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RESEARCH ARTICLE

Botanical diversity as a reservoir of resilience: The emergence of new uses of wild plants under acute food shortages in Karamoja, Uganda

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Abstract

1. Agro-pastoralist communities in Karamoja, Uganda, face food insecurity driven by climate variability, declining livestock numbers and crop failures. In this context, local ethnobotanical knowledge systems play a central role in subsistence and adaptation.
2. This study examines how new uses of wild edible plants emerge under food shortages and the mechanisms underlying their emergence, transmission and establishment in Karamoja. We conducted focus group discussions and semi-structured interviews in five villages among Tepeth and Karamojong communities, combined with walks-in-the-woods for species verification. Qualitative analyses identified the drivers of change, learning pathways and linguistic practices, while logistic modelling assessed plant use patterns in villages.
3. Participants reported the emergence of 27 previously unused edible plant species, mostly herbaceous and sourced from anthropogenic habitats. All new uses emerged during periods of severe food shortages and were developed primarily by women. Most species are consumed as leafy vegetables and are available mainly during the rainy season. Thus, wild plants constitute a living reservoir of resilience.
4. New plant uses emerged largely through asocial learning, involving individual experimentation and trial and error. These uses were subsequently transmitted within and between villages through social learning, as reflected in shared vernacular names and narratives of knowledge transfer.

5. The mechanisms of emergence, transmission and gradual integration of these practices meet the first two of the four core criteria of cumulative cultural evolution and show indications of the remaining two.
6. These results show that the outcomes in rangeland systems depend on how culturally embedded values, norms and perceptions shape behaviour over time. Interventions must therefore recognize locally driven innovation, safeguard access to natural resources and align with the adaptive logics through which pastoralist communities manage rangelands.

KEYWORDS
cultural evolution, cumulative cultural evolution, ethnobotany, food insecurity, Karamoja, pastoralism, wild edible plants

1 | INTRODUCTION

1.1 | Cumulative cultural evolution and wild edible plant knowledge

Indigenous and local biocultural knowledge systems, including ethnobotanical knowledge systems, are generally understood to be shaped by repeated incremental learning through cumulative cultural evolution (CCE) (Berkes, 1999; Ingold, 2000; McCaffree, 2022; Mesoudi & Thornton, 2018). CCE is the process by which cultural traits are developed, transmitted and incrementally modified through social learning, resulting in the progressive accumulation of adaptive knowledge and behaviours over successive generations (Boyd & Richerson, 2024; McCaffree, 2022; Mesoudi & Thornton, 2018). CCE is characterized by four core criteria: (i) a change in behaviour, typically due to asocial learning; (ii) the transfer of that novel or modified behaviour to other individuals or groups through social learning, where (iii) the learned behaviour causes an improvement in performance, which is a proxy for genetic and/or cultural fitness; and (iv) the previous three steps are repeated in a manner that generates sequential improvement over time (Mesoudi & Thornton, 2018). For ethnobotanical knowledge systems, CCE has led to the development of plant use repertoires comprising sets of species that can be employed for a wide range of purposes, including, among others, food, medicine, spiritual practices and ecological functions, and that contribute to sustaining livelihoods worldwide (Pironon et al., 2024).

An example of such an ethnobotanical knowledge system is the knowledge of wild edible plants (WEP). WEPs are plant species that propagate naturally without direct human intervention and are consumed by humans (Priyadarshini et al., 2024; Termote et al., 2011). They constitute an inextricable component of the diets of rural and urban populations around the world and often serve as a critical source of nutrition during periods of food scarcity (Borelli et al., 2020; Ekesa et al., 2022; Lulekal et al., 2011; Oduor et al., 2024). Knowledge required for the identification of WEPs and their foraging practices, as well as their uses and preparation methods, is often deeply embedded in the biocultural heritage of local communities and populations (Antonelli, 2023; Kuhnlein et al., 2009).

However, these systems continuously evolve in response to socio-environmental change (Berkes, 1999; Gómez-Baggethun, 2022). This adaptive nature makes them particularly relevant at present, as communities worldwide face increasing pressures from climate change, biodiversity loss and food insecurity (Antonelli, 2023).

1.2 | Pastoralism and Karamojong people

Pastoralism is one of the most widespread land use systems in the world, occupying around half of the Earth's land surface, primarily in drylands and in areas with highly variable environmental conditions (Galvin et al., 2008; Manzano, 2015; Manzano et al., 2023). In these contexts, pastoralism often constitutes the only viable and sustainable food production system (Manzano et al., 2021).

To cope with these conditions, pastoralists maintain reciprocal relationships with the biodiversity surrounding them: they sustain this biodiversity through their ecosystem stewardship practices, of which extensive grazing constitutes the largest part, while simultaneously relying on this biodiversity to sustain their livelihoods. For pastoralist societies, plant knowledge serves ecological, economical and sociocultural functions, and helps ensure food and health security for both people and their livestock, as well as supporting critical livelihood decision making (Chao et al., 2025; Sharifian et al., 2022). In this context, plants play an inextricable role in adaptation and the development of adaptation strategies to change, which is inherent to the mobility characteristic of these livelihoods (Chao et al., 2025; Manzano et al., 2023; Sharifian et al., 2022).

However, this reliance on highly variable environments also exposes pastoralists to the impacts of climate change (Cho et al., 2025). Furthermore, pastoralist societies around the world face growing mobility restrictions due to sedentarization policies, land privatization, land use change, the establishment of physical barriers and shrinking rangelands, forcing them to explore alternative livelihoods (Bassi, 2017; de Jode, 2010; FAO, 2018; Khazanov, 2013).

This global pattern is particularly visible in Karamoja, a semi-arid region in northeast Uganda and home to more than a million people, traditionally semi-nomadic agro-pastoralists. This area faces compound challenges, including climate change, land degradation, malnutrition and intercommunal conflict, making it one of the most food-insecure areas of East Africa (Levine, 2010; Muggaga et al., 2023; Twinomuhangi et al., 2023). Conflict and political and civil society initiatives have led to a steep decline in livestock numbers in some areas and to an increasing reliance on crop production for food supply (Gray & Sundal, 2017; Manzano et al., 2021; Nakalembe et al., 2017). Many communities in Karamoja, particularly those located near urban centres, are gradually altering their mobile livelihood strategies, reducing the number of livestock and shifting from pastoralist livelihoods to more sedentary ways of life (Nakalembe et al., 2017). Consequently, a drastic dietary shift from animal-based to plant-based diets is occurring in these communities, yet without improvement in food security (Gray & Sundal, 2017; Nakalembe et al., 2017).

Plant knowledge and use in Karamoja are reported to be extensive and closely related to agro-pastoralist livelihoods, including ethnoveterinary practices and the use of plants for food, feed and medicine (Gradé et al., 2009a, 2009b; Gray & Sundal, 2017; Ojelel et al., 2019). For Turkana people, who inhabit the neighbouring Karamoja region on the Kenyan side and live within a mobile pastoralist livelihood system, it is well documented that wild plants are used to obtain essential micronutrients, including folic acid (Oduor et al., 2024). As part of a broader study of the knowledge of wild plants in Karamoja, we observed that among sedentarized communities, novel edible uses of plant species have emerged to bridge periods of acute food shortage, including the use of species that were not used prior to sedentarization.

The effects of livelihood and ecological change on knowledge about wild plants, as well as the social and cultural processes through which this knowledge is adaptable, remain poorly understood. However, these processes are fundamental to understanding how communities respond to change, as they shape what knowledge is retained, modified, or lost and how this affects people's resilience (Marks et al., 2022; Reyes-García et al., 2014). Understanding these dynamics provides direct insight into the mechanisms through which adaptation occurs under rapidly changing environmental conditions (Boyd & Richerson, 2005; Mesoudi & Thornton, 2018) and can play a crucial role in identifying and understanding inclusive pathways to sustainable natural resource management and conservation (Berl et al., 2025).

Therefore, the central research aim of this study was to investigate how new uses of wild edible plants emerge as adaptation strategies to mitigate food insecurity in Karamoja and how these emergent uses reflect processes of cumulative cultural evolution. The specific research questions were: 1. What new plant uses are developed in response to food shortages in Karamoja? 2. What mechanisms underlie the emergence, transmission and establishment of new plant uses within ethnobotanical knowledge systems?

2 | METHODS

2.1 | Study area

Karamoja is a subregion in northern Uganda. It has an Aw tropical savanna climate according to the Köppen-Geiger classification, with mean temperatures ranging from 15 to 32.5°C and average annual rainfall between 500 and 800 mm (Beck et al., 2018; Mubiru, 2010). The region follows a unimodal rainfall regime, with a dry season from November to March and a rainy season from April to October (Mubiru, 2010). Rainfall is highly erratic and spatially variable, and the area experiences recurrent droughts, as well as occasional floods (Mubiru, 2010). The Karamoja plains lie at an average altitude of approximately 1000–1400 m above sea level, leading in the Moroto district to Mount Moroto, which rises to approximately 3080 m (Houdet et al., 2014; MWE, 2019). The mountain ecological gradient changes from tropical savanna in lower elevations to subhumid montane climate on upper slopes. The plains are primarily inhabited by ethnic groups within the Ateker group, whose livelihoods rely on pastoralism and agro-pastoralism, while the mountain slopes are home to the Tepeth, an Indigenous group historically engaged in hunting and gathering, whose livelihoods have gradually shifted towards agro-pastoralism (Gray et al., 2003; Olum et al., 2017).

2.2 | Data collection

2.2.1 | Focus group discussions and interviews

Data collection for this study was conducted in 2025. We selected five villages in Moroto district for data collection: two Tepeth villages, two Karamojong villages and one multi-ethnic village inhabited by Karamojong, Tepeth and Pokot people from Kenya. The Tepeth villages were located on the lower slopes of Mount Moroto, where the climatic conditions are comparable to those of the surrounding plains. The main language spoken in the region is Ng'akarimojong. In addition, Pökoot and Swahili were spoken by Pokot people in the multi-ethnic village. Soo, the Tepeth language, was not documented among participants (Eberhard et al., 2025). Potential differences in interconnectedness between villages were examined in relation to ethnic composition (Table 1) and physical distance between villages (Table 2), both of which were considered potential drivers of variation in social interaction. No other factors were identified as likely to influence the interconnectedness between the selected villages.

In each village, two focus group discussions were held, one with men and one with women. Participants were recruited voluntarily, with the inclusion criterion being that they were over 18 years of age. The discussions were separated by gender to capture potential differences in the repertoires of plant knowledge and to reduce gender-related power dynamics that could otherwise bias participation.

TABLE 1 Overview of data collection methods in selected villages and participant profiles. FGD = Focus group discussion.

Village (ethnic group)	Data collection method	Men	Women	Mean age (years)	SD
Village 1 (mixed ethnic groups)	FGD	11	15	39.1	18.0
	Interviews	—	6	40.0	13.9
Village 2 (Tepeth)	FGD	11	9	46.0	20.3
	Interviews	2	5	39.0	13.2
Village 3 (Tepeth)	FGD	13	13	34.9	15.0
	Interviews	5	6	35.5	11.2
Village 4 (Matheniko)	FGD	9	6	35.4	19.3
	Interviews	—	7	46.7	12.1
Village 5 (Matheniko)	FGD	11	10	47.8	18.9
	Interviews	3	3	51.5	26.0

TABLE 2 Distances between villages (in km).

Distances in km	Village 1	Village 2	Village 3	Village 4	Village 5
Village 1	/	32.6	26.5	34.8	22.9
Village 2		/	10.9	5.0	22.8
Village 3			/	9.8	11.9
Village 4				/	21.3
Village 5					/

Each focus group included freelisting exercises on wild edible plants, in which participants were invited to list the plant species they knew, with particular emphasis on newly adopted uses (Paniagua Zambrana et al., 2018). Participants were also invited to discuss the seasonal availability and importance of species, perceptions of environmental and climatic change, and changes in livelihood strategies.

We asked participants if there were plant species they had started using or if they knew others who had started using edible plant species that were not used previously within the village. When participants mentioned such plant species, they were invited to participate in follow-up interviews.

The semi-structured interviews were then conducted to obtain in-depth insight into new plant uses. Interviews were conducted at the preferred location of the participants, or during walks in the woods (see below), as walking interviews (Kinney, 2021). Depending on the preferences of the participants, the interviews were conducted individually or in pairs. The questions focused on motivations for adopting new plant uses, knowledge acquisition pathways, including asocial and social learning pathways, foraging locations and the timing of first use. For each of the plant species recorded, we discussed the meaning and etymology of the vernacular names according to the participants. Focus group discussion and interview guides are provided in Material S1.

In total, 114 individuals participated in the focus group discussions (55 men and 59 women) and 37 people participated in interviews (10 men and 27 women). The participants had a mean age of 41 years (range = 18–84 years; Table 1).

Data collection was carried out by the first author, a representative of the Karamojong/Tepeth communities (author 3) and three Karamojong research collaborators (authors 4–6). Prior informed consent was obtained from all participants after the research goals and objectives had been explained. The interviews were conducted in Ng'akarimojong and interpreted by the community representative. Post-data collection discussions were held between the data collectors to interpret the research results. Informed consent was obtained from all participants prior to data collection. For participants who were illiterate, the study was explained orally in the appropriate local language and verbal consent was obtained in the presence of an independent witness. Interview data were anonymized, except for plant names containing references to individuals, which were retained as they encode ethnobotanically significant information. To further prevent identification of participants, given the small size of the communities involved, village names were pseudonymized using sequential identifiers (villages 1–5).

2.2.2 | Walks-in-the-woods

After each focus group discussion and interview, walk-in-the-woods with participants were conducted to collect physical specimens of plant species mentioned during the freelisting exercises (Thomas et al., 2007). Only plant species that were observed and verified during these excursions were included in the final dataset, ensuring accurate scientific identification and confirming that only actively used species were recorded. Each specimen was prepared as a physical and a digital voucher, consisting of herbarium samples and high-resolution photographs, respectively (Greene et al., 2023).

2.2.3 | Ethics

The study protocol was reviewed and approved by the Gulu University Research and Ethics Committee (GUREC 2025 850) and received

national clearance from the Uganda National Council for Science and Technology, UNCST (NS1041ES). The study design followed the UNCST (2025), American Anthropological Association (AAA) (2012) and the ISE Code of Ethics (2006) ethical guidelines.

2.3 | Data analysis

2.3.1 | Plant identification

Plant identification was carried out ex situ using dried herbarium specimens and a digital voucher collection, combining both visual and genetic confirmation. The Flora of Central Africa and Plants of the World Online databases were consulted for visual identification of the collected specimens (Meise Botanic Garden, 2025; POWO, 2025). Each identification was cross-checked against physical herbarium samples in the Herbarium of the Meise Botanic Garden. The scientific names, along with their respective families and author citations, were validated for accuracy using the Plants of the World Online database (POWO, 2025). Physical vouchers will be added to the Makerere University Herbarium in Kampala.

2.3.2 | Statistical analysis

To assess the potential influences of interconnectedness between villages, differences in the use of plant species between villages and ethnic groups were evaluated using logistic regression models applied to a presence–absence dataset of plant species reported in each village. Separate models were fitted to test for the effects of village and ethnic affiliation on the probability of species use. To account for the non-independence of observations arising from repeated measurements of the same species across villages, cluster robust standard errors were computed with species as the clustering unit. To assess whether the geographical distance between villages influenced similarity in the use of plant species, the geographical distance was quantified for each village as the mean pairwise distance to all other villages. This variable was included as a continuous predictor in an additional logistic regression model. All tests were performed at a significance level of 5% using Rstudio (version 4.1.1) (RStudio Team, 2020).

2.3.3 | Plant habitat and seasonal availability, and geographic distribution

The habitats from which WEPs were collected and their seasonal availability were derived from focus group discussions. Participants reported when plant species and their edible parts were available and used. We grouped seasonal availability into dry season and rainy season. For every plant species, we evaluated whether it is native to Uganda or recently introduced by assessing the geographical distribution through Plants of the World Online (POWO, 2025).

2.3.4 | Drivers of change, linguistic characterization and knowledge acquisition mechanisms

We transcribed the translated (into English) focus group discussions and interviews that addressed the emergence of new plant uses and conducted a descriptive qualitative analysis of these materials. From the transcripts, we identified the main drivers underlying the development of new plant uses. The identification of drivers was conducted through repeated rounds of discussion among the first six authors, after which the final set of drivers was established and described by the first author and verified by all co-authors. A central focus of the analysis was on the pathways through which knowledge was acquired. Vernacular plant names were considered as indicators of knowledge acquisition and transmission processes. Knowledge acquisition pathways were categorized according to whether they involved asocial learning (i.e. individual experimentation or observation) or social learning (i.e. learning from other individuals). In parallel, the pathways of vernacular name formation were categorized, and the etymologies of the names were descriptively analysed. Both knowledge acquisition pathways and pathways of vernacular name formation were established by the first, third, fourth, sixth and seventh author and verified by all co-authors. Shared naming conventions across communities were used as analytical proxies to explore potential intervillage knowledge transmission. The translations of the Karamojong plant names were conducted in situ during data collection and subsequently verified during data analysis.

2.3.5 | Positionality and limitations

This study was led by the first author, a white European researcher affiliated with Global North research institutions who led data collection in Karamoja. The authors acknowledge that the positionality of the first author, shaped by differences in ethnicity, nationality, language and historically embedded power relations, may influence research interactions and interpretations. To address this, research was carried out in close collaboration with local NGOs, with whom study design and data collection tools were co-developed to promote local relevance and responsiveness to community priorities. The second, fourth, fifth and sixth authors are Karamojong co-researchers and NGO workers in the region.

To support equitable knowledge production, all data collections were carried out together with the third author, a Karamojong/Tepeth community representative and three Karamojong research collaborators (authors 4–6), who acted as co-interviewers, co-moderators, translators, interpreters and cultural mediators. All interviewers adopted the docent method (Chang, 2017), and walking interviews were preferred to reduce power asymmetries (Kinney, 2021). The seventh author, a Karamojong researcher, ensured accurate and detailed translations of vernacular names. Reflexive joint post-fieldwork interpretation and data analysis with all Karamojong and Tepeth co-authors (authors 2–7) were embedded

throughout the research to ensure culturally sound interpretations and to value local epistemologies. The manuscript was developed reflexively with all authors.

Security measures in the study area limited the duration of fieldwork in individual villages, which may have limited the depth of engagement with participants and the breadth of perspectives captured. Knowledge was documented primarily through oral accounts and practices, reflecting locally relevant modes of knowledge transmission. Therefore, the analysis is largely based on qualitative and descriptive approaches.

3 | RESULTS

3.1 | The emergence of new edible plant uses

Participants reported the emergence of 27 plant species as edible plant species, belonging to 14 plant families. All but one newly used plant species were herbaceous, with one tree species represented (*Dalbergia* sp.). For all plant species, the leaves were prepared and consumed as vegetables, and for one plant species (*Coccinia grandis* (L.) Voigt), the fruits were also consumed.

The process of adopting these new plant uses was mentioned and discussed during all but one focus group discussion with women and during only one focus group discussion with men, in village 5. In the latter location, new plant uses were only mentioned by two men during the focus group discussion and not by women.

In four villages, participants mentioned that they started using these plants less than 10 years ago (around 2015), and some plant uses started only 2 years ago. In one village, village 5, the men mentioned that they started using these plants 26 years ago (in 1999), all during the same year, after a hunger shock. An overview of the villages, the number of years since settlement and the emergence of new uses for plants are presented in Table 3.

In each village, a unique set of new plant uses was mentioned, with partial overlaps in sets of plant species used between the different villages (Figure 1b). Furthermore, some plant species uses that were considered new in a specific village were also present, but not new, in other villages. The plant species used in the different villages from the full set of recorded plant uses are presented in Figure 1a.

Logistic regression models did not reveal significant overall differences in the sets of plant species used between villages (likelihood ratio test: $\chi^2 = 6.52$, df = 4, $p = 0.16$) or between ethnic groups ($\chi^2 = 1.60$, df = 2, $p = 0.45$). When incorporating geographical isolation as a predictor, no statistically significant effect was detected at the level of 0.05 ($p = 0.056$). However, the distance-based model indicated a consistent negative relationship between geographical distance and the probability of species use ($z = -1.91$), suggesting that towns located closer to each other tend to share more similar sets of plant species.

The complete set of plant species, including their scientific name, vernacular name, translation or meaning of the vernacular name, origin and etymology of the name, village of record and, where applicable, the village-specific knowledge acquisition pathway, seasonality (wet or dry season), locations of occurrence and status as native or introduced, can be consulted in Material S2 and in the corresponding archived dataset (De Meyer et al., 2026).

TABLE 3 Overview of villages, the number of years since communities have settled and the emergence of new plant uses.

	Years ago, settled	Years ago, emergence of new plants uses
Village 1	10	3–10
Village 2	9	2–10
Village 3	20	5–10
Village 4	15	5–10
Village 5	53	25–30

3.2 | Drivers of the development of new plant uses

In all villages, participants reported that they started using these plant species out of necessity, during a period of severe food shortages. Participants addressed this period with the Nga'karamojong term '*akoro*', which means 'hunger'. In all villages, people mentioned the failure of staple crops (mainly sorghum and maize) and other crops as the main driver of food shortage, combined with an increasing reliance on crop production due to decreased livestock numbers and a subsequent decrease in reliance on animal-based nutrition to compensate for crop failures. In three villages, interrupted food aid was mentioned as an additional reason for sudden food shortages. In village 2, participants mentioned that before sedentarization (around 10 years ago), the harvest of 1 year could cover 2 years, while now this reserve is reduced to 1 year. The following quotes illustrate the main drivers behind the development of new plant uses.

> We started using those plants during that time of hunger (akoro).' There was nothing, absolutely nothing to eat. What could we do…
>
> Woman, 40 years old, village 4

> When the harvest of the previous year is finished and sorghum is planted, but not ready yet. That's when there is hunger (akoro). In those days (A/N: referring to the past), men used to slaughter an animal, but now animals are so few that they don't want to do that anymore.
>
> Woman, 52 years old, village 2

3.3 | Plant habitat and seasonal availability

All plant species were reported to be available only during the wet season. In addition, three plant species were also reported to be available during the dry season. Only *Leptadenia lanceolata* (Poir.)

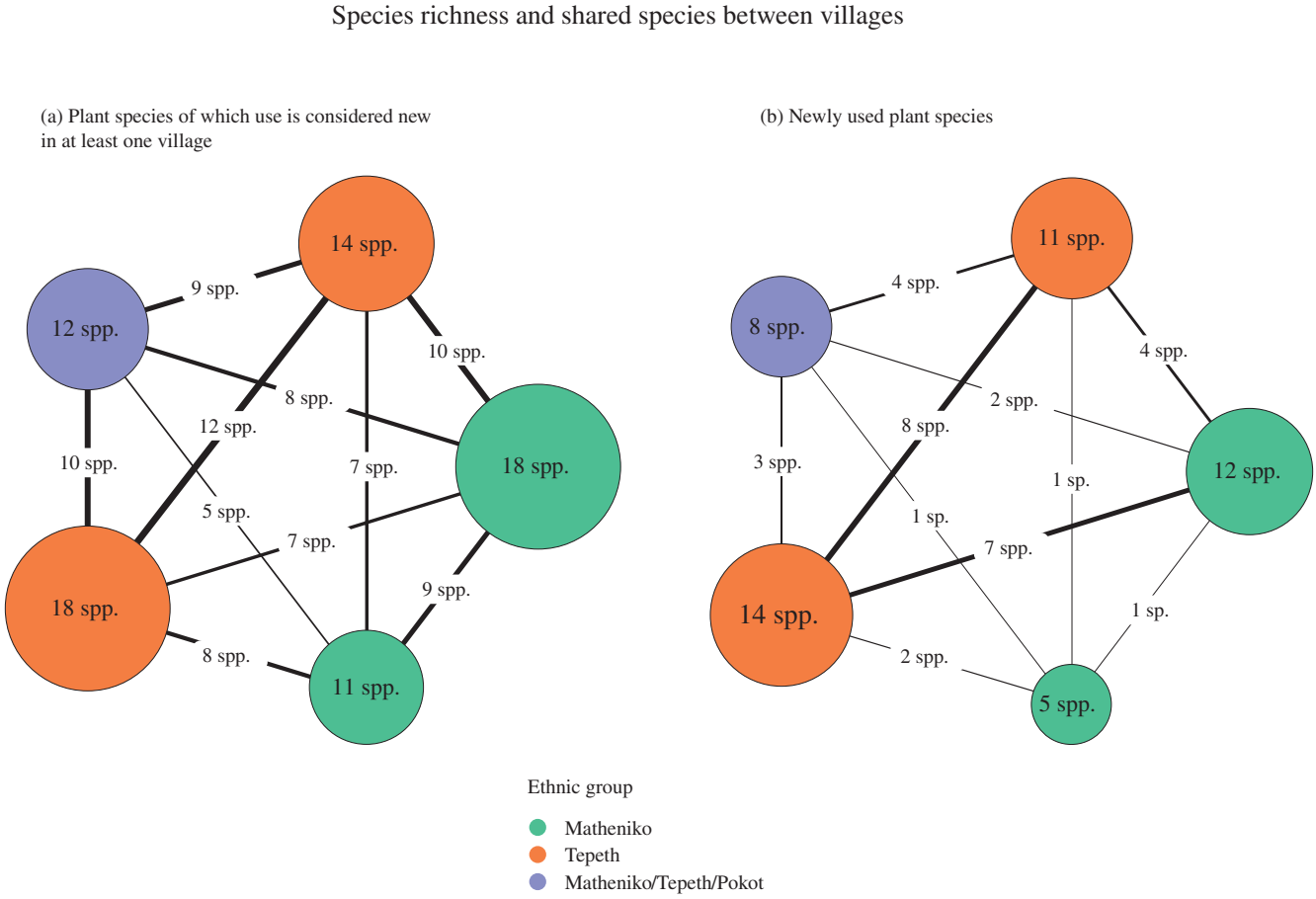

FIGURE 1 (a) Species richness of plant species used in the different villages of which the use is considered new in at least one village. (b) Richness of species of new plant uses per village and shared species between villages. Each circle represents one village. The lines connecting villages represent species shared between those villages.

Goyer (in two villages) and *Dalbergia* sp. (in one village) were reported to be abundantly available and used very frequently during the dry season. *Cyphostemma adenocaule* (Steud. ex A. Rich.) Desc. ex Wild & R. B. Drumm. was also reported to be available during the dry season. In the two Tepeth villages, participants indicated that some species that are only present during the wet season are conserved and consumed during the rainy season.

Twenty plant species were native to Uganda and Karamoja and seven plant species were non-native.

Twenty-four plant species were sourced from anthropogenic habitats, that is, habitats near the manyatta, kraal and agricultural fields. Two plant species were sourced from aquatic habitats (riverbanks and wetlands), and one tree species (*Dalbergia* sp.) was sourced from sites where the species naturally occurs.

3.4 | Linguistic analysis

The giving of names is inherent in the Karamojong and Tepeth culture. At important events or occasions, people and objects receive new names. The vernacular names of plants had diverse origins. Most of the vernacular names had descriptive origins, describing morphological (Boyd & Richerson, 2005), ecological (Bassi, 2017) or sensory traits (Berkes, 1999). In addition, three plant names refer to plant–animal interactions, such as *lomethekin*, which translates as '*for the sheep*', and lotapemo, which refers to guinea fowl (*atapem*), because these birds are known to forage on plant species. Additionally, five plant names had anthropogenic origins. Three plant species were named after the person who discovered their use. *Toto anakong* (*Galisoga parviflora* L.), which means 'the *mother of Nakong*', was named after a woman called *Nakong*, who developed its use in village 2.

> Toto anakong is the plant that was discovered by Nakong. One day we saw that she was eating it, and then we started eating it as well… But she was very old. She suddenly died two or three years ago, in her field, during that time of weeding.
>
> Woman, 42 years old, village 2

In two different villages, people who had started using the plant both knew the plant name and reported that the origin of the knowledge was village 2. A second case was that of *Toto anangiro* (*Malvastrum coromandelianum* (L.) Garcke), which translates as '*the mother of Nangiro*', the latter name was simplified to *Nangiro*

and *Ngagiloro* in two different villages, which are two examples of such names. Another third is *Veronica* (*Asystasia mysorensis* (Roth) T. Anderson), a plant whose edible use was developed by a person called *Veronica*. The latter plant species was named differently in one other village (*Lokiriketa*, which translates as *'where it is round'*), referring to traditional shrines, or the kraal, the location where it is foraged. Two plant names referred to different plant–human interactions. *Alibilib* (*Justicia calyculata* Deflers), which means 'green green', refers to the colour of the plant (before and) after cooking it and *lokungin* (*Asystasia intrusa* (Forssk.) Blume), which means 'knees', referred to the fact that people had to kneel down when picking them. The origin of seven plant names remained unknown.

Integration of people–plant connections in plant naming was uniquely observed for newly identified uses. Vernacular names associated with existing uses included references to morphological characteristics and ecological characteristics, among other aspects. Although for many of the names, it was not clear whether their discovery had led to giving them a new name, for at least the tree plant species that received a name referring to the person who developed their use, this was clear. Furthermore, the names referring to plant–human interactions suggest that these names were given after their use was developed.

3.5 | Acquisition of ethnobotanical knowledge: Asocial and social learning pathways

Different learning pathways for the same plant species were described both within and between villages. Therefore, in the following section, we discuss knowledge acquisition or learning pathways mentioned across villages, which are not linked to specific plant species, unless otherwise stated. As a result, the number of pathways exceeds the total number of plant species used. A schematic overview of knowledge acquisition mechanisms and pathways to new plant uses is shown in Figure 2.

Most of the new plant uses reported in the different villages were developed through individual asocial learning pathways ($n = 31$). This means that a single person developed the use of a plant species that had not previously been used as food. In all these pathways, a phase of trial-and-error was involved, carried out by individuals either individually or collectively. This trial-and-error phase differed between villages but always involved the cooking or frying of the plant parts, and then the consumption of a small amount.

For most asocial learning pathways ($n = 23$), no pre-selection method was mentioned. However, in eight cases, a form of preselection was involved (see Figure 2): In four pathways, people observed which plants animals foraged on, this was the case for *Erere* (*Dalbergia* sp.) and *Lomethekin* (*Bidens subalternans* DC.), which were selected by watching sheep and goats forage on them, and for *Lotapemo* (*Dicliptera verticillata* (Forssk.) C. Chr.), which was known to be foraged on by guinea fowls. In two cases, the plants were selected based on their resemblance to other plant species. In one pathway, plants were 'admired' before being tested, which was narrated as a visual selection method in which a plant species appeared palatable, and one pathway was an adaptation of an existing use. In this case, *Cyphostemma adenocaule* (Steud. ex A. Rich.) Desc. ex Wild and R.B. Drumm. was known as a drug for

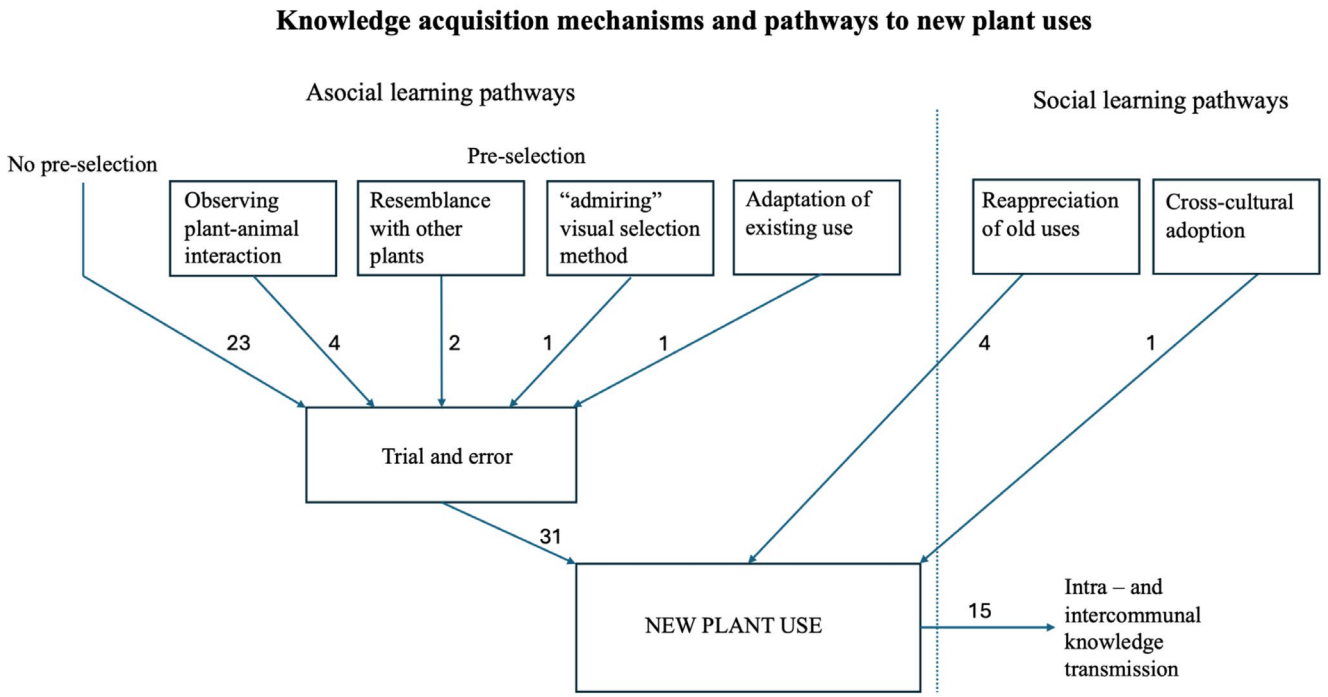

FIGURE 2 Mechanisms and pathways to knowledge acquisition for new plant uses. The numbers indicate how many times this pathway was mentioned by the participants.

treating anaemia in one village and was subsequently developed as an edible plant.

Furthermore, during three focus group discussions with women, cases of self-poisoning and fatalities during these trial-and-error procedures were mentioned. The following quotes illustrate two pathways to the development of new plant uses: one without pre-selected and one pre-selected based on animal observations:

> … one day, a woman decided to try to eat all the plants we could find. We picked them, boiled them, and she tried them all. She was already blind, so she decided that she would be the one to try them all…
>
> Woman, 62 years old, village 4

> … we knew that goats liked to eat the leaves of this plant (N/A: erere, Dalbergia sp.)… Some plants goats eat, people can eat as well… So we tried eating this one…
>
> Woman, 36 years old, village 1

A small minority ($n = 5$) of the pathways involved a form of social learning. In four pathways, people mentioned that an individual remembered seeing older people eating a certain plant species when they were a child. There was also one case of introduction of a plant use (of 'Sasita', translated as 'Midday' in Swahili, the vernacular name for *Galinsoga parviflora* L.) through a Pokot individual who migrated to Karamoja from Kenya.

The knowledge about newly developed uses of plants was then transmitted within villages and between villages through social learning. People narrated social learning as a path of knowledge acquisition in 15 cases. Participants almost always referred to this social learning pathway as a passive form of learning: 'We *saw them eating it*'. Additionally, the linguistic analysis of the plant names further confirmed these pathways. *Toto anakong* was used in three villages, and in two villages people narrated that they learned to use the plant from people in the third village, where the use of the plant was developed and the name was given to the species of plants. The same was applied to '*Toto anangiro*'.

> … I am from that place (A/N: village 2). A couple of years ago, I went there and saw people eating Toto anakong. The same plant was growing here as well, so after that I started preparing it here as well.
>
> Woman, 56 years old, village 1

However, in two villages, people used different names for the same plant species, indicating that social learning within villages can be limited. This was the case for 'Veronica' and 'Lokiriketa' in one Tepeth village and for 'Sasita' and 'Toto anakong' in a village of mixed ethnic origin. In the one village where only men discussed the uses, they mentioned that they learned the uses from people from other villages.

In all villages, participants indicated that since their initial use, some of these plants have been consumed regularly and have become integrated into local diets.

> … I don't eat it (A/N: *Asystasia myosorensis* (Roth) T.Anderson) every day. When I feel like preparing it, I collect it and prepare it… last time was last Sunday.
>
> Woman, 29 years old, village 2

4 | DISCUSSION

In all villages, people developed edible uses for 27 plant species that had not been used previously, in response to acute food shortages. Participants described crop failures related to prolonged drought periods and reduced animal nutrition due to reduced livestock numbers as the main drivers, and decreasing food aid was reported as an additional contributor (World Food Programme, 2015). Declines in livestock numbers are a global trend in pastoral societies, leading to food production shocks among pastoral communities worldwide (Cottrell et al., 2019). Gray and Sundal (2017) report similar changes in diets among Karamojong communities, with a drastically decreased consumption of animal protein resulting from the decrease in livestock numbers. As animal-based nutrition typically plays a central role in bridging the period between harvests (FAO, 2021a), its decline in participating villages has reportedly created a nutritional gap that has led to the search for alternative sources of nutrition, partly addressed through new uses of wild plant resources. Seven of these species were introduced non-native species, and 25 were exclusively available and used during the rainy season, a logical pattern, as during the dry season the previous harvest, combined with wild edible plants (e.g. *Balanites aegyptiaca* (L.) Delile) and animal-based nutrition bridge this period.

The development of new plant uses in response to food shortages in the Karamoja region follows two of the four core criteria of cumulative cultural evolution and shows indications of the remaining two (McCaffree, 2022; Mesoudi & Thornton, 2018).

Most of the new plant uses, which can be considered a change in behaviour of people using them (criterion 1), were developed through asocial learning, with a few cases of reappreciations of abandoned uses and one case of cross-cultural adaptation (Dutta et al., 2021). Although the trial-and-error phase was in some cases an individual, and in some cases, a collective action, the development of new plant uses occurred at least partially on an individual basis. This is supported by the fact that three of the newly used plants are named after the single person who developed their use. Gradé et al. (2009a, 2009b) documented observational learning from livestock as a pathway to acquire ethnoveterinary plant knowledge in Karamoja, which we also observed in our study, where it served as a pre-selection method for the development of new plant uses.

The development of new plant uses was mainly, if not exclusively, undertaken by women. This is evident from the observation

that knowledge of these plants is predominantly held by women, as well as from the vernacular names assigned to the plants, which refer to the individual who developed the edible use, and in all cases, to women (*Toto anakong*, *Toto anaingro*, *Veronica*). Furthermore, men who possessed knowledge of new plant uses reported that they had learned this knowledge from others.

The roles of gender in pastoralist societies are closely related to the organization of livestock production and mobility. Men typically manage herding and animal movements, while women oversee milking, small livestock care and household resource management, reflecting complementary domains of knowledge across mobile and sedentary subsistence activities, respectively (Hodgson, 2001; Kristjanson et al., 2010; Flintan, 2011; International Fund for Agricultural Development (IFAD), 2020). As women are primarily responsible for food provision within the manyatta (Grace & Sundal, 2017; Van Asseldonk, 2026), declining mobility levels and shorter herding trips shift food provision from a partly gender-segregated responsibility towards an increasingly women-centred one. This responsibility likely positions women as key innovators in the development of new plant uses in more sedentary communities. Furthermore, this helps explain why 25 of the plant species used were sourced from anthropogenic habitats, with which women interact most frequently. As plant use is often at least partly shaped by availability, the integration of these plants in plant use repertoires may reflect the increased availability of plants associated with these habitats due to agricultural expansion (De Meyer et al., 2025).

The new plant uses were transmitted through social learning to other individuals and groups (criterion 2). Within and between villages, social learning was narrated by participants and could be partially tracked through linguistic analysis, which, in the cases of *Toto anakong* and *Toto anaingro*, not only revealed processes and pathways of asocial learning, but also of social learning. The fact that in village 1 the same plant species (*Galinsoga parviflora* L.) was adopted through asocial learning pathways of different origin and used in parallel, shown by linguistic analysis, indicated that social learning within villages is not always intensive. Glowacki and Molleman (2017) state that knowledge exchange is done less thoroughly for sedentary agricultural livelihoods compared to mobile pastoral livelihoods.

Participants from the different villages included in our study developed unique but overlapping plant use repertoires of plant uses, with different processes of social and asocial learning taking place at the same time. The observation that these repertoires were not significantly different between villages and ethnic groups can be explained by social learning patterns between villages, across ethnicity, causing a spread of uses across villages and subsequent homogenization of ethnobotanical knowledge on these plants (De Meyer et al., 2025). This is confirmed by the observation that the distance between villages explains similarities in plant uses, as villages located closer to each other are expected to have greater interaction and subsequent knowledge exchange than villages located further apart. Another factor that might explain the similarity in sets of used plants is that the development of uses stems from trial-and-error with any available plant species, with sets of palatable plants available for experimentation being limited. In this context, in addition to the reappreciation of old uses and cross-cultural adaptation, plant species resulting from the development of new uses may not be related to ethnicity, but rather to the tools available to drive adaptation, a process Levi-Strauss called 'bricolage' (Ingold, 2000). The linguistic development of vernacular names aligns the traditional practice of name giving, with objects, concepts and people's names carrying information, history, knowledge and insights and acting as a means of transfer of knowledge (Franco & Suhaimi, 2022).

Criteria 3 states that learned behaviour leads to improved performance, which is a proxy of genetic and/or cultural fitness. Although these plant uses can contribute to food acquisition in times of food scarcity, constituting a direct survival strategy, their translation into improved performance should be treated with caution.

Whether these newly adopted plant uses translate into improved performance depends on several factors. Their nutritional and dietary contributions are unknown. Additionally, the balance between costs and benefits remains unclear, including the energy and risk trade-offs associated with these plant uses, such as the time and energy required to develop their use, forage and process these resources, as well as the risks involved, particularly potential toxicity, given the reported casualties (Bird & O'Connell, 2006; Winterhalder & Smith, 2000). Their dietary contribution relative to previous subsistence patterns for these communities is equally uncertain (Oduor et al., 2024), and uptake may vary depending on acceptability between community members. For the Turkana people, a pastoralist ethnic group living in Kenya adjacent to Karamoja, it has been documented that wild edible plants constitute an essential proportion (12–30%) of the dietary intake of communities and that these plants play a pivotal role during times of food scarcity (Oduor et al., 2024, 2025). On the contrary, Gray and Sundal (2017) report reduced adaptability and population resilience among sedentarized communities in Karamoja, including dietary changes that can indicate declining rather than improved performance.

Furthermore, beyond their nutritional role, food and foodways constitute an important social domain, both globally and in Karamoja (Gray & Sundal, 2017; Van Asseldonk, 2026), where they contribute to social cohesion and can help counter conflict. Sudden changes in dietary patterns can undermine social and ecological dynamics, with serious consequences for human well-being and conservation in Karamoja (Van Asseldonk, 2026). Therefore, a thorough understanding of these factors, situated within the context of broader livelihood changes, is needed to thoroughly assess whether these plant uses contribute to improved performance and meet criterion 3.

Participants' accounts indicate that they began using these plants at different times, between 2 and 30 years ago, showing that new repertoires of plant use have emerged within and between villages over different periods of time. However, as social learning appears limited in some villages, it is possible that knowledge circulated earlier than participants recalled and that additional new uses remain undocumented, given that only a subset of community

members was interviewed (Prakofjewa et al., 2024). Furthermore, the use of the same plant species was considered new in some villages but not in others. This may suggest that in the latter villages, these plants have already been integrated into the food system. As participants confirmed the integration of these plant uses into local diets, this process may have occurred a long enough time ago that it is no longer perceived as new. Furthermore, four of these plant uses (*Portulaca oleracea* L., *Solanum nigrum* L., *Oxygonum sinuatum* (Hochst. & Steud. ex Meisn.) Dammer, and *Leptadenia lanceolata* (Poir.) Goyer) were already documented by Gray and Sundal (2017), further suggesting that certain communities adopted them earlier than others. Given the socioecological mosaic that characterizes Karamoja, with communities exposing different degrees of mobility and engaging in varying livelihood systems, such variation is expected. Integration of these new uses into local diets, apart from original use out of necessity, indicates that the trait is integrated into plant use repertoires and can be seen as the establishment of a stable tradition (Truskanov & Prat, 2018). Although clear evidence of iterative improvements or repeated alterations was not found in our data, these conditions lay the foundation for further refinements to these plant uses, consistent with criterion 4, which states that the previous three steps are repeated in a manner that generates sequential improvement over time (Mesoudi & Thornton). However, it can be concluded that in Karamoja, new plant uses emerge as a complex process of asocial and social learning and transmission mechanisms, rather than as isolated events, enabling communities to navigate and mitigate socio-environmental challenges (Truskanov & Prat, 2018). The rapid adoption of several previously unused plant species illustrates knowledge assimilation driven by urgency and provides insight into how ethnobotanical knowledge can emerge, as well as how abandoned uses may be reappreciated under conditions of necessity (Berkes, 1999).

Living in semi-arid and arid conditions requires continuous adaptation to climatic, ecological and social change, resulting in livelihood systems that are highly flexible and adaptive. In this context, pastoralists are known for their adaptive capacity to maintain long-standing practices, abandon others and adopt new ones. In this sense, adaptation constitutes a traditional, long-standing practice, positioning pastoralist societies among the most resilient communities globally (Krätli et al., 2013; Manzano, 2017; Nori & Scoones, 2019). Although newly developed and assimilated plant uses in Karamoja can appear as part of an emerging knowledge system, their acquisition pathways are rooted in existing experiential knowledge (Gradé et al., 2009a, 2009b). Therefore, these plant uses should be understood as part of a broader, continuous adaptive tradition. In this context, wild plants represent a reservoir of tools that can be used to develop adaptation strategies to change. As such, they can be considered reservoirs of resilience.

Pastoral livelihoods are increasingly shaped by macro-level economic, policy and legal processes that occur largely outside the realm of the communities themselves, influencing both their exposure to stressors and their capacity to respond (Eriksen & Silva, 2009; O'Brien et al., 2009). Changes and adaptations in these livelihoods should therefore be understood as responses to broader macrolevel transformations (Zant et al., 2023). Likewise, in Karamoja, the search for nutrition and food security unfolds against political, climatological, geographical and security pressures that increasingly hinder mobile pastoralist communities from sustaining their mobile pastoral livelihood and associated subsistence system (Nakalembe et al., 2017). The mechanisms of cultural change and evolution should be understood within this context, where changes in performance reflect adaptation to emerging challenges rather than overall improvement. These processes are becoming increasingly prominent in a rapidly changing world (Truskanov & Prat, 2018). Understanding them provides key insights into how individuals and communities adapt their subsistence strategies to rapidly changing socio-ecological conditions under environmental and resource stress. Integrating such locally developed solutions into policy and development initiatives can strengthen food security and support more effective adaptation to changing conditions (FAO, 2021b; IPBES, 2019).

5 | CONCLUSION

This study shows that acute food shortages among the Tepeth and Karamojong communities in Karamoja have led to the adoption of 27 previously unused edible plant species as part of reorganized subsistence strategies responding to intersecting climatic, political and livelihood pressures. These new plant uses are primarily sourced from anthropogenic habitats associated with sedentarization and agricultural expansion and are developed and transmitted primarily by women, reflecting the shift in responsibilities in food provisioning. The emergence and spread of these practices follow a complex process that follows two of the four conditions of cumulative cultural evolution, in which experimentation, social learning and gradual integration shape assimilations of plant species and uses in food repertoires and result in converging plant use patterns across villages. Decreasing pastoral mobility, together with livelihood shifts and associated challenges, is thus reshaping the relationships pastoralist societies maintain with their environments, including their locally developed ethnobotanical knowledge. Understanding these dynamics provides key insights into how individuals and communities adapt their subsistence strategies to rapidly changing socio-ecological conditions under environmental and resource stress.

AUTHOR CONTRIBUTIONS

Emiel De Meyer designed the study in collaboration with Emmanuel Emaruk, Pablo Manzano and Rainer W. Bussmann. Data collection was conducted by Emiel De Meyer, Simon Omeri, Adam Leese, Claudias N. Lokira and Thomas Achilla. Data analysis was performed by Emiel De Meyer, Simon Omeri, Thomas Achilla and Vivian Lomele. The first draft of the manuscript was prepared by Emiel De Meyer in consultation with all authors. All authors reviewed the manuscript during the writing process and approved the final version.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

All data supporting the findings of this study are available within the manuscript and its supplementary material. An archived version of the dataset is available in Zenodo (De Meyer et al., 2026; https://doi.org/10.5281/zenodo.20824256).

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REFERENCES

American Anthropological Association (AAA). (2012). Code of ethics of the American Anthropological Association. http://ethics.americananthro.org/

Antonelli, A. (2023). Indigenous knowledge is key to sustainable food systems. *Nature*, *613*(7943), 239–242. https://doi.org/10.1038/d41586-023-00021-4

Bassi, M. (2017). Pastoralists are peoples: Key issues in advocacy and the emergence of pastoralists' rights. *Nomadic Peoples*, *21*(1), 4–33. https://doi.org/10.3197/np.2017.210102

Beck, H. E., Zimmermann, N. E., McVicar, T. R., Vergopolan, N., Berg, A., & Wood, E. F. (2018). Present and future Köppen-Geiger climate classification maps at 1-km resolution. *Scientific Data*, *5*, 180214. https://doi.org/10.1038/sdata.2018.214

Berkes, F. (1999). *Sacred ecology: Traditional ecological knowledge and management systems*. Taylor and Francis.

Berl, R. E. W., Fisk, J. J., van Eeden, L. M., Salerno, J., Fernández-Llamazares, Á., Leong, K. M., Long, J. W., Boomer, G. S., Williams, C. K., Arbieu, U., Lehnen, L., Landon, A. C., Ellis, E. C., Verschuuren, B., Larson, L. R., & Gavin, M. C. (2025). Foundational principles of an applied cultural evolutionary science for natural resource management and conservation. *Philosophical Transactions of the Royal Society, B: Biological Sciences*, *380*, 20240262. https://doi.org/10.1098/rstb.2024.0262

Bird, D. W., & O'Connell, J. F. (2006). Behavioral ecology and archaeology. *Journal of Archaeological Research*, *14*(2), 143–188. https://doi.org/10.1007/s10814-006-9003-6

Borelli, T., Hunter, D., Powell, B., Ulian, T., Mattana, E., Termote, C., Pawera, L., Beltrame, D., Penafiel, D., Tan, A., Taylor, M., & Engels, J. (2020). Born to eat wild: An integrated conservation approach to secure wild food plants for food security and nutrition. *Plants*, *9*(10), 1299. https://doi.org/10.3390/plants9101299

Boyd, R., & Richerson, P. J. (2005). *The origin and evolution of cultures*. Oxford University Press.

Boyd, R., & Richerson, P. J. (2024). Cultural evolution: Where we have been and where we are going (maybe). *Proceedings of the National Academy of Sciences of the United States of America*, *121*(48), e2322879121. https://doi.org/10.1073/pnas.2322879121

Chang, J. S. (2017). The docent method: A grounded theory approach for researching place and health. *Qualitative Health Research*, *27*(4), 609–619. https://doi.org/10.1177/1049732316667055

Chao, O., Li, X., & Reyes-García, V. (2025). Exploring the dynamic functions of pastoral traditional knowledge. *Ambio*, *54*, 932–946. https://doi.org/10.1007/s13280-025-02131-x

Cho, M. A., Mutanga, O., & Mabhaudhi, T. (2025). Adaptation to climate change in pastoral communities: A systematic review through a social-ecological lens. *International Journal of Climate Change Strategies and Management*, *17*(1), 248–269. https://doi.org/10.1108/IJCCSM-10-2023-0126

Cottrell, R. S., Nash, K. L., Halpern, B. S., Remenyi, T. A., Corney, S. P., Fleming, A., Fulton, E. A., Hornborg, S., Johne, A., Watson, R. A., & Blanchard, J. L. (2019). Food production shocks across land and sea. *Nature Sustainability*, *2*, 130–137. https://doi.org/10.1038/s41893-018-0210-1

de Jode, H. (2010). The obstacles to mobility. In H. de Jode (Ed.), *Modern and mobile: The future of livestock production in Africa's drylands* (pp. 35–47). IIED & SOS Sahel.

De Meyer, E., Ceuterick, M., Vanhove, W., Heytens, J., Mimbu, J. E., Van Damme, P., & de la Peña, E. (2025). Medicinal plant use and diversity in the urban area of Idiofa, Democratic Republic of Congo. *Journal of Ethnobiology*, *45*(1), 38–50. https://doi.org/10.1177/02780771241303900

De Meyer, E., Emaruk, E., Omeri, S., Leese, A., Lorika N, C., Achilla, T., Lomele, V., & Bussmann, R. W. (2026). Wild plant species with newly emerged uses in Karamoja, Uganda [data set]. Zenodo. https://doi.org/10.5281/zenodo.20824256

Dutta, T., Anand, U., Chatterjee Saha, S., Mane, A. B., Prasanth, D. A., Kandimalla, R., Proćków, J., & Dey, A. (2021). Advancing urban ethnopharmacology: A modern concept of sustainability, conservation and cross-cultural adaptations of medicinal plant lore in the urban environment. *Conservation Physiology*, *9*(1), coab073. https://doi.org/10.1093/conphys/coab073

Eberhard, D. M., Simons, G. F., & Fennig, C. D. (Eds.). (2025). *Ethnologue: Languages of the world* (28th ed.). SIL International. https://www.ethnologue.com

Ekesa, B., Fongar-Tiralla, A., & Nasser, M. (2022). Access to and utilization of wild species for food and nutrition security in Teso and Acholi sub-regions of Uganda. *Frontiers in Sustainable Food Systems*, *6*, 836212. https://doi.org/10.3389/fsufs.2022.836212

Eriksen, S., & Silva, J. A. (2009). The vulnerability context of a savanna area in Mozambique: Household drought coping strategies and responses to economic change. *Environmental Science & Policy*, *12*(1), 33–52. https://doi.org/10.1016/j.envsci.2008.10.007

FAO. (2018). Pastoralism in Africa's drylands. Rome. 52 pp. Licence: CC BY-NC-SA 3.0 IGO.

FAO. (2021a). *Pastoralism: Making variability work (FAO Animal Production and Health Paper No. 185)*. FAO. https://doi.org/10.4060/cb5855en

FAO. (2021b). *Indigenous peoples' food systems: Insights on sustainability and resilience from the front line of climate change*. FAO. https://doi.org/10.4060/cb5131en

Flintan, F. (2011). Changing nature of gender roles in the drylands of the horn and East Africa: Implications for DRR programming. Oxfam Regional Learning and Advocacy Programme for Vulnerable Dryland Communities (REGLAP).

Franco, F. M., & Suhaimi, A. (2022). Folk plant names are condensed forms of traditional knowledge: Case study with the Urang Kanekes of Banten, Indonesia. In F. M. Franco, M. Knudsen, & N. H. Hassan (Eds.), *Case studies in biocultural diversity from Southeast Asia (Asia in transition, Vol. 19)*. Springer. https://doi.org/10.1007/978-981-16-6719-0_7

Galvin, K. A., Reid, R. S., Behnke, R. H., & Hobbs, N. T. (Eds.). (2008). *Fragmentation of semi-arid and arid landscapes: Consequences for human and natural systems* (pp. 1–24). Springer.

Glowacki, L., & Molleman, L. (2017). Subsistence styles shape human social learning strategies. *Nature Human Behavior*, *1*, 98. https://doi.org/10.1038/s41562-017-0098

Gómez-Baggethun, E. (2022). Is there a future for indigenous and local knowledge? *The Journal of Peasant Studies*, *49*(6), 1139–1157. https://doi.org/10.1080/03066150.2021.1926994

Gradé, J. T., Tabuti, J. R. S., & Van Damme, P. (2009a). Ethnoveterinary knowledge in pastoral Karamoja, Uganda. *Journal of Ethnopharmacology*, *122*(2), 273–293. https://doi.org/10.1016/j.jep.2009.01.005

Gradé, J. T., Tabuti, J. R. S., & Van Damme, P. (2009b). Four footed pharmacists: Indications of self medicating livestock in Karamoja, Uganda. *Economic Botany*, *63*(1), 29–42. https://doi.org/10.1007/s12231-008-9058-z

Gray, S., Sundal, M., Wiebusch, B., Little, M. A., Leslie, P. W., & Pike, I. L. (2003). Cattle raiding, cultural survival, and adaptability of east African pastoralists. *Current Anthropology*, *44*(S5), S3–S30. https://doi.org/10.1086/377669

Gray, S., & Sundal, M. B. (2017). "Milk has gone": Dietary change and human adaptability in Karamoja, Uganda. *American Anthropologist*, *119*(4), 681–695. https://doi.org/10.1111/aman.12949

Greene, A. M., Teixidor-Toneu, I., & Odonne, G. (2023). To pick or not to pick: Photographic voucher specimens as an alternative method to botanical collecting in ethnobotany. *Journal of Ethnobiology*, *43*(1), 44–56. https://doi.org/10.1177/02780771231162190

Hodgson, D. L. (Ed.). (2001). *Rethinking pastoralism in Africa: Gender, culture and the myth of the patriarchal pastoralist*. Ohio University Press.

Houdet, J., Muloopa, H., Ochieng, C., Kutegeka, S., & Nakangu, B. (2014). *Cost benefit analysis of the mining sector in Karamoja, Uganda* (p. 82). IUCN Uganda Country office.

Ingold, T. (2000). *The perception of the environment: Essays on livelihood, dwelling and skill*. Routledge.

International Fund for Agricultural Development (IFAD). (2020). *How to do: Gender and pastoralism pastoral development*. IFAD.

International Society of Ethnobiology (ISE). (2006). Code of ethics. https://www.ethnobiology.net/what-we-do/core-programs/ise-ethics-program/code-of-ethics/

IPBES. (2019). In E. S. Brondizio, J. Settele, S. Díaz, & H. T. Ngo (Eds.), *Global assessment report on biodiversity and ecosystem services of the intergovernmental science-policy platform on biodiversity and ecosystem services*. IPBES Secretariat. https://doi.org/10.5281/zenodo.3831673

Khazanov, A. M. (2013). Contemporary pastoralism: Old problems, new challenges. In T. Sternberg & D. Chatty (Eds.), *Modern pastoralism and conservation: Old problems, new challenges* (pp. 5–23). White Horse Press.

Kinney, P. (2021). Walking interviews: A novel way of ensuring the voices of vulnerable populations are included in research. In M. Borcsa & C. Willig (Eds.), *Qualitative research methods in mental health* (pp. 65–82). Springer. https://doi.org/10.1007/978-3-030-65331-6_4

Krätli, S., Huelsebusch, C., Brooks, S., & Kaufmann, B. (2013). Pastoralism: A critical asset for food security under global climate change. *Animal Frontiers*, *3*(1), 42–50. https://doi.org/10.2527/af.2013-0007

Kristjanson, P., Waters-Bayer, A., Johnson, N., Tipilda, A., Njuki, J., Baltenweck, I., Grace, D., & Macmilan, D. (2010). Livestock and Women's livelihoods: A review of the recent evidence. Discussion Paper No. 20. Nairobi, Kenya. ILRI.

Kuhnlein, H. V., Erasmus, B., & Spigelski, D. (2009). *Indigenous peoples' food systems*. FAO. http://www.fao.org/3/a-i0370e.pdf

Levine, S. (2010). An unromantic look at pastoralism in Karamoja: How hard hearted economics shows that pastoral systems remain the solution, and not the problem. *Nomadic Peoples*, *14*(2), 147–153.

Lulekal, E., Asfaw, Z., Kelbessa, E., & Van Damme, P. (2011). Wild edible plants in Ethiopia: A review on their potential to combat food insecurity. *Afrika Focus*, *24*(2), 71–122. https://doi.org/10.1163/2031356X-02402006

Manzano, P. (2015). Pastoralist ownership of rural transformation: The adequate path to change. *Development*, *58*, 326–332. https://doi.org/10.1057/s41301-016-0012-6

Manzano, P. (2017). Development interventions on pastoralist areas: A new decision matrix to identify win win situations and no go zones. *The Solutions Journal*, *9*(3).

Manzano, P., Azcarate, F. M., Bencherif, S., Burgas, D., Byambaa, B., Cabeza, M., Cadahía, L., Chatty, D., Eronen, J. T., Galvin, K. A., & Herrera, P. M. (2023). Grazing research should consider mobility and governance. *Science (eLetter)*, *378*(6622). https://www.science.org/doi/10.1126/science.abq4062

Manzano, P., Burgas, D., Cadahía, L., Eronen, J. T., Fernández-Llamazares, Á., Bencherif, S., Holand, Ø., Seitsonen, O., Byambaa, B., Fortelius, M., Fernández-Giménez, M. E., Galvin, K. A., Cabeza, M., & Stenseth, N. C. (2021). Toward a holistic understanding of pastoralism. *One Earth*, *4*(5), 651–665. https://doi.org/10.1016/j.oneear.2021.04.012

Marks, D., Bayrak, M. M., Jahangir, S., Henig, D., & Bailey, A. (2022). Towards a cultural lens for adaptation pathways to climate change. *Regional Environmental Change*, *22*, 22. https://doi.org/10.1007/s10113-022-01884-5

McCaffree, K. (2022). *Cultural evolution: The empirical and theoretical landscape*. Routledge. https://doi.org/10.4324/9781003221289

Meise Botanic Garden. (2025). The flora of Central Africa. https://www.floredafriquecentrale.be/#/en/home

Mesoudi, A., & Thornton, A. (2018). What is cumulative cultural evolution? *Proceedings of the Royal Society B*, *285*(1880), 20180712. https://doi.org/10.1098/rspb.2018.0712

Mubiru, D. N. (2010). *Climate change and adaptation options in Karamoja*. Food and Agriculture Organization of the United Nations. https://nru.uncst.go.ug/server/api/core/bitstreams/9be0585d-15ec-4dda-a089-a1dc76e1b2a4/content

Muggaga, C., Okello-Uma, I., Kaaya, A. N., Taylor, D., Ongeng, D., & Basil, M. (2023). Dietary intake and socio-economic predictors of inadequate energy and nutrient intake among women of childbearing age in Karamoja sub-region of Uganda. *Journal of Health, Population and Nutrition*, *42*, 12. https://doi.org/10.1186/s41043-023-00351-z

MWE. (2019). *Uganda's first Biennal update report to the United Nations framework convention on climate change*. Ministry of Water and Environment.

Nakalembe, C., Dempewolf, J., & Justice, C. (2017). Agricultural land use change in Karamoja region, Uganda. *Land Use Policy*, *62*, 2–12. https://doi.org/10.1016/j.landusepol.2016.11.029

Nori, M., & Scoones, I. (2019). Pastoralism, uncertainty and resilience: Global lessons from the margins. *Pastoralism*, *9*, 10. https://doi.org/10.1186/s13570-019-0146-8

O'Brien, K., Quinlan, T., & Ziervogel, G. (2009). Vulnerability interventions in the context of multiple stressors: Lessons from the southern Africa vulnerability initiative (SAVI). *Environmental Science & Policy*, *12*(1), 23–32. https://doi.org/10.1016/j.envsci.2008.10.008

Oduor, F., Kaindi, D. M., Abong, G., Thuita, F., & Termote, C. (2025). Community-based conservation strategies for wild edible plants in Turkana County, Kenya. *Conservation*, *5*(1), 1. https://doi.org/10.3390/conservation5010001

Oduor, F., Keding, G., Kaindi, D. M., Abong, G., Thuita, F., & Termote, C. (2024). Quantifying Turkana's wild edible plants' contribution to critical micronutrient and dietary diversity among women of reproductive age. *CyTA Journal of Food*, *22*(1), 2413949. https://doi.org/10.1080/19476337.2024.2413949

Ojelel, S., Mucunguzi, P., Katuura, E., Kakudidi, E. K., Namaganda, M., & Kalema, J. (2019). Wild edible plants used by communities in and around selected forest reserves of Teso-Karamoja region, Uganda.

Journal of Ethnobiology and Ethnomedicine, *15*(1), 3. https://doi.org/10.1186/s13002-018-0278-8

Olum, S., Okello-Uma, I., Tumuhimbise, G. A., Taylor, D., & Ongeng, D. (2017). The relationship between cultural norms and food security in the Karamoja sub-region of Uganda. *Journal of Food and Nutrition Research*, *5*(6), 427–435. https://doi.org/10.12691/jfnr-5-6-10

Paniagua Zambrana, N. Y., Bussmann, R. W., Hart, R. E., Moya Huanca, A. L., Ortiz Soria, G., Ortiz Vaca, M., Ortiz Álvarez, D., Soria Morán, J., Soria Morán, M., Chávez, S., Chávez Moreno, B., Chávez Moreno, G., Roca, O., & Siripi, E. (2018). To list or not to list? The value and detriment of freelisting in ethnobotanical studies. *Nature Plants*, *4*, 201–204. https://doi.org/10.1038/s41477-018-0128-7

Pironon, S., Ondo, I., Diazgranados, M., Allkin, R., Baquero, A. C., Cámara-Leret, R., Canteiro, C., Dennehy-Carr, Z., Govaerts, R., Hargreaves, S., Hudson, A. J., Lemmens, R., Milliken, W., Nesbitt, M., Patmore, K., Schmelzer, G., Turner, R. M., Van Andel, T. R., Ulian, T., … Willis, K. J. (2024). The global distribution of plants used by humans. *Science*, *383*(6680), 293–297. https://doi.org/10.1126/science.adg8028

POWO. (2025). Plants of the world online. Facilitated by the Royal Botanic Gardens, Kew. https://powo.science.kew.org/cite-us

Prakofjewa, J., Sartori, M., Šarka, P., Kalle, R., Pieroni, A., & Sõukand, R. (2024). Knowledge in motion: Temporal dynamics of wild food plant use in the polish Lithuanian Belarusian border region. *Journal of Ethnobiology and Ethnomedicine*, *20*, 65. https://doi.org/10.1186/s13002-024-00706-8

Priyadarshini, S., Tudu, S., Dash, S. S., Biswal, A. K., & Sahu, S. C. (2024). Wild edible plants: Diversity, use pattern and livelihood linkage in eastern India. *Genetic Resources and Crop Evolution*, *71*, 3111–3133. https://doi.org/10.1007/s10722-023-01833-z

Reyes-García, V., Paneque-Gálvez, J., Luz, A. C., Gueze, M., Macía, M. J., Orta-Martínez, M., & Pino, J. (2014). Cultural change and traditional ecological knowledge: An empirical analysis from the Tsimane' in the Bolivian Amazon. *Human Organization*, *73*(2), 162–173. https://doi.org/10.17730/humo.73.2.31nl363qgr30n017

RStudio Team. (2020). RStudio 4.1.1.: Integrated Development for R. In RStudio, PBC. http://www.rstudio.com/

Sharifian, A., Fernández-Llamazares, Á., Wario, H. T., Molnár, Z., & Cabeza, M. (2022). Dynamics of pastoral traditional ecological knowledge: A global state-of-the-art review. *Ecology and Society*, *27*(1), 14. https://doi.org/10.5751/ES-12918-270114

Termote, C., Van Damme, P., & Dhed'a Djailo, B. (2011). Eating from the wild: Turumbu, Mbole and Bali traditional knowledge on non-cultivated edible plants, district Tshopo, DRCongo. *Genetic Resources and Crop Evolution*, *58*, 585–618. https://doi.org/10.1007/s10722-010-9602-4

Thomas, E., Vandebroek, I., & Van Damme, P. (2007). What works in the field? A comparison of different interviewing methods in ethnobotany with special reference to the use of photographs. *Economic Botany*, *61*(4), 376–384. https://doi.org/10.1663/0013-0001(2007)61[376:WWITFA]2.0.CO;2

Truskanov, N., & Prat, Y. (2018). Cultural transmission in an ever-changing world: Trial-and-error copying may be more robust than precise imitation. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *373*(1743), 20170050. https://doi.org/10.1098/rstb.2017.0050

Twinomuhangi, R., Sseviiri, H., & Kato, A. M. (2023). Contextualising environmental and climate change migration in Uganda. *Local Environment*, *28*(5), 580–601. https://doi.org/10.1080/13549839.2023.2165641

Uganda National Council for Science and Technology (UNCST). (2025). National guidelines for research involving humans as research participants.

Van Asseldonk, D. (2026). Constructing cohesion, countering conflict: Pastoralist foodways in Moroto District, Karamoja. *Nomadic Peoples*, 1–22. Advance online publication. https://doi.org/10.3828/whpnp.63904085203754

Winterhalder, B., & Smith, E. A. (2000). Analyzing adaptive strategies: Human behavioral ecology at twenty-five. *Evolutionary Anthropology: Issues, News, and Reviews*, *9*(2), 51–72. https://doi.org/10.1002/(SICI)1520-6505(2000)9:2<51::AID-EVAN1>3.0.CO;2-7

World Food Programme. (2015). *Resilience context analysis: Resilience to food insecurity and malnutrition in Karamoja, Uganda* (April 2015). https://reliefweb.int/report/uganda/resilience-context-analysis-resilience-food-insecurity-and-malnutrition-karamoja

Zant, M., Schlingmann, A., Reyes-García, V., & García-del-Amo, D. (2023). Incremental and transformational adaptation to climate change among indigenous peoples and local communities: A global review. *Mitigation and Adaptation Strategies for Global Change*, *28*, 57. https://doi.org/10.1007/s11027-023-10095-0

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Data S1. Focus group discussion and interview guides.

Data S2. Plant list.

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