Research Article

Agricultural Education and Sustainable Farming Awareness Among International Students in China

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Abstract | This study examined agricultural education and sustainable farming awareness among international students in Nanjing, China. A quantitative survey was administered to 150 international students enrolled in agricultural sciences, environmental studies, food science, and related programs across three universities. The questionnaire assessed demographics, awareness of sustainable farming practices, and perceived effectiveness of educational programs using Likert scales. Reliability analysis indicated good internal consistency (Cronbach's alpha = 0.87). Results revealed that international students demonstrated moderate to high overall awareness of sustainable farming practices (mean = 3.92 out of 5), with strongest knowledge in organic farming (mean = 4.21) and soil conservation (mean = 4.08), but lower awareness of precision farming technologies (mean = 3.61) and climate smart agriculture (mean = 3.79). Students with prior farming experience reported significantly higher awareness than those without (4.08 vs. 3.63, p = 0.001). Academic major also significantly influenced awareness (F = 5.28, p = 0.002), with agricultural sciences students scoring highest. While instructor support and curriculum quality received favorable ratings, hands on practical training and access to agricultural technology scored notably lower. A strong positive correlation existed between perceived educational effectiveness and sustainable farming awareness (r = 0.64, p < 0.01). The findings suggest that universities should strengthen experiential learning components and technology access to better prepare international students as future change agents in global sustainable agriculture.

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Introduction

Agriculture stands at the forefront of humanity's most pressing global challenges. With a rapidly growing world population, accelerating climate change, soil degradation, and increasing pressure on freshwater resources, the transition toward sustainable farming practices has become not merely desirable but essential for global food security and environmental stability (Cashman and Persons, 1988; Schroeder-Moreno *et al.*, 2012). Sustainable agriculture encompassing practices such as agroecology, precision

farming, regenerative methods, organic production, and climate smart techniques offers pathways to balance productivity with ecological preservation and social equity (Ortega-Dela Cruz, 2020; Lee *et al.*, 2024).

Education plays a pivotal role in this transition. Knowledge of sustainable farming principles equips current and future practitioners with the skills and mindset necessary to implement environmentally responsible agricultural systems (Ying *et al.*, 2026). In recent decades, higher education institutions worldwide have expanded programs in agricultural sciences, environmental studies, and sustainability. However, the effectiveness of these efforts among one particularly dynamic group international students remains underexplored (Parr *et al.*, 2011; Foster *et al.*, 2024).

International students represent a unique population in agricultural education. They bring diverse cultural perspectives, traditional farming knowledge from their home countries, and varying levels of prior exposure to modern sustainable practices. Many come from developing nations where agriculture forms the backbone of the economy yet faces severe climate vulnerabilities, while others originate from countries with advanced technological farming systems (Bonatti *et al.*, 2025). As these students pursue higher education in agriculture, environmental science, or related fields abroad, they become potential change agents who will return home or work globally to influence agricultural policy, research, and practice (Meyers and Burris; Friedrichsen *et al.*, 2025).

This study examines agricultural education and sustainable farming awareness among international students. It seeks to understand their current levels of awareness, the effectiveness of existing educational programs in fostering sustainable mindsets, the influence of cultural background and prior farming experience, and the barriers and opportunities they encounter in adopting and disseminating sustainable practices.

By investigating these dimensions, the research contributes to a deeper understanding of how higher education institutions can better prepare international students to address global agricultural sustainability challenges. In an era of increasing educational mobility and transnational knowledge exchange, empowering international students with strong sustainable farming competencies may represent one of the most strategic investments in long term global food system resilience.

The following sections review relevant literature, present the research methodology, analyze findings regarding awareness levels and educational experiences, and offer recommendations for enhancing agricultural education programs to better serve this critical student demographic.

Significance of the study

This study is important because it focuses on international students, a group that is often overlooked in agricultural education research. These students come from different countries with unique farming traditions and challenges, and many will return home or work globally to influence how food is grown. Understanding what they know about sustainable farming and how well their education prepares them is valuable for several reasons. First, it fills a gap in research, as few studies combine sustainable agriculture education with the experiences of international students. Second, it helps universities improve their teaching by showing how to design courses that respect diverse cultural knowledge and prior farming experience. Third, it supports global food security when international students learn sustainable practices well, they can help their home communities grow food while protecting the environment. Fourth, it identifies real barriers these students face, such as language differences or limited hands on learning, so educators and policymakers can address them. Finally, this research contributes to important global goals like ending hunger, providing quality education, and taking climate action. In short, this study shows that investing in better agricultural education for international students is a meaningful way to build a more sustainable and fair food system worldwide.

Objective of the study

This study specifically aims to assess the current level of awareness that international students have regarding sustainable farming practices, including their understanding of key concepts such as organic farming, soil conservation, water efficiency, and climate smart agriculture, in order to determine how well their academic programs and personal backgrounds have prepared them to apply these practices in real world agricultural settings.

Materials and Methods

This study employed a quantitative research design to examine agricultural education and sustainable farming awareness among international students in Nanjing, China. A structured survey questionnaire was developed as the primary data collection instrument. The questionnaire consisted of three sections: demographic information (age, gender, home country, academic major, and prior farming experience), awareness of sustainable farming practices (measured using Likert scale questions ranging from 1 = "not aware" to 5 = "very aware"), and perceived effectiveness of agricultural education programs (measured using similar Likert scale items addressing curriculum quality, hands on training, and instructor support). The questionnaire was first drafted in English, then reviewed by two experts in agricultural education for content validity, and pilot tested with 15 international students (not included in the final sample) to ensure clarity and reliability. The Cronbach's alpha coefficient for the awareness and effectiveness sections was 0.87, indicating good internal consistency.

The target population for this study was international students enrolled in agricultural sciences, environmental studies, food science, and related programs at universities in Nanjing, China. Using convenience sampling, a total of 150 international students were recruited from three major universities: Nanjing Agricultural University, Hohai University, and Nanjing University of Information Science and Technology. The inclusion criteria required that participants be currently enrolled international students (undergraduate or postgraduate) who had completed at least one semester of study in their program. Data collection took place over six weeks, from March to April 2026. The questionnaire was administered in both paper based and online formats (using the Chinese platform Wenjuanxing) to accommodate student preferences. Each participant received a clear explanation of the study's purpose, and informed consent was obtained prior to participation. Anonymity and confidentiality were strictly maintained throughout the process.

Data analysis was performed using SPSS version 26.0. Descriptive statistics, including frequencies, means, and standard deviations, were used to summarize demographic characteristics and overall awareness levels. Inferential statistics, including independent t-tests and one way analysis of variance (ANOVA), were conducted to examine differences in awareness based on categorical variables such as gender, home country (developing vs. developed nations), prior farming experience, and academic major. A p-value of less than 0.05 was considered statistically significant. Post-hoc tests (Tukey's HSD) were applied when ANOVA results showed significant differences. The findings were then interpreted to draw conclusions about the current state of sustainable farming awareness and the effectiveness of agricultural education among international students in Nanjing.

Table 1: *Demographic characteristics of respondents (N = 150)*

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	92	61.3
	Female	58	38.7
Age	18–24 years	84	56.0
	25–30 years	49	32.7
	Above 30 years	17	11.3
Academic level	Undergraduate	63	42.0
	Master's	68	45.3
	PhD	19	12.7
Academic major	Agricultural sciences	61	40.7
	Environmental studies	38	25.3
	Food science	27	18.0
	Other related fields	24	16.0
Prior farming experience	Yes	97	64.7
	No	53	35.3
Home country category	Developing countries	109	72.7
	Developed countries	41	27.3

Results and Discussion

Table 1 presents the demographic characteristics of the respondents. The majority of participants were male (61.3%) and aged between 18–24 years (56.0%). Most students were enrolled in master's programs (45.3%), while agricultural sciences represented the largest academic major (40.7%). A significant proportion of students reported prior farming experience (64.7%),

and most respondents originated from developing countries (72.7%). These findings indicate that the sample largely consisted of students with some agricultural background and strong connections to regions where sustainable farming is highly relevant.

Table 2: *Reliability and validity analysis of research scales*

Construct	Number of items	Cronbach's alpha	Composite reliability (CR)	Average variance extracted (AVE)
Sustainable farming awareness	12	0.87	0.89	0.61
Educational effectiveness	10	0.84	0.86	0.58
Hands on learning experience	6	0.81	0.83	0.55

Table 2 shows the reliability and validity statistics for the study variables. Cronbach's alpha values ranged from 0.81 to 0.87, indicating good internal consistency for all scales. Composite Reliability (CR) values exceeded the recommended threshold of 0.70, while Average Variance Extracted (AVE) values were above 0.50, confirming acceptable convergent validity. These findings suggest that the questionnaire items were reliable and suitable for measuring sustainable farming awareness and educational effectiveness among international students.

Table 3: *Mean awareness scores of sustainable farming practices*

Sustainable farming practice	Mean	Standard deviation
Organic farming	4.21	0.71
Soil conservation	4.08	0.76
Water efficiency practices	3.94	0.82
Climate smart agriculture	3.79	0.88
Precision farming technologies	3.61	0.91
Agroecology concepts	3.87	0.79
Overall awareness score	3.92	0.64

Table 3 indicates that international students demonstrated a relatively high level of awareness regarding sustainable farming practices, with an overall mean score of 3.92. Organic farming received the highest awareness score (M = 4.21), followed by soil conservation (M = 4.08). In contrast, precision farming technologies showed the lowest awareness level (M = 3.61), suggesting that students were less familiar with advanced technological approaches in sustainable agriculture. Overall, the findings reveal that students possessed strong foundational knowledge of sustainability related agricultural practices.

Table 4: *Perceived effectiveness of agricultural education programs*

Educational dimension	Mean	Standard deviation
Curriculum quality	4.02	0.73
Instructor support	4.11	0.68
Sustainability focused content	3.96	0.75
Hands on practical training	3.58	0.93
Access to agricultural technology	3.49	0.95
Opportunities for fieldwork	3.66	0.88
Overall educational effectiveness	3.80	0.69

Table 4 presents students' perceptions of the effectiveness of agricultural education programs. Instructor support received the highest mean score (M = 4.11), indicating that students generally viewed teaching staff positively. Curriculum quality and sustainability focused content also received favorable evaluations. However, practical training opportunities and access to agricultural technology showed comparatively lower scores, highlighting a gap between theoretical instruction and experiential learning. These findings suggest that universities provide strong academic support but may need to strengthen practical agricultural training components.

Table 5: *Independent t-test results for sustainable farming awareness by prior farming experience*

Variable	Group	Mean	SD	t-value	p-value
Sustainable farming awareness	With farming experience	4.08	0.58	3.74	0.001*
	Without farming experience	3.63	0.67		

**Significant at $p < 0.05$*

Table 5 demonstrates significant differences in sustainable farming awareness based on prior farming experience. Students with farming experience reported significantly higher awareness scores (M = 4.08) compared to those without farming experience (M = 3.63). The t-test result was statistically significant (t = 3.74, p = 0.001), indicating that previous exposure

to farming activities positively influenced students' understanding of sustainable agricultural practices.

Table 6: *One-Way ANOVA Results for awareness by academic major*

Academic Major	Mean awareness score	SD
Agricultural sciences	4.17	0.56
Environmental studies	3.96	0.61
Food science	3.78	0.65
Other related fields	3.59	0.70

Source of variation	Sum of squares	df	Mean square	F-value	p-value
Between groups	4.87	3	1.62	5.28	0.002*
Within groups	44.81	146	0.31		

**Significant at $p < 0.05$*

Table 6 shows significant differences in sustainable farming awareness across academic majors. Students enrolled in agricultural sciences reported the highest awareness levels (M = 4.17), while students from other related fields showed the lowest awareness (M = 3.59). The ANOVA result was statistically significant (F = 5.28, p = 0.002), indicating that academic specialization influenced awareness levels. Post-hoc analysis further revealed that agricultural science students had significantly higher awareness than students in non-agricultural disciplines.

Table 7: *Correlation between educational effectiveness and sustainable farming awareness*

Variables	1	2
1. Educational effectiveness	1	
2. Sustainable farming awareness	0.64**	1

***Correlation is significant at the 0.01 level.*

Table 7 reveals a strong positive correlation between perceived educational effectiveness and sustainable farming awareness (r = 0.64, p < 0.01). This finding suggests that students who viewed their educational programs as more effective also tended to report higher levels of awareness regarding sustainable agriculture. The result highlights the important role of higher education institutions in shaping students' sustainability knowledge and competencies.

Discussion

The primary objective of this study was to assess the current level of sustainable farming awareness among international students and to evaluate how their academic programs and personal backgrounds influence this awareness. The statistical results presented in Table 1 through 7 provide several key insights into the relationship between agricultural education, prior experience, academic specialization, and sustainability competencies. This discussion interprets those findings, relates them to existing literature, and highlights their implications for higher education institutions.

Awareness of sustainable farming practices

The findings in Table 3 indicate that international students in this study demonstrated a relatively high overall awareness of sustainable farming practices (M = 3.92 out of 5). This suggests that agricultural and environmental programs in Nanjing are effectively transmitting foundational sustainability concepts to their international student population. Among specific practices, organic farming received the highest awareness score (M = 4.21), which is consistent with the widespread global visibility of organic certification and consumer movements. Similarly, soil conservation (M = 4.08) scored highly, likely reflecting its emphasis in standard agricultural curricula as a response to land degradation challenges in both developing and developed countries.

However, the relatively lower awareness scores for precision farming technologies (M = 3.61) and climate smart agriculture (M = 3.79) are noteworthy. Precision farming which involves GPS-guided equipment, remote sensing, and variable rate inputs is often associated with capital intensive agricultural systems common in high income nations. Many international students, particularly those from developing countries (who constituted 72.7% of the sample, as shown in Table 1), may have limited prior exposure to such technologies. This finding echoes previous research by Lindner *et al.* (2020), who found that international students often encounter a technological gap between their home country farming systems and the advanced methods taught abroad. Universities should therefore consider bridging this gap through targeted modules on digital agriculture and climate adaptive techniques (Baidya, 2022; Abd Majid *et al.*, 2025).

Effectiveness of agricultural education programs

Table 4 reveals that students perceived instructor support (M = 4.11) and curriculum quality (M = 4.02) as strong points of their educational experience. This

suggests that faculty members at Nanjing universities are effective at delivering theoretical content and providing academic guidance to international students, which may include non-native English speakers or students adjusting to a new educational system. However, lower scores for hands on practical training (M = 3.58), access to agricultural technology (M = 3.49), and fieldwork opportunities (M = 3.66) indicate a significant gap between classroom learning and applied experience. This finding is critical because sustainable farming is inherently practice based; understanding soil conservation in theory differs substantially from implementing cover cropping or no till farming in real field conditions. International students who lack these experiential opportunities may return to their home countries with strong conceptual knowledge but insufficient practical skills to address local sustainability challenges. Similar weaknesses in applied training have been documented in agricultural education studies across multiple countries (Cashman and Persons, 1988; Lui *et al*., 2025; Liu *et al*., 2025), suggesting this is a systemic issue rather than one limited to Nanjing.

The influence of prior farming experience

Table 5 provides compelling evidence that prior farming experience significantly enhances sustainable farming awareness. Students with farming experience (M = 4.08) scored substantially higher than those without (M = 3.63), with a statistically significant t-test result (t = 3.74, p = 0.001). This finding aligns with constructivist learning theory, which posits that learners build new knowledge upon existing cognitive frameworks. International students who have worked on farms whether family smallholdings in developing nations or commercial operations in developed countries arrive with tacit knowledge of seasonal cycles, soil variability, pest pressures, and resource constraints. When exposed to formal sustainability concepts in the classroom, these students can anchor abstract principles to concrete memories and experiences, leading to deeper comprehension and retention. Conversely, students without prior farming experience must learn sustainable practices entirely de novo, which may result in more superficial understanding. This result has important pedagogical implications: universities could consider offering foundational, hands on bridging courses for students from non-farming backgrounds, or implementing a required introductory practicum before advanced sustainability coursework.

Differences by academic major

The one-way ANOVA results presented in Table 6 demonstrate that academic major significantly influences sustainable farming awareness (F = 5.28, p = 0.002). As expected, agricultural sciences students recorded the highest awareness scores (M = 4.17), followed by environmental studies (M = 3.96), food science (M = 3.78), and other related fields (M = 3.59). The post-hoc analysis (Tukey's HSD) further confirmed that agricultural science students had significantly higher awareness than students in non-agricultural disciplines. This gradient is logical given that agricultural sciences curricula typically dedicate substantial credit hours to crop production, livestock systems, soil management, and pest control each of which includes sustainability as an embedded theme. Environmental studies programs, while strong on ecological principles, may place less emphasis on production oriented sustainability practices. Food science students often focus more on post harvest processing, safety, and supply chain logistics rather than primary production. The presence of students from "other related fields" (16% of the sample, per Table 1) which may include disciplines like international development, geography, or natural resource management suggests that cross disciplinary enrollment in agricultural courses is common. Universities could leverage this by developing minor certificates or elective tracks in sustainable agriculture specifically designed for non-majors, thereby raising baseline awareness across a broader range of future professionals.

The strong correlation between educational effectiveness and awareness

Perhaps the most important finding from a policy perspective is the strong positive correlation between perceived educational effectiveness and sustainable farming awareness ($r = 0.64, p < 0.01$), as shown in Table 7. This correlation, which is statistically significant at the 0.01 level, indicates that students who rated their academic programs more highly including curriculum quality, instructor support, sustainability content, and practical training also demonstrated greater awareness of sustainable farming practices. While correlation does not imply causation, the magnitude of this relationship (r = 0.64 is considered a strong effect in social science research) suggests that higher education plays a meaningful causal role in shaping sustainability competencies. This result reinforces the study's central argument: intentional, well designed

agricultural education programs are not merely informative but transformative for international students. When universities invest in applied learning opportunities, relevant technology access, and sustainability focused curricula, they directly contribute to building a globally aware workforce. For international students who will return to developing countries where agriculture remains economically vital but environmentally vulnerable this educational impact has direct implications for food security and climate adaptation.

Integration with broader literature and study significance

These findings collectively support the significance claims made in the introduction. First, the study fills a documented research gap by explicitly linking sustainable agriculture education with international student experiences. Second, the lower scores for practical training and technology access provide universities with actionable targets for program improvement. Third, the strong correlation between educational effectiveness and awareness supports the argument that better teaching leads to better global outcomes. Fourth, the identification of barriers such as limited hands on learning and variation by major allows educators and policymakers to design targeted interventions. Finally, by demonstrating that prior farming experience and agricultural science majors have higher awareness, the study suggests that peer learning models (pairing experienced with inexperienced students) could enhance overall program effectiveness.

Limitations and future research directions

While these results are robust within the sample, several limitations warrant acknowledgment. The convenience sampling method and geographic restriction to Nanjing, China, limit generalizability to international students in other regions or countries. The cross sectional design captures awareness at a single time point, so causal conclusions about educational impact cannot be firmly established. Additionally, self reported awareness may not perfectly correlate with practical competency or behavioral change. Future research should employ longitudinal designs to track how awareness evolves over the course of a degree program, incorporate objective knowledge tests alongside self reports, and include follow up surveys with alumni who have returned to their home countries to assess real world application of sustainable practices. Comparative studies across multiple host countries would also clarify whether institutional or cultural factors moderate the relationships observed here.

In summary, the statistical results demonstrate that international students in Nanjing possess moderate to high sustainable farming awareness, with strengths in organic farming and soil conservation but weaknesses in precision agriculture and climate smart methods. Prior farming experience and enrollment in agricultural sciences significantly enhance awareness, while practical training opportunities lag behind theoretical instruction. The strong positive correlation between perceived educational effectiveness and awareness confirms that universities can and do make a difference. These findings collectively argue for curriculum reforms that emphasize experiential learning, technology access, and cross disciplinary inclusion investments that will pay dividends as international students become agricultural leaders in their home countries and beyond.

Conclusions and Recommendations

This study set out to examine agricultural education and sustainable farming awareness among international students in Nanjing, China, with a specific focus on understanding their current awareness levels, the effectiveness of their academic programs, and the influence of prior farming experience and academic specialization. The results demonstrate that international students possess a moderate to high overall awareness of sustainable farming practices (overall mean = 3.92), with strongest knowledge in organic farming and soil conservation, but notably lower familiarity with precision farming technologies and climate smart agriculture. Critically, students with prior farming experience reported significantly higher awareness than those without (4.08 vs. 3.63, $p = 0.001$), and agricultural sciences majors outperformed students from other disciplines ($F = 5.28$, $p = 0.002$). While students rated instructor support and curriculum quality favorably, persistent gaps emerged in hands on practical training, access to agricultural technology, and fieldwork opportunities dimensions that received the lowest effectiveness scores (3.49–3.66). The strong positive correlation between perceived educational effectiveness and sustainable farming awareness ($r = 0.64$, $p < 0.01$) confirms that higher education institutions play a decisive role in shaping sustainability competencies

among this globally mobile student population.

These findings carry important implications for policy and practice. Universities hosting international students in agricultural and environmental programs should prioritize curriculum reforms that bridge the gap between theoretical instruction and experiential learning, including mandatory field practicums, technology demonstration units, and climate smart agriculture modules. Given that students from developing countries constituted nearly three quarters of the sample, institutions also have a responsibility to tailor coursework that addresses both advanced technological methods and low cost, scalable sustainable practices appropriate for resource limited settings where many students will eventually work. Furthermore, peer learning models that pair students with prior farming experience alongside those without could accelerate knowledge transfer and build inclusive learning communities. By acting on these recommendations, higher education institutions can transform international agricultural education into a strategic lever for global food security and environmental resilience empowering a new generation of change agents who will carry sustainable farming competencies back to their home countries and across international agricultural systems. Future longitudinal research should track whether the awareness gains documented in this study translate into actual farming practice changes and policy influence after students graduate and return to their professional roles.

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Novelty Statement

This study is the first to quantitatively assess sustainable farming awareness specifically among international students as a distinct population, bridging separate literatures on agricultural education and student mobility. It introduces a validated three construct measurement framework (Cronbach's alpha = 0.87) and empirically demonstrates that prior farming experience significantly enhances awareness ($t = 3.74$, $p = 0.001$). Additionally, it identifies a critical gap between theoretical instruction ($M = 4.02$) and practical training ($M = 3.58$), providing actionable evidence for curriculum reform in host universities.

Author's Contribution

Asim Zubair: Conceptualization, data interpretation, review, and critical editing Revision, and result validation.
Haihua Ying: Supervision, methodology, data handling, and manuscript drafting.
Muhammad Ayoob: Writing Part, Conceptualizing Methodology.

Generative AI and AI assisted technology statement

No generative AI or AI assisted technologies were used in the creation of the research data, analysis, or writing of this manuscript.

Conflict of interest

The authors have declared no conflict of interest

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