



CULTIVATING CORE COMPETENCIES FOR AGRICULTURAL HUMAN CAPITAL: THE ROLE OF INDUSTRY-EDUCATION INTEGRATION IN CHINA

Yinjie Fang,^{1✉} Yijun Shi²

DOI: <https://doi.org/10.15294/jeec.v14i1.24548>

¹Administration Department, Zhejiang A&F University, Hangzhou, China

²School of Landscape Architecture, Zhejiang A&F University, Hangzhou, China

History Article

Received May, 7 2025
Accepted May, 17 2025
Published June, 26 2025

Keywords:

Industry-education
Integration, Agricultural
majors in China, Core
competencies, Human
capital, Rural
revitalization

Abstract

This study investigates the core competencies of agricultural undergraduates in China, aiming to improve their skills through industry-education integration. Using human capital theory, it analyzes the current status via literature review, surveys, and interviews, focusing on L University. Findings show students recognize their field's importance but lack career confidence and practical experience; only 25.5% have internships, and few faculty have industry experience. Gaps in social skills and psychological resilience are noted. To enhance competencies, strategies include creating a pro-agriculture atmosphere, deepening industry-education ties, boosting comprehensive training, and innovating evaluation. The study builds a competency model, highlighting fixed and growth competencies, enriching agricultural education theory. It stresses industry-education integration to meet talent demands for agricultural modernization and points to the need for more research on integration evaluation and context-specific characteristics.

© 2025 Universitas Negeri Semarang

✉ Correspondence address:
School of Landscape Architecture
Zhejiang A&F University, Hangzhou, China
E-mail: yijun_shi@zafu.edu.cn

p-ISSN 2301-7341
e-ISSN 2502-4485

INTRODUCTION

In the context of accelerating globalization, agricultural modernization has emerged as a central theme in global agricultural development. According to statistics from the Food and Agriculture Organization (FAO) of the United Nations, global investment in agricultural science and technology has maintained an annual growth rate of approximately 8% over the past decade, significantly boosting agricultural labor productivity. In developed countries, the contribution rate of agricultural science and technology often exceeds 70%. These statistics underscore the pivotal role of technology in the process of agricultural modernization, profoundly transforming agricultural production methods and business models, while also driving the optimization and upgrading of agricultural industrial structures (Bachano, 2021; Tefera & Awoke, 2025). In China, agricultural modernization similarly holds a prominent position and is undergoing vigorous development. In recent years, the Chinese government has prioritized the strategy of agricultural modernization, launching a series of policy initiatives aimed at advancing agricultural development. For instance, the "Strategic Plan for Rural Revitalization (2018-2022)" explicitly advocates for enhancing agricultural science and technology, strengthening the construction of agricultural innovation platforms, and fostering new types of professional farmers. By 2023, the comprehensive mechanization rate for planting, cultivating, and harvesting major crops in China had exceeded 73%, while agricultural informatization efforts have steadily progressed, with smart agriculture demonstration bases emerging across the country. These achievements underscore the significant effectiveness of China's agricultural modernization.

However, within this process, the shortage of skilled talent has gradually become a critical factor hindering the further development of Chinese agriculture (Lucki, 2024). To effectively address this challenge, the concept of industry-education integration has emerged as an innovative educational strategy. The integration of industry and education emphasizes the coordinated development of educational talent training and industrial economic benefits, aiming to combine the actual needs and experience of the industry with the educational resources and theoretical knowledge provided by universities (Zhang et al., 2024). Under this model, enterprises actively participate in the formulation of university curricula, talent cultivation programs, and practical teaching components, offering students real-world case studies, internship opportunities, and mentorship from industry experts. Universities, in turn, can adjust their teaching content to better align with industry demands, cultivating professionals who are more adept at meeting market needs. This approach accelerates the transformation and application of agricultural scientific achievements, thus promoting innovative development in the agricultural sector (Mulder & Biemans, 2018; Slijper et al., 2022; Yang & Lv, 2023).

Although China has gradually emphasized industry-education integration in the cultivation of undergraduate agricultural majors, it still faces significant challenges. Research indicates that, in the current undergraduate education of agricultural majors in China, approximately 60% of the curriculum remains focused on theoretical instruction,

with relatively limited emphasis on practical training. Furthermore, only about 30% of agricultural enterprises have established deep collaborative relationships with universities, with both the breadth and depth of university-industry cooperation requiring further expansion. Additionally, fewer than 20% of teaching faculty members possess substantial industrial experience, which to some extent hampers the effectiveness of industry-education integration. Considering these challenges, this study aims to explore the core competencies and educational framework that undergraduate students in agricultural majors in China should possess under the guidance of an integration of industry and education. This research not only contributes to the upgrading and sustainable development of China's agricultural industry but also provides valuable practical support and theoretical foundation for enriching and improving the theoretical system of agricultural education.

Higher agricultural education addresses agricultural development needs and is vital in practical education. Industry-education integration enhances its practicality, especially in agriculture (Wang, 2024). This section analyzes international experiences and China's status, highlighting the necessity and urgency of this integration for agricultural talent cultivation.

Research on the Integration of Industry and Education in Agricultural Higher Education

Integration Models

Scholars have explored various models of industry-education integration in higher agricultural education. The U.S. "land-grant college" model integrates education, research, and extension services to support local agricultural development (Kaplan, 2023; Anderson et al., 2024). Germany's "dual system" fosters deep collaboration between enterprises and institutions, with companies providing practical training and schools delivering theoretical instruction, producing skilled agricultural professionals (Yang & Lv, 2023). In the Netherlands, the "university of applied sciences" model emphasizes industry-aligned agricultural education (Mulder & Biemans, 2018; Slijper et al., 2022).

Policy Support and Mechanisms

Governments facilitate integration through laws, regulations, and fiscal policies. For instance, some EU countries offer tax incentives to encourage agribusiness-university collaboration (Qi et al., 2024). Industry associations serve as vital intermediaries. British research highlights the role of policy guidance, while German studies emphasize economic incentives driving enterprise participation to secure a skilled workforce (Ma & Zhou, 2018; Saroyan & Frenay, 2023).

Practical Effects and Influencing Factors

Integration significantly advances agricultural modernization by fostering innovations in science, technology, and production management, boosting productivity

and quality. Enterprise motivation is a key success factor, influenced by economic interests, talent needs, and prior university partnerships (Okubo et al., 2022). University research strength, educational quality, and stable government support also shape outcomes (Chen & Song, 2024).

Evaluating the Effectiveness

Australian scholars have developed multi-dimensional indicators—graduate employment quality, enterprise satisfaction, research conversion rates, and economic benefits to assess integration success (Li & Pilz, 2023). In the U.S., effectiveness is measured by the impact of research outcomes on local yields, quality, and cost reduction, affirming integration's value (Chen & Song, 2024).

China's Agricultural Higher Education Integration Research

Model Exploration and Innovation

Chinese universities have adopted diverse integration strategies. Some partner with leading enterprises to create industrial colleges, collaborating on curricula, training, and faculty development (Han, 2024). Others use "order-based" models, tailoring talent cultivation to enterprise needs (Li & Pilz, 2023). Additionally, institutions promote technology commercialization to upgrade the agricultural industry.

Dilemmas

Despite progress, industry-education integration in China encounters significant challenges. Research highlights a lack of cooperative motivation between enterprises and universities, with enterprises hesitant to participate due to risks of brain drain, technology leakage, and limited short-term economic gains (Han, 2024; Li & Pilz, 2023). Additionally, insufficient funding poses a critical barrier, as both on-campus teaching facilities and off-campus collaborations demand substantial investment, yet many universities face financial constraints and receive inadequate government support (Zhang, 2024).

Impact on Talent Training

Industry-education integration significantly enhances agricultural talent quality by bridging the gap between theory and practice (Chen, 2024). Through enterprise partnerships, students gain practical experience, master advanced technologies, and develop problem-solving and innovation skills, aligning their competencies with modern agricultural needs. Studies also indicate that participants in these programs exhibit stronger professional skills and adaptability, giving them a competitive edge in the job market and facilitating smoother career transitions (Zheng, 2024).

Policies and Mechanisms

National and local policies play a vital role in advancing industry-education integration in higher agricultural education, though challenges like poor publicity and

weak implementation persist (Li, 2024). Scholars stress the need for improved enforcement, oversight, and evaluation processes, alongside frameworks for benefit- and risk-sharing to clarify rights and obligations in university-enterprise collaborations (Xu et al., 2024). Such mechanisms are essential for sustaining effective partnerships.

Research on industry-education integration in higher agricultural education reveals valuable insights. International models provide useful references for China, despite contextual differences, while domestic studies explore integration's alignment with national agricultural goals (Luo et al., 2022). However, gaps remain, including the lack of rigorous evaluation systems and research on regional or institutional variations. Future efforts should focus on developing robust assessment methods and context-specific strategies to strengthen the quality and impact of these initiatives.

Theoretical Explanation and Model Construction for Core Competency Training of Agricultural Undergraduates in China

Higher education plays a crucial role in talent cultivation, tasked with producing high-quality agricultural scientific and technological professionals to support agricultural and rural development. Anchored in human capital theory, this study focuses on enhancing the quality of talent development in the agricultural sector. It analyzes the theoretical mechanisms behind core competency training for agricultural undergraduates and proposes a practical model for cultivating these competencies. The goal is to provide a framework for coupling the enhancement of talent development with the improvement of agricultural and rural service efficiency.

Fundamental Theory of Core Competency Training for Agricultural Undergraduates

Human capital theory treats human capital as an investment, emphasizing its role in promoting social and economic outcomes. According to this theory, individuals can enhance their knowledge and skills through education and training, thus improving both their own productivity and income, while contributing to broader economic development. From this perspective, the primary objective of human capital is to enhance the individual capabilities of workers (Bari et al., 2022). In the context of agricultural undergraduates, higher education plays a pivotal role in the development of these human capital assets. The quantity and quality of agricultural undergraduates directly influence their capabilities, and through educational investment, this can elevate their labor efficiency, ultimately promoting the development of agriculture and rural economies (Yang & Lv, 2023).

Thus, the improvement of higher education investment can follow two pathways: **(1) Increasing the total investment:** This involves boosting individual investment through incremental funding, thereby enhancing the human capital of agricultural undergraduates to meet the demands of agricultural and rural development; and **(2) Enhancing the quality of investment:** This pathway focuses on improving returns on investment by targeting precise and efficient allocation of resources, which in turn

elevates the human capital of agricultural undergraduates to better align with the evolving needs of the agricultural sector.

Both pathways ultimately aim to enhance human capital, but the key lies in the method of investment. Given the limitations in higher education funding and the relatively short time frame for training agricultural undergraduates, the most effective approach is a **targeted investment strategy**. This strategy involves identifying the core competencies to be developed and then streamlining resources and efforts to focus on these areas. By doing so, the quality of training is enhanced, maximizing the value-added benefits of human capital, and producing a workforce that is better suited to meet the current demands of agricultural and rural development.

The core competency theory for university students can be viewed as a form of personal competitiveness, stemming from the fusion of corporate competitive theory and educational success theory (Brundiers et al., 2021). The intersection between business (market) and education is most prominently seen in employment, which serves as the central connection between university education and the job market. Accordingly, this paper argues that the core competencies of agricultural undergraduates should be directly linked to their employability. In short, core competencies are the skills and abilities that enable graduates to achieve high-quality and full employment, while continuously creating greater value for related industries (Zhang et al., 2024). To secure such employment, graduates must not only possess the professional knowledge they acquire during their education but also demonstrate broader qualities required by employers, such as interpersonal communication, teamwork, lifelong learning, innovation, and career sustainability.

Based on these considerations, core competencies can be systematically categorized into two types: **(1) Fixed competencies**: These competencies primarily refer to the mastery of professional knowledge, such as technical skills and subject-specific expertise; and **(2) Growth competencies**: These competencies focus on broader social adaptability, such as problem-solving, communication, and teamwork, which are essential for navigating the dynamic demands of the job market (Brundiers et al., 2021). Moreover, the employment situation for agricultural undergraduates is complex and influenced by a range of external factors. The decision of whether agricultural graduates work in the agricultural sector or rural areas is shaped not only by personal factors but also by government policies, social values, and family expectations. These external influences play a crucial role in shaping the career paths of agricultural graduates, making them important considerations in the development of core competencies (see Figure 1).

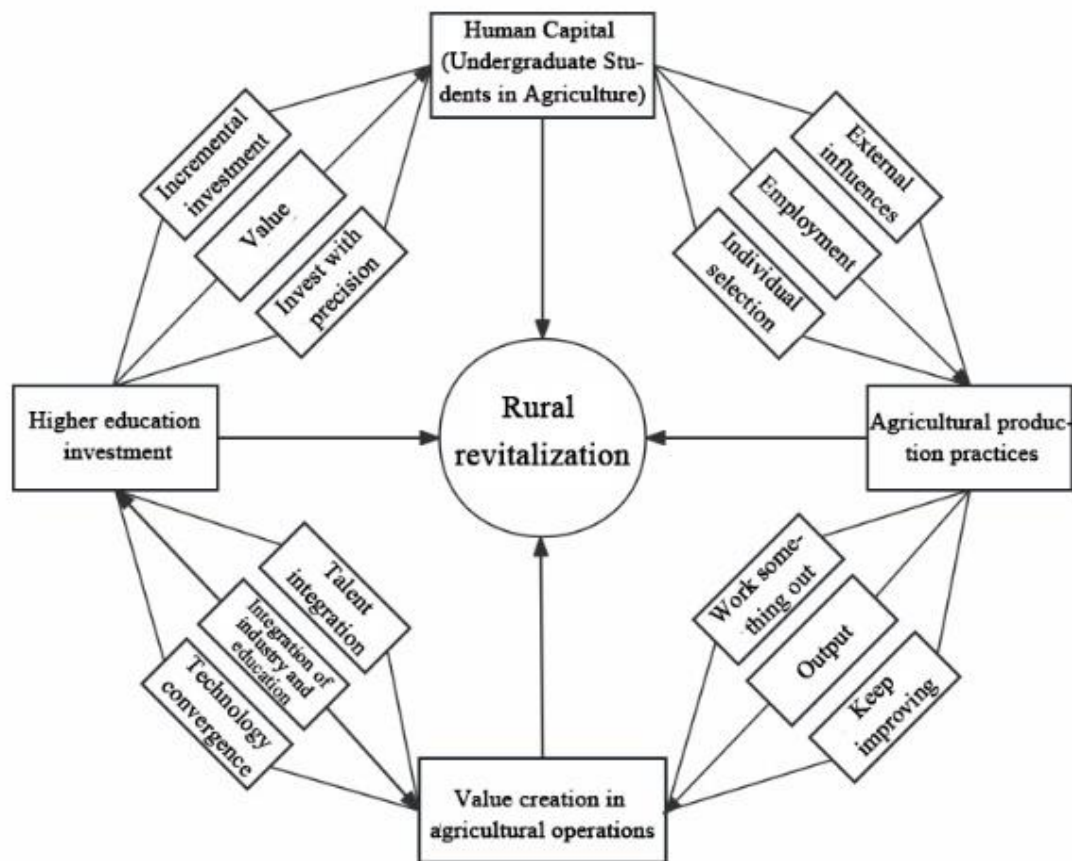


Figure 1. Theoretical mechanism of transforming investment in agricultural education into agricultural and rural productivity

A Model for Core Competency Training of Agricultural Undergraduates in China

The core competencies of agricultural undergraduates are the key abilities that facilitate their employment in agriculture and rural areas, while also enabling them to create greater value in agricultural management and governance. These competencies are divided into two categories: **fixed competencies** and **growth competencies**. Fixed competencies include professional knowledge, professional skills, and professional vision, while growth competencies encompass cognitive abilities, social skills, and psychological abilities (Figure 2).

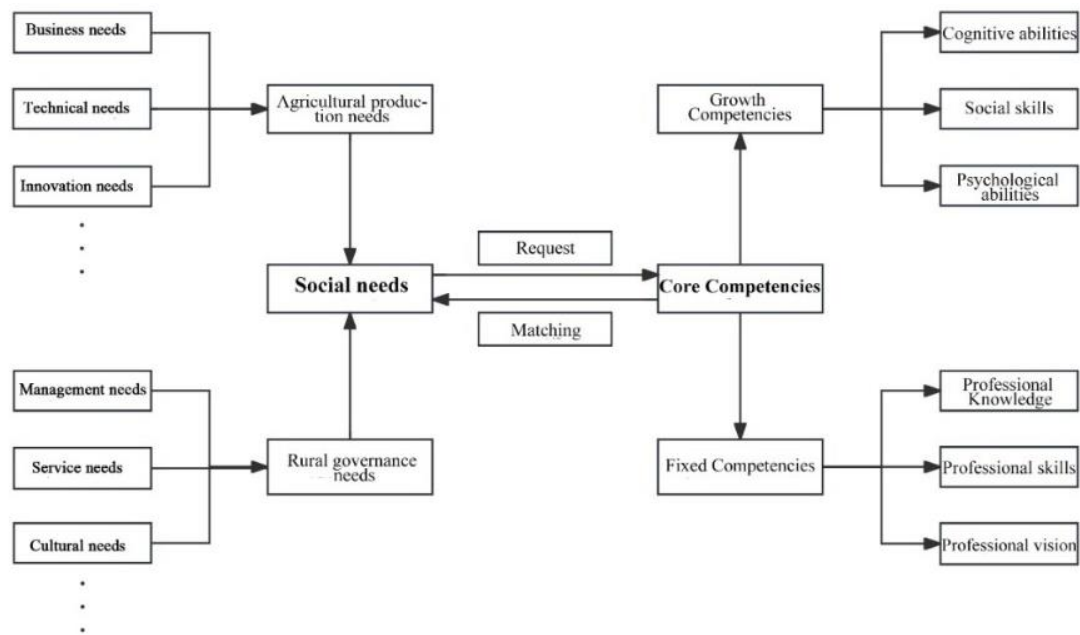


Figure 2. Core competency model for undergraduate students majoring in agriculture

Fixed competencies refer to the professional knowledge, professional skills, and professional vision that agricultural undergraduates accumulate during their studies at university. Specifically:

- Professional Knowledge:** This refers to the systematic understanding of the agricultural field, including mastery of the basic theories of the major. Agricultural undergraduates should possess more credible and comprehensive views than non-agricultural students, particularly in areas such as self-assessment, practical evaluation, and understanding the trajectory of their educational path.
- Professional Skills:** This encompasses practical abilities that allow students to address real-world problems encountered in agricultural industries, contributing to industrial advancement. Key areas of development include practical courses, internships, market understanding, and other hands-on learning experiences.
- Professional Vision:** This refers to the ability to clearly understand the direction of employment in the agricultural sector, knowledge of the current status and challenges facing related industries, awareness of domestic and international industry trends, and an understanding of the career outlook. Professional vision also includes a strong sense of industry prospects, employment awareness, and professional confidence.

Acquiring professional knowledge and mastering the relevant skills are primary objectives for agricultural undergraduates during their academic training. The professional competence achieved during this period forms a crucial measure of their core competencies and their competitive edge in the job market. Thus, in the cultivation of core competencies, emphasis should be placed on enhancing fixed competencies,

improving professional standards, and ensuring alignment with the evolving needs of agricultural and rural development.

Growth competencies refer to the ideological and emotional commitment of agricultural undergraduates to rural and agricultural work, along with a set of comprehensive abilities that promote their overall development. These competencies include cognitive ability, social skills, and psychological resilience. Specifically:

- a) **Cognitive Ability:** This pertains to the overall understanding of China's agricultural and rural development, awareness of the national rural revitalization strategy, and support for key policies that guide this development. Agricultural undergraduates should demonstrate optimism about the future of rural areas and a willingness to work in related fields. This includes understanding policy frameworks, having confidence in the sector's growth, and aligning personal career aspirations with rural revitalization goals.
- b) **Social Skills:** This includes the ability to adapt to different environments, effectively communicate, and foster relationships within the community. Agricultural undergraduates should be capable of becoming leaders in rural areas, promoting the development of local industries, and supporting the community. The cultivation of social skills is reflected in environmental adaptability, communication effectiveness, and a proactive approach to driving local agricultural and rural development.
- c) **Psychological Ability:** This refers to the capacity to maintain a positive and optimistic attitude, even in challenging circumstances. Agricultural undergraduates should demonstrate resilience under pressure, perseverance in the face of hardship, and the ability to overcome setbacks. Psychological resilience is essential for those who intend to engage in long-term rural work, such as expanding agricultural industries or leading community development projects.

In the comprehensive strategy for advancing rural revitalization in China, the demand for high-quality agricultural talent with well-rounded skills is substantial. There is an increasing need for agricultural undergraduates who possess a broad range of competencies to contribute to rural and agricultural progress, thus encouraging more young people to establish themselves in rural areas and actively participate in local agricultural and economic development.

The Current Situation of Core Competency Training for Agricultural Undergraduates in China

This study investigates the core competency training of agricultural undergraduates through a combination of questionnaire surveys and interviews. It analyzes the current status and existing challenges in core competency development for these students. The focus is on L University, an institution in eastern China dedicated to cultivating applied agricultural and forestry professionals. The university primarily

collaborates with agricultural enterprises, new agricultural business entities, and government agricultural and rural departments in the region for student employment.

METHODS

A questionnaire based on the core competency model was developed and administered to agricultural undergraduates at L University. A total of 915 questionnaires were distributed, with a 100% effective recovery rate. Additionally, an interview-based investigation into the current talent demand in the agricultural industry was conducted. This comparison aimed to gain a more accurate understanding of existing issues by aligning industry demand with educational training. Table 1 presents the demographic characteristics of the survey sample, including gender, place of origin, academic year, and volunteer choice.

Table.1 Sample Demographics (%)

Basic infor- ma- tion	Gender		Place of origin		Academic Year				Volunteer Choice			
	Male	Female	Rural	City	Fresh man year	Soph omor e year	Juni or year	Sen ior year	The first choi ce	Seco nd choi ce	The third choi ce	Othe rs
Samp le chara cter- istics	43.2	56.8	58.9	41.1	46.1	20.6	17.1	16.1	52.4	11.6	5.9	30.1

RESULT AND DISCUSSION

Analysis of Core Competency Cultivation for Agricultural Undergraduates

The questionnaire, designed according to the core competency model, consists of two modules: fixed competencies and growth competencies. Each module addresses three key areas: professional vision, professional knowledge, and professional skills.

Current Situation of Fixed Competencies

Agricultural undergraduates generally understand the importance of their major on a macro level but tend to pay insufficient attention to its future development and trends. Their learning pathway is predominantly focused on classroom theory and campus-based practical courses. Industry-specific practice opportunities are limited, leading to a lack of confidence in their own level of competence. Additionally, there is a general lack of awareness regarding employment prospects, and students show limited knowledge of industry demands and technical needs.

Employer feedback suggests that the most significant gaps in fixed competencies among agricultural graduates are related to "agricultural-related professional knowledge and practical work abilities." The key findings are as follows:

- a) Professional vision:** Agricultural undergraduates generally recognize the macro importance of their field, with 80.7% believing their studies are relevant to China's agricultural and forestry development. However, 27.6% exhibit unclear knowledge about their major, and 42.4% express doubts about future career opportunities. Additionally, 39.8% report an average or below-average understanding of the major's development direction. A correlation was found between students' professional vision and their volunteer choice in the college entrance examination, with those who chose agriculture as their first-choice major showing higher levels of understanding and confidence (see Table 2). This indicates that while students acknowledge the social importance of their studies, many lack the confidence and enthusiasm needed for active engagement in their field.

Table 2. Comparison of Professional Vision of Different Volunteers (%)

Professional Vision	Think the Major is Useful		Clear About Major Content		Think the Major Has Prospects		Understand the Direction and Trend of the Major	
	First volunteer	Avrg	First volunteer	Avrg	First volunteer	Avrg	First volunteer	Avrg
Sample characteristics	85.5	80.7	78.7	72.4	68.7	57.6	66.4	60.1

- b) Professional knowledge:** Students primarily acquire knowledge through classroom lectures (91.3%) and on-campus practical courses (84.5%). External practical training and self-study are less common, with only 43.78% engaging in off-campus internships and 31.24% in self-directed learning. This highlights the limited integration between academic training and industry needs. Regarding employment prospects, 57.6% believe their major is beneficial to future employment, while 31.24% see it as average, and 18.7% of seniors view it as either unhelpful or minimally helpful.
- c) Professional skills:** Only 25.5% of students have internship experience in relevant enterprises or industry departments, and among those, 94.3% had internships lasting less than three months. Internship participation correlates with academic year, with 54.7% of seniors having completed internships (see Table 3). Regarding school-based professional courses, 62.9% rated practical course effectiveness positively, though 43.3% felt the number of such courses was insufficient. These findings suggest that while there is a positive attitude toward professional training within the university, the lack of post-graduation industry experience remains a significant barrier due to limited internship opportunities and reluctance by agricultural enterprises to offer such positions.

Table 3. Comparison of Internship Participation by Academic Year (%)

Internship situation	Internship Experience in Relevant Enterprises or Industry Departments			
	Freshman	Sophomore	Junior	Senior
Sample characteristics	12.7	32.7	41.0	54.7

Current Situation of Growth Competencies

Agricultural undergraduates generally perceive the agricultural industry as vital to the construction of a strong socialist modern country and are optimistic about the future of China's agricultural development. They also demonstrate a positive attitude toward working in agricultural and rural areas. However, while most students recognize the importance of social skills, they tend to evaluate their own social abilities relatively low. Furthermore, while most students express strong resilience and adaptability, nearly 40% of them are less proactive in managing stress, adapting to changes, and demonstrating perseverance. Employers, in turn, place greater emphasis on growth-oriented competencies, such as persistence in the face of difficulties, teamwork and management skills, optimism, and the ability to learn autonomously. Graduates who can adapt to environments, endure hardships, and demonstrate a strong ability to learn are more likely to be favored by employers.

- a) Cognitive Ability:** Agricultural undergraduates generally recognize the significance of the agricultural sector, with 97.6% acknowledging its importance and 89.6% rating it as "very important." Additionally, 81.8% are optimistic about the industry's prospects. However, only 61.3% correctly identified the introduction of the rural revitalization strategy during the 19th National Congress, indicating gaps in policy knowledge. Regarding employment, 75.5% are willing to work in agriculture-related fields, with 70.6% open to frontline roles (see Table 4). Students who chose agriculture as their first-choice major show greater enthusiasm for agricultural careers, highlighting the influence of initial major selection. Yet, external factors like income and urban opportunities often draw graduates to non-agricultural industries, underscoring the need for supportive policies and infrastructure to boost rural employment.

Table 4. Comparison of Employment Intentions by Volunteer Choice (%)

Employment intention	Willing to Work in Agriculture				Willing to Work in Rural Areas/Grassroots Positions			
	First volunteer	Second volunteer	Third volunteer	Others	First volunteer	Second volunteer	Third volunteer	Others
Sample characteristics	84.9	66.5	4.0	53.0	79.4	61.9	61.0	60.9

b) Social Skills: While 94.6% of agricultural undergraduates value social skills, with 64.7% deeming them "very important," only 38.7% rate their own skills as strong. Urban students self-assess higher than rural peers (43.0% vs. 35.8%). In environmental adaptability, 59.7% feel confident adjusting to new settings, while 4.9% report low adaptability (see Figure 3). Students enhance these skills through social practices (73.2%), student organizations (72.0%), and class activities (53.4%), with strengths in communication (92.5%), setting boundaries (73.6%), teamwork (65.7%), and emotional control (65.6%) (see Figure 4). As digital natives, many rely on online communication, potentially weakening face-to-face skills. Development efforts should align with student preferences and employer needs.

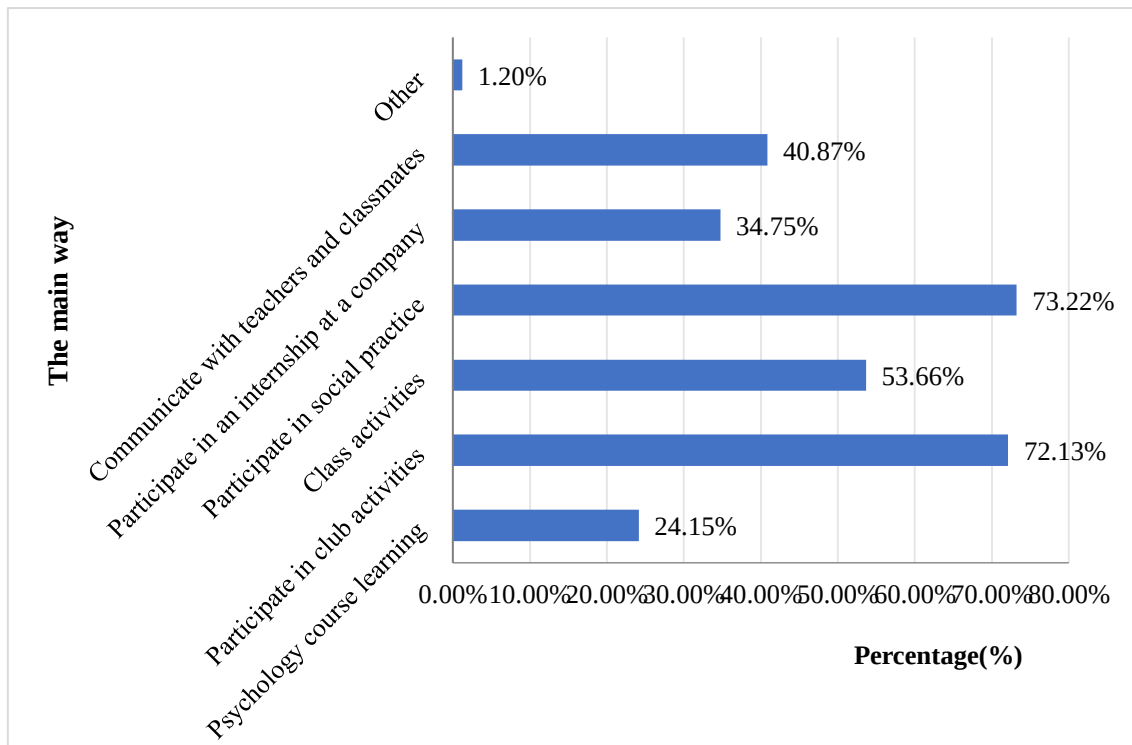


Figure 3. Main Ways to Improve Social Skills

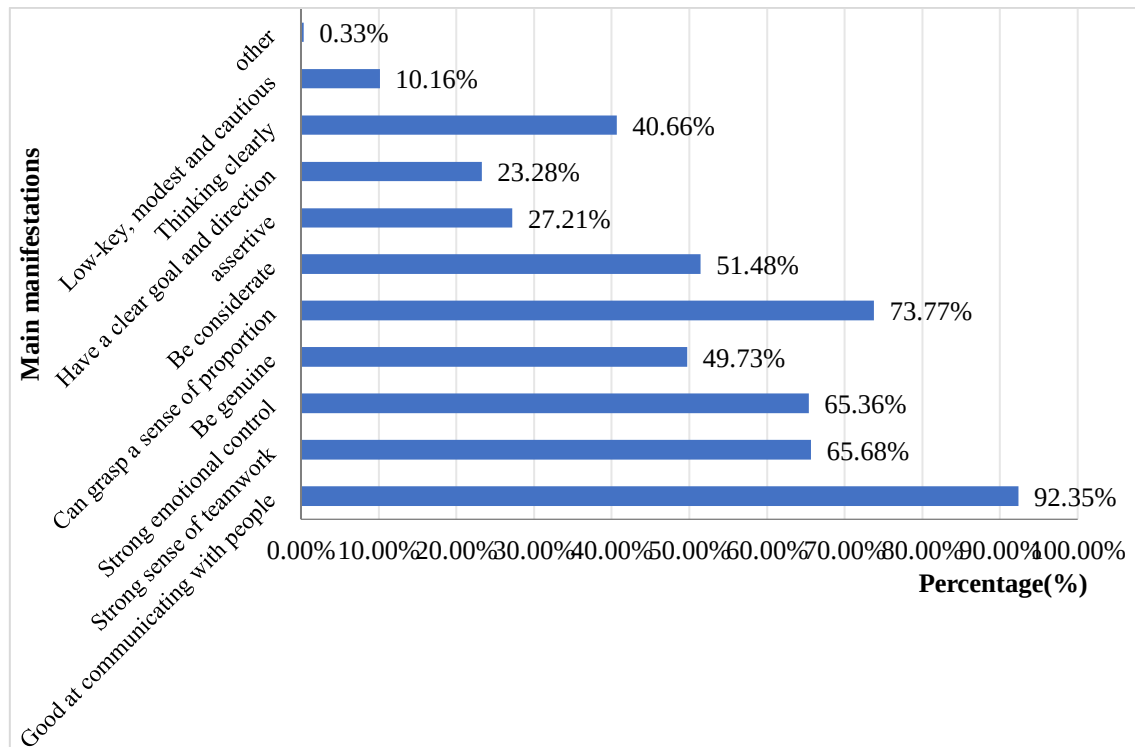


Figure 4. Main Indicators of Strong Social Skills

c) Psychological Ability: Overall, 58.8% of students are confident in stress management, 59.5% in emotional regulation, and 63.2% in coping with hardships (see Table 5). Male students outperform females by 7.8%, 6.9%, and 9.3% in these areas, respectively, while rural students surpass urban peers in coping ability (64.4% vs. 58.5%) (see Table 6). Despite good resilience, nearly 40% rate themselves as average or below, signaling a need for targeted support. The stronger resilience of male and rural students aligns with agricultural employer demands, offering insights for recruitment and training.

Table 5. Students Ability to Cope with Difficult Enviroments by Place of Origin (%)

Ability to cope with difficult environment	Rural Students					Urban Students				
	Very strong	strong er	Gener al	Not very strong	Not strong	Very strong	strong er	Gener al	Not very strong	Not strong
Sample characteristics	18.2	48.2	28.2	3.7	1.7	15.9	42.6	35.9	4.3	1.3

Table 6. Comparison of Psychological Ability by gender (%)

Gender	Strong ability to work under pressure	Strong ability to regulate emotions	Strong ability to cope with difficult environments
Male	63.1	63.3	68.4
Female	55.3	56.4	59.1

In summary, Agricultural undergraduates exhibit strong growth-oriented competencies like resilience and adaptability, but gaps in social skills and psychological abilities remain, especially among female and urban students. Targeted interventions and integration of competency development into education and extracurriculars are essential to prepare students for agricultural careers.

Pathways to Enhancing the Core Competence of Agricultural Undergraduates

With the rural revitalization strategy in progress, agricultural undergraduates are vital to rejuvenating rural talent. Enhancing their core competencies is essential, yet challenges like poor integration with agriculture and rural realities, and limited professional practice, persist. Effective measures are needed to optimize talent training. Guided by human capital theory, this study identifies the integration of production and education as a key strategy to cultivate high-quality talent for the agricultural sector, supporting rural revitalization.

Fostering an Environment to Encourage Pursuit of Agricultural Majors

To draw young students to agricultural majors, an environment promoting agricultural knowledge and affection for the field is crucial. Upgrading the agricultural industry through structural reforms, increased technology investments, and higher productivity can showcase its progress, making it appealing. Supportive policies, such as government-sponsored student programs, can regulate talent quality and boost visibility. Promoting modern agricultural successes and rural cultural values can further inspire a societal shift toward valuing and developing agriculture.

Deepening Production-Education Integration to Boost Problem-Solving Skills

Agricultural undergraduates often lack clarity on career paths and industry needs, weakening their practical skills. Deepening production-education integration addresses this by refining talent training programs with optimized curricula, more practical courses, and potential mandatory internships. Collaborating with agricultural academies, enterprises, and rural departments can establish training bases, while improving instructor qualifications and providing mentors enhances course quality. Stronger university-industry ties will create a practical environment to sharpen problem-solving abilities.

Strengthening Comprehensive Competency Training for Overall Quality

Beyond technical skills, communication, adaptability, and resilience are vital. Enhancing education in agricultural principles fosters enthusiasm and affinity for the sector. Prioritizing mental health education builds social skills and psychological endurance. Organizing agriculture-focused student activities and social practices provides platforms to develop personal and professional growth.

Innovating Evaluation with Agricultural Department Involvement

Traditional evaluations focus on academic performance, overlooking post-graduation abilities. Involving agricultural and rural departments in assessing agricultural majors can improve this. A multi-stakeholder system—spanning education, agricultural sectors, and enterprises—should combine academic and employment assessments. This approach, balancing fixed and growth competencies, offers feedback to align training with agricultural needs.

CONCLUSION

This study underscores the critical role of integrating production and education in cultivating core competencies among agricultural undergraduates in China. By developing a human capital-based theoretical framework and analyzing current training deficiencies, it offers practical strategies to enhance educational relevance and effectiveness. These include fostering an agriculture-oriented learning environment, strengthening hands-on training, and improving collaboration between universities and enterprises. Such efforts not only elevate the quality of talent development but also align higher education with the broader goals of agricultural modernization and rural revitalization.

Despite its contributions, the study has limitations. The sample's geographic and institutional scope may restrict the generalizability of the findings, and the absence of long-term evaluations limits insight into the sustained impact of the proposed strategies. Future research should expand across diverse regions and institutions, incorporate longitudinal assessments to measure the effectiveness of interventions over time, and continue refining the competency framework to reflect evolving industry needs and policy directions.

ACKNOWLEDGMENT

This research was funded by The Key Research Areas in Higher Education for 2024 identified by the Zhejiang Higher Education Society (KT2024006).

REFERENCES

- Anderson, J. D., Malone, T., & Akridge, J. T. (2024). Strategies for Land-Grant Universities to Foster Public Trust. *Journal of Agricultural and Applied Economics*, 1-16. Doi:10.1017/aae.2024.32.
- Bachano, T. (2021). Review on factors affecting the participation of smallholder farmers in improved chicken rearing in Ethiopia. *Journal of biology, agriculture and healthcare*, 11(2), 2021. Doi: 10.7176/JBAH/11-2-02.
- Bari, N., Chimhundu, R., & Chan, K. C. (2022). Dynamic capabilities to achieve corporate sustainability: a roadmap to sustained competitive advantage. *Sustainability*, 14(3), 1531. Doi:10.3390/su14031531.
- Brundiers, K., Barth, M., Cebrián, G., Cohen, M., Diaz, L., Doucette-Remington, S., ... & Zint, M. (2021). Key competencies in sustainability in higher education—toward an agreed-upon reference framework. *Sustainability science*, 16, 13-29. Doi:10.1007/s11625-020-00838-2.
- Chen C. & Song P. (2024). Research on the Evaluation of the Effectiveness of Industry-Teaching Integration Construction of Higher Vocational Excellence Courses--Based on Network DEA Model Analysis. *Applied Mathematics and Nonlinear Sciences*, (1),26-32. (in Chinese)
- Chen L. (2024). Countermeasures and paths for the integration of industry and education to empower the cultivation of "dual-teacher and multi-functional" teachers. *Theory and Practice of Innovation and Entrepreneurship*, (20), 73-75+89. (in Chinese)
- Han J. (2024). Exploration into the Development of "Integration of Production and Education" in Vocational Education in China. *Agricultural Biotechnology*, (4),46-49,56. (in Chinese)
- Li G. (2024). Current Situation, Issues and Countermeasures of Industry Education Integration in Civil Aviation Vocational Education in China. *Open Journal of Social Sciences*, (03),482-496. (in Chinese)
- Li, J., & Pilz, M. (2023). International transfer of vocational education and training: A literature review. *Journal of Vocational Education & Training*, 75(2), 185-218.Doi:10.1080/13636820.2020.1847566.
- Lucki, P. (2024). Challenges of agricultural digitalization in the Guatemalan western highlands. *Frontiers in Communication*, 9, 1505445. Doi: 10.3389/fcomm.2024.1505445.
- Luo Y., Gu J., Chen E. (2022). Higher Education Serves the Revitalization of Rural Talents: Theoretical Framework, Realistic Observation and Policy Path. *Higher Education Research*, (12), 55. (in Chinese)
- Kaplan, R. (2023). Teaching US History through Land-Grant Universities and Agriculture Education. *Agricultural History*, 97(4), 616-621.Doi:10.1215/00021482-10795895.
- Ma Y. & Zhou J. (2018). Characteristics and Enlightenment of Higher Agricultural Education in Germany Serving Society. *Journal of Yunnan Agricultural University (Social Sciences)*, (04),102-106.

- Mulder, M., & Biemans, H. J. (2018). Agricultural education in the Netherlands: from crystallizing to dissolving? *The Journal of Agricultural Education and Extension*, 24(1), 1-5. Doi:10.1080/1389224X.2017.1413742.
- Okubo, K., Sato, K., Yamamoto, T., Itagaki, S., Nakagawa, S., & Horita, T. (2022). Practice and Effects of Programming Education Using Drones in the Agriculture Unit of the Fifth Grade of Elementary School Social Studies. *Information and Technology in Education and Learning*, 2(1), Trans-p010. Doi: 10.12937/itel.2.1.Trans.p010.
- Qi, Z., Jing, M., & Zhu, C. (2024). International Cooperation in Higher Education: Perspectives of Heads of International Cooperation from Cases of European Universities. *International Journal of Higher Education*, 13(5), 29-40. (in Chinese)
- Saroyan, A., & Frenay, M. (Eds.). (2023). *Building teaching capacities in higher education: A comprehensive international model*. Taylor & Francis.
- Slijper, T., Urquhart, J., Poortvliet, P. M., Soriano, B., & Meuwissen, M. P. (2022). Exploring how social capital and learning are related to the resilience of Dutch arable farmers. *Agricultural Systems*, 198, 103385. Doi: 10.1016/j.agsy.2022.103385.
- Tefera Y. D. & Awoke B. G. (2025). Agricultural mechanization in Ethiopia: hiring service transactions, mechanization clusters and land consolidation. *Journal of Agribusiness in Developing and Emerging Economies*, 15(1),109-130. Doi:10.1108/JADEE-06-2022-0127.
- Wang X. (2024). Research report on "Integration of Industry and Education Empowering the High-quality Development of Modern Agriculture". *China Development*, (01),76-80. Doi: 10.15885/j.cnki.cn11-4683/z.2024.01.001.
- Xu S., Li Z. & Wang J. (2024). High-quality Development of Industry-Education Integration in Colleges and Universities: International Experience, China's Advantages and Future Prospects. *Research in Higher Engineering Education*, (03), 109-114. (in Chinese)
- Yang Y. & Lv X. (2023). German "Dual System" Vocational Education: A Theoretical and Practical Study in China in the Past Twenty Years. *Journal of Education and Teaching*, (1),5-24. (in Chinese)
- Zhang X. (2024). Investigation and Research on the Integration of Production and Education in Vocational Education: Current Situation, Dilemma and Countermeasures -- Taking a Province as Sample. *International Journal of New Developments in Education*, 6(8), 220-226.
- Zhang, J., Yang, H., Li, A., Chen, C., & Wang, L. (2024). Research on the Innovation of Practice Teaching System in the Context of Industry-Education Integration. *Transactions on Comparative Education*, 6(3), 150-156.
- Zheng Y. (2024). The Practical Path of the Integration of Industry and Education in Local Comprehensive Vocational Colleges to Help Rural Revitalization. *Smart Agriculture Guide*, (17), 127-130. Doi: 10.20028/j.zhnydk.2024.17.030.