

CONSTRUCTION OF THE “ONE AXIS, DUAL DRIVES, AND FOUR INTEGRATIONS” GRADUATE TRAINING SYSTEM FOR SOUTHERN SEED BREEDING UNDER NATIONAL STRATEGIC GUIDANCE

YongGang Zhou¹, Yan Jing¹, Jie Liu², ZhanYing Zhang², ZhiQiang Xia¹, Jian Wang¹, LiJuan Luo¹, YouGen Wu^{1*}, Yan Liu^{1*}

¹*School of Breeding and Multiplication (Sanya Institute of Breeding and Multiplication), Hainan University, Sanya 572025, Hainan, China.*

²*Sanya Institute, China Agricultural University, Sanya 572025, Hainan, China.*

**These authors contributed equally to this work.*

**Corresponding Author: YouGen Wu, Yan Liu*

Abstract: As a national strategic priority, Southern Seed Breeding (Nanfan) imposes an urgent demand for highly skilled, interdisciplinary talents. However, the conventional graduate training paradigm is ensnared in structural dilemmas characterized by a disconnect between theory and practice, a superficial integration of industry and education, and skewed evaluation orientations. In response, this study establishes and empirically validates a graduate training framework embodying the “One Axis, Dual Drives, and Four Integrations” logic within the southern seed breeding domain, utilizing STIs as practical arenas and employing a triadic analytical framework of value–institution–action. This system centers on the strategic imperatives of southern seed breeding as the axis of value, propelled by the dual engines of scientific-educational synergy and industry-education integration. It advances a four-dimensional fusion encompassing curriculum design, mentorship teams, practical platforms, and evaluation mechanisms, thereby forming a closed-loop educational model of “rooted theoretical foundations, research serving industry, and outcomes enriching teaching.” Empirical verification, based on 136 provincial-level and above institutes in Hainan, demonstrates that this system markedly enhances graduate students’ practical innovation capabilities and industry service competencies, cultivating over 250 talents devoted to agricultural knowledge and passion, transferring more than 30 scientific achievements, and generating over 15 million RMB in technology promotion contracts. By deeply excavating the intrinsic mechanisms embedding national strategic demands into talent cultivation, this research offers a novel paradigm that harmonizes profound theoretical insights with applied efficacy for the reform of professional agricultural graduate education.

Keywords: Southern seed breeding; Science and technology institutes; Graduate training; Scientific-educational fusion; Industry-education integration

1 INTRODUCTION

Southern seed breeding plays a crucial role in supporting innovation in China’s seed industry and ensuring national food security, while also placing new demands on the training of agricultural postgraduates. Compared with traditional training models that focus primarily on coursework, academic papers, and single-discipline supervision, southern seed breeding requires students to engage in real production environments, understand practical breeding needs, address field-based problems, and participate in technology extension activities. In recent years, Hainan has attracted 136 provincial-level and above scientific research institutes, providing relatively stable practice platforms for exploring new training pathways that integrate national strategy with university education, scientific research, and industrial services. However, in practice, the training of professional postgraduates still faces several common challenges, including insufficient alignment between curriculum content and the needs of frontline breeding work, limited depth of university-enterprise collaboration, and evaluation systems that prioritize academic publications over problem-solving capacity and practical application outcomes. Against this background, this study focuses on the context of southern seed breeding and takes the science and technology institute as the primary practical platform to explore how national strategic needs can be translated into concrete training objectives, cultivation processes, and evaluation mechanisms. Based on this analysis, the paper proposes and examines the “One Axis, Dual Drives, and Four Integrations” training system, aiming to provide a more practical reference for reforming the training model of professional postgraduate education in agriculture.

2 THE CORE IMPERATIVES FOR HIGH-QUALITY DEVELOPMENT OF AGRICULTURAL GRADUATE EDUCATION IN THE NEW ERA

Located in Yazhou Bay, Hainan, a strategic fulcrum for China’s seed industry rejuvenation, more than 70% of the nation’s new crop varieties since the founding of the People’s Republic have been cultivated here. Serving as the

“accelerator” for the seed industry, southern seed breeding has established an unassailable bulwark safeguarding national food security. Currently, 136 provincial-level science and technology institutes (STIs) in Hainan host graduate students who transform the vast fields into their classrooms and industry challenges into research themes, converting academic findings into tangible field results. For instance, the Changjiang Fresh Edible Soybean Science and Technology Institute developed environmentally friendly, highly efficient cultivation techniques, increasing the yield per mu from 1,300 to 1,860 jin (a Chinese unit, 1 jin = 0.5 kilogram), increasing company revenues by over three million yuan, and promoting the technology across more than 2,000 acres. These practical endeavors represent a faithful implementation of the important directive to “closely integrate classroom learning with rural practice” within the context of rural revitalization and building an agricultural powerhouse[1].

The deepening implementation of the southern seed breeding strategy urgently demands high-caliber interdisciplinary talents who combine cutting-edge theoretical expertise with frontline practical skills. Nevertheless, traditional graduate training models confront a threefold crisis: misalignment between curricula and industry needs, with coverage of core technologies such as tropical crop stress-resistance breeding and smart agriculture remaining below 15%; erosion of the industry-education integration mechanism, where school-enterprise collaboration lacks sustainable frameworks and most partnerships remain project-based; and skewed evaluation systems dominated by a “paper-centric” paradigm, with less than 20% of assessment emphasizing practical innovation and industrial contribution. Students emerge theoretically proficient yet practically deficient, enterprises face acute technological demands while universities struggle to translate research results, creating palpable tension between talent supply and strategic requisites.

At the heart of this predicament lies a fundamental misalignment of cultivation logic: the traditional model adheres to a “disciplinary logic” centered on knowledge transmission and academic evaluation, whereas southern seed breeding necessitates a “strategic logic” guided by national imperatives and measured by industrial impact. The tension between these two logics encapsulates the principal challenge confronting agricultural professional graduate education today.

The advent of STIs offers a promising pathway to resolve this conundrum. Pioneered by Academician Zhang Fusuo’s team at China Agricultural University, this model enables graduate students to be stationed long-term at the production frontline, fostering a service paradigm characterized by “zero distance, zero latency, zero cost, and zero threshold”, thereby achieving profound integration of theoretical instruction and production practice [2]. Leveraging southern seed breeding advantages, Hainan has established a cluster of such institutes, forming a new collaborative talent cultivation framework through joint efforts among universities, local governments, and enterprises, deeply integrating industry, academia, research, and application [3]. Against this pragmatic backdrop, the southern seed breeding graduate training faces a dual imperative: first, how to embed strategic national demands, such as seed industry security, deeply and precisely into every facet of training to align talent supply with strategic needs; and second, how to transcend traditional educational paradigms to construct an innovative training logic that balances academic profundity with industrial relevance.

3 CONSTRUCTION OF THE “ONE AXIS, DUAL DRIVES, AND FOUR INTEGRATIONS” GRADUATE TRAINING FRAMEWORK

Grounded in the tri-dimensional analytical paradigm of “Value–Institution–Action” [4], this study crafts a coherent graduate training logic system embodied by the “One Axis, Dual Drives, and Four Integrations.” Within this framework, “Value” addresses the foundational question of “Why cultivate”, “Institution” elucidates the mechanisms answering “How to ensure”, and “Action” delineates the pathways clarifying “How to cultivate”, with these three dimensions mutually reinforcing to form a closed logical loop.

(1) The Axis of Value: Endogenous Embedding of National Strategic Imperatives

The strategic mission of southern seed breeding—to safeguard food security, conquer critical seed industry technologies, and champion agricultural green transformation—is established as the pivotal “axis” of talent cultivation [5]. This axis redefines training objectives, detaching them from insular disciplinary confines and instead intricately intertwining them with national strategic demands. The technological exigencies of southern seed breeding (e.g., tropical crop stress resistance breeding), industrial bottlenecks (such as varietal homogeneity and frequent diseases), and developmental frontiers (such as intelligent breeding) are holistically integrated into training goals, curricular designs, and practical engagements, thereby cultivating graduate students who embody the core competencies of being “proficient breeders, innovative thinkers, adept promoters, and dedicated contributors” [3].

(2) Dual Drives: The Synergistic Mechanisms of Scientific-Educational Fusion and Industry-Education Integration

Scientific-Educational Fusion Drive: Translating Knowledge Production into Pedagogical Practice

Forefront scientific research achievements are transmuted into instructional assets through mechanisms such as “research project guidance, incorporation of research outcomes into curricula, and open sharing of research platforms”, effectuating a profound amalgamation of research and teaching [4]. The essence of this drive lies in immersing graduate students within authentic cutting-edge explorations rather than superficial rote memorization. For example, Professor Li Haiyan’s team at Hainan University has incorporated national key research initiatives into graduate training, enabling students to participate thoroughly in core stages like germplasm screening and gene localization, with resultant contributions honored by provincial and ministerial scientific awards [3].

Industry-Education Integration Drive: Translating Industrial Demands into Research Topics

Relying on STIs as a conduit for university-enterprise collaboration, real-world industry demands are transmuted into research subjects through a synergistic mechanism of “enterprise posing problems, academia solving problems, and

graduate students addressing problems”, thereby elevating the industry relevance of talent cultivation [6]. Central to this drive is positioning tangible frontline industrial challenges as the inception points of graduate learning and inquiry. For instance, Hainan Oulande Company and Hainan University jointly established the Changjiang Fresh Edible Soybean Science and Technology Institute, collaboratively tackling industry pain points and developing the green, efficient integrated water and fertilizer technology now disseminated over more than 2,000 acres, which has catalyzed revenue increases exceeding three million yuan [3].

(3) Four-Dimensional Integration: Structural Reconfiguration of the Talent Cultivation System

Curricular Integration: A Modular Course Chain of “Theory–Practice–Innovation”

Shattering traditional disciplinary silos, a triadic modular curriculum comprising “Southern Seed Breeding Theory + Institute-based Practice + Innovation Methodologies” is constructed [7]. The theoretical segment encompasses core breeding courses, accounting for 50% of the curriculum; the practical segment includes hands-on activities such as field trials and eco-friendly pest management, constituting 35%; and the innovation segment introduces coursework on scholarly writing and intellectual property, covering 15%. This structured “learn–apply–innovate” continuum harmonizes the curriculum with the intrinsic logic of competency development.

Mentorship Team Integration: The “Tri-Mentor” Collaborative Guidance Mechanism

The implementation of a “tri-mentor system” [8] incorporates “on-campus academic advisors, southern seed breeding industry mentors, and in-situ institute supervisors.” Academic mentors oversee research direction, industry mentors provide experiential contexts, and onsite mentors offer daily guidance. Through regular joint meetings and coordinated responsibility allocation, these three roles synthesize their distinct knowledge sources into a cohesive mentorship synergy [1], enabling an enriching convergence of diverse expertise upon the students.

Practical Platform Integration: A Full-Chain Platform Encompassing “Laboratory–Field Trial–Production Park”

By amalgamating resources from university laboratories, southern seed breeding bases, institute trial fields, and corporate production sites, a tri-level practice platform is established [9]. Laboratories focus on foundational research; field trials facilitate pilot testing; and production parks enable demonstration of results, thereby realizing comprehensive, end-to-end training spanning from varietal breeding to technology dissemination [2]. This immersive full-chain environment allows students to apprehend the contextual application of knowledge in authentic settings.

Evaluation Mechanism Integration: A Diversified Assessment System Balancing “Scholarship–Practice–Contribution”

Dispelling the “paper-centric” orthodoxy, a composite evaluation framework is instituted, weighting academic achievement (40%), practical competence (30%), and industrial contribution (30%) [10]. This multifaceted standard ensures that assessment metrics genuinely resonate with the intended cultivation objectives.

4 PRACTICAL IMPLEMENTATION OF THE “THREE-STAGE PROGRESSIVE” TRAINING PROCESS

The realization of the “One Axis, Dual Drives, and Four Integrations” cultivation framework necessitates a concrete, phased training pathway. Consequently, a “three-stage progressive” training model is devised, delineating graduate student development into foundational consolidation, immersive practice, and outcome transformation, thereby establishing a systematic and cumulative educational trajectory.

(1) Foundational Consolidation Stage: Theoretical Grounding and Preliminary Institute Practice

The first stage (first academic year) centers upon immersive theoretical study, complemented by preliminary experiential engagement within affiliated institutes. This approach fosters an initial sensuous connection with the agricultural environment before advancing into rigorous cognitive mastery. Graduate students undertake core southern seed breeding courses at their universities, systematically acquiring expertise in tropical crop physiology and stress resistance breeding technologies. Diverging from conventional training protocols, this phase concurrently mandates participation in “preparatory technology institute practicums”, entailing no less than four weeks per semester of field-oriented cognitive learning at southern seed breeding bases. Through direct observation, data collection, and agronomic operations, students cultivate a tangible awareness of industry contexts prior to formal stationing. For instance, empirical evidence from the Yacheng Southern seed breeding Maize Technology Institute indicated that germplasm and agronomic trait data amassed during this preparatory phase furnished invaluable primary resources for subsequent breeding investigations [3].

(2) Immersive Practice Stage: On-Station Problem Solving and Scientific Innovation

During the second phase (second to third academic years), graduate students take up formal residency within STIs, engaging in no fewer than one year of immersive field practice, whereby authentic problem-solving serves as the crucible for skill acquisition. This stage’s hallmark lies in the principle that “research topics emerge from industry and are reintegrated into production.” Here, research themes emanate directly from frontline, practical challenges—such as the low mechanization in southern seed production, recurrent diseases afflicting fresh edible soybeans, and severe flower and fruit drop in dragon fruit cultivation. Taking the Dongfang Rice Technology Institute as a paradigm, resident scholars addressed unstable seed production yields by developing precision row-spacing regulation and mechanized pollination-assist technologies, resulting in a 15% increase in seed yield and a 30% reduction in labor costs [3].

(3) Outcome Transformation Stage: Technology Integration and Extension Services

In the third phase (third academic year), graduate students systematically consolidate their on-site research achievements into standardized technical protocols, patents, or scholarly publications. These achievements are then translated into tangible societal applications through the STIs’ service model characterized by “zero distance, zero latency, zero cost, and zero threshold”, completing the ultimate honing of their competencies via the socialization of

knowledge. For example, the substrate mulching technique developed by students at the Ledong Dragon Fruit Technology Institute not only generated an annual revenue increase of two million yuan for the enterprise but also trained over one thousand farmers through field schools and on-site demonstrations, with the technology extending its footprint across more than 3,000 mu of local plantations [6].

The “Three-Stage Progressive” model transcends a mere linear sequence, embodying instead a spiraling, organic whole. Each stage maintains a distinct emphasis yet mutually reinforces the others: theoretical grounding affords the cognitive framework for practice; hands-on immersion enriches theoretical understanding; and outcome transformation consummates an integrative appraisal of the preceding phases.

(4) Synergistic Operation of Four Supporting Mechanisms

The effective implementation of the “Three-Stage Progressive” process rests upon the coordinated operation of four foundational support mechanisms.

The dynamic curriculum adjustment mechanism ensures real-time incorporation of industry needs into the classroom. A curriculum committee comprising university faculty, enterprise experts, and institute leaders undertakes a biennial revision of the course system. The course *Southern Seed Breeding Practice* integrates authentic problem-solving cases from the Changjiang Fresh Edible Soybean and Ledong Dragon Fruit institutes, thereby establishing a rapid-feedback loop of “industry demand–curriculum content–practical application” [7].

The collaborative mentorship mechanism achieves the convergence and fusion of diverse knowledge streams. The *Tri-Mentor System Implementation Regulations* specify that on-campus advisers shall undertake no less than one month annually of in-field practice, while industry mentors deliver a minimum of eight teaching hours per year on campus. Hainan University engages over 220 industry specialists as enterprise mentors, who routinely conduct lectures and provide on-site guidance [8], ensuring a catalytic “chemical reaction” of knowledge synthesis within the students.

The shared platform co-construction mechanism breaks down departmental silos over resource ownership. A quadripartite alliance of “universities–government–enterprises–technology institutes” is formed [6], where the government supplies policies and funding, enterprises offer venues and practical needs, universities contribute faculty and research capabilities, and the institutes manage daily operations. For instance, the Dongfang Organic Waste Recycling Technology Institute, through this synergistic collaboration, secured nine patents and fostered a 120 million yuan industrialization project [3].

The evaluation and incentive guidance mechanism directs efforts towards desired outcomes. Graduate students who make outstanding industrial contributions receive preferential treatment in honors and job placements [10], while the performance of mentors within STIs is incorporated into their professional evaluations, awarding additional credits for notable guidance achievements [3]. Thus, assessment standards function proactively as behavioral incentives rather than retrospective judgments.

5 PRACTICAL ACHIEVEMENTS AND SYSTEM VALIDATION

5.1 Remarkable Enhancement in Talent Cultivation Quality

Over the past three years, the Hainan Science and Technology Institute have achieved outstanding results in talent development: 83.2% of graduate students report substantial improvement in their comprehensive abilities, with 65.22% mastering core practical skills [2]. At the Yacheng Corn Science and Technology Institute, students have contributed to the creation of more than one hundred novel corn germplasms, with three varieties having passed provincial-level certification; 70% of graduates have committed to frontline agricultural work, published over ten papers in prestigious journals, won two national innovation and entrepreneurship gold awards, and filed more than twenty patent applications [3]. The Changjiang Fresh Edible Soybean Institute developed environmentally friendly and highly efficient cultivation technologies that increased per-acre yields by 43%, secured three invention patents, and retained graduates at the southern seed breeding frontline to continue research endeavors. In total, the STIs have cultivated over 250 high-level, agriculturally passionate application-oriented talents and facilitated the transformation of more than 30 scientific achievements [3].

5.2 Profound Breakthroughs in Industry-Education Integration

Hainan University has forged long-term, stable collaborations with over twenty southern seed breeding enterprises through the STIs, jointly undertaking more than thirty research projects, transferring twelve technological achievements, and securing technology promotion contracts exceeding 15 million yuan [3]. These technologies have been disseminated across more than two million acres, cumulatively training over eighty thousand farmers and contributing to agricultural income increases surpassing 300 million yuan [9].

5.3 Expanding Societal Influence

Six STIs, including Changjiang Fresh Edible Soybean and Ledong Dragon Fruit, have been recognized as “China’s Most Beautiful STIs” [2]. The talent cultivation model has been featured more than twenty times in major mainstream media outlets such as *People’s Daily*, *Guangming Daily*, and *Hainan Daily*. This paradigm has been promoted through Sino-African Science and Technology Institute, nurturing over a hundred agricultural professionals for countries including Malawi and Zambia, establishing five STIs, benefiting 240 villages and 200,000 acres of farmland, and

quadrupling local corn yields in Malawi [6]. The Sino-African dual-mentor team at the Zambia Soybean Technology Institute transformed the corn stalk-based edible fungus substrate technology into accessible, practical solutions for local farmers, setting a pioneering example for global agricultural talent training.

6 CONCLUSION

Grounded in the dual imperatives of national seed industry security and the advancement of New Agricultural Sciences, this study conducts a comprehensive and systematic investigation focused on the critical intersection of the southern seed breeding strategy and the reform of agricultural graduate education. By examining the dynamic interaction between strategic national demands and educational responses, it reveals how these demands are internalized and translated into clear training objectives through a central “value axis.” This axis drives coordinated reforms across curricula, mentorship structures, practical platforms, and evaluation systems, ensuring that talent development aligns seamlessly with strategic priorities. To deepen this understanding, the research introduces a three-dimensional analytical framework—comprising value, institution, and action—that transcends simplistic, one-dimensional models by embedding talent cultivation within an integrated system of value guidance, institutional support, and actionable implementation. This framework provides a robust and adaptable tool for analyzing similar contexts elsewhere [4]. Moreover, the study distills an operational logic characterized by “One Axis, Dual Drives, and Four Integrations.” This logic—anchored in strategic demand orientation, propelled by dual driving forces, and realized through multidimensional integration—offers universally relevant insights for cultivating professional graduate talent amid the ongoing construction of New Agricultural disciplines [7]. Looking forward, this framework must continue to evolve through iterative practice to sustain its relevance and effectiveness. By doing so, it will play a pivotal role in advancing China’s agricultural education system, strengthening the alignment between talent cultivation and national strategic needs, and ultimately contributing to the robust development of a modern, resilient agricultural powerhouse.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

This work was supported by 2026 Annual Degree and Graduate Education and Teaching Reform Research Project of Hainan University (HDJG-Y202607) and Hainan University Higher Education (Graduate) Teaching Achievement Cultivation Project (HDYJXCG2024003).

REFERENCES

- [1] Nongmin Ribao Commentator. Stand on the Ground and Reach the Sky, Cultivate Talents for Strengthening Agriculture and Serving the Country. *Farmers' Daily*, 2025-10-20 (01).
- [2] Zhang Fusuo. Science and Technology Institute: Pioneer in Cultivating Talents Who Know, Love, Strengthen, and Revitalize Agriculture. *Science and Technology Review*, 2020, 38(19): 11-15.
- [3] Hainan University. The Molecular Breeding Research Team for High-Yield and Stress-Resistant Soybean Achieves Promising Yield Results in Fresh Soybean Project. 2026-02-07. <https://www.hainanu.edu.cn/>.
- [4] Li Yajuan, Guo Xin, Zhang Fusuo. Value–Institution–Action: Practice and Enlightenment of Three-Dimensional Talent Cultivation of Professional Degree Postgraduates in Science and Technology Institute. *Degree and Graduate Education*, 2025(8): 20-26.
- [5] Ministry of Agriculture and Rural Affairs. Construction Plan of Nanfan Silicon Valley (2021–2025). 2021.
- [6] Gao Wei, Zhang Lianting, Zhang Hongbin. Exploration of Master’s Training Mode for Agricultural Majors from the Perspective of Triple Helix: A Case Study of Ledong Pitaya Science and Technology Institute. *Journal of Higher Education*, 2024(27): 53-56.
- [7] Xie Zhijian, An Zhichao, Li Yajuan. Exploration of Cultivation Mode for Top Innovative Agricultural Talents Based on Science and Technology Institute. *China University Teaching*, 2023(8): 17-21.
- [8] Li Hong, Wang Wei. Stimulating the Vitality of Off-Campus Supervisors for Professional Degree Postgraduates. *China Education Daily*, 2024-04-22(06).
- [9] Tang Liping, Li Xuan. Adaptive Chimerism: Adaptive Integration: The Logical Mechanism of External Resources Activating the Endogenous Driving Force for Rural Revitalization Based on a Case Study of the Quzhou Technology Courtyard. *Journal of Nanjing Agricultural University (Social Sciences Edition)*, 2026(1): 1-13.
- [10] Fang Chuanying, Sun Xudong, Chen Yinhua. Research on Reform of Scientific Paper Reading and Writing Course under the Background of New Agriculture. *Journal of Higher Education*, 2025(11): 61-65.