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An Innovative Practice-Oriented Talent Cultivation Model for Agricultural Machinery Programs at Local Universities in the Era of Smart Agriculture

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Abstract: With the rapid development of smart agriculture, traditional training models for agricultural machinery professionals face major challenges, including outdated curricula, limited practical platforms, and insufficient industry-education integration. Focusing on local agricultural universities, this study proposes an innovative practice-oriented talent cultivation model centered on industry-education integration, project-driven learning, and multidimensional collaboration. The reform was implemented through curriculum restructuring, optimization of the practical teaching system, development of dual-qualified faculty, and construction of multi-level industry-education platforms. Practice has shown that this model effectively enhances students' innovative and practical abilities, improves their adaptability to industrial demands, and strengthens graduate employability, thereby providing strong talent and technical support for regional agricultural modernization and rural revitalization.

Keywords: Smart Agriculture; Agricultural Machinery Major; Talent Cultivation; Industry-Education Integration; Practical Teaching; Educational Reform

1. Introduction

Grounded in the institutional positioning and distinctive characteristics of local agricultural universities, and informed by reform practices across multiple institutions, this study systematically examines the current bottlenecks in talent cultivation, proposes a structured model for innovation and practice oriented talent development, and verifies its effectiveness through representative cases and empirical evidence. It is intended to provide both a theoretical reference and a practical framework for comprehensive disciplinary reform in comparable institutions.

Agriculture constitutes the foundation of the national economy. As an emerging and advanced form of modern agricultural development, smart agriculture is profoundly reshaping conventional modes of agricultural production through the integrated application of the Internet of Things, big data, artificial intelligence, intelligent equipment, and other advanced information technologies, thereby accelerating the transformation of agriculture toward digitalized, intelligent, and precision oriented systems [1]. This far reaching transformation has generated fundamentally new requirements for the knowledge base, competencies, and professional qualities of agricultural engineering talent. There is an urgent need for compound and innovation driven professionals who are proficient in the design and maintenance of modern agricultural equipment, competent in information sensing and data analytics, and conversant with agricultural production and management practices [2].

As the principal institutions serving regional agricultural development and supplying front line technical personnel, local agricultural universities play a pivotal role in advancing agricultural modernization, and the quality of talent cultivation in their agricultural machinery programs bears directly on this process. Yet agricultural machinery education in many local institutions continues to rely on conventional training paradigms and remains constrained by a series of persistent problems, including a curriculum insufficiently aligned with industrial development, outdated conditions for practical teaching, a faculty structure lacking diversity, and ineffective mechanisms for industry education integration [3]. As a consequence, the graduates produced under these systems often fail to meet the evolving demands of the smart agriculture value chain. Under these circumstances, exploring and establishing a new innovation and practice oriented training model for agricultural machinery programs in the context of smart agriculture has become an urgent and consequential task in higher education reform.

2. Current Status and Challenges in Talent Cultivation for Agricultural Machinery Majors at Local Universities

2.1 Outdated Curriculum Structure and Misalignment with the Demands of Smart Agriculture

At present, the curriculum systems of agricultural machinery programs in many local universities remain centered on conventional mechanical engineering courses, with insufficient interdisciplinary integration across information science, biotechnology, environmental science, and management studies [4]. A survey based analysis of the curricula offered by five local agricultural universities,, as shown in Figure 1, reveals that traditional courses in mechanics and agricultural machinery principles account for as much as 68% of the total curriculum, whereas courses covering core domains of smart agriculture, including intelligent sensing, automatic control, data science, and agricultural robotics, represent only 18%, while agricultural biology and environment related courses account for 14% [5]. This curriculum configuration, characterized by an overemphasis on mechanical engineering and a relative neglect of electronics and agricultural sciences, has resulted in a narrow knowledge structure among students, limiting their capacity to address the complex, multi-technology scenarios inherent in smart agriculture.

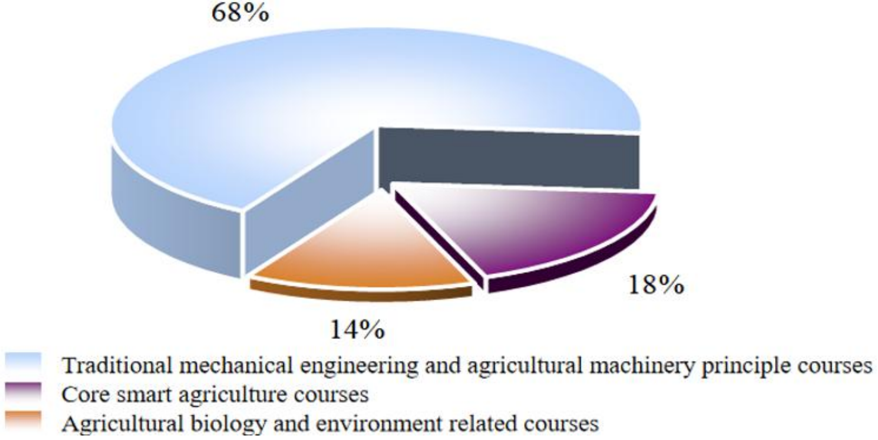

Figure 1. Curriculum Composition of Agricultural Machinery Programs at Selected Local Universities

2.2 Insufficient Practical Teaching and Inadequate Engineering Competence among Students

Practical teaching constitutes a critical component in cultivating students' innovative capacity and hands on competence. Yet local universities commonly face several persistent deficiencies in this regard.

Outdated equipment and a low level of intelligentization: Experimental facilities remain largely centered on conventional machinery such as tractors, seeders, and harvesters, while advanced platforms for smart agricultural machinery, unmanned aerial vehicles, agricultural Internet of Things applications, and spectral analysis are notably lacking.

Practice content dominated by verification based activities: Most practical sessions are limited to principle demonstration and structural disassembly, with insufficient emphasis on integrative, design oriented, and innovation driven projects. As a result, students have limited opportunities to develop the capacity to solve complex engineering problems effectively.

Unstable practice bases: Off campus internship bases are insufficient in number, and university enterprise partnerships are often loosely structured. Consequently, student internships frequently remain confined to site visits and basic operational tasks, making it difficult for students to engage substantively with core technological processes and production management in enterprises.

2.3 A Homogeneous Faculty Structure and a Shortage of Interdisciplinary Educators

The teaching staff in agricultural machinery programs is drawn predominantly from mechanical engineering backgrounds, resulting in a relatively narrow knowledge structure. At the same time, inflexible recruitment mechanisms have led to a severe shortage of dual qualified faculty with either industrial experience in smart agriculture enterprises or interdisciplinary training. Data from multiple institutions indicate that more than 75% of faculty members have traditional mechanical engineering backgrounds, whereas educators with integrated expertise in information technology and agricultural applications remain markedly insufficient [6]. Although Jiangsu University has established 17 interdisciplinary teams, the proportion of such composite faculty remains below 25%. At Hunan Polytechnic of Biological and Electromechanical Technology, dual qualified teachers account for 85% of the faculty, yet most still lack the capacity to integrate intelligent technologies into teaching. Jilin Agricultural Science and Technology University ranks prominently in the discipline, but the depth of its industry-education integration remains limited. Chongqing University of Arts and Sciences has produced notable research and development outcomes, although its interdisciplinary teaching system is still not fully developed.

This structural imbalance has directly contributed to outdated teaching content and constrained the cultivation of students' innovative capacities, thereby constituting a major bottleneck in improving talent training quality. The comparative analysis of the faculty structure of the agricultural machinery major in four institutions is shown in Table 1.

Table 1. Comparative Analysis of Faculty Structures in Agricultural Machinery Programs at Four Institutions

Institution	Strength	Evidence	Limitation
Jiangsu University	Interdisciplinary research teams	17 teams; CNY 30 million annual investment	Low interdisciplinary faculty ratio
Hunan Polytechnic of Biological and Electromechanical Technology	Dual-qualified faculty	85% dual-qualified teachers	Weak intelligent-technology integration
Jilin Agricultural Science and Technology University	Smart-agriculture disciplinary strength	First-ranked smart-agriculture programme	Shallow industry-education integration
Chongqing University of Arts and Sciences	Technology R&D and transfer	More than 10 technologies; CNY 100 million transfer value	Underdeveloped interdisciplinary faculty system

2.4 Superficial Industry-Education Integration and An Underdeveloped Collaborative Talent Cultivation Mechanism

Although industry-education integration has become a widely endorsed principle, its implementation in practice often remains confined to relatively superficial forms of university-enterprise cooperation, such as student internships and corporate recruitment, without extending to core components of talent development, including the formulation of training programs, curriculum co development, joint technological research, and the sharing of innovation outcomes [7]. At the root of this problem is the absence of a stable, mutually beneficial, and sustainable long term cooperation mechanism. Enterprises are often reluctant to engage more substantively in talent cultivation because of concerns over potential disruption to production routines, exposure of proprietary technologies, increased managerial costs, and the lack of tangible returns. As a result, both the willingness and the depth of enterprise participation remain limited.

3. Construction of an Innovation Oriented Practical Talent Cultivation Model

In response to the challenges outlined above, this study establishes an innovation oriented practical talent cultivation model centered on the integrated framework of industry-education collaboration, project driven learning, and multidimensional coordination. The overall architecture of this model is presented in Fig. 2. Its central objective is to remove the structural barriers between talent cultivation and industrial demand through a systematic program of educational reform.

3.1 Core Philosophy and Overall Framework

The central philosophy of this model is to orient talent cultivation toward the demands of the smart agriculture sector, with the enhancement of students' innovative and practical capacities as its defining objective. By transcending the conventional boundaries of disciplines and the physical limits of the campus, the model adopts a project driven pedagogical approach to foster a talent development process characterized by university-enterprise collaboration, interdisciplinary integration, and practice embedded throughout the entire training pathway [8].

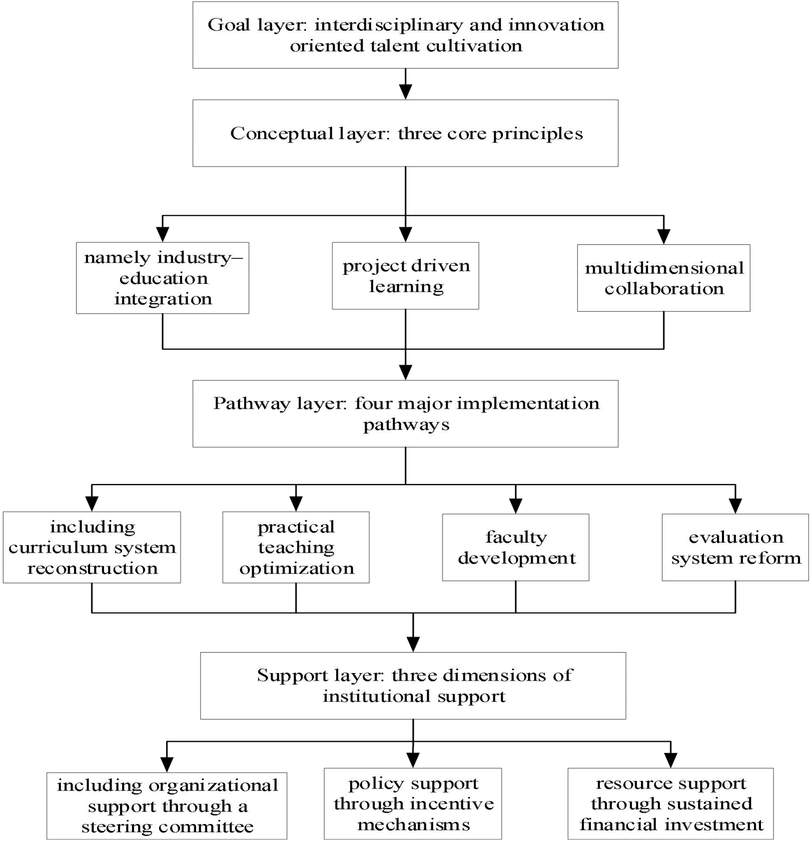

Figure 2. Curriculum Composition of Agricultural Machinery Programs at Selected Local Universities

3.2 Reconstruction of a Platform-and-Module-Based Curriculum System

To address the needs of the entire smart agriculture value chain, a flexible curriculum framework is established, comprising a general education platform, specialized modules, and interdisciplinary extension components.

General education platform courses: These courses are designed to consolidate three foundational domains: the fundamentals of agricultural engineering, represented by courses such as Engineering Graphics and CAD and Engineering Mechanics; the fundamentals of information technology, including Python Programming and Circuits and Electronic Technology; and the fundamentals of agricultural science, exemplified by Introduction to Modern Agriculture.

Specialized module courses: Three flexible directional modules are introduced, namely intelligent agricultural equipment technology, agricultural information sensing and processing, and precision agriculture and smart management, from which students may choose according to their interests and career trajectories. Newly added frontier courses include Intelligent Agricultural Machinery Systems, Agricultural Robotics, Agricultural Big Data and Cloud Computing, and Principles and Applications of the Agricultural Internet of Things.

Interdisciplinary extension courses: Courses such as Agricultural Innovation and Entrepreneurship Management and Project Management are offered to broaden students' interdisciplinary competence. In parallel, intelligent technology related content is embedded into conventional courses such as Agricultural Machinery and Agricultural Mechanization Management to support their systematic upgrading and curricular renewal.

3.3 Optimization of a Four-Level, Three-Integration Practical Teaching System

A progressive and integrated four-level, three-integration practical teaching system was established, as illustrated in Fig. 3, with the objective of systematically enhancing students' practical competence and innovative capacity.

Foundational cognition level: At the on-campus basic laboratories, students complete verification-oriented experiments in engineering materials, mechanical principles, and circuit fundamentals, thereby developing essential engineering literacy.

Specialized skills level: At on-campus training centers, such as intelligent agricultural machinery laboratories and agricultural Internet of Things training facilities, students receive targeted training in intelligent equipment operation, sensor deployment, unmanned aerial vehicle based crop protection, and data analysis.

Comprehensive application level: At university-enterprise jointly established practice bases or "smart farms," students undertake integrated projects grounded in authentic production scenarios, such as the design of full-process mechanization schemes for rice production and the integration of intelligent greenhouse environmental control systems.

Innovation practice level: By participating in faculty research projects, disciplinary competitions, undergraduate innovation and entrepreneurship training programs, and enterprise based research and development projects, students are trained to develop innovative thinking and the capacity to address complex problems.

The "three integrations" refer to the integration of theory and practice, the integration of technology and agriculture, and the integration of on-campus and off-campus learning environments. These three dimensions run through all four levels, ensuring that practical teaching remains closely aligned with theoretical instruction, agricultural application contexts, and industrial development [9].

3.4 Construction and Enhancement of a Dual Qualified Teaching Workforce

The development of a diversified faculty team that integrates full time and part time participation, as well as cross disciplinary expertise, is fundamental to the successful implementation of this model. A structured enterprise based faculty training program should be instituted, under which young faculty members are required to accumulate no less than six months of full time work experience in leading smart agriculture enterprises or demonstration bases within every five year period, with direct involvement in technology development and project management. At the same time, greater efforts should be made to recruit industry mentors by establishing positions for industry professors and appointing senior engineers and technical directors from enterprises as part time instructors to undertake practical teaching, supervise graduation projects, and deliver lectures on emerging technological developments. In parallel, interdisciplinary teaching teams should be formed around specific smart agriculture domains, bringing together faculty from agricultural machinery, computer science, agronomy, and related disciplines to engage jointly in teaching and collaborative research [10]. Faculty evaluation and incentive mechanisms should also be refined so that teaching achievements, technological inventions, technology transfer, and industry commissioned projects are accorded equivalent recognition in professional promotion and performance assessment, thereby encouraging faculty members to engage more directly with real world production contexts.

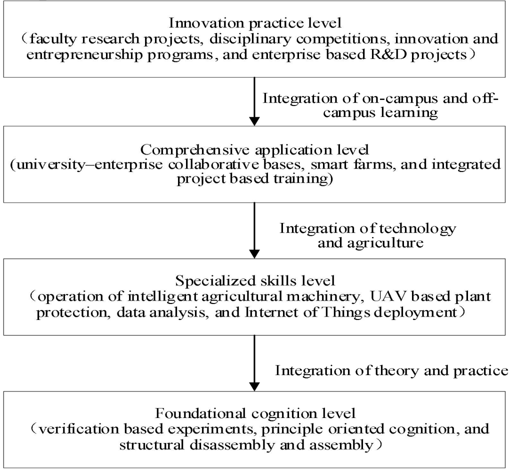

Figure 3. Structure of the Four-Level, Three-Integration Practical Teaching System

3.5 Development and Operation of a Multi-Level Industry-Education Integration Platform

A collaborative operational mechanism for industry-education integration should be established on the basis of co-construction, co-governance, resource sharing, and mutual benefit [11]. Substantive platforms should be jointly developed with leading enterprises in the sector, including smart agriculture industrial colleges, collaborative innovation centers, and joint laboratories, exemplified by the Intelligent Agricultural Equipment Research Institute co-established by Jiangsu University and World Agricultural Machinery. Enterprise participation should be embedded throughout the talent cultivation process, including the revision of training programs, the co-development of teaching materials such as Practical Training Manual for the Agricultural Internet of Things, and the joint construction of online course resource repositories. Educational resources and innovation outcomes should likewise be shared in both directions: university libraries and laboratories should be made accessible to partner enterprises, while advanced industrial equipment, authentic case materials, and real technical challenges should be incorporated into teaching as instructional resources. Technological achievements generated through joint research should be governed by prior agreement with respect to intellectual property ownership and benefit sharing from commercialization. A joint evaluation and continuous improvement mechanism should also be instituted, involving universities, enterprises, and industry associations in the assessment of teaching quality and feedback collection. Regular graduate tracking should be conducted to provide an empirical basis for the ongoing refinement of the talent cultivation model.

4. Practical Cases and Effectiveness Analysis

To verify the effectiveness of the talent cultivation model developed in this study, which is centered on industry-education integration, project driven learning, and multidimensional collaboration, this section conducts an in depth case analysis of three representative local universities that have actively advanced educational reform in practice. Covering institutions from different regions and of different types, these cases are examined through a combination of quantitative evidence and qualitative materials, so as to provide a systematic account of their innovative pathways and practical outcomes.

4.1 Representative Case Analysis

4.1.1 Jiangsu University: Deep industry-education integration in the New Agricultural Sciences experimental class

The College of Agricultural Engineering at Jiangsu University, in collaboration with Jiangsu Runguo Agricultural Development Co., Ltd., a nationally recognized leading agricultural enterprise, established a New Agricultural Sciences experimental class and developed an intensive industry-education integration model that combines centralized workplace based training with decentralized internship and practicum arrangements [12]. A defining feature of this model lies in its close alignment of student learning with the full cycle of agricultural production. During the critical farming season from November each year to April of the following year, students undertake nearly six months of on site practice within the enterprise, participating throughout the entire process of modern agricultural production, from intelligent sowing and precision management to smart harvesting.

Its implementation pathway is driven by field based projects. Front line experts, including Wei Qiao, a deputy to the National People's Congress and chairperson of the enterprise, serve as industry mentors and supervise students in authentic projects such as crop growth assessment and fertilization decision making based on multispectral data. This mechanism, which integrates learning, inquiry, and practice within real production contexts, has substantially stimulated students' enthusiasm for innovation.

The outcomes of this model are highly notable. In her practice report, participating student Du Qingqing wrote that the experience enabled her to understand smart agriculture as a technological system oriented toward solving real world problems. The student team Zhizai Bide developed a fully automated vegetable transplanter that has since been deployed nationwide, with a cumulative operational area exceeding 6,000 mu. In the 14th Challenge Cup Chinese College Student Entrepreneurship Competition, Jiangsu University also achieved a historic breakthrough by winning four gold medals and receiving the Excellence Cup for the first time.

4.1.2 Guangxi Vocational and Technical College of Manufacturing Engineering: Systematic talent cultivation through the "three-stage, three-dimensional, three-integration" model

In response to the demand for intelligent agricultural machinery talent in hilly and mountainous regions, Guangxi Vocational and Technical College of Manufacturing

Engineering has developed a distinctive and systematic talent cultivation model characterized by the “three stages, three dimensions, and three integrations” [13]. The three-stage progression refers to a tiered pathway of competence development, moving from initial adaptation at the freshman stage, which emphasizes foundational cognition, to intermediate practice at the sophomore stage, which focuses on specialized skill acquisition, and ultimately to advanced breakthrough at the junior stage, which centers on comprehensive innovation. The three-dimensional immersion framework denotes the cultivation of students’ affective and value orientation through a progressive process of cognition, understanding, and identification, thereby deepening their commitment to agriculture, rural areas, and farmers. The three-integration synergy encompasses the coordinated integration of ideological and professional education, industry-education collaboration, and the fusion of disciplinary learning with innovation and entrepreneurship.

The effectiveness of this model is underpinned by strong platform support. The college has taken the lead in establishing a vocational education consortium comprising 63 participating units, thereby providing students with authentic practice environments. Over the past three years, students have won seven national level awards and 25 first prizes at the provincial or ministerial level, while also developing 15 small scale intelligent agricultural machinery components tailored to hilly and mountainous areas, several of which have already been commercialized. Through this systematic design, the model has achieved a close alignment between talent cultivation and the specific needs of regional industries.

4.1.3 Hunan Agricultural University: Development of an ecological talent cultivation system based on “three-chain synergy”

Hunan Agricultural University approached talent cultivation from the perspective of ecosystem construction and developed an ecological education framework characterized by the coordinated interaction of the curriculum chain, resource chain, and scenario chain [14]. The curriculum chain was restructured by breaking disciplinary boundaries and introducing interdisciplinary, modularized courses. The resource chain was integrated through the joint establishment of research and development centers and practice bases with more than ten key regional enterprises, thereby incorporating authentic industrial projects and R&D resources into the educational process. The scenario chain was connected through the creation of a hybrid practical network that combined three application scenarios, four categories of research platforms, and five off campus bases. Within physical settings such as the Southern Intelligent Seedling Center, postgraduate students participated throughout the entire innovation process, spanning basic research to prototype testing.

The effectiveness of this framework is reflected in its high quality outputs. Over the past five years, the university has successfully commercialized 12 technological achievements, provided services to more than 30 enterprises, and enabled students to secure 15 national level awards in innovation and entrepreneurship competitions. This framework has thus fostered a virtuous cycle in which research enriches teaching, while teaching, in turn, advances industrial development.

4.2 Quantitative Analysis of Implementation Outcomes

Following a full cycle of reform practice from 2019 to 2023, a quantitative assessment was conducted on the key indicators of the three aforementioned institutions, with the results presented in Table 2. The data indicate that all three institutions achieved substantial improvements across multiple dimensions, including talent cultivation, scientific and technological innovation, and social service capacity [15].

A close examination and comparative evaluation of these three representative cases yield several major findings. First, the depth of industry-education integration largely determines the precision and effectiveness of talent cultivation. The success of all three cases can be attributed to their ability to dismantle the conventional separation between universities and enterprises and to advance from loose cooperation toward substantive integration. Whether through the long term on site practice model adopted by Jiangsu University, the consortium based educational framework developed by Guangxi Vocational and Technical College, or the resource sharing chain established by Hunan Agricultural University, the underlying logic is consistent: frontier industrial demands, technological resources, and authentic practice scenarios were embedded throughout the entire process of talent development. Second, systematic design constitutes the critical safeguard for the effectiveness of reform. A successful cultivation model does not rest on isolated improvements in a single component; it depends on top level design and comprehensive structural reconfiguration. The “three-stage, three-dimensional, three-integration” model of Guangxi Vocational and Technical College is a representative example, as it systematically planned the pathways of competence progression, value cultivation, and resource coordination, thereby ensuring both the rigor and integrity of the educational process. Third, serving regional industrial development remains the institutional foundation of local universities. The reforms implemented by all three institutions were closely aligned with the distinctive characteristics of regional agriculture. This alignment sharpened the objectives of talent cultivation, strengthened graduate employability, and made the contribution of these institutions to regional agricultural modernization more direct and more substantial.

5. Conclusions

By examining the principal tension between the emerging competency requirements of smart agriculture and the conventional training paradigm adopted by local universities, this study developed and implemented a systematic innovation oriented practical talent cultivation model, from which the following conclusions can be drawn.

Table 2. Comparison of Key Indicators Reflecting Reform Outcomes at Three Institutions

Evaluation dimension	Specific indicator	Jiangsu University	Guangxi Vocational and Technical College of Manufacturing Engineering	Hunan Agricultural University
Talent cultivation quality	Graduate employment rate	95.2%	94.5%	93.8%
	Job relevance to the major	85.7%	87.2%	84.9%
	Employer satisfaction	91.5	92.1	90.3
Scientific and technological innovation outcomes	Key technological breakthroughs	45	15	38
	Student patents/publications	35/year	18/year	42/year
	Student competition awards	41/year	25/year	35/year
Faculty and resource development	Proportion of dual-qualified faculty	42.5%	68.0%	45.8%
	University-enterprise collaborative projects	68/year	45/year	52/year
Social service contribution	Area covered by technology extension	500,000 mu	12,000 mu	350,000 mu
	Annual industry-funded research income	6.5 million/year	2.8 million/year	5.8 million/year

The proposed model, centered on industry-education integration, project driven learning, and multidimensional collaboration, effectively addresses the core constraints currently facing agricultural machinery programs at local universities, including outdated curricula, weak practical training, a homogeneous faculty structure, and insufficient integration between education and industry. Through an integrated reform framework encompassing curriculum reconstruction, practical teaching optimization, faculty enhancement, and platform development, the model offers a viable pathway for the transformation and upgrading of agricultural machinery education in local institutions.

The model is grounded in authentic industrial demand, operationalized through comprehensive projects, and sustained by the coordinated participation of multiple stakeholders. Within this framework, students develop through learning by doing and learning through innovation, thereby promoting a substantive shift from knowledge transmission to competence cultivation. As a result, their innovative awareness, practical capability, and adaptability to industrial contexts are all markedly strengthened.

Evidence derived from representative cases and quantitative data further demonstrates that this model has generated substantial outcomes in improving graduate employment quality, stimulating innovation outputs, and enhancing social service capacity. It therefore exhibits considerable value for broader dissemination and application.

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References

[1] Zhao, C.J. Current status and future prospects of smart agriculture. Transactions of the Chinese Society for Agricultural Machinery, 2021, 52(1): 1-18.

[2] Li, D.L., Yang, H. Research on innovation in talent cultivation models for modern agricultural engineering majors. Research in Higher Education of Engineering, 2019(4): 45-50.

[3] Luo, X.W., Zang, Y., Zhou, Z.Y. Reflections and practice on cultivating innovative talents in agricultural engineering disciplines under the background of emerging engineering education. Transactions of the Chinese Society of Agricultural Engineering, 2020, 36(21): 307-314.

[4] Sun, X.B., Zhou, W.Q., Tang, H., et al. Exploration of an innovative teaching model for the agricultural mechanization curriculum under the “New Engineering + New Agricultural Sciences” framework. Heilongjiang Agricultural Sciences, 2024(7): 81-86.

[5] Yang X K, Ye K, Xu D J, Hu Y M. Research and practice on talent training mode of intelligent facility agricultural equipment: Case study of Beijing. Journal of Chinese Agricultural Mechanization, 2022, 43(5): 222-226.

[6] Wu M, Li D, Liu Y H, Zheng Z A, Wei Q. Cultivation and training of graduate students' engineering innovation ability under concept of “New Agriculture + New Engineering”: Taking cultivation of practical abilities for master's degree in Agricultural Engineering at China Agricultural University as an example. Agricultural Engineering, 2023, 13(12): 113-118. DOI: 10.19998/j.cnki.2095-1795.2023.12.019.

[7] Mandler A, Carabin G, Becce L, Nicolosi F F, Mazzetto F. Innovative engineering education in the wake of smart agriculture: revision of the agricultural engineering curriculum//Proceedings of the SEFI 2023 Annual Conference. 2023. DOI: 10.21427/0YDX-QG96.

[8] Zhang H, Wu L B, Wang J. Research on innovative models of industry-education integration to promote sustainable education in agricultural machinery majors. Sustainable Futures, 2025, 10: 101072.

[9] Huang, Y.X. Construction of a practical teaching system and platform for cultivating innovative talents in intelligent agricultural equipment. Agricultural Engineering, 2021, 11(3): 120-125.

[10] Wei, Q., Chen, Y.Q., Sui, B., et al. Exploration of cultivating new types of talents with knowledge of and commitment to agriculture, rural areas, and farmers in the context of a major agricultural nation. China Agricultural Education, 2023, 24(1): 1-8.

[11] Zhang H, Wu L, Wang J. Research on innovative models of industry-education integration to promote sustainable education in agricultural machinery majors. Sustainable Futures, 2025, 10: 101072.

[12] Soma T, Nuckchady B. Communicating the benefits and risks of digital agriculture technologies: perspectives on the future of digital agricultural education and training. Frontiers in Communication, 2021, 6: 762201.

[13] Zhang, H.P., Chen, X.Y. Cultivating modern agricultural equipment professionals through the “three-stage, three-dimensional, three-integration” model. Guangxi Daily, 2025-09-16.

[14] Bampasidou M, Salassi M, Zilberman D, et al. Overcoming ‘digital divides’: leveraging higher education to develop next generation digital agriculture professionals. Computers and Electronics in Agriculture, 2024, 226: 109406.

[15] Li, Z.H., Fu, P., Jiang, S.J., et al. Ideological and political guidance, coordinated advancement of the “three integrations,” and “four-dimensional” synergy: An innovative cultivation model for outstanding engineers in smart agricultural equipment at the College of Agricultural Engineering and Food Science, Shandong University of Technology. China Education Daily, 2025-06-03.