Exploration and Practice of Innovative and Entrepreneurial Talent Cultivation Path for Smart Agriculture under the New Agricultural Science Context

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Abstract With the deepening advancement of the new agricultural science strategy, the modern agricultural industry is accelerating its transformation toward intelligent and precision paradigms. As the core pillar of the new agricultural science system, the smart agriculture major imposes stricter standards on the knowledge structure, practical skills, and innovative thinking of talents with entrepreneurial and innovative qualities. In this paper, the smart agriculture major of Yulin Normal University is taken as the research object. Combining the requirements of new agricultural science construction with the development needs of Guangxi's regional agricultural industry, the current difficulties in cultivating innovative and entrepreneurial talents in the smart agriculture major are analyzed, and a talent cultivation practice path characterized by "guidance from new agricultural science, deep integration of industry and education, comprehensive empowerment of innovation and entrepreneurship, and precise regional adaptation" is explored, providing ideas for the reform of innovative and entrepreneurial talent cultivation in agricultural universities.

Key words New agricultural science; Smart agriculture; Innovative and entrepreneurial talents; Talent cultivation; Practical path

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The construction of new agricultural science is a core strategy implemented by the Ministry of Education to meet the needs of agricultural industry transformation and upgrading, and to comprehensively empower the rural revitalization strategy. The fundamental purpose of this initiative is to construct a new ecology of higher agricultural education that adapts to the evolution of modern agriculture through the systematic reshaping of disciplines and the iterative innovation of talent cultivation paradigms, and to cultivate a group of high-level composite talents with the characteristics of "knowing agriculture, loving agriculture, and promoting agriculture"[1]. At present, information technologies such as big data, artificial intelligence, the Internet of Things, and drones are deeply integrated with the entire agricultural industry chain. Smart agriculture has become the core driving force for the development of new agricultural science, gradually replacing traditional extensive production methods and giving rise to emerging industries such as precision irrigation, intelligent monitoring, smart breeding, and digital marketing[2]. In this macro context, there is an increasingly urgent demand from all sectors of society for composite smart agricultural talents with interdisciplinary knowledge architecture, excellent practical skills, and innovative and entrepreneurial spirit[3].

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As a key hub connecting the top-level planning of the new agricultural science and the practice of agricultural industry transformation, the quality and efficiency of talent cultivation in the smart agriculture profession directly constrain the progress of regional agricultural modernization and the implementation of rural revitalization strategies[4-5]. In 2022, the General Office of the Ministry of Education and four other ministries jointly issued the *Opinions on Accelerating the Construction of New Agricultural Science and Promoting Innovative Development of Higher Agricultural and Forestry Education*, which clearly emphasizes the need to deepen the integration of industry and education and the mechanism of school - enterprise cooperation, promote the organic connection between the education chain, talent chain and industry chain, innovation chain, and focus on strengthening students' practical ability and innovation literacy. As a local applied undergraduate institution, Yulin Normal University is based on the distribution pattern of characteristic horticultural crops in Guangxi and the current development status of smart agriculture. After being approved to establish a smart agriculture major, it adheres to the mission of "strengthening agriculture and promoting agriculture", and focuses on the cultivation of innovative and entrepreneurial talents. By deepening the reform of industry - education integration, it accelerates the construction of new agricultural science, and supports the construction of a strong agricultural country. Yulin Normal University is actively exploring the reconstruction of training mode, optimization of curriculum system, construction of practical platforms, and development of teaching staff,

and has initially condensed a new paradigm for cultivating innovative and entrepreneurial talents of smart agriculture with distinct regional characteristics.

1 Realistic demands and existing bottlenecks of cultivating innovative and entrepreneurial talents

1.1 Mismatch between the existing cultivation mode and the new agricultural science standards The training inertia of traditional agricultural science majors still exists, and smart agriculture majors in some universities are still trapped in the trap of "emphasizing theory over practice" and "emphasizing technology teaching over entrepreneurship and innovation incubation". Their talent training goals have not fully demonstrated the core concepts of "cross integration, practice orientation, and entrepreneurship and innovation guidance" advocated by the new agricultural science, and it lacks deep integration with the cutting-edge industries of smart agriculture[6]. At the same time, the mechanism of collaborative education between schools and enterprises is not yet sound, the endogenous motivation for enterprises to participate in talent cultivation is insufficient, and cooperation often remains at a superficial level of interaction. In the development of training programs, curriculum module settings, and practical arrangements, the failure to effectively incorporate enterprise job competency models and industry technology standards has resulted in graduates finding it difficult to match the actual job needs of the smart agriculture industry, highlighting the phenomenon of "learning-application disconnecting". This is significantly different from the fundamental purpose of the new agricultural science, which is to "serve the industry and empower rural areas"[7-8].

1.2 Response of the curriculum system to the demand for cross integration of new agricultural science lagging behind The current curriculum system for smart agriculture generally suffers from structural contradictions of "separation of agricultural technology" and lacks systematic interdisciplinary integration design. On the one hand, the proportion of traditional agricultural courses is too high, and new formats, technologies, and methods such as intelligent breeding, agricultural big data modeling, and intelligent irrigation system operation and maintenance have not been embedded in a timely manner. On the other hand, information technology courses are loosely integrated with agricultural production scenarios, with a focus on pure theoretical lectures and a lack of targeted agricultural application scenario design[9-10]. In addition, the entrepreneurship and innovation courses present fragmented characteristics and fail to achieve deep integration with the content of smart agriculture majors, making it difficult to effectively shape students' interdisciplinary application abilities and entrepreneurship and innovation thinking, which deviates from the original intention of the new agricultural science to build "interdisciplinary and industry – education integration"[11].

1.3 Insufficient support efficiency of practical teaching platform Practical teaching is a key link in cultivating innovative and entrepreneurial talents for smart agriculture under the background of new agricultural science. However, most universities currently face the dilemma of lagging behind in the construction of practical platforms. At the campus level, there is insufficient investment and a lack of complete hardware facilities such as intelligent greenhouses, agricultural IoT monitoring systems, big data analysis platforms, and intelligent agricultural machinery training centers, making it difficult for students to carry out systematic practical training. At the off campus level, the construction of practical bases has become superficial, mainly focused on visits and internships, lacking deep cooperation bases with leading enterprises and research institutes in smart agriculture[12]. Students find it difficult to participate in real production projects and research and development projects of enterprises, and cannot effectively integrate agricultural knowledge, information technology, and entrepreneurship and innovation practice, resulting in low effectiveness of practical teaching and failure to achieve the four-step progressive teaching goal of "basic experiments – professional training – innovative practice – entrepreneurial incubation".

1.4 A gap between the structure of the teaching staff and the demand for entrepreneurship and innovation training The teaching staff is a core element in ensuring the quality of innovative and entrepreneurial cultivation for smart agriculture under the background of new agricultural science. At present, there are three main shortcomings: firstly, teachers have a single disciplinary background, mostly originating from traditional agricultural majors, lacking experience in information technology application and practical experience in entrepreneurship and innovation, making it difficult for them to handle teaching tasks in the context of cross disciplinary integration. Secondly, the construction of "dual-qualified and dual-competent teacher" teaching staff lags behind, and there is a lack of two-way communication mechanism between schools and enterprises. Teachers are difficult to deeply understand the industry dynamics and job demands in the front line of smart agriculture, resulting in teaching content and methods deviating from the actual talent cultivation. Thirdly, there is a lack of part-time teachers with both profound industry experience and excellent teaching abilities, making it difficult to provide accurate guidance and technical assistance for students in entrepreneurship and innovation. As a result, a talent echelon pattern of "leading talents guidance, backbone support, and youth reserve succession" has not yet been formed[13].

2 Exploration and achievements in the practice of cultivating innovative and entrepreneurial talents

2.1 Innovating integration model of industry and education, in line with the new requirements of collaborative education in new agricultural science

2.1.1 Reshaping the positioning of talent cultivation goals. Following the outline of the new agricultural science construction and the demand for smart agriculture industry in Guangxi region, Yu-

lin Normal University has comprehensively revised the professional talent training plan and established the core training objectives of "understanding agriculture, being proficient in technology, being good at innovation and entrepreneurship, and being able to implement". This goal focuses on the characteristic fields of smart production, smart breeding, smart agricultural machinery and equipment, and agricultural digital marketing in Guangxi. It is committed to cultivating composite talents who can use smart agriculture technology to solve pain points of regional agricultural production and have excellent innovation and entrepreneurship capabilities. It ensures that the talent training standards resonate with the requirements of new agricultural science construction, and are accurately adapted to the needs of regional industrial development, thereby effectively promoting the modernization process of agriculture and the implementation of the comprehensive rural revitalization strategy in Guangxi.

2.1.2 Building a four in one integration model of "school – enterprise collaboration, job, course, competition and certification". It deepens strategic cooperation with smart agriculture research institutes, enterprises and institutions, signs industry – education integration agreements, jointly builds high-level talent training bases, and clarifies the division of rights and responsibilities between schools and enterprises in the process of education. Enterprises are deeply involved in the entire chain of talent cultivation, covering program development, curriculum development, teaching implementation, practical guidance, and assessment and evaluation, seamlessly integrating enterprise job requirements and vocational skill standards into various teaching modules. At the same time, using subject competitions as a carrier, and implementing the concept of "promoting learning and innovation through competitions", students' practical operation and innovative and entrepreneurial abilities are comprehensively enhanced, and a four in one integrated training model of "job, course, competition, and certification" is constructed. On this basis, a three-level education system consisting of "professional general education training + targeted job training + entrepreneurial practical incubation" is built. Drawing on advanced experience in the integration of industry and education in domestic and foreign universities, the trinity coordinated development of education, technology, and talent is promoted.

2.1.3 Promoting "order based" cultivation and innovative and entrepreneurial incubation mechanism. In response to the specific job requirements of enterprises, it jointly carries out an "order based" talent training project with partner enterprises, aiming to provide enterprises with composite professional talents who possess both capability of applying smart agriculture technology and innovative and entrepreneurial literacy. The goal is to accurately connect with the employment gap of enterprises, and simultaneously enhance the job adaptability and employment competitiveness of students. Based on high-level scientific research and innovation platforms such as the Guangxi Zhuang Autonomous Region Engineering Research Center of Facility Agriculture, Guangxi Key Laboratory of Smart Agriculture for Special Horticultural Crops, Academician Workstation, and Yulin Agricultural Product Production and Deep Processing Engineering Technology Center, a service ecology integrating project incubation, technical guidance, financial support, and site guarantee has been constructed. This mechanism encourages students to delve into the forefront of smart agriculture, conduct practical exercises such as intelligent greenhouse operation and maintenance, facility planting and breeding, agricultural product e-commerce live streaming, and smart production technology services, and promote the implementation of innovation and entrepreneurship projects from concept to reality, ultimately achieving a fully integrated development pattern of "teaching – production – innovation – entrepreneurship".

2.2 Refactoring the curriculum system of cross integration and innovation and entrepreneurship oriented new agricultural science

2.2.1 Building a four-dimensional curriculum framework of "foundation + core + cross disciplinary + innovation and entrepreneurship". Breaking through the disciplinary boundaries of traditional curriculum design, curriculum modules are reshaped according to the standards of new agricultural science construction, and a curriculum system with four dimensions organically coupled is constructed. The basic course modules focus on theoretical foundations such as mathematics, computer science, biology, and soil and fertilizer science, laying a solid foundation for the application of digital intelligence technology and innovation and entrepreneurship practice. The professional core module strengthens key courses such as Introduction to Smart Agriculture, Agricultural Internet of Things, Agricultural Big Data Analysis, Intelligent Agricultural Machinery Technology, and Smart Breeding, highlighting the regional characteristics of smart agriculture in hilly and mountainous areas of Guangxi. The cross integration module introduces emerging courses such as Agricultural Artificial Intelligence, Digital Agriculture Technology, Agricultural Product E-commerce Marketing, and Smart Agriculture System Design, promoting the deep penetration of agriculture and information technology. Drawing on the construction paradigm of "agricultural artificial intelligence +" at Huazhong Agricultural University, the layout of interdisciplinary fields is continuously optimized. The innovation and entrepreneurship course module covers topics such as innovation and entrepreneurship foundation, smart agriculture entrepreneurship practice, patent transformation, and agricultural project management, aiming to cultivate students' innovative thinking and business operation ability, achieve deep integration of professional knowledge, information technology, and innovation and entrepreneurship skills, and fully meet the construction demands of new agricultural science cross integration.

2.2.2 Driving course content iteration and teaching mode innovation. It should proactively benchmark the construction standards of new agricultural science and the new formats and technologies of smart agriculture industry, and dynamically update the course content. Embedding real enterprise projects such as intelligent greenhouse control, precision irrigation operation and maintenance, ag-

ricultural big data modeling, and intelligent agricultural machinery operation into teaching processes, it significantly enhances the pertinence and practicality of the curriculum, and accelerates the iterative upgrading of the textbook system. At the same time, it deepens the reform of teaching methods and comprehensively promotes project-based learning, case-based teaching, flipped classroom, and blended online and offline teaching models. Using real-life enterprise projects as a carrier, it guides students to participate in the entire process of project design, implementation, and review, and effectively hones their problem-solving skills and innovative thinking. Relying on online teaching platforms, it integrates high-quality smart agricultural resources, builds virtual training courses, improves teaching efficiency, and promotes the deep integration of agricultural science and artificial intelligence technology.

2.3 Consolidating the practical teaching platform and strengthening the support system for innovation and entrepreneurship

2.3.1 Building a digital and intelligent campus training base guided by new agricultural science. It increases investment in on campus practical platforms, and constructs high-standard on campus bases such as smart agriculture training centers, intelligent greenhouses, agricultural IoT laboratories, and big data analysis laboratories. The advanced digital and intelligent facilities such as IoT monitoring systems, intelligent irrigation equipment, big data analysis software, drones, and intelligent agricultural machinery are configured to provide students with a systematic practical training and innovative and entrepreneurial simulation environment. It enables students to engage in practical activities such as smart planting, intelligent monitoring, and big data analysis on campus, achieving seamless integration of theory and practice, constructing a practical carrier of "on campus training + simulated entrepreneurship", and comprehensively improving the functions of the on campus platform.

2.3.2 Optimizing the collaborative construction system of off campus practice bases. It deeply integrates high-quality resources from cooperative enterprises and research institutes, and builds an off campus practical teaching network covering multiple dimensions such as smart production, intelligent breeding, agricultural machinery and equipment, and digital agriculture. By formulating clear practical teaching content and standards, and guiding students to conduct on-the-job internships and project practical exercises in the front line of enterprises, enabling them to directly participate in real production scenarios such as smart greenhouse control, agricultural big data mining, and intelligent agricultural machinery operations, and strengthening students' practical abilities and job competency. At the same time, enterprise technical backbones are selected as practical mentors, implementing "one-on-one" technology teaching and innovation and entrepreneurship guidance, and bridging the "last mile" of scientific research achievements from the laboratory to the field. By utilizing platforms such as co built scientific research platforms, "science and technology backyards," and industry – university – research cooperation projects, it promotes the comprehensive empowerment of talent cultivation throughout the entire lifecycle of practical bases.

2.3.3 Building a diversified platform to enhance the effectiveness of entrepreneurship and innovation. Based on the advantages of the innovation and entrepreneurship college and the smart agriculture major in Yulin Normal University, it builds a high-level innovative and entrepreneurial practice platform, regularly holds smart agriculture innovation competitions, intelligent agricultural machinery skills competitions, and other events, and encourages students to form teams to participate, thereby stimulating their innovative thinking and entrepreneurial potential. It collaborates with local governments and industry leaders to carry out innovation and entrepreneurship training of smart agriculture, seed project incubation, and subject competitions, vigorously support students in applying for college students' innovation and entrepreneurship training programs, promote the transformation of creative ideas into physical projects, accelerate the output and transformation process of scientific research results, and comprehensively improve the overall quality of innovation and entrepreneurship practice.

2.4 Accurately connecting with the industry demand for cultivating innovative and entrepreneurial talents in new agricultural science

2.4.1 Consolidating teachers' cross disciplinary competence and innovative and entrepreneurial guidance ability. It develops a systematic teacher improvement plan, regularly organizes teachers to participate in specialized training and academic exchanges in the fields of new agricultural science construction, smart agriculture, artificial intelligence, and innovation and entrepreneurship, and supports and motivates teachers to obtain relevant vocational skill qualification certifications. Relying on the school – enterprise cooperation platform, a teacher practice training base is jointly built, and backbone teachers are regularly selected to work in cooperative enterprises for training, deeply participate in the technical research and operation management of smart agriculture projects, and accumulate front-line experience in industrial practice. It focuses on improving information technology application capabilities and the professional level of innovation and entrepreneurship guidance, and gradually builds a "dual-qualified and dual-competent" high-quality teaching staff team. As of now, more than 80% of the full-time teachers in this major have obtained doctoral degrees or possessed the "dual-qualified and dual-competent" qualification. The high-quality faculty configuration provides a solid guarantee for talent cultivation, achieving a systematic adaptation of the teacher's ability structure to the development needs of new agricultural science. By deepening the comprehensive reform of industry – education integration, significant achievements have been made in key areas such as smart planting, intelligent breeding, high-value utilization of agricultural products, and facility agriculture. The quality of talent cultivation is highly compatible with the strategic goal of "strengthening agriculture and promoting agriculture" in the new agricultural science.

2.4.2 Cultivating high-level interdisciplinary and innovative and entrepreneurial talents. It intensifies efforts to attract and cultivate talents, with a focus on attracting high-level talents who have interdisciplinary backgrounds in smart agriculture, rich experience in information technology application, and excellent innovative and entrepreneurial backgrounds and senior technical backbones from enterprises, to enrich the reserve pool of teaching staff. At the same time, enterprise technology experts and industry leaders are hired as part-time teachers, to deeply participate in course teaching, practical guidance, and project incubation work. A dual teacher teaching team of "full-time teachers on campus + specially appointed experts from enterprises" is built, providing solid teacher qualifications for the cultivation of innovative and entrepreneurial talents and helping to form a talent echelon of "leading talent leadership, backbone support, and youth reserve succession".

2.4.3 Deepening the mechanism of integrating industry and education. It encourages teachers to apply for educational reform and research projects related to the integration of industry and education, innovation and entrepreneurship education, and the construction of new agricultural science. It supports teachers to conduct in-depth research on the cultivation of innovation and entrepreneurship talents in smart agriculture, and explore reform paths for teaching methods, curriculum systems, and practical models. It adheres to the principle of "promoting education through research", improves the quality of talent cultivation, promotes the deep development of industry – education integration, and strengthens the supporting role of scientific research in teaching. At present, stable cooperative relationships have been established with 35 enterprises and research institutes, and multiple practical teaching bases have been jointly built. The "order based" training mode has been explored, and the school – enterprise collaborative education mechanism is becoming increasingly perfect. The enthusiasm of enterprises to participate has significantly increased, and a good situation of "school – enterprise cooperation, complementary advantages, and mutual benefit and win-win" is formed. In collaboration with Guangxi Academy of Agricultural Sciences, Guangxi Special Crop Research Institute, and Guangxi Xinjiaheng Agricultural Technology Service Co., Ltd., the Guangxi Key Laboratory of Smart Agriculture for Special Horticultural Crops and the Guangxi Zhuang Autonomous Region Engineering Research Center of Facility Agriculture have been jointly established, to carry out research and development of intelligent irrigation, intelligent breeding, and intelligent production technologies, and to provide dual support of talent and technology for industrial quality and efficiency improvement, promoting the transformation of industry – education integration from simple "cooperation" to deep "symbiosis".

2.4.4 Continuously enhancing professional influence. Thanks to the deepening of the integration of industry and education reform, the curriculum system, practical platform, and teaching staff of this major have been significantly optimized. This smart agriculture has become the core supporting major of the agricultural master's program, with multiple research platforms such as the Guangxi Key Laboratory of Smart Agriculture for Special Horticultural Crops, the Guangxi Zhuang Autonomous Region Engineering Research Center of Facility Agriculture, the Academician Workstation, and the Yulin Engineering Technology Center for Agricultural Product Production and Deep Processing, forming an advantageous discipline of agriculture in Guangxi Plateau (first-class discipline). The regional competitiveness and influence of the major continue to rise, providing strong talent and technical support for the transformation and upgrading of smart agriculture industry and rural revitalization in Guangxi. It has been unanimously recognized by local governments and industry enterprises, effectively promoting the modernization process of agriculture in Guangxi.

3 Conclusion

Against the backdrop of the deepening of the new agricultural science construction strategy, the Smart Agriculture major at Yulin Normal University has explored and constructed an innovative and entrepreneurial talent training model with the core features of "new agricultural science as the guide, deep integration of industry and education, comprehensive empowerment of innovation and entrepreneurship, and precise regional adaptation". This model has expanded the theoretical connotation and practical boundaries of industry – education integration, achieved certain practical results, and effectively improved the quality of talent cultivation. However, there is still significant room for improvement in the coverage breadth and implementation depth of the innovative and entrepreneurial talent training model from the perspective of industry – education integration. In the future, the smart agriculture major should closely align with the needs of industrial evolution, transformation and upgrading, comprehensively deepen the mechanism of industry – education collaboration and school – enterprise linkage, continuously improve the interdisciplinary comprehensive literacy of the teaching staff and the professional ability of entrepreneurship and innovation guidance, and continuously enhance the pertinence and effectiveness of talent cultivation, thereby providing more high-quality applied entrepreneurship and innovation talents for the high-quality development of the smart agriculture industry and the implementation of the comprehensive rural revitalization strategy.

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