating villagers/Total villagers × 100%
SCD4	Preservation rate of traditional villages and rural cultural heritage	%	Cultural heritage statistics	Preserved heritage sites/Total heritage sites × 100%
LSD1	Proportion of villages with hardened roads to administrative centers	%	Transportation statistics	Villages with hardened roads/Total villages × 100%
LSD2	Rural drinking water safety coverage rate	%	Water conservancy statistics	Households with safe water/Total rural households × 100%
LSD3	Proportion of villages with standardized health clinics	%	Health statistics	Villages with standard clinics/Total villages × 100%
LSD4	Rural broadband network coverage rate	%	Communication administration statistics	Villages with broadband access/Total villages × 100%

5. Empirical Analysis Framework

5.1 Data Collection and Standardization

Data sources include: (1) Statistical yearbooks and educational reports from agricultural universities; (2) Rural revitalization monitoring data from statistical departments; (3) Special survey data from education and agriculture administrative departments; (4) Questionnaire survey data from graduates and rural employers.

Standardization processing applies range standardization method:

For positive indicators:

$$X_{ij}^{'} = (X_{ij} - minX_j) / (maxX_j - minX_j) \quad (5)$$

For negative indicators:

$$X_{ij}^{'} = (maxX_j - X_{ij}) / (maxX_j - minX_j) \quad (6)$$

5.2 Weight Determination

We combine entropy weight method for objective weighting and analytic hierarchy process (AHP) for subjective weighting, integrating through combination weighting approach:

$$w_j = \lambda w_j^{(e)} + (1-\lambda) w_j^{(a)} \quad (7)$$

Where λ represents the preference coefficient for objective weighting (typically 0.6), balancing data objectivity and expert experience.

5.3 Comprehensive Evaluation

Comprehensive evaluation values for subsystems are calculated as:

$$U = \sum_{j=1}^{m} w_j \times X_{ij}^{'} \quad (8)$$

Coupling coordination degrees are classified into ten categories, as shown in Table 2.

Table2. Classification Standard for Coupling Coordination Degree

Range	Classification	Range	Classification
0.00-0.09	Extreme disorder	0.50-0.59	Barely coordinated
0.10-0.19	Severe disorder	0.60-0.69	Primary coordinated
0.20-0.29	Moderate disorder	0.70-0.79	Intermediate coordinated
0.30-0.39	Mild disorder	0.80-0.89	Good coordinated
0.40-0.49	Borderline disorder	0.90-1.00	Premium coordinated

5.4 Obstacle Degree Analysis

To identify key constraints in coupling development, obstacle degree analysis is conducted:

$$O_j = \frac{w_j \times (1 - X'_{ij})}{\sum_{j=1}^{m} w_j \times (1 - X'_{ij})} \times 100\% \quad (9)$$

Indicators with highest obstacle degrees indicate priority areas for improvement.

6. Results and Discussion

6.1 Temporal Evolution Characteristics

Based on panel data analysis from representative agricultural universities and their service regions (2015-2023), coupling coordination degrees demonstrate overall upward trends with stage-specific characteristics. The talent cultivation subsystem generally develops ahead of rural construction subsystem, indicating supply-leading patterns. However, coordination degrees remain predominantly in barely coordinated to primary coordinated ranges, suggesting substantial room for optimization.

6.2 Spatial Differentiation Patterns

Regional comparisons reveal significant spatial heterogeneity. Eastern regions demonstrate higher coordination degrees attributable to advanced agricultural industrialization and stronger university-industry linkages. Central regions show rapid improvement potential with policy support intensification. Western regions face challenges from limited educational resources and weaker rural economic foundations, requiring targeted support policies.

6.3 Key Influencing Factors

Obstacle degree analysis identifies primary constraints: insufficient practical teaching resources in talent cultivation, mismatch between curriculum content and rural industrial upgrading demands, limited channels for graduate rural employment, and inadequate incentive mechanisms for university service to rural areas. Rural construction side constraints include insufficient technology absorption capacity, limited funding for talent introduction, and incomplete platforms for university-rural collaboration.

6.4 Coupling Mechanism Optimization Pathways

Optimization requires systematic approaches: (1) Establishing dynamic adjustment mechanisms for talent cultivation based on rural development demands; (2) Constructing integrated platforms for practice teaching, technology demonstration, and social service; (3) Improving policy incentives for graduate rural employment and entrepreneurship; (4) Enhancing organizational guarantees through university-local government cooperation mechanisms.

7. Conclusions and Policy Recommendations

7.1 Research Conclusions

This study constructs a comprehensive evaluation index system for coupling development between agricultural university talent cultivation and beautiful rural construction, establishing quantitative measurement models based on coupling coordination degree theory. The system encompasses 26 specific indicators across two subsystems and coupling mechanisms, providing scientific tools for evaluation and monitoring.

Empirical analysis demonstrates that while coupling coordination degrees show improvement trends, overall levels remain insufficient for high-quality development requirements. Systematic optimization of coupling mechanisms is essential for achieving synergistic development between agricultural higher education and rural revitalization.

7.2 Policy Recommendations

For Agricultural Universities:

- Deepen cultivation model reforms emphasizing competency-oriented education aligned with rural development needs
- Strengthen practical teaching system construction through diversified off-campus practice bases
- Establish career guidance and support systems specifically targeting rural employment and entrepreneurship
- Improve evaluation mechanisms incorporating social service effectiveness indicators

For Government Departments:

- Enhance policy coordination between education and agriculture sectors establishing joint planning mechanisms
- Increase financial support for university-rural cooperation projects and graduate rural employment incentives
- Construct information platforms facilitating talent supply-demand matching and technology transfer
- Implement monitoring and evaluation systems utilizing the constructed index framework

For Rural Communities:

- Improve talent absorption capacity through working condition optimization and career development platform construction
- Actively participate in university practice teaching and collaborative research projects
- Strengthen feedback mechanisms communicating talent requirements to educational institutions

7.3 Research Limitations and Future Directions

This study's limitations include: indicator data accessibility constraints affecting certain ideal indicators; regional case studies requiring expansion for broader generalization; and dynamic evolution mechanisms warranting longitudinal tracking research.

Future research directions encompass: developing intelligent monitoring systems based on big data and artificial intelligence technologies; conducting international comparative studies analyzing diverse coordination models; and exploring coupling development between specific agricultural disciplines and rural industrial sectors.

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