Research on the Training Path of Compound Talents Based on Smart Agriculture

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Abstract: This study aims to explore the training paths for compound talents in the context of smart agriculture to meet the needs of modern agricultural development. As global agriculture progresses towards intelligent and precise methodologies, the development of smart agriculture requires professionals with multidisciplinary knowledge and skills. Training such compound talents has become a significant challenge in global agricultural education. Therefore, this research is based on the technological characteristics and industrial demands of smart agriculture, utilizing methods such as literature analysis and expert interviews to analyze the current state and existing issues of talent cultivation in smart agriculture. The research process first systematically sorts out the core elements of smart agriculture technology, clarifying the specific needs of intelligent devices, big data analysis, and IoT applications in modern agriculture. Next, through comparative analysis of educational models in agricultural colleges at home and abroad, it discusses the advantages and shortcomings of the current education system in multidisciplinary integration and practical ability cultivation. The study finds that the development of smart agriculture requires breaking through the disciplinary barriers of traditional agricultural education, emphasizing the importance of interdisciplinary curriculum design and practical teaching to cultivate students' comprehensive application abilities and innovative thinking. Additionally, it suggests strengthening cooperation between schools and industries, establishing practical bases that integrate production, education, and research, providing students with real industry experiences and project practice opportunities. The research concludes that promoting the cultivation of compound talents requires support from educational policies and optimized resource allocation, proposing specific implementation strategies and paths to provide theoretical support and practical guidance for educational reform and development in smart agriculture.

Keywords: Smart Agriculture; Compound Talent; Educational Reform; Interdisciplinary Integration; Industry-Academia-Research Collaboration

1. Introduction

1.1 Research Background and Significance

Smart agriculture, as an important path for the modernization of traditional agriculture, is redefining agricultural production methods globally. With the increase in global population and the intensification of resource constraints, agricultural production must not only ensure increased yield but also consider environmental protection and sustainable resource utilization. Smart agriculture achieves precision and intelligence in agricultural production by integrating cutting-edge technologies such as the Internet of Things, big data, and artificial intelligence. This modern agricultural model not only improves production efficiency but also reduces the use of chemical inputs, minimizing environmental impacts. The rise of smart agriculture urgently requires a new knowledge system to support it, demanding that agricultural practitioners possess comprehensive capabilities across various fields.

In this context, cultivating compound talents that adapt to the development of smart agriculture has become an important task for educational reform in various countries. Compound talents can effectively integrate multidisciplinary knowledge and flexibly apply

technology to enhance agricultural production efficiency. This training not only promotes technological progress in agriculture but also facilitates the transformation and upgrading of the rural economy. Therefore, researching the training paths for compound talents in the context of smart agriculture holds significant theoretical value and practical significance.

1.2 Research Objectives and Questions

This study aims to construct a complete training path for compound talents in smart agriculture to address the increasingly complex technical demands of modern agriculture. Specific research questions include: first, how to define the knowledge and skill requirements for compound talents in smart agriculture; second, what existing successful models and experiences are there in domestic and international talent cultivation in smart agriculture; and third, how to construct an effective compound talent training system within China's educational environment. Addressing these questions will provide a scientific basis for the cultivation of compound talents in smart agriculture and offer references for educational reform and policy formulation.

1.3 Review of Domestic and International Research Status

As a frontier field in modern agricultural development, smart agriculture has garnered widespread attention and research globally. Internationally, the development of smart agriculture mainly focuses on technological innovation, data-driven agricultural management, and sustainable agricultural practices. Developed countries such as the United States, the Netherlands, and Japan have been at the forefront of smart agriculture development, promoting production efficiency and sustainability through advanced technological means and management models. Based on technologies like IoT, big data, and artificial intelligence, smart agriculture has made significant progress in precision agriculture, intelligent irrigation, and drone monitoring.

For instance, the application of meteorological big data in the United States has been widely utilized in agricultural production, allowing farmers to better plan planting activities through precise analysis of meteorological data, thereby reducing losses caused by natural disasters. The application of this technology plays an important role in agricultural production, enhancing not only production efficiency but also the resilience of agriculture (Luo Zizhi et al., 2024). Additionally, European countries have also been at the forefront of optimizing agricultural information service systems, with their agricultural information services deeply integrated into various aspects of agricultural production, enhancing the precision of agricultural management (Zhuang Wenhui, 2023).

In China, research on smart agriculture has received high attention from both the government and academia in recent years, especially under the national "Rural Revitalization" strategy, where smart agriculture is viewed as an important means to enhance agricultural productivity and achieve modernized agriculture. The development of smart agriculture in China faces many opportunities and challenges, among which talent cultivation is considered a key issue. Smart agriculture requires not only traditional agricultural skills but also the ability to utilize information technology. Therefore, the cultivation of compound talents has become an important support for the development of smart agriculture (He Ting, 2021).

Domestic research mainly focuses on the following aspects: first, exploring smart agricultural management models aimed at changing traditional agricultural production methods through technological means to improve efficiency and sustainability. Researchers have proposed various information technology-based management strategies to address the challenges faced in current agricultural production (Ge Jing, 2017). Second, studies on the impact of smart agriculture on agricultural economic growth have empirically analyzed how smart agricultural technologies can enhance agricultural production efficiency and proposed corresponding policy recommendations (Lü Ting, 2021).

The cultivation of compound talents is a key link in the development of smart agriculture. Internationally, the training of compound talents is often achieved through interdisciplinary integration, emphasizing educational models that cross multiple disciplines to address the complexity and diversity of modern agriculture (Zhu Shuai Meng et al., 2023). On this basis, curriculum design includes not only agricultural

sciences but also knowledge from information technology, management, and environmental sciences to cultivate high-end agricultural talents with comprehensive qualities.

China has also made certain progress in the research and practice of cultivating compound talents in smart agriculture. Studies indicate that the "Agricultural Science + Law" and "Law + Agricultural Science" compound talent training models have achieved good results in practice, with graduates demonstrating strong adaptability in agricultural management and policy formulation (Cheng Liang, 2022). Vocational colleges play an important role in cultivating talents for smart agriculture by strengthening practical teaching and school-enterprise cooperation, thereby training a group of high-quality labor talents with technical operation capabilities and innovative awareness (Deng Mingming and Zhang Yue, 2023).

Currently, the development of smart agriculture is not only a technical issue but also a hot topic in society and policy. Under the guidance of the "carbon neutrality" goal, smart agriculture is endowed with more social responsibilities. Research shows that the application of smart agricultural technologies can effectively reduce carbon emissions in agricultural production, achieving green development (Zhang Yu and Yang Ping, 2023). This aligns closely with the national "dual carbon" strategy, and the contribution of the agricultural sector to energy conservation, emission reduction, and efficient resource utilization is increasingly being emphasized.

Furthermore, the development of smart agriculture is closely related to the rural revitalization strategy. By promoting smart agricultural technologies, the productivity level in rural areas and the income of farmers have been enhanced, thereby driving the comprehensive development of the rural economy and society (Zhou Nannan, 2022). This also reflects the spirit of the Two Sessions, where national policy support provides a solid guarantee for the development of smart agriculture.

In the future, the development of smart agriculture will require more support from compound talents, necessitating deep reforms in the talent cultivation system by educational and research institutions. Drawing on international experiences, China can further strengthen interdisciplinary collaboration in the cultivation of compound talents in smart agriculture, develop a systematic curriculum, and promote deep cooperation between universities and enterprises to form an integrated model of production, education, and research (Gao Anchong et al., 2021).

On the policy level, encouraging innovative practices and application-oriented educational reforms, incorporating smart agricultural talent cultivation into the national talent strategy, and supporting higher education and vocational education institutions in continuous investment in teacher training, curriculum development, and equipment input is essential. At the same time, utilizing modern technological means such as big data and artificial intelligence to create education and training platforms that adapt to future agricultural development will enable precise and personalized talent cultivation (Liu Yaohan, 2020).

In summary, the development of smart agriculture requires joint efforts both domestically and internationally, with the cultivation of compound talents being a crucial aspect. Influenced by social hotspots and policy directions, smart agriculture will develop towards a more efficient and sustainable direction, and related research and practice will continue to deepen, providing new models and experiences for the modernization of global agriculture.

2. Technical Characteristics and Industrial Demand of Smart Agriculture

2.1 Core Technological Elements of Smart Agriculture

Smart agriculture integrates various advanced technologies to achieve automation and precision management in agricultural production. The Internet of Things (IoT) technology enables real-time monitoring of the growth environment of crops through sensor networks, significantly improving the accuracy and timeliness of data collection. Big data analytics utilizes cloud computing platforms to process vast amounts of agricultural data, providing a scientific basis for farmland management decisions. The application of artificial intelligence technology is reflected in the establishment of crop growth models, pest and disease identification, and prediction, which enhances both the yield and quality of crops.

Additionally, the application of drone

technology in smart agriculture is becoming increasingly widespread. Through aerial imaging analysis, it can efficiently monitor the growth status and environmental changes of large areas of farmland. The combination of these technological elements not only has a profound impact on agricultural production methods but also raises higher demands for the knowledge and skills of agricultural practitioners.

2.2 Analysis of Modern Agriculture's Demand for Compound Talents

The rapid development of modern agriculture requires compound talents who can navigate multiple fields such as technology, management, and marketing. Compound talents should possess specialized knowledge in agricultural sciences, mastery of information technology applications, familiarity with modern agricultural management models, and interdisciplinary thinking abilities. Agricultural practitioners not only need to understand the production laws of traditional agriculture but must also be able to apply advanced technological means in practical production.

According to data from the World Bank, global agricultural technology investment is growing at a rate of 7% annually, indicating a sharp increase in market demand for high-end agricultural technology talents. Particularly in China, where the development of smart agriculture is still in its infancy, the lack of compound talents has become a bottleneck restricting industrial development. How to cultivate talents that meet market demands through systematic educational methods has become a pressing core issue.

3. Theoretical Foundations for Cultivating Compound Talents

3.1 Educational Philosophy of Multidisciplinary Integration

The cultivation of compound talents requires the education system to break down traditional disciplinary barriers and promote an educational philosophy of multidisciplinary integration. Smart agriculture involves multiple fields, including agricultural sciences, engineering technology, management sciences, and information technology. Students need to comprehensively master the fundamental knowledge and application skills of these fields during their learning process. Through interdisciplinary learning, students can establish connections between different knowledge domains, enhancing their ability to solve complex problems.

Educational theory research indicates that a multidisciplinary integrated teaching model can stimulate students' creativity and innovative thinking. Curriculum design should focus on the integration of theory and practice, cultivating students' comprehensive application abilities through project-driven, case analysis, and field research methods. This educational philosophy has been practically applied in agricultural colleges in some European and American countries, providing a model for cultivating future-oriented agricultural talents.

3.2 Knowledge Structure and Capability Requirements of Compound Talents

The knowledge structure of compound talents should include three levels: foundational, professional, and applied. At the foundational level, students need to master the basic principles and technical means of agricultural sciences. At the professional level, students should delve into specialized knowledge in specific areas such as crop cultivation, livestock management, and agricultural economics. At the applied level, students must possess the ability to comprehensively apply various technologies in agricultural production and management.

In terms of capability requirements, compound talents not only need solid professional knowledge and technical skills but also must possess certain management abilities and innovative awareness. This includes keen insights into agricultural markets, the ability to optimize production processes, and the capacity to quickly adapt to new technologies. To achieve this, the education system needs to provide diverse learning opportunities and practical platforms to support the comprehensive development of students.

4. Comparison of Domestic and International Talent Cultivation Models in Smart Agriculture

4.1 Analysis of International Education Models in Smart Agriculture

Internationally, the education model for smart agriculture has developed into diverse pathways, with typical representatives including the United

States, the Netherlands, and Japan. The agricultural education systems in these countries demonstrate strong adaptability and innovative awareness in responding to modern agricultural technological changes and market demands.

As the birthplace of precision agriculture, the United States places great emphasis on the integration of technology and agricultural sciences in its agricultural colleges' curriculum design. For example, the University of California, Davis, not only offers foundational science courses related to agriculture but also incorporates technical courses on IoT, big data analysis, and drone applications. Through comprehensive course learning, students can master skills from data collection to analytical application. Moreover, agricultural education in the U.S. emphasizes the combination of field operations and laboratory research, allowing students to participate in real agricultural projects to enhance their comprehensive abilities.

The Netherlands is renowned for its leading position in greenhouse cultivation technology and meticulous environmental management. In Dutch agricultural education, the close relationship between environmental science and agricultural production is emphasized. Wageningen University creates laboratories that simulate real agricultural environments, providing opportunities for multidisciplinary cross-research, helping students understand the practical needs of agricultural production while mastering theoretical knowledge.

Japan, on the other hand, introduces industry practice courses into higher agricultural education through cooperation between government and enterprises. Notable institutions such as the University of Tokyo and Hokkaido University collaborate with local enterprises to promote the application of smart agricultural technologies in education. Students not only learn the latest technological knowledge in school but also apply what they have learned in practical production through internships and collaborative projects. This model effectively enhances students' technical application abilities and shortens the gap between educational institutions and industry demands.

4.2 Current Status and Challenges of Agricultural Education in China

In recent years, China's agricultural education has made significant progress, but it still faces numerous challenges. As an emerging field, smart agriculture-related courses in most institutions have not yet been systematically and standardized designed. Currently, the curriculum in domestic agricultural colleges primarily focuses on traditional agricultural sciences, with a low prevalence of courses in information technology and engineering, leading to difficulties for students in integrating interdisciplinary knowledge.

Additionally, the disconnect between education and practice is also prominent. Although many colleges have established experimental farms and laboratories, the modernization level of these facilities is relatively low, making it difficult to meet the teaching needs of smart agriculture. The cooperation between schools and industries often remains at the theoretical level, lacking in-depth project collaboration and practical base construction. As a result, graduates may possess theoretical knowledge but often lack problem-solving abilities when faced with actual agricultural production issues.

In terms of educational resource allocation, there is insufficient investment in research and teaching related to smart agriculture, and teachers have limited opportunities for training in new technologies. These factors collectively restrict the quality of talent cultivation in domestic smart agriculture. Therefore, optimizing curriculum design, enhancing practical teaching, and improving educational effectiveness through policy support and resource allocation have become urgent key issues to address.

5. Constructing the Training Path for Compound Talents in Smart Agriculture

5.1 Design of an Interdisciplinary Curriculum System

The first step in constructing a training path for compound talents in smart agriculture is to design an interdisciplinary curriculum system. This curriculum should encompass various fields, including agricultural sciences, information technology, environmental sciences, and management. By setting up comprehensive courses, students can engage with and master the core knowledge of different disciplines during their learning process.

In the specific implementation process, curriculum design should emphasize the integration of theory and practice. It is

recommended to introduce case-based teaching methods and project-oriented learning into the curriculum to stimulate students' interest and creativity. By analyzing actual agricultural cases, students can understand the applications of smart agricultural technologies in different contexts. Additionally, project-oriented learning allows students to develop teamwork and problem-solving abilities while completing real projects.

5.2 Practical Teaching and Capability Development

Practical teaching is the core link in cultivating compound talents. In smart agriculture education, it is essential to strengthen the combination of laboratory teaching and field practice. Schools can establish modern agricultural practice bases, such as smart greenhouses and intelligent farmland, to provide students with authentic practical environments. In such environments, students can apply what they have learned in class to practice and discover problems through observation and experimentation, seeking solutions.

At the same time, school-enterprise cooperation is an important way to address the shortcomings of practical teaching. By collaborating with agricultural enterprises and technology companies, schools can offer internship and employment opportunities for students. During internships, students can access the latest technological equipment and management models, enhancing their practical skills. Furthermore, encouraging students to participate in enterprise R&D projects not only improves their technical application abilities but also enhances their understanding of and adaptability to the industry.

5.3 Construction of Practice Bases Combining Production, Education, and Research

The construction of practice bases that integrate production, education, and research is a crucial support for cultivating talents in smart agriculture. By integrating resources from universities, research institutions, and enterprises, the organic combination of teaching, research, and production can be achieved. Schools can jointly build laboratories and internship bases with enterprises, while research institutions can provide technical support and guidance, and enterprises can offer market demands and application scenarios.

This cooperation model not only enhances the effectiveness of teaching but also promotes the transformation of scientific and technological achievements. Students participating in project R&D in the bases can not only develop practical abilities but also provide technical support to enterprises, achieving a win-win situation. Through the construction of practice bases, schools can continuously update curriculum content and keep pace with industry developments.

6. Educational Policies and Resource Optimization

6.1 Support and Assurance from Educational Policies

The cultivation of compound talents in smart agriculture requires support and guidance from policies. The government should introduce relevant policies to encourage and fund universities to develop courses and research projects related to smart agriculture. Through policy guidance, deep cooperation between universities and enterprises can be promoted, facilitating the dissemination and application of smart agricultural technologies.

Additionally, the government can establish special funds to support education and research in smart agriculture. By investing funds, the conditions for teaching facilities can be improved, and the technical proficiency of teachers can be enhanced, creating a favorable environment for the cultivation of talents in smart agriculture. Policy support not only ensures the supply of talents for smart agriculture but also promotes the overall development of the industry.

6.2 Strategies for Optimizing Educational Resource Allocation

Optimizing the allocation of educational resources is key to enhancing the quality of talent cultivation in smart agriculture. Universities should reasonably allocate teaching resources and research capabilities based on their characteristics and industry demands. In terms of curriculum design, it is important to focus on resource sharing and collaborative development across different disciplines to avoid redundant construction and resource wastage.

Teacher training and continuing education are

also important aspects of resource optimization. By organizing technical training and academic exchanges for teachers, their professional levels and teaching abilities can be improved. Furthermore, encouraging teachers to participate in enterprise projects and research activities can enhance their practical experience and provide rich case materials for teaching.

7. Conclusion

The research indicates that the cultivation of compound talents in smart agriculture requires comprehensive reform in educational models, curriculum systems, practical teaching, and policy support. Successful experiences from advanced international education models demonstrate that interdisciplinary integration and practice-oriented teaching methods are effective paths for cultivating talents in smart agriculture. Although domestic efforts in this area have started later, optimizing the allocation of educational resources and deepening school-enterprise cooperation can significantly improve the quality of talent cultivation.

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