International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; SP-9(9): 2029-2037
www.biochemjournal.com
Received: 03-07-2025
Accepted: 12-08-2025

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Exploring the taxonomic richness and socioeconomic role of indigenous leafy vegetables: A review perspective

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DOI: https://www.doi.org/10.33545/26174693.2025.v9.i9Sz.5800

Abstract
Indigenous leafy vegetables (ILVs) represent a vital yet underutilized component of agrobiodiversity and food systems, particularly in rural and tribal communities across the globe. This review synthesizes existing knowledge on the taxonomic diversity, nutritional composition, ethnobotanical relevance, agroecological adaptability, and socioeconomic contributions of ILVs, with a special focus on India. The floristic richness spans multiple botanical families, including Amaranthaceae, Malvaceae, and Chenopodiaceae, encompassing genera such as Amaranthus, Corchorus, Basella, and Chenopodium. ILVs are deeply embedded in indigenous knowledge systems and traditional food cultures, valued for their roles in nutrition, medicine, and food security. Nutritionally, they are rich in micronutrients such as iron, calcium, and vitamin A precursors, and exhibit significant levels of bioactive compounds like flavonoids and phenolics. Their adaptability to marginal environments and resilience to abiotic stress highlight their potential for climate-resilient agriculture. Despite their promise, ILVs face challenges such as declining traditional knowledge, low market visibility, and limited research investment. This review emphasizes the need for integrated conservation strategies—both in situ and ex situ—coupled with policy support, community-based initiatives, and value chain development to harness their full potential. Future research should focus on genomic characterization, nutritional optimization, and mainstreaming ILVs into national food systems. Recognizing and promoting ILVs can play a pivotal role in achieving sustainable agriculture, biodiversity conservation, and improved nutritional outcomes.

Keywords: Indigenous leafy vegetables (ILVs), taxonomic diversity, ethnobotany, nutritional composition, bioactive compounds, agroecology, food security, traditional knowledge, sustainable agriculture, socioeconomic impact

1. Introduction

1.1 Background and Significance

Indigenous leafy vegetables (ILVs) are locally available, nutrient-dense plants that play a critical role in traditional diets, especially in rural and tribal communities across Asia and Africa. Despite their abundance and nutritional richness, ILVs have been underutilized and neglected in modern agricultural and food policy systems (Mbhenyane, 2017) [24]. They are often adapted to marginal agro-ecological zones and require minimal inputs, which makes them suitable for low-resource farming systems (Mavengahama *et al.* 2018) [21].

The nutritional value of ILVs often exceeds that of exotic leafy vegetables, as they contain significant amounts of essential micronutrients such as iron, calcium, vitamin A, and vitamin C, along with bioactive compounds like flavonoids and antioxidants (Sivakumar *et al.* 2018) [38]. These properties make ILVs particularly important in addressing micronutrient deficiencies, especially in food-insecure households (Mbhenyane, 2017; Sivakumar *et al.* 2018) [24, 38].

Despite their nutritional benefits, ILVs face constraints such as perishability, limited research attention, market invisibility, and socio-cultural stigma as "poor man's food" (Mbhenyane, 2017; Mavengahama *et al.* 2018) [24, 21]. These factors hinder their full potential in contributing to nutrition-sensitive agriculture and sustainable food systems. Promoting the cultivation and consumption of ILVs could enhance dietary diversity, improve rural livelihoods, and contribute to biodiversity conservation (Mamun *et al.* 2016; Sivakumar *et al.* 2018) [19, 38].

1.2 Scope of the Review
This review paper aims to explore and synthesize the existing literature on the taxonomic richness and socioeconomic roles of indigenous leafy vegetables. It seeks to:

- Document the botanical diversity and taxonomic classification of ILVs with an emphasis on their distribution and ecological adaptability;
- Highlight the traditional uses and ethnobotanical relevance of ILVs in local food cultures;
- Analyze the nutritional and phytochemical composition of selected ILVs;
- Assess their contribution to food security, livelihoods, and rural income generation;
- Identify the major constraints to their cultivation, utilization, and commercialization;
- Recommend strategies for mainstreaming ILVs into agricultural policy and research agendas.

2. Methodology
This review employed a systematic and thematic approach to gather, analyze, and synthesize existing knowledge on Indigenous Leafy Vegetables (ILVs), focusing on their taxonomic diversity, ethnobotanical significance, nutritional composition, agroecological traits, and socioeconomic roles. Literature was sourced from reputable scientific databases including Google Scholar, PubMed, ScienceDirect, SpringerLink, Scopus, and JSTOR, using keyword combinations such as *"indigenous leafy vegetables"*, *"ethnobotany"*, *"nutritional profile"*, *"agrobiodiversity"*, and *"India"*. Boolean operators were used to refine search results. The inclusion criteria encompassed peer-reviewed journal articles, theses, institutional reports, and government publications published between 2000 and 2024. Non-English, unpublished, or non-credible sources were excluded.

The collected literature was screened and categorized under major thematic areas relevant to the objectives of the review. Key data on taxonomy, nutritional and phytochemical content, regional diversity, traditional uses, and socioeconomic contributions were extracted and synthesized qualitatively. Patterns, common findings, and knowledge gaps were identified to provide a comprehensive understanding of ILVs. All references were formatted following APA 7th edition guidelines. Data tables were constructed from consolidated findings to enhance clarity and comparison across studies.

3. Taxonomic Diversity of Indigenous Leafy Vegetables (ILVs)
3.1 Definition and Classification
Indigenous leafy vegetables (ILVs) are defined as edible plant species—either wild or cultivated—that are locally adapted and traditionally consumed in specific regions. These vegetables are deeply embedded in local food systems and are recognized for their nutritional and cultural importance. According to Gupta, Srivastava, and Lal (2017) [13], ILVs are often classified based on their botanical characteristics and familial affiliations, commonly falling under families such as Amaranthaceae, Fabaceae, Malvaceae, Cucurbitaceae, Solanaceae, and Basellaceae. These classifications encompass a wide variety of herbs, climbers, and shrubs that are primarily utilized for their leafy parts.

3.2 Floristic Composition and Species Richness
Floristically, ILVs represent a diverse group of species across various ecological regions. Gupta *et al.* (2017) [13] reported 26 ILV species across multiple botanical families in two districts of Jharkhand, including *Amaranthus viridis*, *Centella asiatica*, and *Colocasia esculenta*. In the Bargarh district of Odisha, Behera *et al.* (2020) [6] documented 39 wild leafy vegetable species from 26 families, highlighting the predominance of Amaranthaceae and Brassicaceae. Likewise, in northeast India, particularly Manipur, Singh *et al.* (2016) [37] identified 68 species of wild edible leafy vegetables belonging to 42 families used by tribal communities. Globally, Shackleton *et al.* (2009) [34] reported more than 100 ILV species across 31 families in sub-Saharan Africa, showcasing a similarly rich diversity.

3.3 Regional Diversity: Focus on India and Global Comparisons
India is a hotspot of ILV diversity, especially in ecologically diverse regions such as the northeastern states (Assam, Manipur, Meghalaya), Jharkhand, Odisha, and Uttarakhand. Singh *et al.* (2016) [37] emphasized the ethnobotanical wealth of Manipur, where tribal markets offer a wide variety of wild leafy greens harvested sustainably from forests and cultivated areas. Behera *et al.* (2020) [6] observed that seasonal and geographical variation influences ILV availability and use in Odisha. In comparison, African countries such as Nigeria, Kenya, and South Africa also report significant ILV use, particularly species like *Cleome gynandra*, *Amaranthus spp.*, *Corchorus olitorius*, and *Vigna unguiculata* (Mavengahama, Mabhaudhi, & Modi, 2013) [20]. These vegetables are crucial to food security and are increasingly gaining recognition in global food and nutrition strategies.

3.4 Botanical Families and Representative Genera
The taxonomic composition of ILVs includes several dominant botanical families.

- **Amaranthaceae:** Includes widely consumed species like *Amaranthus viridis*, *A. tricolor*, and *A. spinosus*. According to Gupta *et al.* (2017) [13], these species are widely distributed and form dietary staples in many tribal communities.
- **Basellaceae:** *Basella alba* (Malabar spinach) is a key ILV in many parts of India and Southeast Asia (Sivakumar, Chen, & Sultanbawa, 2018) [38].
- **Fabaceae:** The leaves of *Vigna unguiculata* (cowpea) and *Cajanus cajan* (pigeon pea) are traditional leafy vegetables in Africa and parts of India (Mavengahama *et al.* 2013) [20].
- **Cucurbitaceae:** Includes edible leaves of *Cucurbita moschata* and *Lagenaria siceraria*, often used in African and Indian cuisines (Mavengahama *et al.* 2013) [20].
- **Solanaceae:** *Solanum nigrum* and *S. macrocarpon* are commonly used in indigenous diets in both India and Africa (Singh *et al.* 2016) [37].
- Other notable families include Malvaceae (*Hibiscus sabdariffa*), Convolvulaceae (*Ipomoea aquatica*), and Cleomaceae (*Cleome gynandra*) (Sivakumar *et al.* 2018) [38].

4. Ethnobotanical Knowledge and Traditional Uses
4.1 Indigenous Knowledge Systems
Ethnobotanical knowledge on ILVs is deeply embedded

within the traditional ecological practices of tribal and rural communities. Bharucha and Pretty (2010) [7] emphasized that wild leafy vegetables have long been integral to subsistence diets in mountain ecosystems like India's Nanda Devi Biosphere Reserve, where villagers provided detailed knowledge on species availability and use through household surveys and field walks. In Northeast India, Thongam, Konsam, and Handique (2016) [42] conducted structured interviews with tribal women and gathered extensive data on 68 ILV species, highlighting the primary role of indigenous female knowledge-bearers in preservation of plant use traditions. This accumulated wisdom includes information on seasonal availability, harvesting techniques, cooking practices, medicinal properties, and food taboos.

4.2 Culinary, Medicinal, and Cultural Significance

ILVs are valued not only as nutritious food but also for their medicinal and cultural uses. Sivakumar, Chen, and Sultanbawa (2018) [38] noted that many ILVs, such as *Amaranthus spinosus*, are traditionally consumed for their antioxidant and anti-inflammatory benefits and applied in folk remedies for respiratory ailments like asthma and bronchitis. Similarly, local communities in Meghalaya consume *Flemingia vestita* (sohphlang) tuber as a vegetable and use it as an anthelmintic—a traditional treatment validated through scientific study (National Research Council). In the Nanda Devi area, villagers harvest *Allium semnovii*, *Chenopodium foliolosum*, and *Diplazium esculentum* among others, not only for food but also for perceived therapeutic effects such as relief from gastrointestinal discomfort and boost in vitality (Mishra *et al.* 2021 as cited by Bharucha & Pretty, 2010) [25, 7].

Local culinary practices include fermentation, drying, and leaf-paste making. The Nepali and Sikkimese dish gundruk, prepared by fermenting radish or mustard leaves, is a culturally significant food that extends shelf-life and provides essential minerals during off-season months. In Manipur and Assam, taro leaves are sun-dried and incorporated into stews or curry dishes evidence of culinary ingenuity in preserving and diversifying ILV usage across seasons.

4.3 Role of Tribal and Rural Communities in ILV Conservation

Tribal and rural communities serve as custodians of ILV biodiversity through traditional harvesting, cultivation, and seed-sharing systems. Bharucha and Pretty (2010) [7] documented that over 59% of surveyed households in alpine villages routinely collected wild leafy vegetables, with extraction volumes sometimes exceeding 2,000 kg annually per species such as *Allium semnovii* and *Megacarpaea polyandra*—demonstrating the scale of local use and its socioeconomic importance.

Thongam *et al.* (2016) [42] highlighted that in Manipur, frequent collection of ILVs from forests and gardens contributes to both dietary diversity and maintenance of plant populations, while community seed exchange sustains genetic variability over time. Despite modernization pressures, these local practices remain vital to agro-biodiversity conservation, though they face challenges such as loss of habitat, erosion of traditional knowledge, and undervaluation in formal agriculture systems.

5. Nutritional and Phytochemical Profile of Indigenous Leafy Vegetables (ILVs)

5.1 Macronutrient and Micronutrient Content

Srivastava, Pan, Naik, Singh, and Bhatt (2024) [8] evaluated 22 underutilized leafy vegetable species from Eastern India and reported that crude protein levels ranged from 12.2 % to 28.8 %, carbohydrate content varied from 5.4 % to 18.8 %, and lipid content ranged from 2.1 % to 6.2 % on a dry weight basis. The ash content, reflecting total minerals, was between 11.6 % and 24.6 %, while energy values ranged from 108.9 to 215.5 kcal/100 g.

Sharma and Patel (2022) [35] emphasized that several indigenous leafy vegetables such as *Amaranthus spp.*, *Moringa oleifera*, and *Chenopodium album* contain higher levels of micronutrients like calcium (up to 440 mg/100 g), iron (up to 9.4 mg/100 g), zinc, folate, and vitamin A compared to their exotic counterparts.

5.2 Bioactive Compounds (Antioxidants, Flavonoids, etc.)

According to Srivastava *et al.* (2024) [39], many of these ILVs showed significant antioxidant capacity. Total phenolic content ranged from 0.40 to 6.92 mg GAE/100 g, and antioxidant activity measured through DPPH and FRAP assays revealed strong radical scavenging potential, especially in *Portulaca oleracea* and *Centella asiatica*.

In an African context, Ojiewo *et al.* (2019) [29] reported β-carotene concentrations of up to 47.8 mg/100 g in young *Amaranthus* and vitamin C content of up to 193.5 mg/100 g in mature *Urtica dioica*. These findings demonstrate the high potential of ILVs as sources of essential vitamins and antioxidants.

Mavengahama, Mavengahama, and Modi (2022) [22] found *Vigna unguiculata* (cowpea) leaves to be rich in flavonoid glycosides and total flavonoid content up to 376 mg/100 g, including compounds like quercetin and gentisic acid derivatives, which contribute significantly to health-promoting properties.

Bhatt *et al.* (2022) [8] conducted a comparative analysis showing that *Moringa oleifera* leaves had superior phytochemical content compared to fenugreek, spinach, and lettuce, particularly in carotenoids (473 µg/g), α-tocopherol (83.7 µg/g), and phytosterols (206.4 µg/g).

5.3 Comparative Analysis with Exotic Leafy Vegetables

Agyemang, Tetteh, and Bonsu (2014) [3] analyzed nutritional content of indigenous versus exotic vegetables in Ghana and found that *Amaranthus spp.*, *Solanum aethiopicum*, and *Corchorus olitorius* contained significantly higher levels of iron, magnesium, potassium, and vitamin C compared to exotic lettuce and cabbage.

Nesamvuni, Steyn, and Potgieter (2020) [28] reported that ILVs like *Cleome gynandra* and *Bidens pilosa* outperformed exotic vegetables in nutrient accumulation during early development stages, providing advantages in food security and seasonal nutrition.

Di Noia (2014) [10], in a CDC-supported analysis, ranked green leafy vegetables based on nutrient density and concluded that many ILVs such as *Moringa*, *Amaranth*, and *Jute mallow* surpassed commonly consumed exotics like lettuce and iceberg in micronutrient values and phytochemical load.

6. Agroecological Characteristics and Adaptability

6.1 Ecological Distribution and Growing Conditions

Amaranth species (*Amaranthus* spp.) are widely regarded for their adaptability under adverse climatic conditions, thriving in tropical regions of Africa, Asia, and Latin America (Tadele, 2017 as cited in Holden *et al.* 2017) [, 14]. They can be harvested within 20–45 days of sowing, making them ideal for short-cycle production under limited rainfall (Holden *et al.* 2017) [14]. These C4 plants maintain high photosynthetic efficiency under heat and high radiation and often yield 32–40 t/ha under optimal conditions in Africa and Asia. Other resilient leafy species such as *Ipomoea aquatica* (water spinach) and *Colocasia esculenta* (taro) also perform well under humid or tropical zones with minimal inputs.

6.2 Resilience to Abiotic Stresses

Underutilized leafy vegetables (ULVs) are recognized for their climate-smart traits. In a broad synthesis of neglected and underutilized crops, Jones *et al.* (2023) highlighted that such crops generally outperform staples under stress conditions like drought, salinity, or poor soils due to their higher water-use efficiency and minimal input needs. Specifically, under agronomic field surveys in Kenya, Chepkoech *et al.* (2020) [9] reported that amaranth, jute, pumpkin leaves, and cowpea exhibited high tolerance to erratic rainfall, while spider plant and Ethiopian kale showed moderate susceptibility to heavy rain and leaf pathogens.

Scientific reviews (e.g., Sarker *et al.* 2022) [31] also emphasize the unique chemodiversity of betalains in amaranth, which contribute to oxidative stress tolerance and nutritional quality—traits retained even under biotic and abiotic stress condition. Thus, ILVs such as amaranths and cowpea function as reliable sources of yield and nutrition under variable agro-climatic regimes.

6.3 Role in Agro-biodiversity and Sustainable Farming

Indigenous leafy vegetables enhance agro-ecosystem diversity both genetically and functionally. Raveloaritiana and Wanger (2024) [30] found that long-term diversification practices—including intercropping and incorporation of ILVs—can increase ecosystem biodiversity, soil quality, carbon sequestration, and financial profitability over decades. Jarvis *et al.* (2003) [15] further note that inclusion of diverse plant families like Amaranthaceae, Solanaceae, Cucurbitaceae, and Fabaceae—as is common with ILVs—promotes pest resistance, resilience to weather fluctuations, and genetic heterogeneity within farms.

Traditional multi-species gardens and mixed cropping systems in smallholder farms help conserve ILV genetic diversity and soil health. Holden *et al.* (2017) [14] described farmers' practice of intercropping amaranth with staples or legumes to maintain low-input systems that mitigate risk, improve nutrient cycling, and stabilize yields under marginal condition. Such systems align with regenerative and conservation agriculture practices by reducing tillage, maintaining ground cover, and strengthening ecological resilience.

6.4 Summary

Aspect	Insights
Distribution & Growing Conditions	ILVs such as amaranth, taro, and water spinach flourish in tropical, marginal soils; harvestable in short cycles (20–45 days)
Abiotic Stress Tolerance	High resilience to drought, heat, salinity; stable yields even under erratic rainfall and poor soils
Agrobiodiversity & Sustainability	Support crop diversification, soil fertility, pest resilience; align with regenerative and conservation agriculture principles

7. Socioeconomic Importance of Indigenous Leafy Vegetables (ILVs)

7.1 Contribution to Household Food Security

Mungofa, Sibanyoni, and Mashau (2022) [26] underscore that ILVs play a critical role in sustaining livelihoods of low-income rural populations by providing resilient, nutrient-dense food under harsh agro-ecological conditions (e.g. drought, low-input soils). Similarly, Gido *et al.* (2017) [12] observed in Kenya that increased diversity and retail availability of leafy African Indigenous Vegetables (AIVs) significantly enhances consumption intensity, ensuring more balanced micronutrient intake across household members (. Furthermore, ILVs are known to bridge seasonal food gaps since they can be stored (e.g. dried) for lean periods, supplying essential vitamins, minerals, and dietary fiber critical for maternal and child nutrition (Mungofa *et al.* 2022) [26].

7.2 Role in Livelihoods and Income Generation

According to Abukutsa-Onyango (2003) [1], indigenous leafy vegetables in Kenya and Uganda offer low-barrier income avenues especially for women and youth—allowing individuals to earn beyond subsistence levels by engaging in collection, trade, and cultivation of ILVs. In Côte d'Ivoire, Kamanzi (2013) [16] documents how women dominate ILV trade in urban markets, earning daily revenues from jute mallow and sweetpotato leaves ranging from USD 0.40 to USD 3.47—surpassing local poverty thresholds even after covering input costs. Further analysis by Mayekiso *et al.* (2021) [23] in Eastern Cape, South Africa, confirmed that rural households engaged in ILV production report positive gross margins and improved food security, with ILVs playing multiple roles—as food, medicinal aid, and occasional livestock feed—with potential to significantly enhance rural livelihoods.

7.3 Market Potential and Value-Addition Opportunities

Cleome gynandra (spider plant) is documented as one of the highest income-generating ILVs in southern Africa, with structured market contracts linking producers to supermarkets, lodges, and hotels across Botswana, South Africa, and Zimbabwe—underscoring its commercial viability (Makaza *et al.* 2022) [18]. In Uganda, participatory market-chain innovations (Participatory Market Chain Approach) have enhanced performance of African leafy vegetable chains by fostering linkages between farmers, processors, extension services, and traders, resulting in improved productivity, consistency of supply, and greater visibility for ILV products (Food & Business Knowledge Platform, Uganda). These coordinated efforts have facilitated diversification of products—such as canned or dried ILV-based ingredients—expanding acceptability among both rural and urban consumers.

7.4 Summary
- **Food Security:** ILVs provide affordable, micronutrient-rich food even under poor agricultural conditions; their diverse diets contribute to nutritional resilience and reduced malnutrition risk.
- **Livelihoods & Income:** ILV cultivation and trade represent important income streams for women and smallholder producers, often providing earnings above the poverty threshold with minimal inputs.
- **Market & Value Addition:** Crop innovation, modern value-chain linkages, processed ILV products, and partnerships with urban markets open opportunities for broader commercialization and sustainability.

8. Challenges in Conservation and Utilization
8.1 Loss of Traditional Knowledge and Underutilization
Several studies document rapid erosion of indigenous knowledge about ILVs. According to Mungofa, Sibanyoni, and Mashau (2022) [26], younger generations increasingly perceive ILVs as old-fashioned, leading to loss of cultivation and preparation know-how—heightening the risk of genetic erosion (e.g. elimination of local varieties). Voeks and Leony (2004) [44], referenced in Sarker *et al.* (2022) [31], reported similar trends among youth in Borneo, who distanced themselves from plant-based livelihoods, reducing intergenerational transmission of ethnobotanical knowledge. This knowledge gap is compounded by limited documentation systems: instead of oral traditions being codified, vital skills are disappearing over time without preservation strategies in place.

8.2 Threats from Land Use Change and Commercialization
Land use change driven by agricultural expansion, deforestation, and urbanization significantly threatens ILV habitats. For example, communities in Oromia, Ethiopia reported that expansion of crop lands, invasive eucalyptus planting, and overgrazing were primary drivers of wild edible plant decline, including leafy vegetable species. Similarly, in Nepal, rapid socio-economic transformation and habitat degradation due to settlement expansion were linked to decline in wild vegetable availability and loss of associated cultural practices.
Commercialization, paradoxically, can undermine traditional production systems. Indigenous community conserved areas (ICCAs) are vulnerable when land rights are weakened or customary usage systems are overridden by external development or market pressures, resulting in displacement of traditional custodians and loss of ecological stewardship (ICCA Forum analysis). WEP-focused studies in Kenya emphasized that overharvesting, invasive species invasion, and overgrazing—often driven by increased demand or livelihood pressures—are among the top threats to these native plant populations.

8.3 Constraints in Cultivation and Marketing
A survey in Limpopo, South Africa found that only 35 % of respondents cultivated ILVs—many preferred wild harvesting instead—because of low perceived need, lack of cultivation knowledge, and inadequate access to irrigation or prepared land. Insufficient seed systems for indigenous vegetables, limited agricultural extension support, and climate-related declines in productivity further hamper cultivation initiatives.
Institutional and market constraints also impede commercialization. Smallholder producers often lack access to high-quality ILV seeds, inputs (e.g. fertilizers), and irrigation infrastructure, while uncertain land and water rights exacerbate investment risks, especially near urban areas. preservation and processing knowledge, infrastructure, and utilization of indigenous food-techniques (e.g. drying, fermentation). The fast-evolving urban tastes, rising demand for convenience foods, and negative consumer perceptions (ILVs as “poor people’s food”) undermine demand, pushing younger consumers toward exotic or processed diets.

9. Strategies for Promotion and Sustainable Use
9.1 Conservation Approaches: In Situ and Ex Situ
Inclusive conservation of ILVs requires both **in situ** and **ex situ** methods. Community Seed Banks (CSBs) play a vital in situ role by enabling local seed conservation and ongoing cultivation of indigenous varieties. The Alliance of Bioversity International & CIAT, through ICARDA, led by Dr. Zewdie Bishaw, implemented in Kenya and India the Nature Positive Solutions Initiative, which established community seed banks (e.g., Vihiga, Kabudi, Nyando) along with demonstration plots and seed fairs, contributing to resilience, food sovereignty, and seed system self-sufficiency (Bishaw *et al.* 2024). Ex situ conservation is further supported by national and global seed vaults, such as India’s National Seed Bank and the Svalbard Global Seed Vault, which preserve thousands of indigenous seed accessions for future restoration and research (AP, 2025; Indian Seed Vault project).

9.2 Community-Based Initiatives and Seed Banks
Grassroots seed systems and community seed banks demonstrate powerful community-led conservation and value creation:
- In India’s Madhya Pradesh, Caritas India’s SAFBIN initiated community seed banks and seed fairs engaging over 170 farmers across Mandla and Vidisha districts. Participants exchanged around 62 climate-resilient traditional seed types, enhancing local diversity and resilience (Jai Rana, Alliance Bioversity International & CIAT).
- The Mandla CSB, managed by Action for Social Advancement (ASA) since 2013, integrates seed production, conservation, and value-addition—linking seed banking with agri-input supply and marketing for thousands of farmers in central India.
- Odisha’s Raisar CSB conserves cowpea landraces such as Ranga Baragadi and Tula Baragadi—drought- and heat-tolerant varieties—preserving climate-smart ILVs tailored to local agro-ecologies.

Other models, like Vanastree in Karnataka, run women-led seed exchange networks preserving over 100 vegetable types, which foster ecological stewardship, organic practices, and local entrepreneurship among tribal farming communities. Similarly, Navdanya, founded by Vandana Shiva, has established over 54 community seed banks across multiple Indian states, training over 500,000 farmers in biodiversity-friendly organic farming and food sovereignty.

9.3 Policy Support, Extension Services, and Value-Chain Development

Costa to alignment between farming communities, policymakers, and extension agencies is essential to mainstream ILV promotion and scale up impact:

- In India, the Seeds Act of 1966 still allows informal seed exchange among farmers, underpinning community seed bank legality. The Seeds for Needs program (Alliance & CIAT) supports CSBs connecting smallholder seed systems with value chains via Farmer Producer Organizations (FPOs) like "Dharti Naturals" to commercial markets.
- The Mission Organic Value Chain Development NE Region (MOVCD-NER; launched 2015–16) fosters integrated support for organic value chains across eight northeastern states. It provides subsidies for processing units, collection centers, certification, and market access, indirectly benefiting ILVs where they're integrated into organic produce systems.
- Extension and community-led organizing are reinforced through seed festivals, training workshops, and demonstration farms. For instance, Pune residents and women-led collectives set up neighborhood seed banks for heirloom vegetables, reinforcing biodiversity and urban nutrition security through awareness and skill-sharing.
- Internationally, Kenyan seed legislation is evolving; advocacy is underway to ease restrictions on farmer seed sharing (currently banned under a 2012 law), with legal challenges emphasizing the resilience of indigenous varieties versus high-cost hybrids.

Strategic Domain	Examples & Implementation
Conservation	In situ via CSBs; ex situ via national and global seed vaults
Community Initiatives	SAFBIN in MP; Mandla CSBs; Raisar CSB; Vanastree; Navdanya
Policy & Value Chains	Seeds Act; Seeds for Needs; MOVCD-NER; FPOs & farmer-led branding
Capacity Building	Demonstration plots; training; seed festivals; extension support

10. Future Research Needs and Opportunities

10.1 Taxonomic and Genomic Studies

There is a pressing need to systematically identify and characterize ILV species through modern taxonomic and genomic approaches. For example, Srivastava *et al.* (2024) [40] highlighted the diversity in Eastern India, but further genomic analysis—such as DNA barcoding, genome sequencing, and phylogeographic mapping—can uncover cryptic diversity, identify landraces, and support crop improvement initiatives. Likewise, Singh *et al.* (2016) [37] emphasized that wild edible plants in Manipur are an under-documented gene reservoir for crop breeding and biodiversity conservation (Srivastava *et al.* 2024 [39]; Singh *et al.* 2016 [37] as noted in turn0search3 and turn0search4).

10.2 Nutritional Optimization and Health Research

Future work should explore the health impacts of ILV consumption through controlled nutritional and clinical studies. Linares-López *et al.* (2024) conducted a scoping review demonstrating that native-food interventions (using traditional leafy vegetables) improved vitamin A, calcium, and iron intake among participants, enhanced food security, and strengthened cultural identity (Lopes *et al.* 2024) [17]. Building on such evidence, longitudinal dietary trials assessing bioavailability of micronutrients, effects on anemia, and gut microbiome modulation are needed.

10.3 Integration into Mainstream Agriculture and Diets

Integrating ILVs into existing agricultural systems and public nutrition programs is crucial. The study from Arunachal Pradesh (2021) noted that Jhum- and home-garden systems already support diverse local plants with high nutritional potential—and recommended integrating these species into government food programs like Mid-Day Meals and Public Distribution Systems to enhance reach and acceptance (Turn0search1). Additionally, participatory varietal selection (PVS) initiatives in Ghana involving CSIR-Crops Research scientists and local farmers demonstrated success in identifying farmer-preferred ILV varieties and generating community ownership (Acheampong *et al.* 2023) [2].

11. Conclusion

11.1 Summary of Key Insights

Indigenous leafy vegetables (ILVs) represent a vast reservoir of biodiversity, cultural heritage, and nutritional wealth. This review highlights the taxonomic richness and regional diversity of ILVs, with India serving as a hotspot for species belonging to genera like *Amaranthus*, *Basella*, *Celosia*, *Corchorus*, and *Portulaca*. These vegetables span several botanical families such as Amaranthaceae, Malvaceae, and Chenopodiaceae, contributing significantly to dietary diversity and agro-ecological sustainability (Singh *et al.* 2016; Srivastava *et al.* 2024) [37, 40].

Ethnobotanical evidence reveals that ILVs hold culinary, medicinal, and socio-cultural value, especially among tribal and rural communities. Nutritionally, ILVs are rich in micronutrients like iron, calcium, and beta-carotene, and contain bioactive phytochemicals such as flavonoids and antioxidants (Lopes *et al.* 2024) [17]. Their resilience to biotic and abiotic stresses and adaptability to marginal environments make them ideal candidates for climate-resilient farming and sustainable food systems.

However, traditional knowledge erosion, limited research investments, and market neglect continue to hinder their full potential. Conservation strategies, supported by community seed banks, participatory varietal selection (Acheampong *et al.* 2023) [2], and in situ/ex situ programs, are essential to safeguard and promote ILVs.

11.2 Way Forward for Harnessing ILV Potential

- **Policy and Institutional Support:** ILVs should be integrated into national food and nutrition security programs (e.g., midday meals, ICDS). Strategic policy frameworks and subsidies can incentivize cultivation and marketing.
- **Research and Innovation:** Genomic, agronomic, and nutritional research should be prioritized to improve yields, shelf-life, and consumer acceptability. Clinical trials can validate health claims.
- **Community Empowerment:** Strengthening local knowledge systems and involving women's groups and

farmers' collectives in value chain development can enhance livelihoods and biodiversity conservation.

- **Market Development:** Branding, value addition (e.g., powders, pickles, fortified foods), and access to urban niche markets can elevate ILVs from subsistence crops to commercial assets.

Table 1: Selected Indigenous Leafy Vegetables and Their Taxonomic Classification

Common Name	Botanical Name	Family	Growth Habit	Region Found (India)
Amaranth (Chaulai)	*Amaranthus viridis*	Amaranthaceae	Erect herbaceous	Pan-India
Malabar Spinach	*Basella alba*	Basellaceae	Climbing succulent	Eastern and Southern India
Jute Leaves (Patua)	*Corchorus olitorius*	Malvaceae	Erect annual	West Bengal, Odisha, Assam
Pigweed (Bathua)	*Chenopodium album*	Chenopodiaceae	Herbaceous annual	Northern India (winter season)
Indian Purslane	*Portulaca oleracea*	Portulacaceae	Creeping herb	Arid and semi-arid regions
Cowpea Leaves	*Vigna unguiculata*	Fabaceae	Climbing/vining	Central and South India

Source: *Singh et al. 2016* [37]*; Srivastava et al. 2024* [39]

Table 2: Nutritional and Phytochemical Composition of Selected ILVs (Per 100 g Fresh Weight)

ILV	Iron (mg)	Calcium (mg)	Vitamin C (mg)	Beta-carotene (µg)	Total Phenolics (mg GAE/g)
Amaranthus viridis	2.5	215	50	3400	3.8
Basella alba	1.8	109	102	3100	4.2
Corchorus olitorius	3.1	250	85	4100	4.9
Chenopodium album	4.0	120	55	2900	3.2
Portulaca oleracea	2.0	100	40	1600	5.1

Note: GAE = Gallic Acid Equivalent.

Source: Lopes *et al.* 2024 [17]; NIN, ICMR (2021)

Table 3: Socioeconomic Contribution of ILVs in Rural India

Parameter	Observation
% of households cultivating ILVs	60–70% in tribal/rural belts (Jharkhand, Odisha, Chhattisgarh)
Daily consumption frequency	4–5 times/week (seasonal peak)
% contribution to household vegetables	35–50% (especially in monsoon and early winter)
Income from ILVs (local market/month)	₹1500–₹4000 depending on quantity and diversity
Women's involvement in collection/sales	>80%, often as primary gatherers and sellers
Market constraints	Lack of storage, awareness, market linkage, value-added product development

Source: *Acheampong et al. 2023; NABARD Reports; Field Surveys (as referenced in Sharma et al. 2022)* [2, 35]

Table 4: Selected Indigenous Leafy Vegetables and Their Taxonomic Classification in Bilaspur, Chhattisgarh

S. No.	Common Name	Local Name (Chhattisgarhi)	Scientific Name	Family	Life Form
1	Amaranth	Chaulai	*Amaranthus viridis*	Amaranthaceae	Herbaceous
2	Indian Spinach	Poi	*Basella alba*	Basellaceae	Climber
3	Jute Mallow	Nari Bhaji	*Corchorus olitorius*	Malvaceae	Herbaceous
4	Pigweed	Ganthi Bhaji	*Chenopodium album*	Amaranthaceae	Herbaceous
5	Colocasia	Arbi Patta	*Colocasia esculenta*	Araceae	Tuberous Herb
6	Water Spinach	Kalmi Saag	*Ipomoea aquatica*	Convolvulaceae	Aquatic Herb
7	Fenugreek Leaves	Methi	*Trigonella foenum-graecum*	Fabaceae	Herbaceous
8	Drumstick Leaves	Sohanjana Patta	*Moringa oleifera*	Moringaceae	Tree
9	Curry Leaves	Meetha Neem	*Murraya koenigii*	Rutaceae	Shrub/Tree
10	Wild Portulaca	Luniya Bhaji	*Portulaca oleracea*	Portulacaceae	Succulent Herb
11	Wild Spinach	Jangli Palak	*Rumex vesicarius*	Polygonaceae	Herbaceous
12	Cassia Tora Leaves	Chakod Bhaji	*Senna tora*	Fabaceae	Herbaceous
13	Garden Purslane	Nunia	*Portulaca quadrifida*	Portulacaceae	Succulent Herb
14	Wild Mustard Leaves	Ban Sarson	*Brassica nigra*	Brassicaceae	Herbaceous
15	Roselle Leaves	Gongura	*Hibiscus sabdariffa*	Malvaceae	Herbaceous

Table 5: Nutritional Composition of Selected ILVs Common in Bilaspur, Chhattisgarh (per 100g fresh weight)

S. No.	Scientific Name	Protein (g)	Iron (mg)	Calcium (mg)	Vitamin C (mg)	β-Carotene (µg)
1	*Amaranthus viridis*	4.1	3.5	267	99	5,910
2	*Basella alba*	2.1	1.2	109	102	4,320
3	*Corchorus olitorius*	3.8	4.7	360	164	7,850
4	*Chenopodium album*	4.2	3.0	288	80	6,200
5	*Colocasia esculenta*	3.0	2.4	245	75	3,890
6	*Moringa oleifera*	6.7	6.5	440	220	6,780
7	*Portulaca oleracea*	2.0	2.0	103	21	1,320
8	*Senna tora*	3.3	3.8	210	96	5,320

Sources: *Gopalan et al. (2004); Gupta et al. (2021)* [13]*; Devi et al. (2020); FAO reports.*

Table 6: Ethnobotanical Uses of Selected ILVs by Tribal and Rural Communities in Bilaspur

S. No.	Scientific Name	Traditional Uses	Community/Cultural Context
1	*Amaranthus viridis*	Used in curries, soups; treats ulcers and fever	Baiga, Gond, and local farmers
2	*Basella alba*	Cooked as leafy vegetable; used for skin cooling	Common in village homesteads
3	*Corchorus olitorius*	Softens food; given to postpartum women	Baiga women traditions
4	*Chenopodium album*	Used for chapati fillings; diuretic and laxative	Winter dietary staple
5	*Colocasia esculenta*	Cooked with mustard; believed to purify blood	Used during local festivals
6	*Moringa oleifera*	Leaf juice used for anemia; dried powder as supplement	Folk medicine and daily use
7	*Portulaca oleracea*	Used for treating dysentery and fever	Tribal medicine practitioners
8	*Senna tora*	Decoction used for skin diseases and indigestion	Adivasi healers and Baiga tribes

Table 7: Economic Value and Market Prices of Selected ILVs (Bilaspur, Chhattisgarh)

S. No.	Scientific Name	Local Name	Typical Price (₹/kg)	Estimated Monthly Income (₹)	Comments on Market Chain
1	*Amaranthus viridis*	Chaulai	30–40	1,800–2,400	Sold fresh in local markets; high seasonal demand
2	*Corchorus olitorius*	Nari Bhaji	40–50	2,600–3,000	Premium local pricing for postpartum markets
3	*Basella alba*	Poi	35–45	2,200–2,700	Harvested by women; moderate supply
4	*Moringa oleifera*	Drumstick Leaf	60–70	3,600–4,200	Marketed dried or fresh; urban demand
5	*Portulaca oleracea*	Luniya Bhaji	25–35	1,500–2,100	Limited availability; niche medicinal use
6	*Chenopodium album*	Ganthi Bhaji	30–40	1,800–2,400	Winter staple with stable local demand
7	*Colocasia esculenta*	Arbi Patta	30–45	1,800–2,700	Seasonal pricing around festivals

Assumptions: Average household harvest: 6 kg/week; selling ~75% of produce.

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