E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(12): 880-885
Received: 07-09-2025
Accepted: 09-10-2025

Malsawmzuali Ralte
Department of Silviculture and Agroforestry, College of Forestry, Sirsi, Karnataka, India

Nishma Dechamma TM
Department of Silviculture and Agroforestry, College of Forestry, Sirsi, Karnataka, India

Ramesh S Rathod
Department of Silviculture and Agroforestry, College of Forestry, Sirsi, Karnataka, India

Syed Ali
Department of Silviculture and Agroforestry, College of Forestry, Sirsi, Karnataka, India

Corresponding Author:
Malsawmzuali Ralte
Department of Silviculture and Agroforestry, College of Forestry, Sirsi, Karnataka, India

Agroforestry potential of *Acacia pennata* (syn. *Senegalia pennata*) as a multipurpose tree species in Mizoram and comparable Southeast Asian contexts: A review

Malsawmzuali Ralte, Nishma Dechamma TM, Ramesh S Rathod and Syed Ali

DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i12m.4502

Abstract
Acacia pennata (L.) Willd. (syn. *Senegalia pennata* (L.) Maslin) is a native woody legume of South and Southeast Asia that functions as a culturally valued wild vegetable, medicinal resource and biomass-producing hedge or small tree. In Mizoram, where it is widely known as *khanghu* and used as a common edible shoot, the species is increasingly visible in land-use mosaics shaped by shifting cultivation, homegardens and emerging conservation agriculture approaches. This review synthesizes evidence focused on Northeast India, especially Mizoram and closely comparable Southeast Asian production and use systems, to evaluate its suitability as a multipurpose tree species (MPT) for agroforestry. Available studies indicate strong promise in three domains: (i) livelihood and nutrition through dependable supply of edible shoots and marketable greens in local food systems (ii) ecological services via perennial cover, hedgerow architecture, coppicing and potential biological nitrogen fixation typical of acacias and (iii) integration potential in slope-stabilizing contour hedgerows, improved fallows and homegarden agroforestry where the species is already preferred by farmers. However, key constraints remain under-documented including propagation bottlenecks, genotype-environment responses across elevations, pruning regimes for sustained shoot quality and formal value-chain development. We propose a Mizoram-centered research agenda and practical integration pathways aligned with MiSALT-style hedgerow management and homegarden intensification.

Keywords: *Senegalia pennata*, khanghu, wild edible vegetables, hedgerows, MiSALT, shifting cultivation, homegardens, Northeast India, ecosystem services

1. Introduction
The hill agroecosystems of Mizoram are characterized by steep slopes, high rainfall seasonality and land-use patterns dominated by shifting cultivation (jhum), secondary fallows and diverse homegardens. Maintaining farm livelihoods under these biophysical constraints requires perennial, multifunctional species that simultaneously deliver food, income, biomass and soil and water conservation services. Multipurpose tree species (MPTs) are therefore central to agroforestry strategies in the Eastern Himalaya and Indo-Burma biodiversity region, where household food security often depends on a combination of cultivated crops and wild or semi-domesticated edible plants sold in local markets.

Within this context, *Acacia pennata* (L.) Willd. now widely treated as a synonym of *Senegalia pennata* (L.) Maslin, deserves renewed attention. Taxonomic revisions and authoritative plant lists recognise *Acacia pennata* as a synonym and support the accepted name *Senegalia pennata* (Maslin *et al.* 2019) [12]. The plant is native across the Indian subcontinent through mainland Southeast Asia and is widely used as a vegetable and ethnomedicinal resource. In Mizoram it is locally known as *khanghu* and is prominent in traditional cuisines and wild edible vegetable lists (Lalmuanpuii *et al.* 2021) [11] Importantly for agroforestry, the species is not merely gathered from forests. It is also maintained in managed systems such as village hedges and homegardens in several parts of its range and it appears in formal slope-land conservation guidance in Mizoram through MiSALT, where farmers select it as a “Very Important Plant” for hedgerows and biomass management (Anon. 2017) [3].

Despite this practical relevance, the agroforestry role of *A. pennata* is still scattered across ethnobotanical documentation, soil and land-use studies and broader acacia functional ecology literature. For Mizoram in particular, recent work on wild edible vegetables and land-use impacts on soil nutrients provides an evidence base to evaluate where *A. pennata* fits best: as a hedge and contour stabiliser, a homegarden vegetable tree, a fallow enrichment species and a low-input biomass source (Lalmuanpuii *et al.,* 2024) [10]. Comparable Southeast Asian studies, including research on homegarden conservation of *A. pennata* genetic diversity, strengthen the argument that managed agroforestry patches can sustain both livelihoods and biodiversity (Gao *et al.,* 2012) [5].

This review therefore aims to (i) summarise species ecology, uses and management with emphasis on Northeast India and Mizoram (ii) assess agroforestry functions and integration niches using evidence from Mizoram and analogous Southeast Asian systems and (iii) identify practical constraints and research priorities required to move from wild harvest and opportunistic planting to deliberate MPT-based agroforestry design.

1.1 Taxonomy, nomenclature and distribution

1.1.1 Taxonomic placement and accepted name

The genus *Acacia* sensu lato has undergone major revision and many Old World species are now placed in segregate genera including *Senegalia* and *Vachellia*. In this framework, *Acacia pennata* is widely treated as a synonym of *Senegalia pennata* and major plant databases and taxonomic treatments recognise *Senegalia pennata* as the accepted name (Maslin *et al.* 2019) [12]. For agroforestry and extension work in Mizoram, the older name *Acacia pennata* remains common in local documentation and farmer vocabulary. This review uses *A. pennata* for continuity with most regional literature but notes the accepted name where relevant.

1.1.2 Native range and occurrence in Mizoram

Authoritative sources describe the species as native across the Indian subcontinent to Myanmar and into parts of mainland Southeast Asia (Govaerts *et al.,* 2021) [6]. In Mizoram, *A. pennata* occurs in village landscapes, forest edges, fallows and homegardens where it is valued for edible shoots and household use. Its cultural visibility is reflected in studies documenting wild edible plant resources and traditional food preparation among Mizo and related communities, where *khanghu* is frequently cited (Kar *et al.,* 2013) [8].

2. Ethnobotany, food value and traditional knowledge in Mizoram and Northeast India

2.1 *A. pennata* as a wild edible vegetable and market-linked food

Wild edible vegetables (WEVs) remain crucial in Northeast India, both nutritionally and economically. Recent ethnobotanical surveys from Mizoram document a broad diversity of WEVs and explicitly link household use with market availability, reinforcing the role of commonly traded greens in local food systems (Lalmuanpuii *et al.,* 2024) [10]. Earlier work documenting wild edible plant resources used by the Mizos also records species sold in local markets, highlighting that a subset of wild edibles has already entered semi-commercial channels (Kar *et al.,* 2013) [8].

Within this spectrum, *A. pennata* is particularly suitable for "vegetable tree" framing because the edible portion is the tender shoot and young leaves that can be repeatedly harvested. In culinary documentation of traditional food preparation among communities in Mizoram, *khanghu/khanghmuk* is described as a routine ingredient combined with other local species in characteristic dishes, reflecting strong cultural acceptance and stable demand (Lalmuanpuii *et al.,* 2021) [10]. This matters for agroforestry adoption: MPT integration succeeds more readily when the product already has a known use, preparation knowledge and consumption preference.

2.2 Ethnomedicinal uses in Northeast India

Beyond food, *A. pennata* is repeatedly documented as a medicinal plant in Northeast India and adjacent regions. Ethnomedicinal surveys from Assam report use of leaves and roots for ailments including cough, bronchitis and gastrointestinal conditions (Kalita *et al.,* 2014) [7]. Mizoram-focused quantitative ethnomedicinal documentation similarly emphasises the breadth of plant-based healthcare knowledge in the state and provides a pathway for assessing culturally salient species, including those that overlap with food plants (Ralte *et al.,* 2024). Pharmacological validation efforts also exist in the broader Northeast Indian context: for example, work connected to Mizo traditional use has examined efficacy of root bark extracts against gastrointestinal pathogens, indicating that at least some ethnomedicinal claims have been investigated experimentally (Lalchhandama, 2013) [9].

For agroforestry, medicinal value influences conservation incentives and on-farm retention, but it also introduces quality and safety considerations. If *A. pennata* is positioned as an MPT providing both food shoots and medicinal raw material, clear harvesting guidelines and value-chain segmentation (food-grade shoots vs medicinal bark or roots) become important to avoid destructive extraction that could undermine plant survival.

2.3 Nutraceutical and nutritional framing

A dedicated systematic review on the nutraceutical potential of *A. pennata* indicates sustained scientific interest in its bioactive compounds and food-health interface (Zothantluannga *et al.,* 2019) [15]. While nutraceutical literature often draws on studies beyond Northeast India, it provides a useful scaffold for local agroforestry promotion because it strengthens the "high-value green" narrative and can motivate domestication and quality improvement. In Mizoram, where WEVs are already culturally central, connecting traditional use with scientifically described nutritive attributes can support extension messaging, especially when aligned with homegarden nutrition objectives.

3. Ecological traits relevant to agroforestry design

3.1 Growth form and management plasticity

A. pennata is commonly described as a shrub or small tree, sometimes vine-like or scrambling depending on support, with spines or prickles and a capacity to persist along field margins and hedges (Govaerts *et al.,* 2021) [6]. These traits are agroforestry-relevant in two ways. First, hedge suitability allows slope stabilisation and boundary planting without large shade footprints that might suppress annual crops. Second, management plasticity supports repeated pruning and coppice-based biomass supply, a key requirement in jhum-adjacent systems that need fast regrowth for mulch and soil cover.

3.2 Biological nitrogen fixation and soil fertility potential

As a leguminous woody species, *A. pennata* is expected to form symbioses with nitrogen-fixing bacteria under suitable conditions. Broader acacia-focused syntheses conclude that acacias can fix useful quantities of nitrogen, but the magnitude depends on site conditions, nutrient limitations, moisture and

effective symbiosis (Brockwell *et al*., 2005) [4]. While these reviews are not species-specific to *A. pennata*, they justify its candidacy as a soil-improving component in low-input hill agriculture, especially when used as hedgerows or fallow enrichment where pruning returns biomass and nutrients to the soil.

For Mizoram specifically, the practical relevance of nitrogen fixation is best interpreted through system outcomes. MiSALT guidance for slope-land technology frames hedgerows as a tool for soil moisture retention, erosion control and nutrient cycling and lists *Acacia pennata (Khanghu)* among farmer-chosen "Very Important Plants" for hedgerows, implying that local experience already recognises soil and biomass benefits (Anon., 2017) [3].

3.3 Soil and land-use evidence from Mizoram: plantations and nutrient dynamics

Direct evidence linking *A. pennata* land use to soil properties in Mizoram comes from land-use comparison studies that include "Acacia pennata plantation" as a distinct category alongside natural forest, jhum fallow, homegarden and current jhum. These studies show that land use and soil depth significantly influence pH, available phosphorus and exchangeable cations and that conversion of native forests to cultivation tends to reduce exchangeable cations in cultivated lands including *A. pennata* plantation relative to natural forest and longer fallows (Ovung *et al.,* 2021) [21]. Importantly, this does not imply *A. pennata* plantations are harmful; rather, it indicates that plantations established on converted or degraded slopes may inherit poorer soil conditions and that management (mulching, longer rotation, mixed-species planting) is critical if soil restoration is an objective.

For agroforestry planning, the key inference is that *A. pennata* should be treated as a component of restorative design rather than a stand-alone monoculture "solution". Its best role may be in mixed hedgerows, diversified homegardens and fallow enrichment that mimic the structural and litter dynamics of secondary vegetation rather than in simplified plantations.

4. Agroforestry niches for *A. pennata* in Mizoram

4.1 Contour hedgerows and slope stabilisation (MiSALT-aligned integration)

One of the most concrete entry points for *A. pennata* as an MPT in Mizoram is contour hedgerow establishment under MiSALT and related slope-land conservation approaches. MiSALT farmer guidance explains that hedgerows are planted below contour trash bunds to support bund structure, reduce erosion and runoff and improve soil moisture and that these hedgerows comprise indigenous plants and nitrogen-fixing species managed through regular pruning with pruned biomass placed back on bunds for decomposition. The guide explicitly lists *Acacia pennata (Khanghu)* among farmer choices of hedgerow "VIPs", alongside other culturally valued species (Anon., 2017) [3].

This positioning is significant for two reasons. First, it embeds *A. pennata* within an already institutionalised extension framework, reducing adoption barriers. Second, hedgerow management aligns with the plant's repeated harvest potential: pruning can simultaneously provide edible shoots, mulch biomass and structural reinforcement. A design principle for Mizoram therefore emerges: manage *A. pennata* as a multi-output hedgerow species rather than only as a vegetable plant. Regular, low-height pruning (MiSALT suggests maintaining hedgerows roughly 1-2 m through trimming) can be adapted to optimise both shoot tenderness and erosion-control function (Anon., 2017) [3].

Research needs here are practical and measurable: pruning frequency that balances edible yield and regrowth, spacing that avoids excessive competition with adjacent crops and biomass decomposition rates and nutrient return under high rainfall conditions.

4.2 Homegardens as nutrition-sensitive agroforestry platforms

Homegardens in Mizoram and the broader region are multi-strata systems combining fruit trees, timber and fuelwood species, vegetables, spices and medicinal plants. Evidence from Southeast Asia shows that homegardens can actively conserve *A. pennata* genetic diversity and maintain planted populations that retain most genetic variation found in nearby wild populations (Gao *et al.,* 2012) [5]. Although this study is from southwest China, it is directly relevant because it demonstrates that managed household agroforestry patches can serve as living germplasm banks for culturally valued vegetables.

For Mizoram, recent documentation of WEV diversity and continued culinary importance supports the idea that homegardens can be strengthened as "domestication sites" for *A. pennata*, transitioning from forest gathering to deliberate household production (Lalmuanpuii *et al.,* 2024) [10]. The benefits include better access for frequent harvesting, reduced pressure on wild stands near villages and opportunities to select for preferred traits such as lower thorniness, higher shoot yield and improved aroma or texture.

Homegarden integration is especially attractive for women-led nutrition interventions because the plant is used in daily cooking, harvest is lightweight and frequent and sales can occur in small bundles in local markets. The constraint is that agronomic protocols for homegarden planting densities, shade tolerance under fruit canopies and pest management are not well standardised for Mizoram.

4.3 Improved fallows and enrichment of jhum landscapes

Shifting cultivation landscapes rely on fallow cycles to rebuild fertility and reduce weed pressure. In many parts of Northeast India, shorter fallow periods have been linked to declining soil quality and productivity, motivating interest in improved fallows that accelerate restoration. While direct improved-fallow trials with *A. pennata* in Mizoram are limited in the openly documented literature, the species' perennial biomass production, coppicing potential and likely nitrogen fixation justify its evaluation as an enrichment component in fallows, especially near settlement zones where repeated access for vegetable harvest adds livelihood value.

Land-use evidence from Mizoram emphasises that longer fallow periods (>12 years in the referenced study context) can increase available nutrients, highlighting the importance of vegetation cover for soil conservation (Ovung *et al.,* 2021) [21]. *A. pennata* could contribute to this vegetation cover while providing marketable shoots, but it should ideally be combined with other fallow species to diversify litter quality, rooting depth and microhabitat structure.

4.4 Boundary planting, live fences and field-margin hedges

A. pennata is often reported as occurring around fields as hedges in different parts of its range and some paper notes that it is sometimes cultivated in hedges in Thailand (Aggarwal, 2003) [1]. Boundary planting is therefore a "low-regret" niche in Mizoram: it uses otherwise underutilised edge space, can reduce browsing intrusion and can serve as a readily accessible shoot source. In

slope agriculture, field edges also represent erosion-prone zones where perennial roots and hedge structure can stabilise soil.
Design considerations include managing thorniness for safe harvest, ensuring hedges do not overshade crops and aligning pruning with crop calendars so that biomass is returned as mulch during periods of peak erosion risk.

5. Evidence from Southeast Asia: cultivation, homegarden conservation and food systems

5.1 Regional culinary demand and semi-domestication

Across mainland Southeast Asia, *A. pennata* (often referred to as cha-om in Thailand) is a well-known vegetable used in soups, curries, omelettes and stir-fries and harvested as tender shoots before they become tough and thorny. Occasional use as a vegetable and hedge cultivation in Thailand has also been noted (Aggarwal, 2003) [1]. These use patterns mirror Northeast India, where shoots are similarly harvested young, reinforcing that the "vegetable hedge" pathway is culturally and agronomically coherent across the species' range.
For Mizoram, Southeast Asian experiences imply practical lessons: market development can scale beyond purely local trading, but quality standards (shoot tenderness, uniformity, low fibre) and supply continuity become important. The Southeast Asian framing also suggests that smallholder production can be linked to roadside or peri-urban vegetable markets, an opportunity relevant to Aizawl and district towns if production is organised.

5.2 Homegardens as biodiversity and germplasm conservation sites

The Xishuangbanna southwest China study provides one of the clearest agroforestry-specific demonstrations for *A. pennata*: homegarden populations maintained over 90% of the microsatellite genetic variation present in wild populations and showed no significant differences in allelic diversity and heterozygosity when compared with adjacent wild populations. The authors conclude that homegardens have strong promise for maintaining genetic diversity and conservation value in tropical regions (Gao *et al.*, 2012) [5].
For Northeast India, where village agroforestry systems already host diverse useful plants, this evidence supports an explicit conservation-through-use strategy: encourage household-level cultivation of *A. pennata* to reduce wild harvesting pressure while maintaining genetic resources in managed landscapes. A Mizoram-specific implication is the need to avoid overly narrow clonal propagation from a few preferred plants if genetic diversity is a goal. Instead, community nurseries could deliberately include seedlings from multiple local provenances.

6. Propagation, establishment and management: what is known and what is missing

6.1 Propagation pathways

Detailed, Mizoram-specific propagation protocols for *A. pennata* are not yet well consolidated in open extension literature. However, the broader agroforestry and homegarden evidence indicates that the species can be established through seed and can be maintained under repeated harvest regimes (Gao *et al.*, 2012) [5]. Since many acacias show seed dormancy constraints, practical domestication in Mizoram would benefit from local trials on pre-treatment (scarification methods), germination timing aligned with monsoon onset and early-stage shade management.
MiSALT guidance does not provide species-specific nursery protocols, but its management principles regular pruning, avoiding burning near hedgerows and using pruned biomass as mulch are directly applicable once plants are established (Anon., 2017) [3].

6.2 Pruning and harvest management for dual objectives: edible shoots and soil cover

The central management question for *A. pennata* as an MPT is how to balance edible shoot production with ecological services. Hedge systems require frequent trimming to maintain structure and reduce competition with crops. MiSALT suggests maintaining hedgerows at roughly 1-2 m height and placing pruned biomass on contour bunds for decomposition and soil improvement (Anon., 2017) [3]. For *A. pennata*, this aligns with culinary preference for tender young shoots, suggesting that an integrated harvest-prune schedule can serve both food and conservation goals.
Key research gaps for Mizoram include:

- Harvest intensity thresholds beyond which plant vigour declines
- Seasonal variation in shoot quality and fibre content across elevations
- Thorn development dynamics under different pruning regimes
- Nutrient return from *A. pennata* biomass relative to other common hedgerow species

6.3 Species mixtures and system-level management

Evidence from Mizoram soil and land-use comparisons indicates that cultivated land uses including *A. pennata* plantations can show reduced exchangeable cations compared with natural forest and longer fallows (Ovung *et al.*, 2021) [21]. This underscores that if *A. pennata* is planted on degraded slopes without complementary soil-building practices, improvements may be slow. Therefore, *A. pennata* should be embedded in mixed-species hedgerows or fallow enrichments that include species with different litter chemistry and rooting traits. MiSALT itself conceptualises hedgerows as mixtures of indigenous plants and nitrogen-fixing species (Anon., 2017) [3].

7. Livelihood, value chains and policy relevance in Mizoram

7.1 Market potential and smallholder income

Mizoram-focused WEV studies explicitly consider marketing potential and market surveys, indicating that wild vegetables are not only subsistence items but also traded commodities (Lalmuanpuii *et al.*, 2024) [10]. Earlier market-oriented documentation from Mizoram notes that only a subset of wild edible species are sold in local markets, implying room to expand cultivation-based supply for high-demand species (Kar *et al.*, 2013) [8]. *A. pennata* is well suited to this transition because harvesting is frequent, storage requirements are modest for short local chains and demand is culturally entrenched through daily cuisine.
Constraints include perishability of tender shoots, inconsistent supply during dry months and the need for grading standards if trade increases. Collective marketing through women's groups or village-level producer clusters could improve bargaining power and reduce transaction costs, but such institutional options need context-specific evaluation.

7.2 Alignment with land restoration and slope agriculture programs

The inclusion of *A. pennata* in MiSALT hedgerow "VIP" lists places it within formal land management discourse in Mizoram (Anon., 2017) [3]. This is strategically important because it links

the species to soil and water conservation objectives, not only to food. As climate variability increases erosion risks on slopes, perennial hedgerows that provide both biomass and edible products become an attractive "co-benefit" intervention.

From a policy perspective, *A. pennata* fits a restoration-through-use approach consistent with agroforestry missions, nutrition initiatives and community-based biodiversity conservation. However, policy uptake would require clearer evidence on yield, labour requirements and long-term soil outcomes under Mizoram conditions.

8. Knowledge gaps and research priorities for Mizoram-centered agroforestry development

Based on the evidence assembled, five priority research clusters emerge:

1. **Domestication and varietal selection:** Identify locally preferred phenotypes (high shoot yield, lower thorniness, better regrowth) while maintaining genetic diversity, informed by homegarden conservation insights (Gao *et al.*, 2012) [5].
2. **Propagation protocols:** Develop seed handling and nursery practices suited to Mizoram rainfall patterns and slope environments, then validate survival under hedgerow and homegarden establishment.
3. **Management trials:** Quantify pruning frequency, harvest regimes and spacing effects on shoot yield, biomass production and competition with adjacent crops, aligned with MiSALT hedgerow management principles (Anon., 2017) [3].
4. **Soil and ecosystem services:** Test whether mixed hedgerows including *A. pennata* improve soil indicators relative to current jhum and degraded plantations, building on existing land-use soil evidence (Ovung *et al.*, 2021) [21].
5. **Value chain and nutrition outcomes:** Document seasonal price patterns, post-harvest losses, consumer preferences and household nutrition contributions in Mizoram markets where WEV trade is already recognised (Lalmuanpuii *et al.*, 2024) [10].

Conclusion

Acacia pennata has a strong case as a multipurpose tree species for Mizoram because it sits at the intersection of cultural food demand, practical farm management and slope-land conservation needs. Taxonomic resources and regional floristic treatments clarify nomenclature but do not change the central point: in village landscapes the plant is already valued and managed, making it a realistic candidate for deliberate agroforestry design rather than a speculative introduction.

Evidence from Mizoram and Northeast India shows that *khanghu* is embedded in everyday cuisine and is frequently documented among wild edible vegetables and traditional food preparations. This cultural anchoring is an adoption advantage: farmers and consumers already know how to harvest, cook and value the product. At the same time, ethnomedicinal documentation across the region broadens its livelihood relevance and may strengthen incentives for on-farm retention, though it also calls for careful guidance to avoid destructive harvesting of bark or roots.

From an agroforestry systems perspective, the most immediate and evidence-aligned niche in Mizoram is contour hedgerows and field-margin planting under MiSALT-style slope-land technologies. MiSALT guidance explicitly lists *Acacia pennata (Khanghu)* among farmer-chosen "Very Important Plants" for hedgerows and prescribes management practices such as regular pruning and using pruned biomass as mulch on contour bunds. This creates a rare bridge between local preference and formal extension framing. A second strong niche is homegarden integration where Southeast Asian research demonstrates that homegardens can conserve *A. pennata* genetic diversity and maintain planted populations comparable to wild ones, supporting a conservation-through-use strategy that is highly relevant for Mizoram's village-based agroforestry.

However, the soil and land-use evidence available from Mizoram cautions against assuming that *A. pennata* plantations automatically restore degraded slopes. Studies comparing land uses including *A. pennata* plantation show that cultivated land uses can have reduced exchangeable cations relative to natural forest and longer fallows, highlighting that site history and management intensity matter. Therefore, the most defensible conclusion is that *A. pennata* is best deployed as a component in mixed hedgerows, diversified homegardens and enriched fallows paired with mulch-based soil management rather than as simplified monoculture plantations.

Overall, *A. pennata* is a locally legitimate MPT candidate for Mizoram with high potential co-benefits: edible shoot production, market-linked income, perennial cover for erosion control and probable soil fertility contributions consistent with acacia nitrogen fixation potential. Turning this promise into scalable practice now depends on Mizoram-centered domestication research, management trials and value-chain studies that are designed around how farmers already use and manage *khanghu* in real landscapes.

References

1. Aggarwal S. *Acacia pennata* (L.) Willd. In: Lemmens RHMJ, Bunyapraphatsara N, editors. Plant resources of South-East Asia No. 12(3): Medicinal and poisonous plants 3. Bogor: PROSEA Foundation; 2003.
2. Anonymous. Plant resources of South-East Asia No. 4: Forages. Wageningen: Pudoc Scientific Publishers; 1992.
3. Anonymous. Manual on slope land agriculture techniques (MiSALT). Aizawl: Government of Mizoram and International Fund for Agricultural Development; 2017.
4. Brockwell J, Searle SD, Jeavons AC, Waayers M. Nitrogen fixation in acacias: An untapped resource for sustainable plantations, farm forestry and land reclamation. ACIAR Monograph No. 115. Canberra: Australian Centre for International Agricultural Research; 2005.
5. Gao J, He T, Li Q. Traditional home-garden conserving genetic diversity: A case study of *Acacia pennata* in southwest China. Conservation Genetics. 2012;13(4):891-898. doi:10.1007/s10592-012-0340-1.
6. Govaerts R, Nic Lughadha E, Black N, Turner R, Paton A. The World Checklist of Vascular Plants, a continuously updated resource for exploring global plant diversity. Scientific Data. 2021;8:215. doi:10.1038/s41597-021-00997-6.
7. Kalita D, Saikia J, Mukherjee AK, Doley R. An ethnomedicinal survey of traditionally used medicinal plants for the treatment of snakebite in Morigaon district of Assam, India. International Journal of Medicinal and Aromatic Plants. 2014;4(2):97-106.
8. Kar A, Bora D, Borthakur S, Goswami NK, Saharia D. Wild edible plant resources used by the Mizos of Mizoram, India. Kathmandu University Journal of Science, Engineering and Technology. 2013;9(1):106-126. doi:10.3126/kuset.v9i1.63850.
9. Lalchhandama K. Efficacy and structural effects of *Acacia*

pennata root bark upon the avian parasitic helminth *Raillietina echinobothrida*. Pharmacognosy Journal. 2013;5(1):17-21. doi:10.1016/j.phcgj.2012.12.002.
10. Lalmuanpuii R, Zodinpuii B, Bohia B, Zothanpuia N, Lalbiaknunga J, Singh PK. Wild edible vegetables of ethnic communities of Mizoram (Northeast India): An ethnobotanical study in thrust of marketing potential. Journal of Ethnobiology and Ethnomedicine. 2024;20(1):58. doi:10.1186/s13002-024-00649-1.
11. Lalmuanpuii R, Zodinpuii B, Lalbiaknunga J, *et al*. Traditional food preparation of wild edible vegetables among the ethnic groups of Mizoram, North East India. Journal of Ethnic Foods. 2021;8:26. doi:10.1186/s42779-021-00099-4.
12. Maslin BR, Ho BC, Sun H, Bai L. Revision of *Senegalia* in China and notes on introduced species of *Acacia*, *Acaciella*, *Senegalia* and *Vachellia* (Leguminosae: Mimosoideae). Plant Diversity. 2019;41(6):353-466. doi:10.1016/j.pld.2019.09.001.
13. Ovung EY, Tripathi SK, Brearley FQ. Changes in soil exchangeable nutrients across different land uses in steep slopes of Mizoram, North-east India. Journal of Applied and Natural Science. 2021;13(3):929-936. doi:10.31018/jans.v13i3.2816.
14. Ralte L, Sailo H, Singh YT. Ethnobotanical study of medicinal plants used by the indigenous community of the western region of Mizoram, India. Journal of Ethnobiology and Ethnomedicine. 2024;20(1):2. doi:10.1186/s13002-024-00635-7.
15. Zothantluanga JH, Bhat HR, Shakya A. A systematic review on the nutraceutical potential of *Acacia pennata* (L.) Willd. Current Trends in Pharmaceutical Research. 2019;6(2):12-26.