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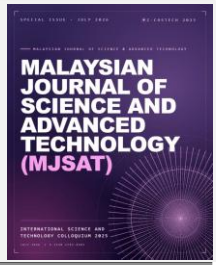

An Assessment of Vascular Plant Species in Five Elephant Movement Corridors in Jeli, Kelantan, with Observations on Plant Availability and Utilisation by Asian Elephants (*Elephas maximus*)

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ABSTRACT

A field survey was conducted in the Jeli District of Kelantan to assess vascular plant species composition and examine plant availability and utilisation by Asian elephants (*Elephas maximus*) within identified movement corridors associated with human-elephant conflict (HEC). The study focused on five sites with the highest reported incidences of HEC: Batu Melintang, Kalai, Lata Janggut, Sungai Rual, and Kampung Jabir. Vegetation sampling was conducted along transects near forest edges and agricultural interfaces to document plant diversity and identify species consumed by elephants. A total of 135 vascular plant species representing 47 botanical families were recorded. Among these, 12 species from nine families were confirmed as part of the elephants' diet. These comprised native pioneer species (e.g., *Macaranga bancana*, *Melastoma malabathricum*, *Ficus variegata*), introduced or potentially invasive species (e.g., *Chromolaena odorata*, *Lantana camara*), and cultivated crops (*Manihot esculenta* and *Musa acuminata*). Most utilised species were associated with disturbed habitats, forest margins, and plantation boundaries. The findings indicate that elephants exploit ecotonal zones that provide a combination of native, introduced, and cultivated food resources, which may increase their movement into agricultural landscapes and contribute to recurring HEC. As this study represents a one-time field assessment, the document dietary composition reflects a temporal snapshot and may expand with longer-term observation. These results underscore the importance of vegetation management, habitat restoration, and strategic land-use planning in elephant corridors to support conservation objectives while mitigating HEC and safeguarding local livelihoods.

1. INTRODUCTION

Human-wildlife conflict arises when humans and wildlife share the same area and compete for limited resources, resulting in negative interactions or costs to one or both parties [1]. Such conflicts increase with rising human population, land-use changes, forest degradation, and habitat fragmentation [2]. When no negative interaction or cost occurs, coexistence rather than conflict is present. Common human-wildlife conflict incidents globally include crop raiding, property damage, livestock depredation (more commonly associated with large carnivores), and, less frequently but most controversially, human fatalities [3]. In the case of elephants, conflict primarily involves crop damage and property destruction (e.g., fences, storage facilities, and infrastructure) rather than livestock predation. Elephants are often driven into human-dominated landscapes in search of food, water, and minerals [4].

Human-elephant conflict (HEC) is a growing concern across the 13 Asian elephant range countries, including India, Sri Lanka, Bhutan, Bangladesh, Nepal, Indonesia, Malaysia, Vietnam, and Cambodia [5]. Elephants frequently enter agricultural landscapes to feed on cultivated crops, damaging plantations, food stores, water facilities, and infrastructure, and occasionally causing human injuries or deaths [6]. These interactions generate fear among communities and pose serious threats to rural livelihoods and elephant conservation [7].

In Peninsular Malaysia, there are seven states namely Perak, Kelantan, Terengganu, Pahang, Johor, Negeri Sembilan, and Kedah with Asian elephants and among these, five key states which are Perak, Kelantan, Terengganu, Pahang, and Johor record the highest frequency of HEC incidents especially at villages and small-scale oil palm plantations level. Between 2001 and 2007, the five key states experienced an annual increase of 8% to 22% in reported HEC incidents [8]. More recent national reports continue to indicate persistent HEC trends, particularly in forest-agriculture interface zones, although the magnitude varies annually. Although reports declined in 2010 and 2011, financial losses between 2005 and 2010 were still substantial, totalling approximately RM18.8 million [9].

The Jeli District in Kelantan is one of the areas experiencing serious HEC [10]. According to PERHILITAN records (Jeli District), from 2017 to 2021, 496 HEC-related complaints were recorded, peaking at 205 cases in 2021. During this period, local farmers, primarily small-scale agriculturists, suffered losses amounting to RM1,050,670, with over half (RM523,300) recorded in 2021 alone. The high conflict rate in Jeli is largely attributed to habitat fragmentation driven by agricultural expansion, human settlements, and disruption of traditional elephant migration routes. The cultivation of rubber tree clones also adds pressure on elephant habitats. As forest areas shrink and become increasingly fragmented, elephants move through ecotonal zones between forest and farmland, leading to crop damage and property intrusion [10,11].

For conceptual clarity, native plant species refer to species that occur naturally within the local ecosystem; introduced species are those brought intentionally or unintentionally outside their natural range and may become invasive if they spread aggressively and outcompete native flora; cultivated species are intentionally planted crops or managed plants within agricultural landscapes.

Understanding the availability of these plant categories within elephant corridors is important, as elephants may utilise a mix of native pioneer species, introduced or weedy species, and cultivated crops.

In response to this issue, this study focuses on understanding the ecological dimensions of HEC in the Jeli District by examining vegetation composition within identified elephant movement corridors. Specifically, the objectives of this study are: i) to identify vascular plant species that serve as food sources for elephants along designated transects within the elephant corridor in Jeli, Kelantan; ii) to determine the diameter at breast height (DBH) and height class of vascular plant species consumed by elephants within the same transects; and iii) to document the overall diversity of vascular plant species present in the elephant corridor area.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in the Jeli District, Kelantan, Peninsular Malaysia, within identified elephant movement corridors and areas with recurring human-elephant conflict (HEC). Five sites were selected based on official HEC records provided by the PERHILITAN. These sites represent areas with the highest recorded HEC incidents in the district and include Batu Melintang, Kalai, Lata Janggut, Sungai Rual, and Kampung Jabir (Figure 1).

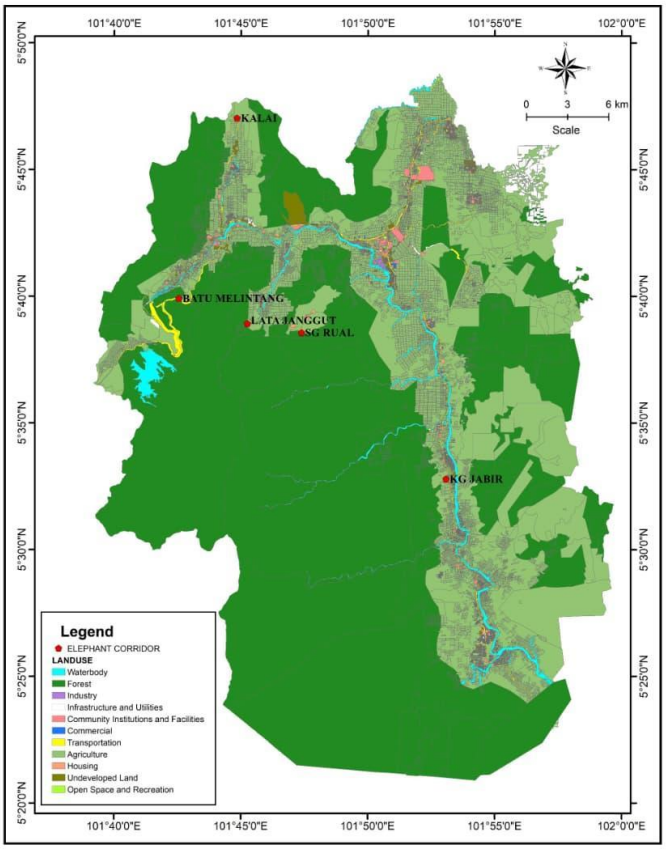

Fig. 1. Map showing the location of all study transects within the elephant corridor in Jeli District, Kelantan.

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The selected sites represent different land-use types located along forest-agriculture interfaces. Batu Melintang consists mainly of secondary forest adjacent to mixed smallholder agriculture. Kalai is characterised by banana and rubber plantations bordering forest edges. Lata Janggut includes secondary forest areas with an electric fence demarcating agricultural land. Sungai Rual comprises mixed agricultural plots and disturbed vegetation. Kampung Jabir consists of rubber plantations, durian orchards, and surrounding secondary forest. The variation in land-use composition among sites allows comparison of vegetation availability across different habitat types within elephant corridors.

2.2 Determination of Transect Line Length

The length of the straight line transects used in this study ranged from 100 to 800 meters, depending on the existing vegetation and evidence of elephant browsing. In Batu Melintang, a 300 m transect was established following visible elephant trails and browsing signs. In Kalai, a 150 m transect was surveyed within a banana plantation severely damaged by elephants. In Lata Janggut, an 800 m transect was established extending towards the electric fence boundary based on PERHILITAN recommendations (pers. comm., Mohd Khairi bin Mohamad on 4th January 2024), although only old signs of elephant activity were observed near the end of the transect. In Sungai Rual, a 150 m transect was surveyed within mixed agricultural areas despite the absence of recent browsing signs. In Kampung Jabir, a 300 m transect was established to document plant species within rubber and durian plantations and adjacent secondary forest.

All transects were georeferenced using handheld GPS units, and spatial descriptions are provided using cardinal directions (North, South, East, West) to ensure clarity.

2.3 Analysis of Vascular Plant Species

Direct field observations were conducted to identify vascular plant species available within each transect and to document species consumed by elephants. Evidence of utilisation included browsing marks, stem breakage, bark stripping, and feeding traces. For intact woody plants, Diameter at Breast Height (DBH) was measured at 1.3 m above ground level. For browsed or broken stems, diameter at the breakage point was measured to reflect the size class selected by elephants. Tree height class was estimated using visual assessment and, where feasible, direct measurement. All vascular plant species within the transect boundaries were recorded. Specimens were collected for species that could not be confidently identified in situ. Voucher specimens included complete parts (leaves, branches, flowers, and fruits when available). A pole cutter was used to collect samples from taller individuals, and secateurs were used for lower vegetation.

Fresh specimens were preserved in 70% alcohol and transported to the laboratory for processing. Specimens were pressed between newspaper sheets, stacked, and oven-dried at 60 °C for one week. Dried specimens were mounted on herbarium sheets and deposited at the Herbarium of Universiti Kebangsaan Malaysia (UKMB) for reference. Voucher specimens were identified to genus and species level using standard taxonomic references, including *Flora of the Malay Peninsula* [12,13,14,15,16], *Foresters' Manual of Dipterocarps* [17], *Wayside Trees of Malaya* [18], *Tree Flora of Malaya* [19,20,21,22], *Flora of Peninsular Malaysia* [23,24,25,26,27,28,29,30], and [31]. Specimens were also compared with reference collections at UKMB and the Herbarium of the Forest Research Institute Malaysia (KEP). The taxonomic nomenclature used in this study is also based on the most recent updates from the Plants of the World Online [32].

3. RESULT AND DISCUSSION

3.1 Vascular Plant Species Utilised by Elephants

A total of 135 vascular plant species representing 47 families were recorded across the five elephant corridor transects in Jeli District, Kelantan. Of these, 12 species from nine families showed clear evidence of utilisation by Asian elephants during the survey period (Table 1). It is important to note that this study represents a one-time field assessment, and active feeding signs were detected in only two transects (Batu Melintang and Kalai) at the time of sampling. Therefore, the documented food plants reflect a temporal snapshot rather than a comprehensive representation of elephant diet in the area. Longer-term monitoring or repeated seasonal surveys would likely yield a broader list of utilised species.

Table 1. Complete list of vascular plant species recorded in the five elephant corridor transects in Jeli District, Kelantan. Elephant food sources are marked with *

Species	Family	BM	K	LJ	SR	KJ
Acacia mangium	Fabaceae	X				
Adinobotrys atropurpureus	Fabaceae				X	
Ageratum conyzoides	Asteraceae					X
Alpinia javanica	Zingiberaceae	X				
Alstonia angustiloba	Apocynaceae	X				
Amorphophallus sp.	Araceae					X
Aporosa aurea	Phyllanthaceae	X				
Archidendron jiringa	Fabaceae					X
Argyreia sp.	Convolvulaceae			X		X
Artabotrys suaveolens	Annonaceae					X
Artocarpus elasticus	Moraceae	X		X		X
Artocarpus heterophyllus	Moraceae					X
Artocarpus rigidus	Moraceae	X				
Artocarpus scortechinii	Moraceae			X		
Asystasia gangetica	Acanthaceae	X		X		X
Baccaurea motleyana	Phyllanthaceae					X
Balakata baccata	Euphorbiaceae			X		
Barringtonia sp.	Lecythidaceae			X		X
Blechnum finlaysonianum	Aspleniaceae	X		X	X	
**Bridelia insulana*	Phyllanthaceae	X				
Bridelia tomentosa	Phyllanthaceae	X		X		X
Callicarpa tomentosa	Lamiaceae	X		X		X
Causonis japonica	Vitaceae	X		X		
**Chromolaena odorata*	Asteraceae	X	X	X	X	X
Cissus hastata Miq.	Vitaceae	X				
**Clerodendrum villosum*	Lamiaceae	X				X
Codiaeum variegatum	Euphorbiaceae					X
Colocasia esculenta	Araceae			X		
Commersonia bartramia	Malvaceae				X	
Croton argyratus	Euphorbiaceae					X
Croton caudatus	Euphorbiaceae					X
Dasymaschalon dasymaschalum	Annonaceae	X				

Desmodium sp.	Fabaceae			X		
Dicranopteris linearis	Gleicheniaceae	X			X	
Dillenia grandifolia	Dilleniaceae					X
Dillenia sumatrana	Dilleniaceae		X			
Dissochaeta gracilis	Melastomataceae	X				
Donax canniformis	Marantaceae	X				X
Duabanga grandiflora	Lythraceae	X		X		
Durio zibethinus	Malvaceae		X	X		X
Elaeis guineensis	Arecaceae				X	
Elaeocarpus stipularis	Elaeocarpaceae	X				
Eleusine indica	Poaceae			X		X
Embelia rugosa	Primulaceae	X				
Endospermum diadenum	Euphorbiaceae			X		
Entada spiralis	Fabaceae		X	X		
**Etlingera* sp.	Zingiberaceae	X		X	X	X
Eurya acuminata	Pentaphylacaceae	X				
Ficus aurata	Moraceae				X	
Ficus auriculata	Moraceae					X
Ficus fistulosa	Moraceae			X	X	
Ficus globosa	Moraceae	X				
Ficus hispida	Moraceae	X	X	X		X
Ficus obscura	Moraceae	X		X		
**Ficus variegata*	Moraceae		X	X		
Fimbristylis sp.	Cyperaceae					X
Glochidion glomerulatum	Phyllanthaceae	X		X		
Glochidion obscurum	Phyllanthaceae	X	X	X		X
Glochidion sp.	Phyllanthaceae	X				X
Grewia laevigata	Malvaceae	X				
Hedyotis sp.	Rubiaceae			X	X	X
Hellenia speciosa	Costaceae	X		X		X
Hevea brasiliensis	Euphorbiaceae			X		X
Hodgsonia macrocarpa	Cucurbitaceae			X		X
Hyptis capitata	Lamiaceae			X		
Ixora sp.	Rubiaceae					X
Lansium domesticum	Meliaceae			X		X
**Lantana camara*	Verbenaceae	X		X		X
Leea indica	Vitaceae	X				X
Litsea sp.	Lauraceae	X				
Litsea umbellata	Lauraceae					X
**Macaranga bancana*	Euphorbiaceae	X		X	X	X
Macaranga denticulata	Euphorbiaceae			X		X
Macaranga gigantea	Euphorbiaceae	X	X		X	X
Macaranga hosei	Euphorbiaceae			X		
**Macaranga hullettii*	Euphorbiaceae	X				
Macaranga hypoleuca	Euphorbiaceae	X				
Macaranga laciniata	Euphorbiaceae	X		X	X	
Macaranga recurvata	Euphorbiaceae	X				
**Macaranga tanarius*	Euphorbiaceae	X	X	X	X	X
Maesa ramentacea	Primulaceae	X		X	X	
Mallotus macrostachyus	Euphorbiaceae			X	X	X
Mangifera foetida	Anacardiaceae					X
Mangifera indica	Anacardiaceae		X			
**Manihot esculenta*	Euphorbiaceae		X			
**Melastoma malabathricum*	Melastomataceae	X	X	X	X	X
Melochia corchorifolia	Malvaceae	X				
Miconia crenata	Melastomataceae	X	X			X
Micromelum minutum	Rutaceae	X				
Mikania cordata	Asteraceae			X		
Millettia sericea	Fabaceae					X
Mimosa pigra	Fabaceae			X	X	
Mimosa pudica	Fabaceae		X			
Mischocarpus pentapetalus	Sapindaceae					X
Monocarpia maingayi	Annonaceae	X				
Musa sp.	Musaceae			X		
**Musa acuminata*	Musaceae		X			
Neolamarckia cadamba	Rubiaceae			X		
Nephelium lappaceum	Sapindaceae					X
Neuropeltis maingayi	Convolvulaceae	X				
Pandanus sp.	Pandanaceae	X				
Parkia speciosa	Fabaceae		X			
Pericampylus glaucus	Menispermaceae	X				
Phyllanthus niruri	Phyllanthaceae					X
Poikilospermum scortechinii	Urticaceae	X				
Polyscias diversifolia	Araliaceae				X	
Pterocymbium tinctorium	Malvaceae	X				X
Rubroshorea leprosula	Dipterocarpaceae			X		
Rubroshorea parvifolia	Dipterocarpaceae	X				
Salacca zalacca	Arecaceae					X
Saraca declinata	Fabaceae		X	X		
Saraca indica	Fabaceae			X		
Saurauia pentapetala	Actinidiaceae	X				
Schizostachyum grande	Poaceae			X	X	X
Scleria sp.	Cyperaceae				X	
Scleria sumatrensis	Cyperaceae					X
Selaginella willdenowii	Selaginellaceae					X
Smilax calophylla	Smilacaceae		X			X
Smilax setosa	Smilacaceae	X				
Smilax sp.	Smilacaceae	X				
Spatholobus ferrugineus	Fabaceae	X			X	X
Stachytarpheta jamaicensis	Verbenaceae			X		X
Tetracera scandens	Dilleniaceae					X
Tetrastigma leucostaphylum	Vitaceae	X				
Tetrastigma sp.	Vitaceae	X		X		X
Thelypteris sp.	Aspleniaceae	X				
Themeda villosa	Poaceae			X	X	
Thysanolaena latifolia	Poaceae			X	X	
Trema tomentosum	Cannabaceae			X	X	
Trevesia burckii	Araliaceae					X
Uncaria sp.	Rubiaceae	X				
Urena lobata	Malvaceae	X		X		X
Vitex gamosepala	Lamiaceae	X				
Vitex pinnata	Lamiaceae	X				X
Xanthophyllum griffithii	Polygalaceae	X				

Note: BM = Batu Melintang; K = Kalai; LJ = Lata Janggut; SR = Sungai Rual; KJ = Kampung Jabir

The ten naturally occurring species recorded with feeding signs were *Bridelia insulana*, *Chromolaena odorata*, *Clerodendrum villosum*, *Etlingera* sp., *Ficus variegata*, *Lantana camara*, *Macaranga bancana*, *M. hullettii*, *M. tanarius*, and *Melastoma malabathricum*. The remaining two species, *Manihot esculenta* (cassava) and *Musa acuminata* (banana), were cultivated crops found in agricultural plots adjacent to forest edges.

Evidence of elephant utilisation was determined based on characteristic feeding signs, including stem breakage consistent with trunk pulling, bark stripping, uprooting, large bite marks,

presence of elephant footprints, dung, and established elephant trails. Differentiation from tapir browsing was based on breakage height and stem damage pattern. Elephant feeding signs typically involved breakage at heights exceeding 1 m, twisting or snapping of stems with substantial force, and associated large footprints and dung piles. In contrast, tapir browsing is generally lower (<1 m), involves cleaner cuts, and lacks associated large trampling signs. Only feeding signs consistent with elephant activity and accompanied by elephant tracks or dung were classified as elephant utilisation.

In Batu Melintang, which recorded the highest number of feeding signs, *Macaranga tanarius* showed the greatest frequency of browsing. Two individuals located on the northern side of the transect near the East-West Highway were broken at heights of 1.0 m and 1.7 m, with stem diameters of 4.9 cm and 3.7 cm measured at the breakage point. Three additional individuals of similar diameter (approximately 3.0 cm) showed no signs of utilisation, suggesting selective feeding rather than random damage. Other *Macaranga* species, including *M. bancana* and *M. hullettii*, also exhibited browsing signs. Stem diameters of utilised individuals ranged between 1.0 cm and 3.0 cm (measured at the breakage point), indicating preference for small to medium-sized pioneer trees.

For *Ficus variegata* in Kalai, two individuals were recorded with stem diameters of 1.6 cm and 2.5 cm measured at the breakage point at heights of 0.2 m and 0.4 m, respectively. Because measurements were taken at varying breakage heights rather than at 1.3 m above ground, these values are reported as stem diameter rather than Diameter at Breast Height (DBH). For intact woody individuals, DBH was measured at 1.3 m above ground level.

In Kalai, extensive damage was observed within the banana plantation. The plantation consisted of young to mid-maturity banana plants (approximately 8-12 months old, based on farmer information), many of which had not yet reached peak fruiting stage during the survey. The survey was conducted outside the main fruiting season, which may explain the absence of fruit consumption evidence in some orchard areas such as Kampung Jabir. The Kalai transect was located outside the electric fence boundary, facilitating elephant access.

Although *Chromolaena odorata* was present in all transects, browsing was recorded only in Kalai. Similarly, *Etlingera* sp. and *Clerodendrum villosum* were present in multiple sites but showed feeding signs only in Batu Melintang. This pattern suggests that availability alone does not determine utilisation; rather, feeding may be influenced by proximity to movement routes, disturbance level, and seasonal resource availability.

3.2 Vegetation Composition and Land Use Context

The elephant corridor transects comprised a mosaic of rubber plantations, oil palm estates, banana and durian orchards, and secondary forest. These land use types are illustrated in the updated land use map (Figure 1), which includes transect locations, forest types, agricultural areas, and corridor alignments.

Canopy height across sites ranged between 5 and 18 m. Secondary forests were typically dominated by pioneer species, particularly *Macaranga* spp., *Mallotus* spp., and *Ficus* spp., reflecting disturbed or regenerating conditions. Dense ground cover of herbaceous plants and ferns such as *Dicranopteris linearis* was common in areas with open canopy structure.

Batu Melintang, located on both the northern and southern sides of the East-West Highway, exhibited the highest species richness (66 species). The northern side consisted of gently undulating terrain, while the southern side included steeper slopes. Feeding signs were recorded primarily within secondary forest patches dominated by pioneer species.

Kalai recorded the lowest species richness (17 species), reflecting its dominance by monoculture banana cultivation. Lata Janggut and Kampung Jabir exhibited moderate to high species richness (55 and 61 species, respectively), but no recent feeding signs were recorded during the survey period. Sungai Rual, located outside the electric fence, recorded only 25 species, with vegetation dominated by *Dicranopteris linearis* and remnants of abandoned oil palm plantation.

3.3 Interpretation and Comparison with Previous Studies

The relatively low number of food plant species recorded in this study (12 species) contrasts with findings from Sungai Betis Forest Reserve, Kelantan, where 39 species from 21 families were documented as elephant food sources [33]. The discrepancy likely reflects differences in sampling duration, seasonal coverage, habitat composition, and survey intensity. Importantly, only two transects in the present study exhibited recent feeding signs, reinforcing the need for repeated surveys across wet and dry seasons to capture seasonal dietary variation.

Elephants in Jeli utilised a mixture of native pioneer species, introduced species, and cultivated crops, particularly within forest-agriculture ecotones. Pioneer genera such as *Macaranga* appear to play an important ecological role as early successional food resources. Meanwhile, cultivated species such as banana and cassava represent high-calorie food sources that may increase the attractiveness of agricultural landscapes.

The absence of feeding damage in fruit orchards at Kampung Jabir during the survey period may be attributed to the timing of sampling outside peak fruiting season. Elephant foraging behaviour is often influenced by seasonal fruit availability, rainfall patterns, and crop phenology. Extending monitoring to include both wet and dry seasons would improve understanding of temporal feeding dynamics and migration patterns.

From a management perspective, maintaining secondary forest patches within designated elephant corridors is critical. These areas provide naturally occurring forage species that may reduce reliance on agricultural crops. However, if corridor vegetation is degraded or removed, elephants may increasingly target rubber and oil palm plantations where accessible vegetation is limited but agricultural crops are abundant.

Overall, the findings highlight the importance of landscape-level vegetation management within elephant movement corridors. While this study provides baseline information on plant availability and utilisation, longer-term ecological monitoring and integration with elephant movement tracking would strengthen understanding of feeding ecology and inform more effective human-elephant conflict mitigation strategies.

4. CONCLUSION

This study assessed vascular plant diversity and documented plant species utilised by Asian elephants within five identified elephant movement corridors in the Jeli District, Kelantan, an area experiencing persistent human-elephant conflict (HEC). In relation to the first objective, a total of 135 vascular plant species representing 47 families were recorded across the five transects, reflecting considerable plant diversity within forest-agriculture interface zones. Regarding the second objective, 12 plant species were confirmed as being utilised by

elephants based on direct field evidence of browsing. These species consisted primarily of naturally occurring pioneer such as *Macaranga* spp., *Melastoma malabathricum*, and *Ficus variegata*, alongside introduced or weedy species and two cultivated crops (*Musa acuminata* and *Manihot esculenta*). In relation to the third objective, measurements of stem diameter at the breakage point indicated that elephants predominantly utilised small to medium-sized woody plants within regenerating secondary forest habitats.

However, this study represents a one-time field survey, and direct feeding signs were observed in only two of the five transects during the sampling period. The findings therefore reflect a temporal snapshot of elephant foraging activity rather than a comprehensive account of dietary breadth. The absence of browsing in certain orchard areas may also be influenced by seasonal factors, as the survey did not fully coincide with peak fruiting periods. These limitations highlight the need for long-term and seasonally replicated monitoring, ideally integrated with elephant movement tracking, to better understand temporal variations in feeding behaviour and habitat use.

Despite these constraints, the results provide important baseline ecological data. The predominance of pioneer and disturbed-habitat species among utilised plants underscores the ecological importance of maintaining secondary forest patches and scrub vegetation within designated elephant corridors. Such habitats may function as buffer foraging zones, potentially reducing elephant reliance on cultivated crops and lowering the risk of HEC. From a conservation and land use planning perspective, strategic retention and restoration of native vegetation within movement corridors, careful placement of high value crops away from corridor routes, and incorporation of vegetation management into corridor design are recommended.

Overall, this study contributes to evidence-based planning for elephant corridor management in Jeli and similar conflict prone landscapes. Strengthening ecological connectivity while integrating agricultural land use considerations will be essential for balancing elephant conservation objectives with the livelihoods of local communities.

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