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Evaluating the importance of local food plants through citizen science: A Luvi-based assessment in agroforestry systems of Gorontalo

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Abstract

Understanding the importance of local food plants is essential for strengthening biodiversity-based food systems, particularly in communities that rely on agroforestry. This study aims to examine how local people perceive the importance of food plants using the Local User Value Index through a citizen science approach. The research employed participatory methods involving community members in identifying, discussing, and scoring food plant species based on their daily use, cultural relevance, and contribution to household food security. Data were collected through field observation, group discussions, and structured valuation activities, and the Local User Value Index was applied to quantify perceived importance. The findings reveal significant variation in food plant valuation between villages and gender groups, reflecting ecological conditions, cultural practices, and livelihood strategies. Maize emerged as the most important food species in both locations, underscoring its central role in local subsistence and income generation. Fruit-bearing species showed higher importance in areas with more diverse agroforestry systems, and women assigned greater value to plants associated with household nutrition and daily food preparation. The participatory process demonstrated that local knowledge provides nuanced insights into the multifunctional roles of food plants that cannot be captured through ecological surveys alone. These results highlight the need to integrate community-defined priorities into sustainable food planning and biodiversity-based agricultural strategies, and demonstrate the value of citizen science for documenting and strengthening local food systems.

Keywords: Food plants; Local User Value Index; Citizen science; Community perception; Agroforestry

1. Introduction

Food security has become one of the most pressing global challenges, particularly as nations confront the combined pressures of climate change, geopolitical instability, population growth, and declining biodiversity. Contemporary definitions of food security emphasize not only sufficient food availability but also the diversity, nutritional adequacy, accessibility, and long-term sustainability of food systems. The Global Network Against Food Crisis (GRFC) and the Food and Agriculture Organization (FAO) highlight how disruptions to ecological systems and global supply chains intensify food insecurity, especially among vulnerable populations. The COVID-19 pandemic further exacerbated these conditions by destabilizing production networks, restricting access to nutritious food, and amplifying structural inequalities (Lasminingrat & Efriza, 2020). Within the framework of the Sustainable Development Goals—particularly Goal 2 (Zero Hunger)—ensuring food security therefore requires a holistic, ecosystem-based, and socially inclusive approach (FAO, 2019).

Indonesia, recognized as one of the world's megabiodiversity hotspots, possesses a rich reservoir of biological resources that should, in principle, support resilient and sovereign food systems. However, the national food structure remains heavily dependent on a limited set of staple crops, especially rice and maize, creating systemic vulnerabilities (M. Amin

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et al., 2024). This narrow agricultural base increases the risk of food shortages in the face of climatic anomalies, market fluctuations, or pest outbreaks, while simultaneously limiting dietary diversity and economic options for rural households. At the same time, Indonesia's landscapes harbor hundreds of local food plants—ranging from tubers and legumes to fruits and leafy vegetables—that are nutritionally rich, ecologically adaptive, and culturally embedded. Hadihardjono et al. (2021) note that Indonesia hosts at least 100 carbohydrate sources, 100 legumes, 450 fruits, and 250 vegetables and mushrooms traditionally consumed by communities. Despite this wealth, many local food species remain underutilized due to the ascendancy of modern, market-driven agricultural models that prioritize standardized crops over locally adapted biodiversity.

This paradox is evident in Gorontalo Province, a region characterized by its strong agroecological traditions and diverse agroforestry systems, yet categorized as food-vulnerable. The Prevalence of Undernourishment (PoU) in Gorontalo rose sharply from 7.81% in 2019 to 15.06% in 2023—one of the highest nationally (Badan Pangan Nasional, 2024). These patterns reflect a disconnect between local biodiversity potential and its integration into regional food planning. Villages such as Modelidu and Dulamayo Selatan illustrate the persistence of traditional agroforestry systems in which communities manage a wide array of food plants for daily subsistence, medicinal use, cultural practices, and ecological protection. Nevertheless, this knowledge remains largely undocumented, transmitted orally across generations, and increasingly threatened by modernization. As emphasized by Dunggio (2024), community-managed agroforestry systems are repositories of ecological knowledge, shaped through long-term interactions between people and their environment, and contribute significantly to biodiversity conservation and local food resilience.

The challenges surrounding food security in Gorontalo are further compounded by the expansion of national food estate programs. Although introduced as strategic interventions to enhance national food production, many food estate initiatives adopt top-down planning models and large-scale monocultural schemes that inadequately consider local socio-ecological contexts. Experiences across Indonesia reveal that such programs often lead to environmental degradation, socio-economic conflict, reduced community participation, and the erosion of traditional agroecological knowledge (Handayani et al., 2023). Previous failures of food estate projects have been attributed to insufficient planning, overextended budgets, and limited sustainability, particularly in areas where local communities were not meaningfully involved in the decision-making process. Moreover, homogenized agricultural systems risk suppressing local food plants and inadvertently diminishing agrobiodiversity (Pecamuya, 2025). Without intentional documentation and integration of local knowledge, these plants face the possibility of being forgotten or displaced, weakening long-term adaptive capacity (IPBES, 2019).

Against this backdrop, a central research problem emerges: the lack of systematic scientific documentation of local food plants, their ecological roles, and their cultural value to rural communities. Without such documentation, incorporating local species into formal food security strategies becomes increasingly difficult. Furthermore, insufficient community involvement in agricultural decision-making contributes to the erosion of traditional ecological knowledge that has historically sustained rural food systems. Addressing these gaps requires participatory, bottom-up approaches capable of capturing local perceptions and priorities concerning food plants.

Citizen science represents a promising solution to this challenge. By engaging community members—such as farmers, gatherers, elders, and women—in the documentation and evaluation of local plant species, citizen science democratizes the research process and enhances the accuracy and contextual relevance of data. The Local User Value Index (LUVI), developed by Sheil et al. (2004), is one of the most widely used tools in participatory ecological assessment. LUVI quantifies the importance of plant species based on frequency of use, diversity of functions, and perceived cultural value. Its participatory scoring system, often facilitated through focus group discussions and Pebble Distribution Methods (PDM), allows communities to articulate their own priorities and rank species accordingly. Research shows that LUVI is effective for evaluating multifunctional plant roles—food, medicine, culture, construction materials—and for informing sustainable landscape planning.

Several studies illustrate the applicability of this approach. Dunggio (2024) used LUVI to identify key food and medicinal plants in agroforestry systems in Gorontalo, demonstrating that LUVI captures complex, community-based valuations of species such as aren (Arenga pinnata), kemiri (Aleurites moluccanus), and cengkeh (Syzygium aromaticum). Similarly, Putri et al. (2022) applied LUVI and PDM to assess plant utilization in Silokek National Geopark, revealing that species with high cultural and medicinal value tend to receive higher LUVI scores. Research in Dulamayo Selatan by Hiola et al. (2010; 2019) further underscores the importance of traditional agroforestry (ilengi) as a mosaic of food, fruit, timber, and medicinal species selected according to ecological suitability and household needs. These studies collectively demonstrate that LUVI-based citizen science approaches are well suited for documenting local perceptions of plant importance in complex agroforestry landscapes.

While these works provide valuable insights, a significant research gap persists: few studies have explicitly analyzed the importance of *local food plants* using LUVI within the context of community-managed agroforestry systems in Gorontalo, particularly in Modelidu and Dulamayo Selatan. Existing research tends to focus on medicinal plants, timber trees, or general agrobiodiversity rather than the specific valuation of *food plants* essential to local food security. Moreover, the gendered dimensions of plant valuation—how men and women assign different levels of importance to food species—remain underexplored. Understanding these dimensions is crucial for designing inclusive food security strategies that reflect community priorities.

The present study aims to address this gap by assessing the importance of local food plants in agroforestry systems using the LUVI method through a citizen science approach. Specifically, the study seeks to answer the research question: *How do communities in Modelidu and Dulamayo Selatan perceive and assign importance (LUVI) to local food plants?* The novelty of this research lies in its integration of participatory ecological assessment with food security analysis in a region where agrobiodiversity remains central to rural livelihoods yet insufficiently documented. By focusing on community perceptions, the study provides an empirical basis for promoting local food plants within sustainable food planning and agroforestry development. Through this approach, the research not only documents local knowledge but also strengthens community participation, supports biodiversity conservation, and contributes to more adaptive and context-responsive food security policies.

2. Methodology

The study was conducted in the villages of Modelidu and Dulamayo Selatan, Gorontalo Province, using a mixed-methods design centered on documenting community perceptions of the importance of local food plants through a citizen science approach. Participants—including farmers, gatherers, traditional leaders, and women responsible for household food preparation—were selected purposively for their experiential knowledge of agroforestry. Data collection involved field-based identification of food plant species, followed by focus group discussions (FGDs) in which male and female groups independently evaluated the plants. Using the Pebble Distribution Method (PDM) as recommended by Sheil et al. (2004), participants assigned importance scores based on frequency of use, functional diversity, and cultural relevance. These scores were quantified using the Local User Value Index (LUVI), calculated by dividing total use-values assigned to each species by the number of participants. This metric enabled an explicit measurement of perceived importance across species, including gender-based differences in valuation. Qualitative insights from interviews were integrated with LUVI scores to explain why particular plants were considered essential for food security, household consumption, and cultural practices. Through this participatory method, citizen science functioned not only as a data collection tool but as a framework that positioned community knowledge at the center of evaluating the significance of local food plants—directly addressing the research question on how communities perceive and determine LUVI-based importance of agroforestry food species.

3. Results and discussion

The assessment of local food plant importance using the Local User Value Index (LUVI) provided a structured representation of how communities in Modelidu and Dulamayo Selatan perceive and prioritize the species that compose their agroforestry landscapes. As a participatory and perception-based index, LUVI captures the frequency, context, and socio-cultural meaning of plant utilization, reflecting both functional and symbolic dimensions of food plant importance within local lifeways. In this study, LUVI was applied through a citizen science framework, emphasizing the direct involvement of men and women from both villages in scoring, discussing, and validating the relevance of each plant species present in their agroforestry systems. The participatory methodology ensured that the valuation process was grounded in community epistemologies rather than externally imposed criteria, aligning with the conceptual positioning of LUVI described as a tool capable of mapping species that are valued not only for their material uses but also for their ecological, economic, and cultural contributions to the food system.

The findings indicate that maize (*Zea mays*) stands unanimously as the most important food plant in both research sites, receiving the highest LUVI values across gender groups. In Modelidu, maize obtained strikingly high LUVI scores—23.04 among men and 20.64 among women—demonstrating its centrality to both household consumption and local economies. In Dulamayo Selatan, maize also ranked highest, although with lower relative scores—17.85 among men and 12.6 among women—reflecting its importance but also the broader diversity of food plants available in this more ecologically varied and agroforestry-rich site. The strong valuation of maize across both villages indicates its irreplaceable role as a staple food, a function reinforced in community narratives captured during participatory sessions. Maize remains a foundational component in daily meals, and its reliable production capacity provides a buffer against food shortages. In addition, the crop holds market value, enabling households to generate income from surplus

harvests. The predominance of maize aligns with Kuyah et al. (2019), who emphasize that agroforestry systems integrating staple crops strengthen food security by combining nutritional provisioning, income generation, and ecological stability.

Beyond maize, the LUVI analysis reveals notable inter-village differences in the perceived importance of other food plants, illuminating how ecological conditions, livelihood strategies, and cultural preferences intersect to shape community valuation. Coconut (*Cocos nucifera*) exemplifies this divergence. In Modelidu, coconut was ranked as the second most important food plant, with LUVI scores of 13.44 (men) and 12.96 (women), suggesting its multifaceted role in household sustenance. Coconut is used extensively as a culinary ingredient, a source of oil, and occasionally as livestock feed, while also serving as a commodity that can be sold to supplement household income. In Dulamayo Selatan, however, coconut received significantly lower LUVI values—1.75 (men) and 0.35 (women)—indicating its marginal role in local food systems. This discrepancy is shaped largely by ecological and structural differences: Modelidu is drier and more dependent on drought-tolerant species such as coconut, whereas Dulamayo Selatan possesses a more diversified agroforestry profile dominated by fruit-bearing trees and perennial species. These differences underscore the capacity of LUVI to detect context-specific gradients of plant importance shaped by ecological availability, traditional subsistence systems, and market orientations.

Fruit-bearing species also exhibited variation in LUVI values between the two villages, providing further insight into localized food plant valuation. In Modelidu, bananas and jackfruit were perceived as the most important fruits, with LUVI scores of 4.32 and 3.36 among male participants, respectively. These fruits are readily available, easy to cultivate, and often incorporated into daily diets. Their moderate LUVI scores reflect their role as supplementary foods that diversify household nutrition but do not replace staple crops such as maize. In contrast, Dulamayo Selatan's LUVI scores reveal a more substantial reliance on fruit plants, particularly langsat (*Lansium domesticum*), which received high LUVI values of 6.3 among men and 8.05 among women. Banana also displayed strong gender differentiation, with women assigning significantly higher LUVI scores (5.95) compared to men (1.05). The higher valuation of fruit species in Dulamayo Selatan indicates a food system structured around the availability of perennial fruit trees supported by the village's complex agroforestry design, which has been documented in prior studies such as those by Hiola and Puspaningrum (2019). The gendered differences in fruit valuation reflect women's central role in household nutrition, meal preparation, and knowledge of seasonal food cycles, thereby offering an important reminder that ecological knowledge is socially situated.

The citizen science framework used in the study plays a crucial role in contextualizing these LUVI results. Unlike purely ecological inventories that document species presence, citizen science allows community members to articulate the cultural logic, economic reasoning, and lived experiences that inform their valuations. Through participatory discussions, local people provided qualitative explanations for the LUVI scores they assigned. Their narratives revealed how plant importance is shaped not only by physiological traits such as yield or growth rate but also by relational considerations including customary practices, food preferences, and intergenerational knowledge transmission. By involving local people in scoring via the Pebble Distribution Method (PDM), the study ensured that the numerical values assigned to each species reflected collective deliberation, local memory, and shared experiences with agroforestry systems. This participatory process aligns with broader literature on citizen science, which highlights its ability to bridge formal scientific methods with community knowledge systems, giving voice to local expertise that typically remains marginalized in top-down agricultural planning.

The LUVI results thus illuminate distinct food security profiles for each village. In Modelidu, where ecological constraints limit perennial fruit diversity, community members prioritize annual and multifunctional crops such as maize and coconut. In Dulamayo Selatan, where agroforestry systems are more structurally complex and ecologically stable, the community maintains a greater reliance on fruit-bearing species, with LUVI scores reflecting a diversified food system that depends less heavily on a single staple crop. This contrast is further reinforced by production data, which indicates that Dulamayo Selatan produces higher volumes of high-value crops such as chocolate, clove, chili, tomatoes, and local fruits, while Modelidu excels mainly in maize and coconut production. Such differences reveal how LUVI captures not only cultural preferences but also the ecological histories and economic realities that shape local food systems.

Gender differences observed in LUVI valuation provide another layer of insight into community perceptions of food plant importance. Women consistently attributed higher LUVI scores to fruit-bearing plants compared to men, suggesting their deeper involvement in daily food preparation, nutritional decision-making, and the management of household food diversity. Meanwhile, men tended to assign higher scores to crops that are publicly traded or associated with more labor-intensive production. These patterns affirm the argument that food plant valuation is not monolithic but distributed across differentiated experiences that are gendered, ecological, and socio-economic in nature.

The LUVI assessment also reveals the significance of local ecological knowledge in shaping community perceptions. For example, fruit species such as langsat and banana are valued in Dulamayo Selatan not only for their edibility but also for their cultural uses and their reliability during seasons when annual crops are scarce. The inclusion of such knowledge through citizen science methods enriches the dataset beyond what ecological surveys alone could capture. This supports the argument that systematic documentation of local food plant importance had not previously been conducted in either village and that LUVI provides a valuable means to bridge this knowledge gap.

Overall, the LUVI results derived through citizen science demonstrate that community perceptions of food plant importance are shaped by the interplay of ecological resource availability, cultural preferences, household nutritional needs, and market opportunities. The participatory nature of LUVI ensures that these valuations are rooted in community realities and reflect the dynamic ways in which people interact with their agroforestry environments. Rather than offering a uniform or externally prescribed ranking of species, LUVI captures a mosaic of perspectives that together contribute to a fuller understanding of the food plant assemblages that sustain local livelihoods. Through this methodological approach, the study provides an empirically grounded depiction of how communities perceive and prioritize local food plants, offering critical insights into food system resilience in the context of agroforestry landscapes.

4. Conclusion

This study demonstrates that the Local User Value Index (LUVI), when applied through a citizen science approach, provides a robust and context-sensitive measure of how communities perceive the importance of local food plants within their agroforestry systems. The findings reveal that plant importance is shaped not only by frequency of use but also by ecological suitability, cultural practices, gendered knowledge, and livelihood strategies. Maize emerged as the most valued species in both Modelidu and Dulamayo Selatan, reflecting its central role in local food security, while the relative importance of fruits and multipurpose species varied significantly between villages due to differences in ecological conditions and household subsistence patterns. The participatory nature of LUVI strengthened the reliability of these insights by grounding valuation processes in community knowledge rather than external criteria.

The study contributes to existing scholarship by empirically demonstrating how LUVI can operationalize local perceptions of food plant importance in biodiverse agroforestry landscapes, addressing a major gap in regional documentation of community-based food systems. These findings have practical implications for food planning and biodiversity-based agricultural policy, highlighting the need to incorporate community-defined priorities into sustainable food security strategies. Future research should explore the temporal dynamics of LUVI values, the influence of shifting market conditions, and deeper gendered dimensions of plant valuation across seasons and socioeconomic contexts.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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