

Biodiversity and Ecological Dynamics of Angiosperms in the Common Pasturelands of Mavli Block

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Abstract:

The pasturelands of Mavli Block, Udaipur, Rajasthan, are critical ecosystems supporting local livelihoods and harboring significant floristic diversity. This study investigates the ecological and biological diversity of angiosperms across five key pastureland sites—Naharmagra, Salera Kala, Bheemaal, Mavli Village, and Namri—using a nested quadrat method to assess species composition, abundance, and ecological parameters. A total of 155 plant species, including herbs, grasses, shrubs, trees, and climbers, were documented, with *Cynodon dactylon* and *Parthenium hysterophorus* identified as dominant species in Naharmagra and Mavli Village, respectively. Ecological indices, including Shannon-Weaver Diversity Index, Simpson Dominance Index, and Species Evenness, revealed moderate diversity, with Naharmagra exhibiting higher species richness and evenness compared to Mavli Village, where invasive species dominance was pronounced. The study highlights the impact of overgrazing, invasive species, and semi-arid conditions on pastureland health, emphasizing the need for integrated conservation strategies to enhance ecosystem resilience and support sustainable pastoralism in the region.

Keywords: Angiosperm diversity, Pastureland ecology, Mavli Block, Invasive species, Species richness.

INTRODUCTION:

The Udaipur region, in particular, stands out for its exceptional floristic diversity, supported by a blend of tropical climates conducive to thriving plant life. Beyond its ecological significance, this region is renowned for its cultural heritage, with many plant species holding deep cultural and economic value for local communities. Exploring the biodiversity and ecology of angiosperm of the Mavli Block in the Udaipur region offers valuable insights into the intricate relationships between plants and humans. Such studies are essential for fostering conservation efforts and ensuring the preservation of this invaluable natural heritage for future generations.

The term “biodiversity” was first coined by Walter G. Rosen in 1986 and has since become widely recognized and studied (Caillon & Degeorges, 2007). It encompasses the immense variety of living organisms on Earth, including plants, animals, invertebrates, and microorganisms. Scientists estimate that the planet may harbor over 50 million species, yet only a small fraction—around two million—have been formally identified and documented (May, 1988). With continuous advancements in science and technology, our ability to explore, understand, and appreciate the intricate complexity and richness of biodiversity has significantly improved. This growing knowledge emphasizes the importance of conserving biodiversity to ensure the stability and resilience of ecosystems worldwide.

Biodiversity encompasses the vast array of living organisms on Earth, including plants, animals, fungi, and microorganisms, along with their genetic diversity, species diversity, and the ecosystems they inhabit, such as forests, deserts, grasslands, wetlands, rainforests, and coral reefs. It represents not just the sheer number of species but also the complex interactions and relationships among these organisms and their physical environment. Biodiversity operates at three primary levels: genetic diversity, which refers to the variety of genes within a species, enabling adaptation and resilience to environmental changes; species diversity, which indicates the variety of different species within an ecosystem, each playing a distinct ecological role; and ecosystem diversity, representing the different habitats, biological communities, and ecological processes that exist across the planet.

Biodiversity refers to the vast variety of species, genetic diversity, and ecosystems that exist on Earth. It includes the wide range of plants, animals, fungi, and microorganisms, as well as unique ecosystems such as deserts, rainforests, and coral reefs (Shah & Khan, 2014). This intricate web of life supports essential ecological processes and provides invaluable resources for human survival, including our food supply, which primarily relies on a limited number of plant species (Khan et al., 2012). The conservation of biodiversity is not only vital for maintaining natural ecosystems but also crucial for ensuring human well-being and long-term sustainability. The richness and complexity of life on Earth stem from the genetic variation within species and the diverse interactions between species and their environment. These interactions are essential for maintaining ecological balance and supporting life processes.

Pasturelands in Rajasthan play a vital role in the everyday lives of rural communities, serving as the backbone of traditional pastoralism and animal husbandry practices. These lands are crucial for sustaining the local economy, supporting livestock-based livelihoods, and preserving the rich cultural heritage of the region. Recognizing their ecological and socio-economic importance, efforts are consistently made to manage and conserve pasturelands, enhancing their sustainability and resilience amidst increasing environmental challenges.

Mavli Block is situated in the Udaipur district of southern Rajasthan, India, and holds significant ecological and agricultural importance. Geographically, it lies between 24.58°N to 24.90°N latitude and 73.55°E to 73.85°E longitude, covering an area characterized by a semi-arid climate and diverse topographical features. The block serves as an important administrative and agricultural division within the district, contributing significantly to the region's rural economy and ecological landscape. The terrain of Mavli Block is primarily undulating, with a mix of plains, gentle hills, and scattered rocky outcrops. The block is part of the Aravalli mountain range, which contributes to its unique geomorphology. These ancient hills not only add to the region's scenic beauty but also influence soil composition, vegetation patterns, and water availability.

This study aims to comprehensively assess the ecological and biological diversity of angiosperms in selected common pasturelands of Mavli Block. It seeks to document species composition, abundance, and distribution patterns while analyzing ecological parameters such as species richness, diversity indices, and habitat preferences. The findings of this research will contribute to a better understanding of the role of angiosperms in pastureland ecosystems, highlighting their ecological importance and the need for integrated conservation and management approaches in the region.

MATERIALS AND METHODOLOGY:

The research focuses on the ecological assessment of five pastureland sites—Naharmagra and Mavli Village—located in Mavli Block, Udaipur district. Two experimental sites were chosen within each Tehsil, with 10 quadrats established at each site for field studies. Surveys were conducted biannually, from July to September and January to March. The process involved an initial comprehensive survey of Mavli Block to collect site-specific data, followed by quadrat-based studies to examine vegetation patterns. All plant species

within the quadrats were identified and recorded. The collected data was organized and tabulated for analysis, including details on plant species and their abundance. Quantitative analysis was conducted to evaluate vegetation, focusing on parameters such as species richness, diversity, and other relevant ecological factors. Phytosociological analysis was performed using randomly placed quadrats to assess various ecological parameters, including:

- (i) **Species richness:** The number of different species present within the quadrats (Magurran (1988).
- (ii) **Species density:** The number of individuals of each species per unit area (Oosting and Billings, 1942).
- (iii) **Frequency:** The occurrence or presence of a particular species within the quadrats (Raunkiaer & Stowe, 1936).
- (iv) **Frequency class:** Categorizing species based on their frequency of occurrence, such as common, frequent, or rare.
- (v) **Abundance:** The total number of individuals of each species within the quadrats.
- (vi) **Species diversity index:** A measure that combines species richness and the evenness of species abundance to assess the overall diversity of the plant community (Shannon and Weaver, 1949), Simpson, 1949).
- (vii) **Index of species evenness:** A measure of how evenly distributed the individuals are among the different species in the community, indicating the level of uniformity in species abundance (Pielou (1966).

These parameters were analyzed to understand the composition, structure, diversity, and dominance patterns of the plant community within the studied quadrats.

The quadrat method, as outlined by (Tripathi & Misra, 1971), was employed to investigate the ecological characteristics of the district. This study builds on a previous comprehensive ecological survey conducted in the same district. Field surveys were conducted twice a year in each site, ensuring complete coverage of the Mavli block. During these field trips, detailed documentation was carried out, with each collected plant specimen assigned a sequential number for identification and reference purposes.

A nested quadrat method was used to assess pastureland ecology in two sites (Naharmagra and Mavli Village) in Mavli block, Udaipur. Two quadrats per site (total 4) were employed, each with a 25 m² plot for shrubs, trees, and climbers, a 1 m² sub-plot for grasses and herbs, and a 0.25 m² sub-plot for dense herbs and grasses. Quadrats were placed randomly in two ecological zones per site (e.g., grassy, shrubby) using stratified sampling. During September–October, individuals were counted or cover was estimated in each quadrat.

RESULTS AND DISCUSSION:

A phytosociological study was conducted to assess the ecological and plant diversity of pasturelands across five sites—Naharmagra and Mavli Village—in the Mavli block, Udaipur, Rajasthan, a semi-arid region characterized by rocky soils, limited irrigation, and heavy grazing pressure. Utilizing a nested quadrat sampling method with two quadrats per site, the study quantified key ecological parameters, including species richness, density, frequency, abundance, and diversity indices (Shannon-Weaver, Simpson, and evenness), to evaluate pastureland health and inform management strategies. By targeting the 155 identified plant species encompassing herbs, grasses, shrubs, trees, and climbers, the research aimed to capture the compositional and structural dynamics of these vital ecosystems, addressing challenges such as overgrazing, invasive species proliferation, and fodder scarcity prevalent in the region.

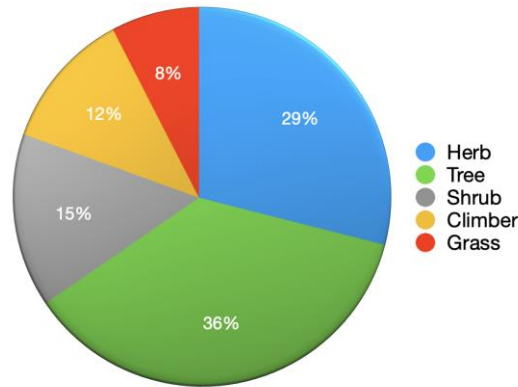


Figure.1 Species representation reported in study area

Table 1 Ecological study of study site I (Naharmagra) of Mavi block, Udaipur

Sr. No.	Species	Density	RD (%)	Frequency (%)	RF (%)	Frequency Class	Abundance
1	<i>Cynodon dactylon</i>	24.4	49.59	100	14.71	E (Constant)	24.4
2	<i>Cenchrus setigerus</i>	8	16.26	80	11.76	D (Mostly)	10
3	<i>Tridax procumbens</i>	3.6	7.32	80	11.76	D (Mostly)	4.5
4	<i>Parthenium hysterophorus</i>	7.8	15.85	100	14.71	E (Constant)	7.8
5	<i>Euphorbia hirta</i>	2.2	4.47	80	11.76	D (Mostly)	2.75
6	<i>Ageratum conyzoides</i>	0.6	1.22	40	5.88	B (Seldom)	1.5
7	<i>Ziziphus nummularia</i>	0.8	1.63	60	8.82	C (Often)	1.33
8	<i>Lantana camara</i>	1.2	2.44	80	11.76	D (Mostly)	1.5
9	<i>Calotropis procera</i>	0.4	0.81	40	5.88	B (Seldom)	1
10	<i>Prosopis cineraria</i>	0.2	0.41	20	2.94	A (Rare)	1

Notes: Density for grasses/herbs is per 1 m²; for shrubs/trees, per 25 m².

Table 2 Ecological study of study site II (Mavli village) of Mavi block, Udaipur

Sr. No.	Species	Density	RD (%)	Frequency (%)	RF (%)	Frequency Class	Abundance
1	<i>Parthenium hysterophorus</i>	18	46.63	100	12.5	E (Constant)	18
2	<i>Lantana camara</i>	3	7.77	100	12.5	E (Constant)	3
3	<i>Prosopis juliflora</i>	1	2.59	80	10	D (Mostly)	1.25
4	<i>Ipomoea carnea</i>	2.4	6.22	100	12.5	E (Constant)	2.4
5	<i>Cynodon dactylon</i>	9.6	24.87	100	12.5	E (Constant)	9.6
6	<i>Achyranthes aspera</i>	2	5.18	100	12.5	E (Constant)	2
7	<i>Euphorbia hirta</i>	1	2.59	80	10	D (Mostly)	1.25
8	<i>Calotropis procera</i>	0.4	1.04	40	5	B (Seldom)	1
9	<i>Ageratum conyzoides</i>	0.4	1.04	40	5	B (Seldom)	1
10	<i>Tribulus terrestris</i>	0.8	2.07	60	7.5	C (Often)	1.33

Notes: Density for grasses/herbs is per 1 m²; for shrubs/trees, per 25 m².

Table 3 Ecological indices of study site

Study site	Shannon-Weaver Diversity Index (H')	Simpson Dominance Index (D)	Species Evenness (e)
Naharmagra (S1)	1.732	0.316	0.752
Mavli village (S2)	1.587	0.352	0.689

The phytosociological study conducted across five pastureland sites in Mavli Block, Udaipur, Rajasthan, revealed significant insights into the ecological and biological diversity of angiosperms. A total of 155 plant species, including herbs, grasses, shrubs, trees, and climbers, were identified across the study sites, with detailed analyses focused on two key sites: Naharmagra (S1) and Mavli Village (S2). The ecological parameters assessed included species richness, density, frequency, relative density (RD), relative frequency (RF), abundance, and diversity indices (Shannon-Weaver Diversity Index, Simpson Dominance Index, and Species Evenness).

SPECIES COMPOSITION AND ECOLOGICAL PARAMETERS

Naharmagra (S1):

As presented in Table 1, the dominant species in Naharmagra was *Cynodon dactylon* (Bermuda grass), with a density of 24.4 individuals per m², a relative density of 49.59%, and a frequency of 100% (classified as "Constant" in Frequency Class E). This species exhibited the highest abundance (24.4), indicating its widespread presence and ecological dominance in the pastureland. Other notable species included *Cenchrus setigerus* (density: 8, RD: 16.26%) and *Parthenium hysterophorus* (density: 7.8, RD: 15.85%), both frequently occurring (80% and 100%, respectively). Less abundant species, such as *Prosopis cineraria* (density: 0.2, RD: 0.41%, Frequency Class A - Rare), were recorded sparingly, reflecting their limited distribution in the site. The Shannon-Weaver Diversity Index (H') for Naharmagra was 1.732, with a Simpson Dominance Index (D) of 0.316 and a Species Evenness (e) of 0.752 (Table 3), indicating moderate diversity and relatively even species distribution.

Mavli Village (S2):

In Mavli Village (Table 2), *Parthenium hysterophorus* emerged as the dominant species, with a density of 18 individuals per m², a relative density of 46.63%, and a frequency of 100% (Frequency Class E - Constant). *Cynodon dactylon* followed as the second most dominant species (density: 9.6, RD: 24.87%, frequency: 100%). Other species, such as *Lantana camara* (density: 3, RD: 7.77%) and *Ipomoea carnea* (density: 2.4, RD: 6.22%), were also consistently present (frequency: 100%). Less frequent species, such as *Calotropis procera* and *Ageratum conyzoides* (both with density: 0.4, frequency: 40%, Frequency Class B - Seldom), indicated limited distribution. The Shannon-Weaver Diversity Index (H') for Mavli Village was 1.587, with a Simpson Dominance Index (D) of 0.352 and a Species Evenness (e) of 0.689 (Table 3), suggesting slightly lower diversity and evenness compared to Naharmagra.

The ecological indices (Table 3) provide a comparative overview of the two sites. Naharmagra exhibited a higher Shannon-Weaver Diversity Index (1.732) compared to Mavli Village (1.587), indicating greater species diversity. Conversely, Mavli Village had a higher Simpson Dominance Index (0.352) than Naharmagra (0.316), suggesting greater dominance by a few species, particularly *Parthenium hysterophorus*. Species Evenness was higher in Naharmagra (0.752) than in Mavli Village (0.689), reflecting a more equitable distribution of individuals among species in the former.

Figure 1 illustrates the representation of plant species across the study area, highlighting the prevalence of grasses and herbs (*Cynodon dactylon*, *Parthenium hysterophorus*) alongside invasive species (*Lantana*

camara, *Prosopis juliflora*). Shrubs and trees, such as *Ziziphus nummularia* and *Prosopis cineraria*, were less abundant, likely due to the heavy grazing pressure and semi-arid conditions of the region.

The results of this study underscore the ecological complexity and challenges faced by pastureland ecosystems in Mavli Block, Udaipur. The dominance of *Cynodon dactylon* in Naharmagra and *Parthenium hysterophorus* in Mavli Village reflects the resilience of these species in semi-arid, heavily grazed environments. *Cynodon dactylon*, a perennial grass, is well-adapted to grazing pressure and drought, contributing to its high density and frequency. Its ecological success is likely due to its robust root system and ability to regenerate quickly, making it a critical component of pastureland ecosystems for livestock fodder (Lebed et al., 2012). However, the high prevalence of *Parthenium hysterophorus*, an invasive weed, in Mavli Village raises concerns about its impact on native biodiversity. This species is known for its allelopathic properties, which can suppress the growth of other plants, reducing species diversity and altering ecosystem dynamics (Khan & Pant, 2017; Khan et al., 2012).

The presence of invasive species such as *Lantana camara* and *Prosopis juliflora* in both sites further highlights the ecological challenges in these pasturelands. These species, while contributing to species richness, often outcompete native flora, leading to reduced fodder availability and habitat degradation. The low abundance of native trees like *Prosopis cineraria* and shrubs like *Ziziphus nummularia* suggests that overgrazing and land use pressures may be limiting their establishment and survival. These species are culturally and ecologically significant in Rajasthan, providing fodder, fuelwood, and medicinal resources, and their decline could have long-term socio-economic implications for local communities.

The higher Shannon-Weaver Diversity Index in Naharmagra indicates a more diverse plant community compared to Mavli Village, likely due to differences in grazing intensity, soil conditions, or land management practices. The lower Species Evenness in Mavli Village, coupled with a higher Simpson Dominance Index, suggests that a few dominant species, particularly invasives, are disproportionately influencing the ecosystem. This imbalance could reduce the resilience of the pastureland, making it more vulnerable to environmental stressors such as drought or further invasion.

The nested quadrat method employed in this study provided a robust framework for assessing vegetation patterns and ecological parameters. The variation in quadrat sizes (25 m² for shrubs/trees, 1 m² for grasses/herbs, and 0.25 m² for dense herbs/grasses) allowed for a comprehensive analysis of different plant functional groups, capturing the structural and compositional diversity of the pasturelands. The biannual surveys (July–September and January–March) ensured that seasonal variations in plant growth and phenology were accounted for, enhancing the reliability of the data.

The findings highlight the urgent need for integrated conservation and management strategies to address the ecological challenges in Mavli Block's pasturelands. The dominance of invasive species like *Parthenium hysterophorus* and *Lantana camara* calls for targeted control measures, such as manual removal, biological control, or selective herbicide application, to mitigate their impact on native biodiversity. Promoting the regeneration of native species, such as *Prosopis cineraria* and *Ziziphus nummularia*, through sustainable grazing practices and reforestation efforts could enhance ecosystem resilience and support local livelihoods. Furthermore, the moderate diversity indices suggest that while these pasturelands harbor significant angiosperm diversity, they are under stress from anthropogenic and environmental pressures. Community-based management approaches, involving local pastoralists in conservation efforts, could help balance ecological preservation with socio-economic needs. For instance, rotational grazing systems and the establishment of protected pasture zones could reduce grazing pressure and allow for the recovery of native species.

CONCLUSION

This study provides a comprehensive assessment of the ecological and biological diversity of angiosperms in the pasturelands of Mavli Block, Udaipur. The dominance of grasses like *Cynodon dactylon* and invasive weeds like *Parthenium hysterophorus* reflects the combined influence of environmental conditions and human activities on these ecosystems. The variation in diversity indices between Naharmagra and Mavli Village underscores the importance of site-specific management strategies. By addressing the challenges of invasive species, overgrazing, and habitat degradation, conservation efforts can ensure the long-term sustainability of these vital pastureland ecosystems, preserving their ecological and cultural significance for future generations.

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