Asian Agricultural Research 2025, 17(4): 14-18, 27 DOI: 10.19601/j.cnki.issn1943-9903.2025.04.004

Evaluation of the Utilization and Application Value of Vine Plant Resources in Shenyang Area of China

Lifu LIU, Nan SHEN

Liaoning Vocational College of Ecological Engineering, Shenyang 110101, China

Abstract [**Objectives**] To evaluate the utilization and application value of vine plant resources, and enrich the urban vertical greening landscape. [**Methods**] Route survey and sample plot observation methods were employed to investigate 96 greening sites in Shenyang area, China. [**Results**] There are 21 species of vines used in vertical greening, including 15 species of woody vines and 6 species of herbaceous vines. According to the biological characteristics of vine plants and the actual needs of vertical application in landscape greening, a comprehensive evaluation system with one target layer, three criterion layers and a total of 14 indicators was constructed, and the application value of 21 species of vines was evaluated. Based on the comprehensive evaluation value, the vine plants were divided into four grades, and four of them had good application prospects and could be used in urban vertical greening. [**Conclusions**] The evaluation model and evaluation results will provide a theoretical basis for the rational use of vine plant resources.

Key words Vine plants, Vertical greening, Resource utilization, Shenyang area

0 Introduction

With the rapid development of urban construction in China, the available land for urban landscaping is extremely limited, and ecological issues closely related to human survival have garnered increasing attention. To enhance urban greening standards, the government has vigorously promoted vertical greening to expand green spaces, improve the functional efficiency and aesthetic impact of green areas, and mitigate urban ecological challenges. Among these efforts, ornamental vine plants, valued for high aesthetic appeal, significant market potential, and ecological benefits, serve as excellent materials for vertical greening landscapes[1]. Utilizing climbing organs such as aerial roots, tendrils, hooks, suckers, and stems, vine plants ascend by twining or clinging to supports or other vegetation, making them ideal for vertical greening in both urban and rural areas. In this study, we investigated the current application of vine plants in greening projects in Shenyang area, analyzed their ornamental value and application methods, and employed the Analytic Hierarchy Process (AHP) to evaluate their practical value. The aim is to identify vine species with outstanding ornamental traits, comprehensive adaptability, and suitability for wide application, thereby providing a theoretical foundation for promoting Shenyang's urban landscaping development.

1 Methods and methods

1.1 Overview of the study area Shenyang City, located in northeastern China, lies within the temperate zone and experiences a temperate continental monsoon climate. Characterized by four distinct seasons and ample sunlight, the region features cold winters and warm summers, with precipitation concentrated in the summer months. The southern areas receive more rainfall than the northern parts. The annual average temperature is 8.1 ℃, with winter average temperature of −9.1 ℃ and a prolonged cold period (≥51 d with temperatures ≤0 ℃). Summer hot temperatures are relatively short, averaging 22.3 ℃. The average annual precipitation reaches 716.6 mm, predominantly occurring from June to August, while annual sunshine duration totals approximately 2 516 h[1]. Situated at the convergence of three floristic regions (Northeast China, North China, and Mongolia), Shenyang boasts relatively rich plant diversity.

1.2 Selection of survey sites From June 2021 to June 2023, a survey was conducted on vine plant species across four types of green spaces in Shenyang. The investigation focused on 40 residential communities (*e.g.*, China Resources, COBOC, Vanke, Gemdale, Greentown, Country Garden, Longfor, Star River), 20 urban parks (*e.g.*, Shenyang Botanical Garden, Beiling Park, Zhongshan Park, Vanke Hunan New City Center Park, Nanhu Park, Mozishan Park, Wanquan Park, Shenshuiwan Park, Laodong Park, Dingxiang Lake Park, Botanical Garden of the Institute of Ecology, CAS), 6 universities (Northeastern University, Liaoning University, Shenyang Agricultural University, Shenyang University, Shenyang Normal University, Shenyang Jianzhu University), and 30 pocket parks.

1.3 Survey methods Field surveys on vine plants were carried using a combination of route surveys and sample plot observations[2]. Ten routes in both north-south and east-west directions were designed within Shenyang City, specifically following main roads in each district. Surveys were conducted along these routes to record locations, plant species names, and application patterns. Meanwhile, 96 representative sample sites were selected across Shenyang for vine plant investigations, documenting plant species and quantities. Sites with abundant vine plants were chosen as observation plots for phenological period monitoring.

1.4 Application value evaluation method The AHP has been widely used in material selection and comprehensive evaluation of

Received: February 2, 2025 Accepted: April 7, 2025

Supported by Scientific Research Funding Project of Educational Department of Liaoning Province in 2021 (LJKZ1243).

Lifu LI, associate professor, research fields: garden plant breeding and cultivation techniques.

ornamental plants, using quantitative specific indicators as the standard for evaluation, combining qualitative and quantitative evaluation, objectively improving the effectiveness, reliability and feasibility of the evaluation results[3-5]. The vine plants obtained from the investigation were evaluated using the AHP. Comprehensive scoring was conducted based on systematic investigation, analysis, and statistical evaluation of various assessment indicators, including: plant morphology (growth form), leaf characteristics (shape and color), floral traits (flower diameter, color, uniqueness of shape, flowering period, and fragrance), fruit attributes (shape, color, and fruiting duration), as well as practical values (edible and medicinal properties)[6].

1.4.1 Establishment of evaluation model based on AHP. Based on the biological characteristics of vine plants and the practical requirements of vertical applications in landscaping, we established an evaluation system for utilization of vine plants in urban greening, comprising four hierarchical levels: target layer (A), criterion layer (B), standard layer (C), and base layer (D)[7]. The vertical application value of vine plants was established as the target layer (A), aiming to scientifically evaluate vine plant resources, enrich the diversity of urban greening species, and enhance vertical greening standards. Key factors related to vine plant resource evaluation (development potential, ornamental value, and other functional values) were identified as the criterion layer (B). Under each criterion, 14 specific indicators reflecting these criteria were selected as the standard layer (C). The base layer (D) comprises the vine plant species applied in Shenyang's urban green spaces that are to be evaluated.

Table 1 Application value evaluation model of vine plants

Target layer (A)	Criterion layer (B)	Standard layer (C)	Base layer (D)
Application value A	Development potential B1	Resource quantity C1	The 21 species of vines to be evaluated are listed in Table 4
		Utilization degree C2	
		Growth speed C3	
		Maintenance degree C4	
	Ornamental value B2	Plant type C5	
		Flower type and color C6	
		Flowering period C7	
		Leaf type and color C8	
		Leaf viewing period C9	
		Fruit shape and color C10	
		Fruit viewing period C11	
	Other values B3	Edible value C12	
		Medicinal value C13	
		Aromatic value C14	

1.4.2 Determination of comprehensive evaluation indicator weight. Based on AHP, we first implemented the evaluation using the aforementioned evaluation model (Table 1). The construction of judgment matrices and the scaling of hierarchical single-ranking calculation tables in the system were designed according to the requirements of the target layer (A), referencing work records, input from nine horticultural experts, and relevant literature to establish a 5-point scoring criteria (Table 2). Following these criteria, the introduced vine plant species were scored, and the average score for each indicator was calculated. These scores were then weighted and synthesized with the corresponding indicator weights to derive a comprehensive score for each plant. Judgment matrices were constructed, and both the matrices and their consistency were verified. Next, the hierarchical total-ranking weights were calculated: after determining the weight values of each evaluation indicator in layer C relative to its associated layer B (denoted as W2), these were synthesized with the weight values of layer B (W1) to obtain the total-ranking values of layer C relative to the target layer (A) (denoted as W) (Table 3). Finally, we calculated the comprehensive evaluation values using the absolute evaluation selection method. A 5-point scale was employed to quantify the relative importance of each indicator, assigning numerical values to each criterion. These values were then weighted and synthesized using the indicator-specific weights to yield a comprehensive numerical evaluation value. This process determined the application value grades of the vine plant resources[8].

2 Results and analysis

2.1 Utilization of vine plant resources in Shenyang The survey results of 96 sample sites in Shenyang City (Table 4) revealed that 21 species of vine plants, belonging to 13 families and 14 genera, are utilized for vertical greening. Among these, the most widely applied family is Vitaceae, with 2 genera and 4 species, followed by Rosaceae (1 genus, 3 species). The families Caprifoliaceae, Ranunculaceae, and Convolvulaceae each include 1 genus and 2 species. Other families—Actinidiaceae, Celastraceae, Magnoliaceae, Bignoniaceae, Fabaceae, Aristolochiaceae, Dioscoreaceae, and Menispermaceae—each contain 1 genus and 1 species. In terms of ecological habits, 15 species are woody vines and 6 species are herbaceous vines. Regarding the frequency of application, the most commonly used vine plant species are: *Parthenocissus tricuspidata*, *Parthenocissus quinquefolia*, *Vitis amurensis*, *Lonicera japonica*, *Rosa multiflora*, *Celastrus orbiculatus*, *Rosa multiflora* var. *carnea*, and *Ipomoea quamoclit* (8 species in total). From a growth perspective, three vine plant species—*Pharbitis nil*, *Menispermum dauricum*, and *Dioscorea nipponica*—were not artificially planted. Vertical greening primarily includes greening forms such as walls, pergolas, railings, and tree trunks. Wall greening refers to greening on vertical surfaces of buildings[9]. However, wall greening is constrained by wall materials, limiting the choice of plant species. It mainly utilizes plants with clinging abilities, such as *P. tricuspidata*, *P. quinquefolia*, and *Campsis radicans*. Weak-climbing plants like *Rosa hybrida* can also be used to create floral walls[10]. Pergola and trellis greening offer a wider variety of plant options, as any twining or climbing vines can be applied, achieving excellent vertical greening effects. Railing greening involves using plants to green vertical structures like road guardrails and residential fences, serving purposes such as beautification, screening, and protection. Trunk greening refers to adorning dead trees with twining vines to create a "dead wood coming back to life" scene. This type of vertical greening is less commonly applied in the Shenyang area.

Table 2 Evaluation criteria of each evaluation indicator

Indicator//points	5	4	3	2	1
Resource quantity (C1)	Abundant	Relatively abundant	Moderate	Limited	Rare
Utilization degree (C2)	Not utilized	Rarely utilized	Utilized	Moderately utilized	Extensively utilized
Growth speed (C3)	Annual branch growth ≥ 100 cm	Annual branch growth 80 – 100 cm	Annual branch growth 50 – 80 cm	Annual branch growth 30 – 50 cm	Annual branch growth ≤ 20 cm
Maintenance degree (C4)	No manual care required	Extensive management	Manual control of 1 environmental factor	Manual control of 2 environmental factors	Intensive management, requiring artificial binding
Plant type (C5)	Highly branched, extremely dense foliage	Moderately branched, dense foliage	Moderately branched, uniform foliage distribution	Sparse branching, large gaps in foliage	No branching, sparse foliage
Flower type & color (C6)	Unique shape, flower diameter ≥5 cm; vivid color	Unique shape, flower diameter 3 – 5 cm; moderately vivid color	Common shape, flower diameter 1 – 3 cm; ordinary color	Common shape, flower diameter 0.5 – 1 cm; dull color	Unique shape, flower diameter ≤0.5 cm; dull color
Flowering period (C7)	≥3 mth	1.5 – 3 mth	20 – 45 d	10 – 20 d	≤10 d
Leaf type & color (C8)	Unique shape, variegated/color-changing leaves	Common shape, green or color-changing leaves	Common shape, compound green leaves	Common shape, simple green leaves	Common small leaves, gray-green
Leaf viewing period (C9)	Deciduous in Dec., autumn/winter color change	Deciduous in Nov., autumn/winter color change	Deciduous in Dec., no autumn/winter color change	Deciduous in Nov., no autumn/winter color change	Deciduous in Oct., no autumn/winter color change
Fruit shape & color (C10)	Vivid color, unique shape, abundant fruit	Moderate color, unique shape, abundant fruit	Ordinary color and shape, abundant fruit	Dull color and shape, abundant fruit	Dull color and shape, moderate fruit yield
Fruit viewing period (C11)	≥3 mth	1.5 – 3.0 mth	20 – 45 d	10 – 20 d	≤10 d
Edible value (C12)	Extremely high medicinal value, market scarcity	High medicinal value, significant market demand	High medicinal value, moderate market demand	Moderate medicinal value, limited market demand	No medicinal value
Medicinal value (C13)	Extremely high edible value, market scarcity	High edible value, significant market demand	High edible value, moderate market demand	Moderate edible value, limited market demand	No edible value
Aromatic value (C14)	Pleasant fragrance, long-lasting during flowering	Subtle fragrance, long-lasting during flowering	Pleasant fragrance, early flowering period	Subtle fragrance, early flowering period	No fragrance

Table 3 Overall ranking of standard layers with respect to target layers

Target layer A	Criterion layer B	Criterion weight W1	Standard layer C	Factor weight W2	Comprehensive weight W
A	Development potential B1	0.297	Resource quantity (C1)	0.261	0.078
Application value A			Utilization degree (C2)	0.522	0.155
			Growth speed (C3)	0.130	0.039
			Maintenance degree (C4)	0.087	0.026
	Ornamental value B2	0.539	Plant type (C5)	0.160	0.086
			Flower type & color (C6)	0.079	0.042
			Flowering period (C7)	0.308	0.166
			Leaf type & color (C8)	0.040	0.022
			Leaf viewing period (C9)	0.320	0.172
			Fruit shape & color (C10)	0.040	0.022
			Fruit viewing period (C11)	0.053	0.029
	Other values B3	0.164	Edible value (C12)	0.542	0.089
			Medicinal value (C13)	0.277	0.045
			Aromatic value (C14)	0.181	0.030

In different types of green spaces in the Shenyang area, the diversity of vine species and the proportion of vertical greening vary significantly (Table 5). Among 40 residential area samples, 98% implemented vertical greening, the highest proportion among the four green space types studied. This is primarily due to ground-floor residents voluntarily planting vines for courtyard beautification. In 20 urban parks and 40 pocket parks, 16 vine species were recorded, with 96% of these parks incorporating vertical greening. In contrast, school green spaces and roadside greening had fewer vine species, with 8 and 6 species, respectively. Notably, roadside greening had the least application of vertical greening, with only 30% of streets utilizing vines.

Table 4 Investigation of vine plant species in Shenyang area

No.	Plant name	Family	Genus	Ecological habits	Value	Application mode	Wild/cultivation
1	*Actinidina arguta*	Actinidiaceae	*Actinidia*	Woody vines	Edible	Pergolas, railing	Cultivation
2	*Celastrus orbiculatus*	Celastraceae	*Euonymus*	Woody vines	Leaf and fruit	Trellis, tree trunk	Cultivation
3	*Schisandra chinensis*	Magnoliaceae	*Schisandra*	Woody vines	Medicinal	Pergolas, trellis	Cultivation
4	*Parthenocissus tricuspidata*	Vitaceae	*Parthenocissus*	Woody vines	Leaf	Wall, trellis	Cultivation
5	*Parthenocissus guinguefolia*	Vitaceae	*Parthenocissus*	Woody vines	Leaf	Wall, trellis	Cultivation
6	*Vitis amurensis*	Vitaceae	*Vitis*	Woody vines	Fruit	Pergolas, railing	Cultivation
7	*Vitis vinifera*	Vitaceae	*Vitis*	Woody vines	Fruit	Pergolas, railing	Cultivation
8	*Campsis radicans*	Bignoniaceae	*Campsis*	Woody vines	Flower	Wall, trellis	Cultivation
9	*Wisteria sinensis*	Legume	*Wisteria*	Woody vines	Flower	Pergolas, tree trunk	Cultivation
10	*Lonicera japonica*	Caprifoliaceae	*Lonicera*	Woody vines	Flower/medicinal	Pergolas, tree trunk	Cultivation
11	*Lonicera × tellmanniana*	Caprifoliaceae	*Lonicera*	Woody vines	Flower	Pergolas, tree trunk	Cultivation
12	*Rosa hybrida*	Rosaceae	*Rosa*	Woody vines	Flower	Pergolas, flower wall	Cultivation
13	*Rosa multiflora*	Rosaceae	*Rosa*	Woody vines	Flower	Pergolas, flower wall	Cultivation
14	*Rosa multiflora* var. *carnea*	Rosaceae	*Rosa*	Woody vines	Flower	Pergolas, flower wall	Cultivation
15	*Isotrema manshuriense*	Aristolochiaceae	*Aristolochia*	Woody vines	Flower	Railing, pergolas	Cultivation
16	*Clematrs mandshusica*	Ranunculaceae	*Clematis*	Herbaceous vines	Flower	Railing, pergolas	Cultivation
17	*Clematis brevicaudata*	Ranunculaceae	*Clematis*	Herbaceous vines	Flower	Railing, pergolas	Cultivation
18	*Quamoclit pennata*	Convolvulaceae	*Ipomoea*	Herbaceous vines	Flower	Railing, pergolas	Cultivation
19	*Pharbitis nil*	Convolvulaceae	*Ipomoea*	Herbaceous vines	Flower	Railing, pergolas	Wild
20	*Menispermum dauricum*	Menispermaceae	*Menispermum*	Herbaceous vines	Leaf	Railing, pergolas	Wild
21	*Dioscorea nipponica*	Dioscoreaceae	*Dioscorea*	Herbaceous vines	Leaf /medicinal	Railing, pergolas	Wild

Table 5 Vine plant species and vertical greening proportion in different green space types

Type of green space	Main vine plants	Proportion of vertical greening//%
Residential area	*P. tricuspidata*, *P. guinguefolia*, *R. hybrida*, *R. multiflora*, *C. radicans*, *W. sinensis*, *V. amurensis*, *V. vinifera*, *L. japonica*, *Q. pennata*, *P. nil*, *A. arguta*, *S. chinensis*, *R. multiflora* var. *carnea*	98
Park	*P. tricuspidata*, *P. guinguefolia*, *C. orbiculatus*, *V. amurensis*, *S. chinensis*, *A. arguta*, *Lonicera × tellmanniana*, *C. mandshusica*, *C. brevicaudata*, *M. dauricum*, *D. nipponica*, *I. manshuriense*, *Q. pennata*, *L. japonica*, *R. multiflora*, *R. multiflora* var. *carnea*	96
Road	*P. tricuspidata*, *P. guinguefolia*, *L. japonica*, *R. multiflora*, *R. multiflora* var. *carnea*, *Q. pennata*	30
School	*P. tricuspidata*, *P. guinguefolia*, *V. amurensis*, *L. japonica*, *R. multiflora*, *C. orbiculatus*, *R. multiflora* var. *carnea*, *Q. pennata*	50

2.2 Application value evaluation of vine plants in Shenyang Area The comprehensive evaluation value (A) was calculated using the aforementioned absolute rating selection method. Based on the scores of each pricing indicator in Table 2 and the comprehensive weights (W) from the total ranking of the criterion layer relative to the target layer in Table 3, the evaluation ranking of vine species applications in Shenyang's urban greening was determined (Table 6). According to the evaluation model for vine application value, the 21 vine species used in Shenyang's green spaces were classified into four grades based on the distribution of comprehensive evaluation values and empirical observations.

Grade I ($A \geqslant 3.60$): 4 species with high development potential, recommended for prioritized promotion.

Grade II ($3.30 \leqslant A < 3.60$): 6 species with moderate development value, requiring further research before promotion.

Grade III ($3.00 \leqslant A < 3.30$): 6 species with limited application value. Examples include *C. mandshurica* and *C. brevicaudata*, which exhibit low ornamental value and minimal practical significance despite limited current use.

Grade IV ($2.70 \leqslant A < 3.00$): 5 species, including ecologically valuable native vines like *D. nipponica* and *M. dauricum*, receiving lower scores due to the high weight assigned to ornamental value in the evaluation.

Table 6 Application value and grade of vine plants for landscaping in Shenyang area

No.	Plant name	Comprehensive evaluation score/points	Grade
1	*W. sinensis*	3.909	I
2	*C. radicans*	3.864	I
3	*R. hybrida*	3.678	I
4	*I. manshuriense*	3.613	I
5	*R. multiflora* var. *carnea*	3.575	II
6	*L. japonica*	3.539	II
7	*S. chinensis*	3.532	II
8	*A. arguta*	3.511	II
9	*Lonicera × tellmanniana*	3.476	II
10	*P. guinguefolia*	3.323	II

(To be continued)

(Continued)

No.	Plant name	Comprehensive evaluation score/points	Grade
11	*R. multiflora* var. *carnea*	3.279	III
12	*Q. pennata*	3.254	III
13	*P. thicuspidata*	3.240	III
14	*C. mandshusica*	3.239	III
15	*C. brevicaudata*	3.239	III
16	*C. orbiculatus*	3.030	III
17	*D. nipponica*	2.986	IV
18	*V. amurensis*	2.979	IV
19	*M. dauricum*	2.867	IV
20	*P. nil*	2.851	IV
21	*V. vinifera*	2.797	IV

3 Conclusions

3.1 Conclusions A species survey of vines in landscaped green spaces in the Shenyang area identified 21 vine plant species belonging to 13 families and 14 genera. Focusing on vertical greening applications and grounded in the biological characteristics of these vines, a comprehensive evaluation system was established. This system integrates 14 indicators across three dimensions: development potential, ornamental value, and additional values (*e. g.*, ecological or cultural significance). By combining quantitative calculations with qualitative assessments, the evaluation results demonstrate scientific validity and practical effectiveness.

The evaluation model, tailored to the biological traits, ornamental value, and other attributes of the 21 vine species, constructed a hierarchical structure comprising one objective layer, three criterion layers, and 14 specific indicators. This framework quantitatively and qualitatively assessed the application value of all 21 species. Based on their comprehensive evaluation values (A), the vines were classified into four grades, providing actionable insights for prioritized utilization in urban greening. The comprehensive ranking is *W. sinensis* > *C. radicans* > *R. hybrida* > *I. manshuriense* > *R. multiflora var. carnea* > *L. japonica* > *S. chinensis* > *A. arguta* > *Lonicera × tellmanniana* > *P. guinguefolia* > *R. multiflora* > *Q. pennata* > *P. tricuspidata* > *C. mandshusica* > *C. brevicaudata* > *C. orbiculatus* > *D. nipponica* > *V. amurensis* > *M. dauricum* > *P. nil* > *V. vinifera*. Among them, *W. sinensis*, *C. radicans*, *R. hybrida* and *I. manshuriense* have good application prospects and can be further applied in Shenyang area. In other grades, some native plants are outstanding in growth adaptability, but general in other aspects, so the overall evaluation value is not high after comprehensive evaluation.

3.2 Discussion

3.2.1 There is still room for development of vertical greening in garden green space. Research on the urban application of vine plant resources has been conducted in cities across northern China. Although vines exhibit excellent greening effects and require relatively low-maintenance management, making them a crucial and effective group for improving ecological environments and enhancing landscape aesthetics[11], current urban green spaces face issues such as limited species diversity (predominantly a few common vines), monotonous visual outcomes, and insufficient use of native species[12]. Field surveys in Shenyang identified the eight most frequently utilized vine species in urban green spaces: *P. tricuspidata*, *P. quinquefolia*, *V. amurensis*, *L. japonica*, *R. multiflora*, *C. orbiculatus*, *R. multiflora* var. *carnea*, and *Q. pennata*. Over 95% of residential areas and park green spaces incorporated vertical greening, while roadside greening had the lowest adoption rate at merely 30%. To fill these gaps, it is imperative to increase the proportion of vertical greening and expand the diversity of high-value vine species suitable for such applications. Vertical greening plays a vital role in urban landscaping by delivering both aesthetic and ecological benefits, which are essential for improving urban environments, expanding green coverage, and fostering healthy, coordinated, and sustainable urban development.

3.2.2 The evaluation model of application value of vine plants needs to be optimized. From the final evaluation results of the comprehensive assessment system, the Analytic Hierarchy Process (AHP) method proves to be a scientifically sound approach. However, further research and validation are required for the selection, quantification, and grading of vine evaluation indicators. For instance, Grade 1 vines such as *W. sinensis*, *C. radicans*, and *R. hybrida*, while capable of surviving in microclimates, exhibit sensitivity to low temperatures during cultivation in Shenyang, a critical factor inadequately addressed in the current evaluation framework. Additionally, although native species are preferred for urban landscaping, the model fails to prioritize their inherent advantages. Therefore, expert collaboration is essential to refine the formulation and scoring of evaluation criteria, alongside practical validation of the indicator system and weight assignments. Such efforts would enhance the evaluation system's scientific rigor, flexibility, and applicability.

From the perspective of vine application value, the proposed method, primarily focused on ornamental value, provides a relatively comprehensive assessment of greening potential for Shenyang's vine species. By iteratively improving the indicator system, this model will establish a theoretical foundation for selecting and evaluating high-performance vertical greening species, ultimately advancing sustainable urban horticulture practices.

References

[1] HU WZ, ZHOU GZ, LI P, *et al.* Summary of several wild plant resources suitable for vertical greening in Shenyang area[J]. Agricultural Technology Service, 2008, 25(12): 106,114. (in Chinese).

[2] LI BC. Study on the selection and application of vertical greening plant species in Tianjin[D]. Tianjin: School of Agriculture and Bioengineering, Tianjin University, 2011. (in Chinese).

[3] SAATY TL. The analytical hierarchy process[M]. NY: McCraw Hill Inc., 1993: 89–94. (in Chinese).

[4] WU XX, YOU J, LIN QM. Establishment of the evaluation system for exploitation value of the wild resources of ornamental plants and evaluation of the resources in Wuchuan area of Inner Mongolia[J]. Chinese Agricultural Science Bulletin, 2006, 8: 464–469. (in Chinese).

[5] LIANG M, SUN B, YANG YH, *et al.* Evaluation of ornamental characteristics of autumn red-leaf plants in Heilongjiang Province[J]. Journal of Northeast Forestry University, 2008, 36(7): 84–86. (in Chinese).

(To page 27)

structured mechanisms such as regular reporting systems between interns and their corporate or academic mentors, consistent communication channels linking corporate mentors with academic supervisors, periodic dialogues with practice base administrators, and scheduled evaluations of interns. Concurrently, comprehensive guidance, continuous monitoring, and routine assessments should be reinforced throughout the internship period to ensure systematic oversight and sustained support for student development.

3.5 Effectively strengthening the construction of school-enterprise cooperation base The practice teaching base focuses on construction, management, and operation, including laying a solid foundation of industry-university-research collaboration with the school, providing teachers with a conducive research environment and space for achievement transformation, offering practice teaching content and venues aligned with students' professional internships, assigning corporate mentors to students, and providing necessary financial support. Taking the Environmental Engineering program at Zhaoqing University as an example, one of its partnered practice teaching bases, Guangdong Xijiang Environmental Protection Technology Co., Ltd., has been established as a provincial-level university student practice teaching base. It is recommended to collaborate with local governments to implement ecological governance projects, such as Guangdong Environmental Protection College dispatching cadres to rural areas for resident assignments to carry out environmental science outreach, green industry cultivation projects, and promote technology achievement transformation. A "science and technology commissioner" system could be established to channel university research capabilities into rural areas, addressing practical issues like agricultural non-point source pollution and solid waste treatment.

4 Conclusions

In the context of the rural revitalization strategy, practice teaching is not only an inevitable choice for educational reform but also the core driving force to break through rural development bottlenecks. Through curriculum innovation, industry-education integration, and policy guarantees, practice teaching can deliver "ready-to-use and locally-retained" high-quality talents to rural areas, driving the transformation of villages from "blood transfusion" to "blood creation." It is projected that by 2030, such models will cover more than 60% of agriculture-related universities in the whole country, significantly enhancing rural industrial competitiveness and sustainable development capacity.

References

[1] DAI QM, LU YP, XU CB, *et al.* The requirement and realization of the cultivation of agricultural talents in local college under the background of rural revitalization[J]. Journal of Southwest Forestry University (Social Sciences), 2019, 3(2): 89–92. (in Chinese).
[2] ZHU DQ, SHI XJ. The technical logic and value purpose of vocational education serving rural revitalization[J]. China Educational Technology, 2021(1): 41–49. (in Chinese).
[3] TANG LX. Practical exploration on talent demand and solution of rural revitalization strategy[J]. Guizhou Social Sciences, 2021(1): 161–168. (in Chinese).
[4] ZHOU GL, MA HQ. Integration of science and teaching: The change and innovation of higher education ideas[J]. China Higher Education Research, 2012(8): 15–23. (in Chinese).
[5] ZHANG DM. Exploration and practice of industry-education integration mode of traffic engineering specialty in application-oriented universities[J]. Science and Technology & Innovation, 2021, 175(7): 85–86. (in Chinese).
[6] LI YH, MA J. Construction of outside-school practice base for the transforming development of local undergraduate colleges[J]. Journal of Tianjin Academy of Educational Science, 2019(1): 21–25. (in Chinese).
[7] QI YS, LIU SL, GAO S, *et al.* Design of talent training system for mechanical engineering specialty of printing industry based on integration of industry and education[J]. Digital Printing, 2021(4): 8–14. (in Chinese).
[8] CHEN Y. Analysis on the construction path of college students' off-campus practice teaching base[J]. Journal of Jiangxi Vocational and Technical College of Electricity, 2018(7): 34–35. (in Chinese).
[9] CAO R. Analysis on the problems and paths of the construction of off-campus practice teaching bases in local colleges and universities under the background of transformation and development[J]. Journal of Taiyuan City Vocational College, 2018(6): 143–144. (in Chinese).
[10] LU HJ. Strategies for disciplinary construction in application-oriented universities[J]. Journal of Ningbo University (Educational Science Edition)[J]. 2020(1): 80–85. (in Chinese).
[11] MOU YL, LI KJ, LI JJ, *et al.* Promoting the program cluster construction of the application-oriented college by industry-education integration[J]. Journal of Higher Education, 2020,41(3): 42–50. (in Chinese).

(From page 18)

[6] LIU BB, SUN QL, LIU X, *et al.* Park green space in Xiongan New District based on group decision and AHP[J]. Chinese Journal of Applied and Environmental Biology, 2022, 28(3): 770–778. (in Chinese).
[7] ZENG XY, LIU LA, GAO YH. Selection of vine plants in three-dimensional greening in Chengdu[J]. Journal of Northwest Forestry University, 2012, 27(1): 196–200. (in Chinese).
[8] LIN QN. Decision Analysis[M]. Beijing: Beijing University of Posts and Telecommunications Press, 2003: 89–94. (in Chinese).
[9] GU MP. Application of plant materials in three-dimensional greening [J]. Northern Horticulture, 2009(7): 217–219. (in Chinese).
[10] WENG L. The application of vines to urban vertical greening[J]. Acta Agriculturae Shanghai, 2007, 23(2): 123–125. (in Chinese).
[11] XIA JB, XU JW, ZHAO YY. Research progress of Lianes in China [J]. Journal of Zhejiang Forestry Science and Technology, 2008, 28 (3): 69–74. (in Chinese).
[12] LU DD, NIE GH. Analysis of vine plants application in landscape gardening: A case study of Jiujiang City[J]. Shaanxi Forest Science and Technology, 2024,52(2): 93–100. (in Chinese).