

Construction of a Whole-process Training Model for Agricultural Master's Degree in the Field of Food Processing and Safety under the Background of New Agricultural Science Empowered by Artificial Intelligence

Zhengen REN, Binbin LI, Xinhui WANG*

College of Food and Biological Engineering, Chengdu University, Chengdu 610106, China

Abstract Under the background of new agricultural science construction and the digital transformation of education, the cultivation of agricultural master's degree students in the field of food processing and safety faces practical problems such as insufficient cultivation of innovation ability, weak digital research ability, and a loose connection between practical education and industrial needs. Based on the OBE (Outcome-Based Education) concept and the theory of collaborative education, combined with the development background of artificial intelligence (AI) technology, an AI-empowered whole-process training model is constructed. Its operational mechanisms are proposed from the aspects of knowledge acquisition and research topic selection, research design and innovation training, data analysis and research expression, industrial practice and problem solving, as well as training quality evaluation. This model is conducive to enhancing graduate students' innovation ability, practical ability, and digital literacy, providing a reference for the innovation of agricultural master's degree training models under the background of new agricultural science.

Key words Artificial intelligence; New agricultural science; Agricultural master's degree; Food processing and safety; Whole-process training

DOI:10.19759/j.cnki.2164-4993.2026.04.011

In recent years, the rapid development of a new generation of information technology, represented by artificial intelligence (AI), has provided new technical support for the digital transformation of higher education and the innovation of talent cultivation models. Under the backdrop of the in-depth advancement of the strategy for building a strong agricultural country and rural revitalization, the construction of new agricultural science emphasizes promoting the deep integration of agriculture-related disciplines with modern information technology, and cultivating interdisciplinary agricultural talents with innovative spirit, practical ability, and digital literacy^[1-2]. Meanwhile, AI-empowered education has gradually become a research hotspot, and has achieved positive results in curriculum teaching reform, smart classroom construction and teaching evaluation optimization^[3-5]. However, existing studies have focused more on undergraduate education and single-course teaching scenarios, with relatively insufficient attention paid to the cultivation of professional degree graduate students, particularly the reform of the whole-process training model for agricultural master's programs. The agricultural master's degree program in the field of food processing and safety serves as an important talent cultivation carrier for modern agriculture and the food industry. As the food industry undergoes digital, intelligent, and high-quality development transformation, higher demands are placed on graduate students' innovation ability, practical ability,

and digital literacy^[6-7]. However, the current training process still faces problems such as low knowledge acquisition efficiency, insufficient scientific research innovation ability, weak data analysis ability, loose connection between practical training and industrial needs, and a relatively lagging evaluation system^[8]. Existing research has mainly focused on the construction of dual-mentor systems, practical base development, and industry-education integration training^[9-12]. However, research on how to apply AI technology to penetrate key links such as knowledge learning, research training, data analysis, industrial practice, and training evaluation and to construct a whole-process collaborative training model, remains relatively insufficient. Based on this, guided by the OBE (Outcome-Based Education) concept and the theory of collaborative education, this paper constructs an AI-empowered whole-process training model for agricultural master candidates in the field of food processing and safety, and proposes corresponding operational mechanisms, aiming to provide theoretical reference and practical guidance for the reform of agricultural master's degree training models under the background of new agricultural science.

Practical Dilemmas in the Cultivation of Agricultural Master's Degree in the Field of Food Processing and Safety under the Background of New Agricultural Science

Challenges in innovation ability training under the accelerated pace of knowledge updating

Under the background of new agricultural science construction, the field of food processing and safety is rapidly advancing

Received: March 27, 2026 Accepted: May 30, 2026

Zhengen REN (1994 -), female, P. R. China, assistant research fellow, devoted to research about food microbiology and microbial biotechnology.

* Corresponding author.

toward digitalization, intelligence, and interdisciplinary integration. The disciplinary knowledge system is characterized by rapid updates, strong cross-disciplinarity, and a large volume of information. Faced with massive amounts of research information, graduate students need not only to master professional knowledge, but also to possess the abilities of frontier tracking and knowledge integration. However, knowledge acquisition still mainly relies on supervisor recommendations and literature retrieval, and research training is largely supervisor-led. Graduate students have insufficient participation in key steps such as scientific problem formulation and innovative design. The traditional training model is no longer able to meet the demands of cultivating innovative talents.

Transition pressure on research ability training under the data-driven research background

With the rapid development of omics technologies, high-throughput detection technologies, and intelligent analysis technologies, research in food processing and safety is progressively entering the data-driven era, placing higher demands on graduate students' ability in data processing, statistical analysis, and result interpretation. However, some graduate students have a weak foundation in data analysis and the application of digital tools. Training evaluation still focuses primarily on course grades and research outputs, with insufficient attention given to digital literacy and innovation ability, making it difficult to adapt to the development needs of digital research.

Urgently needs for optimization of the practical training system under the background of industrial upgrading

The food industry is accelerating its transformation toward intelligent manufacturing, green processing, and high-quality development, placing higher demands on the practical ability of high-level applied talents. However, current practical teaching still relies mainly on laboratory research and short-term internships, with insufficient participation from enterprise mentors and loose connection between practical content and industrial needs. How to build a school-enterprise collaborative, industry-education integrated practical training system, and achieve deep integration of research training with industrial practice, has become an important direction for the reform of agricultural master's degree training.

Construction of an AI-empowered Whole-process Training Model for Agricultural Master's Degree in the Field of Food Processing and Safety

In response to the contemporary demands of building a strong agricultural country, new agricultural science construction, and the digital transformation of education, the training of agricultural master candidates in the field of food processing and safety is shifting from a knowledge-transmission orientation to a competency-development orientation. The development of AI technology provides new technical support for knowledge learning, research training, practical innovation, and training evaluation. Based on the OBE educational concept, guided by the achievement of training objectives, this paper constructs a whole-process training model covering training objectives, training process, training evaluation, and continuous improvement, with the whole-process training as the main line and AI technology as the support, so as to promote the synergistic enhancement of knowledge, ability and literacy.

Construction of a "four-dimensional integration" competency training system

Training objectives are the logical starting point for constructing a talent cultivation system. In accordance with the requirements of new agricultural science construction and the characteristics of talent demand in the field of food processing and safety, this paper constructs a "four-dimensional integration" competency training system, comprising professional knowledge competency, research innovation competency, practical application competency, and digital literacy competency (Table 1). Among these, professional knowledge competency forms the foundation of training; research innovation competency is the core of training; practical application competency reflects the characteristics of professional degrees; and digital literacy competency provides essential support for high-level talents in the digital era. The synergistic development of these four competencies together constitutes the training objective system for agricultural master candidates in the field of food processing and safety in the new era.

Table 1 Training objectives and AI-empowered pathways for agricultural master candidates in food processing and safety

Training objective dimension	Training connotation	AI-empowerment focus	Corresponding training stage
Professional knowledge competency	Mastery of the professional knowledge system in the field of food processing and safety, and understanding of the latest developments in the discipline	Intelligent literature retrieval, knowledge integration, hotspot analysis	Knowledge acquisition and research topic selection
Research innovation competency	Ability to identify problems, analyze problems, and conduct innovative research	Research design assistance, technical route optimization, innovative thinking training	Research design and innovation training
Practical application competency	Ability to solve practical problems in the food industry and serve industrial development	Enterprise case analysis, process optimization, decision support	Industrial practice and problem solving
Digital literacy competency	Ability to apply digital technologies in scientific research and practical activities	Data processing, statistical analysis, intelligent tool application	Data analysis and research expression

Construction of an AI-empowered whole-process training framework

The training of agricultural master candidates is a systematic

project that integrates knowledge learning, research training, and industrial practice in a coordinated manner. To address the problem of insufficient connection among the various stages in the

traditional training process, this paper constructs an AI-empowered whole-process training framework (Fig. 1), which divides the training process into five core stages: knowledge acquisition and research topic selection; research design and innovation training; data analysis and research expression; industrial practice and

problem solving; and training quality evaluation. AI runs through the entire training process, enabling the integration of training resources, the coordination of the training process, and the improvement of training quality, thereby promoting the organic unity of knowledge learning, ability cultivation, and competency development.

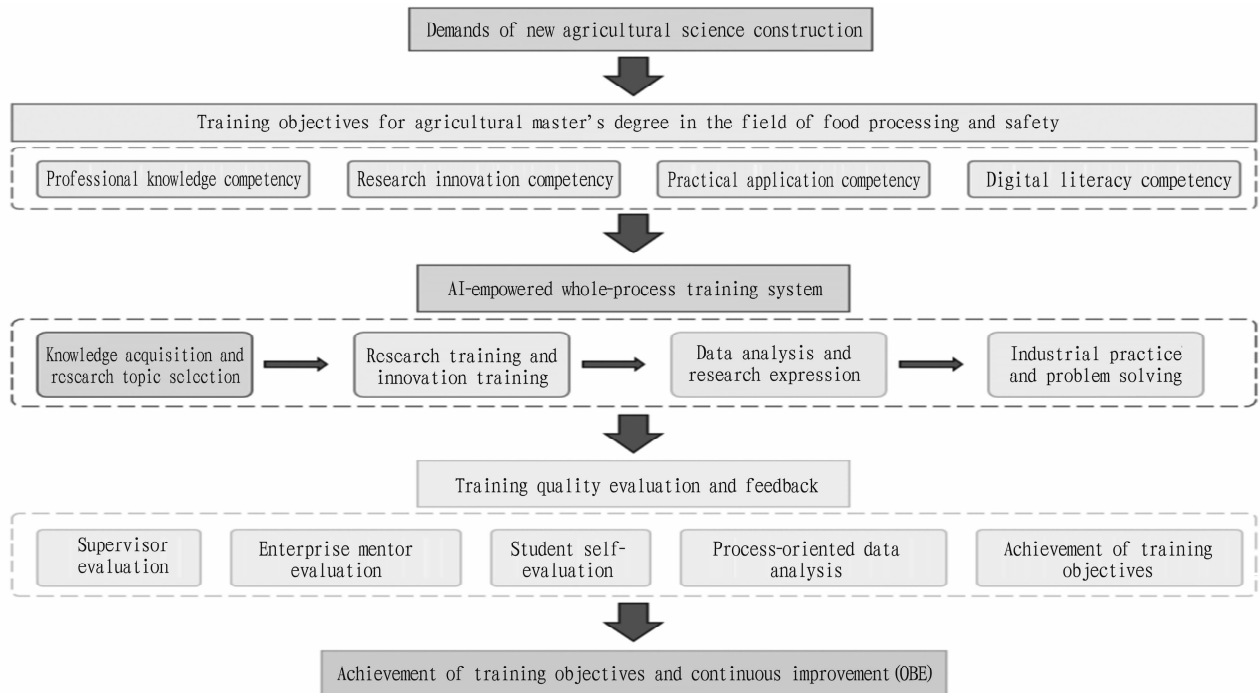


Fig. 1 AI-empowered whole-process training framework for agricultural master's degree in the field of food processing and safety

Construction of a whole-process competency growth chain

Based on the developmental patterns of graduate students, this paper constructs a whole-process competency growth chain covering knowledge learning, research training, and practical innovation. In the early stage of training, emphasis is placed on enhancing knowledge acquisition and problem-identification ability. During the research training phase, innovative thinking and research design abilities are strengthened. In the practical training stage, the focus is on improving complex problem-solving ability and industrial service ability. In the later stage of training, academic expression and outcome-translation abilities are enhanced. AI serves as a supporting tool throughout all stages of training, facilitating the continuous linkage and progressive development of competency cultivation, and promoting the transformation of graduate students from knowledge accumulation to ability enhancement.

Establishment of a competency-oriented evaluation system

Training evaluation is a critical component in ensuring the quality of talent cultivation. Based on the OBE educational concept, this paper constructs a competency-oriented whole-process evaluation system, extending the evaluation content to multiple dimensions, including knowledge acquisition competency, research innovation competency, practical application competency, and digital literacy competency. In terms of evaluation methods, a

dynamic evaluation mechanism combining pre-training, during-training, and post-training assessments is established. In terms of evaluation subjects, a multi-stakeholder evaluation system involving supervisors, enterprise mentors, and students is formed. Through evaluation feedback, the synergistic improvement of training objectives, training processes, and training evaluation is promoted, thereby achieving continuous enhancement of training quality.

Operational Mechanisms of the AI-empowered Whole-process Training Model

AI-empowered training of agricultural master candidate in the field of food processing and safety is not merely the application of technical tools, but a systematic transformation of training concepts, training methods, and the training ecosystem. To ensure the effective operation of the whole-process training model, operational mechanisms covering the entire graduate training process should be established around key stages such as knowledge learning, research training, practical innovation, and quality improvement, thereby achieving the synergistic optimization of training objectives, training processes, and training evaluation.

AI-empowered mechanism for knowledge acquisition and research topic selection

Knowledge acquisition and research topic selection mark the

starting point of graduate training. To address issues such as low efficiency in knowledge acquisition and insufficient innovation in research topic selection, an AI-assisted topic selection mechanism of "basic knowledge acquisition – research hotspot identification – scientific problem formulation – research topic optimization" can be constructed. Graduate students employ AI for literature retrieval, knowledge integration, and hotspot analysis, and identify research gaps and key scientific question under the guidance of their supervisors, gradually forming research ideas. Through the synergistic effect of AI assistance and supervisor guidance, the transition from knowledge acquisition to problem identification is achieved, enhancing the scientific rigor and innovativeness of research topic selection.

AI-empowered mechanism for research design and innovation training

Research design is a critical stage in the cultivation of innovation ability. To address the problem of insufficient student participation in traditional research training, a research training mechanism of "problem identification – AI-assisted scheme generation – student comparative analysis – supervisor optimization guidance – final scheme formation" can be constructed. Graduate students use AI to expand research ideas and compare technical routes, and complete the optimization of research plans under the guidance of supervisors. Through the construction of a student-led, supervisor-guided, and AI-assisted research training model, the cultivation of innovative thinking and the enhancement of independent research ability are promoted.

AI-empowered mechanism for data analysis and research expression

As research in food processing and safety gradually enters the data-driven era, data analysis ability has become an important component of graduate students’ core research ability. To address the problem of insufficient data analysis training, an AI-assisted training mechanism of "data organization – statistical analysis – result interpretation – research expression" can be constructed. AI assists graduate students in completing data organization, statistical analysis, and result visualization, and helps establish logical

connections between experimental results and scientific questions. Through the training model of "AI-assisted analysis – independent thinking by graduate students – supervisor review and quality control", graduate students’ digital research ability and academic expression ability are enhanced.

AI-empowered mechanism for industrial practice and competency enhancement

The cultivation of practical ability is a distinctive feature of agricultural master’s degree education. Relying on platforms such as university-industry cooperation bases, graduate practice bases, and science and technology backyards, a practical training mechanism of "industrial problem introduction – AI-assisted analysis – scheme design and optimization – enterprise verification and feedback" can be constructed. Enterprises bring real production problems into the training process, and graduate students employ AI to conduct case analysis and design technical solutions, continuously optimizing them during the practice process. Through the collaborative training of on-campus supervisors, enterprise mentors, and graduate students, the deep integration of research training and industrial practice is achieved, enhancing graduate students’ ability to solve complex industrial problems.

AI-empowered mechanism for continuous improvement of training quality

Continuous improvement is an important safeguard for the whole-process training model. Based on the OBE educational concept, a whole-process evaluation mechanism covering pre-training, during-training, and post-training is established, and an evaluation system centered on professional knowledge competency, research innovation competency, data analysis competency, practical application competency, digital literacy competency, and comprehensive development competency is constructed (Table 2). Meanwhile, a multi-evaluation mechanism combining supervisor evaluation, enterprise mentor evaluation, student self-evaluation, and process evaluation is established. Relying on AI technology, dynamic monitoring and feedback of the training process are achieved, forming a closed-loop management system of "evaluation-feedback-improvement" to promote continuous enhancement of training quality.

Table 2 AI-empowered whole-process training evaluation system

Primary indicator	Secondary indicators
Professional knowledge competency	Literature reading, knowledge integration, frontier tracking
Research innovation competency	Scientific problem formulation, research design, research output
Data analysis competency	Data processing, statistical analysis, result interpretation
Practical application competency	Enterprise practice, case analysis, problem solving
Digital literacy competency	AI tool application, digital research capability
Comprehensive development competency	Team collaboration, academic ethics, professional competence

Conclusions

Against the backdrop of building a strong agricultural country, new agricultural science construction, and the digital transformation of education, AI provides new opportunities for the innovation of agricultural master’s degree training models. Guided by the OBE educational concept and the theory of collaborative

education, this paper constructs an AI-empowered whole-process training model for agricultural master candidates in the field of food processing and safety, forming a training system covering knowledge acquisition and research topic selection, research design and innovation training, data analysis and research expression, industrial practice and problem solving, as well as continuous

improvement of training quality. A closed-loop operational mechanism of "training objectives – training process – training evaluation – continuous improvement" has been established. This model is conducive to promoting the synergistic enhancement of graduate students' knowledge, ability and literacy, providing a reference for the reform of agricultural master's degree training models under the background of new agricultural science. In the future, further empirical research should be conducted to continuously improve the operational mechanisms and quality assurance system of AI-empowered graduate training.

References

[1] HAN X, GUO FZ. Development motivations, comparative advantages, and empowerment pathways of China's new agricultural science education from a global perspective[J]. Journal of Northeast Agricultural University: Social Science Edition, 2026, 24(1): 90 – 99. (in Chinese).

[2] LI P. The internationalization of new agricultural education: Building China's advantages and cultivating competitiveness from a global comparative perspective[J]. Journal of Northeast Agricultural University: Social Science Edition, 2026, 24(1): 47 – 57. (in Chinese).

[3] WU GF, LYU GL, XUE WJ, *et al.* Exploration of innovative teaching models for genetics courses empowered by "AI + new agricultural science"[J]. Journal of Smart Agriculture, 2026, 6(9): 24 – 27. (in Chinese).

[4] SUN C, WANG JC, BI ZZ, *et al.* Reform and practice of AI-empowered ideological and political education in the *Molecular Biology* course under the background of "New Agricultural Science"[J]. Chinese Journal of Biochemistry and Molecular Biology: 1 – 12. (in Chinese).

[5] YU N. AI-empowered ideological and political teaching model and practice in

new agricultural science courses: A case study of the *Flower Arrangement and Floral Design* course[J]. Journal of Liaoning Teachers College: Social Sciences Edition, 2026, 28(2): 84 – 86. (in Chinese).

[6] XIAO JR, HUANG YW. A preliminary study on the practical education and training mechanism for agricultural master's degree students from the perspective of new agricultural science[J]. Jilin Education, 2026(11): 1 – 3. (in Chinese).

[7] GAO YS, LIU SW, LU LM, *et al.* Exploration of interdisciplinary integration teaching based on the cultivation of graduate students' scientific innovation ability in the context of new agricultural science[J]. Agricultural Technology and Equipment, 2026(2): 122 – 123, 126. (in Chinese).

[8] JIN SY, LUO S, WANG DY, *et al.* A Study on the problems and solutions in the cultivation of agricultural masters in food processing and safety[J]. Education Forum, 2024(25): 177 – 180. (in Chinese).

[9] WANG SN, CAO XH, YANG LN, *et al.* Exploration of master's degree cultivation mode of food specialties under the perspective of industry-education integration: Taking the food processing and safety major of Bohai University as an Example[J]. Farm Products Processing, 2025(18): 127 – 129, 136. (in Chinese).

[10] NIU GC, WANG CY, WEI WY, *et al.* Discussion on the training mode of "dual tutorial system" for full-time professional master degree in food processing and safety[J]. Farm Products Processing, 2021(20): 102 – 104. (in Chinese).

[11] YUN XY, RENQING KRL, CHEN YF, *et al.* Based on the practice base to explore the integrated training model of food processing and safety master's degree students[J]. Farm Products Processing, 2025(8): 130 – 132, 136. (in Chinese).

[12] SONG JJ, SUO HY. Problems and countermeasures in the industry-education integration training model for master's degree students in food processing and safety[J]. China Food Industry, 2023(22): 104 – 105, 108. (in Chinese).

Editor: Yingzhi GUANG

Proofreader: Xinxiu ZHU



(Continued from page 40)

[20] XU JS. Effects and mechanisms of polypropylene nanoplastics on biological nitrogen removal and microbial nitrogen metabolism[D]. Hefei: Anhui Jianzhu University, 2024. (in Chinese).

[21] WU T, DING J, ZHAO YJ, *et al.* Microplastics shaped performance, microbial ecology and community assembly in simultaneous nitrification, denitrification and phosphorus removal process[J]. Science of The Total Environment, 2024, 929: 172651.

[22] WANG CZ, WANG SW, LIAN DM, *et al.* Short-term effects of microplastics on the denitrification performance of anammox granular sludge and the inhibition kinetic analysis[J]. Water Treatment Technology, 2025, 51(11): 80 – 85. (in Chinese).

[23] ZHU Y, MA B, LI D, *et al.* The impact of microplastics and nanoplastics on biological nitrogen removal processes: Exacerbating the greenhouse effect[J]. Journal of Hazardous Materials, 2025.

[24] LIU YH. Mechanisms of the effects of polyethylene micro/nanoplastics on nitrogen removal performance of sequencing batch bioreactors[D]. Shenyang: Liaoning University, 2024. (in Chinese).

[25] LI L, HE P, LIU Y, *et al.* Mechanistic insights into the impact of multi-dimensional microplastic stress on nitrogen removal by heterotrophic nitrifying-aerobic denitrifying bacteria: A meta-transcriptomic analysis[J]. Journal of Environmental Management, 2025.

[26] SUN CL, ZHANG H, WU RX, *et al.* Mechanisms of polyethylene nanoplastics on biological phosphorus removal and microbial enzymes[J]. Water Treatment Technology, 2025, 51(5): 60 – 64. (in Chinese).

[27] ALFONZ KEDVES, MÁTÉ BALOGH, ZOLTÁN KÓNYA, *et al.* From

impact to restoration: Biodegradable polylactic acid microplastics in microalgal-bacterial granular sludge systems[J]. Process Safety and Environmental Protection, 2025, 204: 108146.

[28] WU RX. Response of extracellular polymeric substances and microorganisms in nitrogen removal systems under nanoplastics stress[D]. Hefei: Anhui Jianzhu University, 2024. (in Chinese).

[29] LI DY, LI JR, ZHU YH, *et al.* Effects of microplastics on substance transformation, sludge characteristics, toxicological effect, and microbial communities in different biochemical sludge systems: A review[J]. Critical Reviews in Environmental Science and Technology, 2024, 54(12): 931 – 952.

[30] ZHOU G, GAO J, HUANG X, *et al.* Response mechanism of sludge anaerobic fermentation on polyethylene terephthalate microplastic (PET-MPs) particle sizes[J]. Process Safety and Environmental Protection, 2025, 194: 1315 – 1324.

[31] KWIATKOWSKA K, ORMANIEC P. Analysis of the potential role of microplastics as transporters of microorganisms in activated sludge[J]. Desalination and Water Treatment, 2025, 322: 101124.

[32] LI D, LI J, LIANG D, *et al.* Effects of degradable and non-degradable microplastics on SPNEDPR-AGS system: Sludge characteristics, nutrient transformation, key enzyme, and microbial community[J]. Bioresource Technology, 2024, 418: 131917.

[33] YANG X, NIU S, LI M, *et al.* Leaching behavior of microplastics during sludge mechanical dewatering and its effect on activated sludge[J]. Water Research, 2024, 266: 122395.