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Research on the Pathways of Collaborative Innovation in Facilitating the Transformation of Scientific and Technological Achievements through Forest and Grass Vocational Education Integration

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Abstract: The transformation of forest and grass scientific and technological achievements has long been trapped by the "last mile" barrier, while there exists a "last step" mismatch between vocational education talent training and industrial demands. This paper proposes that these two major problems originate from the same root and can be systematically solved by constructing a "two-way collaborative innovation" mechanism. The study analyzes the internal correlation between the dual dilemmas of "technology supply" and "talent supply" in the forest and grass sector. On this basis, taking three types of practices including science and technology courtyards, industrial colleges, and the integration of science and education as research samples, it puts forward policy suggestions at the institutional design level. The research holds that the two-way collaborative innovation in the forest and grass field is essentially a systematic project of transforming "forest and field sites" into "open field laboratories" and turning "vivid practical experience" into educational and teaching resources, which provides a feasible path to resolve the dual dilemmas of "difficult achievement transformation" and "difficult talent cultivation" in agriculture, forestry and grass-related sectors.

Keywords: Forest and grass science and technology; Transformation of scientific and technological achievements; Vocational education; Two-way collaboration

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1. Introduction

Forest and grass undertakings serve as the main battlefield for ecological civilization construction and an important platform for scientific and technological innovation. According to statistics, since the launch of the 14th Five-Year Plan, China has accumulated more than 30,000 newly authorized patents in the forest and grass sector, covering cutting-edge fields such as germplasm resource improvement, forest carbon sink monitoring, smart forestry, and bamboo substitution for plastic [1]. However, there is a huge gap between the abundant output of scientific and technological achievements and the low transformation and application efficiency. A large number of forest and grass scientific research achievements are confined in laboratories and academic papers, failing to be applied in forest areas and mountainous regions. The difficulty in transforming forest and grass scientific and technological achievements and the mismatch of talent cultivation in vocational education are not two independent problems, but two sides of the same structural dilemma. The key to breaking this deadlock lies in eliminating institutional barriers between achievement transformation and talent cultivation, and creating a new "two-way collaborative innovation" mechanism. Under this mechanism, the process of transforming scientific and technological achievements becomes a practical training classroom for talent cultivation, and the teaching reform of vocational education acts as a booster for technology implementation. This is not only the internal requirement for the transformation of forest and grass scientific and technological innovation paradigm from linear transmission to co-production, but also an inevitable choice for vocational education to shift from supply orientation to demand orientation.

2 Theoretical logic: Why two-way collaboration?

2.1. Dilemma of the traditional linear model

For a long time, the transformation of forest and grass scientific and technological achievements has followed a linear model of scientific research, pilot test, promotion and application. The implicit assumption of this paradigm is that scientists generate knowledge in laboratories, which is then transmitted downward to technical promoters who will teach frontline practitioners [2]. Nevertheless, the special attributes of the forest and grass industry lead to repeated failures of this model.

Firstly, forest and grass technologies are highly context-dependent. Seedling cultivation technologies verified to be effective under laboratory conditions may fail to adapt to specific forest areas due to differences in soil, climate and management levels. Technology implementation is not a simple application process, but a process of re-debugging and re-creation in production scenarios, which means laboratory achievements separated from frontline production are semi-finished products in nature.

Secondly, the users of forest and grass technologies are scattered forest farmers and grassroots forest workers with limited technical proficiency [3]. Studies show that technical training alone usually yields unsatisfactory results, as there are time and space gaps between teaching and practical application. Trainees may understand theories during training but be at a loss when encountering real problems in forests and fields. Effective technology promotion should be accompanied by long-term on-site technical support for producers.

2.2. Limitations of industry-education integration in vocational education

Vocational education faces similar dilemmas. Although industry-education integration and school-enterprise cooperation have been advocated for years, practical cooperation mostly stays at a shallow level: enterprises provide internship positions and schools organize student visits. The deep-seated problem lies in the capability mismatch between talents cultivated by schools and skilled workers demanded by enterprises.

The mismatch stems from the difference between tacit technical knowledge owned by enterprises and explicit knowledge taught in schools. Enterprise technical know-how is attached to specific production procedures, equipment operation and problem-solving experience, which can hardly be fully conveyed through classroom lectures [4]. In contrast, school curriculum knowledge is systematic and standardized in textbooks, yet stripped of real complexity and uncertainty. In other words, students lack practical capabilities to apply knowledge in uncertain real scenarios.

3. Practical investigation: Comparative analysis of three collaborative modes

3.1. Science and technology courtyard model: From sending technology to rooted co-cultivation

Science and technology courtyards are not new concepts, yet systematic operation after their introduction into forest areas is an important exploration in the past two years. In July 2025, Habei Science and Technology Courtyard, the first science and technology courtyard built in forest areas nationwide, was officially put into operation. Co-constructed by Longjiang Forest Industry Group, Northeast Forestry University and Heilongjiang Vocational College of Ecological Engineering, it features distinct school-enterprise collaboration characteristics [5].

Its innovations are reflected in three "zero-distance" links:

(1) Zero distance between research and application: The courtyard moves laboratories to forest fields, with researchers stationed in forest areas to identify and conduct research based on real production problems. As stated by the courtyard director, identifying problems during production can better hit the core of issues than conceiving problems in laboratories. This problem-oriented mechanism ensures a high degree of alignment between research directions and industrial demands.

(2) Zero distance between experts and forest workers: The courtyard serves not only a scientific research platform but also a carrier for technical training and accompanying services. Experts work side by side with forest staff to realize technology transfer in the process of jointly solving production problems. This learning-by-doing approach enables practitioners to internalize practical abilities better than traditional training.

(3) Zero distance between education and employment: Frontline forest production sites act as field laboratories for students, who complete the transition from theoretical knowledge to practical capabilities by participating in real projects [6]. Meanwhile, children of forest workers gain access to high-quality nearby education, forming a virtuous cycle of education feeding back local communities. The practice of Habei Science and Technology Courtyard proves that organic unification of technology research, achievement transformation and talent cultivation can be realized when researchers, vocational teachers and students, as well as forest staff work together in the same venue.

3.2. Industrial college model: From school-enterprise cooperation to community construction

If science and technology courtyards bring classrooms into forest areas, the industrial college model introduces industries into campuses. Lishui Vocational and Technical College provides a typical case. Relying on mountain industrial chains, the college has built three major specialty clusters including forest technology, e-commerce and bamboo intelligent manufacturing, precisely matching post demands of mountain characteristic industries [7].

Its core mechanism is four-party linkage among government, schools, industries and enterprises: the government issues policies, schools supply talents, industries set standards and enterprises provide posts, jointly forming an ecosystem for talent cultivation. A breakthrough reform is its thesis-writing on land initiative. The college expands classrooms to mountains and farmlands to build "four-qualified" practical classrooms that are useful, interesting, situational and effective. It has formulated classroom certification standards covering 3 dimensions and 32 indicators, incorporating mountain dedication and other curriculum ideological and political elements into evaluation. This means that the cultivation goal of being capable and hardworking is no longer an empty slogan but measurable and assessable [8].

The core contribution of industrial colleges lies in proving that it is feasible to design majors and courses following industrial and post demands through institutional arrangements. When real enterprise production tasks become course content, students' learning and working are no longer sequential relations but simultaneous processes.

3.3. Science-education integration model: From separation of research and teaching to two-way empowerment

The exploration of science-education integration at Fujian Vocational College of Forestry breaks the binary opposition between scientific research and teaching from another dimension, summarized as "five database interconnection" and "five synchronized development" [9].

Five database interconnection connects the research resource library, teaching resource library, science and innovation project library, and training venue library, as well as the dual-qualified teacher library, opening seven major scientific research platforms, including provincial collaborative innovation centers and CMA testing centers, to teaching activities.

Five synchronized development takes standard construction, digital efficiency improvement, project traction, integrated education and industrial implementation as five starting points to reconstruct the operation process of science-education integration.

In practical operation, the college adopts a project-based model: enterprises put forward technical problems, teachers undertake research tasks, students participate in problem-solving, and industries conduct result verification. Real enterprise technical demands become research topics [10]. Teacher-student teams complete technological research, whose achievements are directly applied to enterprise production and simultaneously transformed into loose-leaf textbooks and training projects, forming a closed loop of scientific research, achievement transformation, teaching application and industrial feedback.

The key breakthrough of this model is breaking the traditional division that scientific research belongs to teachers and teaching belongs to students. When students participate in real scientific research projects, they shift from knowledge recipients to knowledge producers. When scientific research achievements directly serve industries, teachers' academic value is no longer only judged by papers but also verified through production benefits.

4. Mechanism design for two-way collaborative empowerment

4.1. Curriculum restructuring: From discipline logic to task logic

Traditional curriculum systems are discipline-centered, arranged in the sequence of basic courses, professional courses and internships with knowledge categorized by disciplines. Its flaw is that real work problems are interdisciplinary and require comprehensive application of multiple subjects. Two-way collaboration demands curriculum transformation from discipline logic to task logic [11].

Specifically, course content shall be organized around typical work tasks. Students mobilize relevant knowledge while completing tasks instead of storing knowledge first for future use. This transformation requires supporting textbook reform. Traditional planning textbooks feature long update cycles and excessive theoretical content, failing to keep up with rapidly changing industrial demands. Loose-leaf textbooks and work manual textbooks adopted by Fujian Vocational College of Forestry serve as alternative solutions, whose contents can be updated in a timely manner with technological iteration and presented in operable forms such as operation guides and case collections [12].

4.2. Platform reconstruction: From closed to open and shared resources

Opening scientific research platforms to teaching and enterprise resources to schools forms the material foundation of two-way collaboration. The five database interconnection experiences of Fujian Vocational College of Forestry are worthy of reference. It systematically sorts scientific research equipment, data, projects, teachers and venues, establishes an open sharing mechanism, and realizes the transformation of scientific research resources into teaching resources and teaching resources into industrial resources.

Meanwhile, outward-oriented platforms such as science and technology courtyards are equally important. Essentially a mobile laboratory and mobile classroom, Habei Science and Technology Courtyard transports intellectual resources of universities to frontline production sites, making fields the primary venue of knowledge creation [13]. This model is especially applicable to forest and grass sectors with highly scattered application scenarios.

4.3. Evaluation reform: From single standard to multidimensional portrait

Evaluation acts as a baton. If teacher title evaluation only relies on papers and student assessment solely on written exams, two-way collaboration can hardly be fully implemented.

The reform direction of teacher evaluation is a multidimensional portrait: assessing both teaching and research achievements, both papers and transformed achievements, both academic influence and industrial contributions. Practices such as the Dual Competency Promotion Plan of Fujian Vocational College of Forestry and incorporating science and technology commissioner work into teacher performance assessment at Lishui Vocational and Technical College can be adopted for reference.

Student evaluation shall be competency-oriented, adopting five assessment criteria including theoretical knowledge, practical skills, scientific innovation, performance and comprehensive literacy [14]. Students with outstanding performance in scientific research projects or technology promotion shall be granted extra credits and priority in evaluation and awards.

4.4. Institutional safeguard: From short-term projects to long-term mechanisms

Current two-way collaborative practices mostly exist in the form of projects and face the risk of interruption after personnel changes. To sustain collaborative innovation, relevant practices shall be embedded into regular institutional systems. First, at the college level, posts such as industrial professors and skill masters shall be set to incorporate enterprise technical backbones into part-time teaching staff and realize two-way mobility between enterprise and school personnel. Second, at the government level, platforms including industry-education integration communities and science and technology courtyards shall be incorporated into the forest and grass technology promotion system with stable financial support and policy status. The positioning of Habei Science and Technology Courtyard as a specific achievement of the national ecological industry-education integration community reflects this thinking. Third, at the industrial level, a technical manager system shall be established to cultivate interdisciplinary talents proficient in technology, market and education, bridging the last mile from laboratories to farmlands [15].

5. Conclusion

The dilemmas of forest and grass scientific and technological achievement transformation and vocational education talent cultivation share the same root cause, and the solution lies in constructing a two-way collaborative innovation mechanism. The essence of this mechanism is transforming forest and field sites into open field laboratories and vivid practical experience into educational and teaching resources, enabling co-evolution of scientific research, teaching and production in the same venue. From a practical perspective, three models, including science and technology courtyards, industrial colleges, and science-education integration, have provided replicable experience. These practices prove that two-way collaboration is not an ideal slogan but a realistic path achievable through institutional design. Facing the dual demands of high-quality development of the forest and grass industry and type-based reform of vocational education in the future, collaborative rules need to be refined and multi-party consensus gathered in practice to promote two-way collaborative innovation from pilot exploration to regular operation, and provide solid technical and talent support for ecological civilization construction.

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