



STUDY ON EFFECTS OF SOIL TEXTURE, COLOUR ON GRASSES DISTRIBUTION IN TADoba ANDHARI TIGER RESERVE, MAHARASHTRA STATE, INDIA

G. D. Muratkar¹, Kokate U. R², and P. A. Gawande³

¹Assistant Prof. Department of Environmental Science, Arts , Science &Commerce College Chikhaldara Dist. Amravati M. S. 444807

²Prof. Department of Botany, Arts , Science &Commerce College Chikhaldara Dist. Amravati M. S. 444807

³Professor Department of Botany, S. G. B. Amravati University Amravati
gmuratkar@gmail.com

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ABSTRACT:

To assess the influence of soil texture and colour on grass species distribution and biomass in Tadoba Andhari Tiger Reserve (TATR), Maharashtra. Soil samples (n = 35) were collected from five ranges (Moharli, Tadoba, Kolara, Kolsa, Karwa) across major grasslands. Soil colour (Munsell chart), texture (sieve analysis), pH (pH meter), moisture (tensiometer), and temperature were recorded alongside grass species inventories. Black clay-loam soils (pH 4.1–6.4, moisture 59–85%) supported high-biomass, palatable grasses (e.g., *Cynodon dactylon*, *Themeda quadrivalvis*). Red-murmi soils hosted annual, moderately palatable species (*Setaria spp.*, *Heteropogon contortus*). Sandy/white soils (e.g., Piperheti) showed low moisture and sparse, non-palatable grasses (*Aristida setacea*, *Saccharum spontaneum*). Soil texture and colour significantly govern grass community composition and forage quality, informing habitat management and prey base sustainability in tiger reserves.

Keywords:- Soil Texture, Color, grasses distribution , TATR.

INTRODUCTION:

The *Tadoba–Andhari Tiger Reserve (TATR)* derives its name from the local tribal deity “Tadoba” (also known as *Taru*), worshipped by indigenous communities residing in and around the forested landscape of the reserve. The term “Andhari” refers to the *Andhari River*, a major seasonal river that traverses the reserve and significantly influences its ecological character. Tadoba–Andhari Tiger Reserve is the largest tiger reserve in Maharashtra State and represents one of the most important tiger conservation landscapes in Central India. The reserve comprises Tadoba National Park and Andhari Wildlife Sanctuary, which together form a contiguous protected area notified under relevant provisions of the Wildlife (Protection) Act, 1972.

2. Location, Extent and Legal Status

Tadoba National Park was notified in the year 1955 with a geographical area of 116.55 km². Subsequently, the Andhari Wildlife Sanctuary was declared in 1986, covering an area of 508.85 km². Together, these two protected areas constitute the core (critical tiger habitat) of the Tadoba–Andhari Tiger Reserve, with a total core area of 625.40 km².

The buffer/peripheral area of the tiger reserve extends over 1,101.60 km², notified to ensure ecological integrity and to promote co-existence with surrounding human settlements. Thus, the total area of the Tadoba–Andhari Tiger Reserve is approximately 1,727 km².

In addition to the core and buffer areas, the reserve includes 32.51 km² of protected forest and 14.93 km² of other forest/non-forest categories, which function as important ecological connectors and transitional zones.



3. Administrative Composition

The administrative components of Tadoba–Andhari Tiger Reserve include:

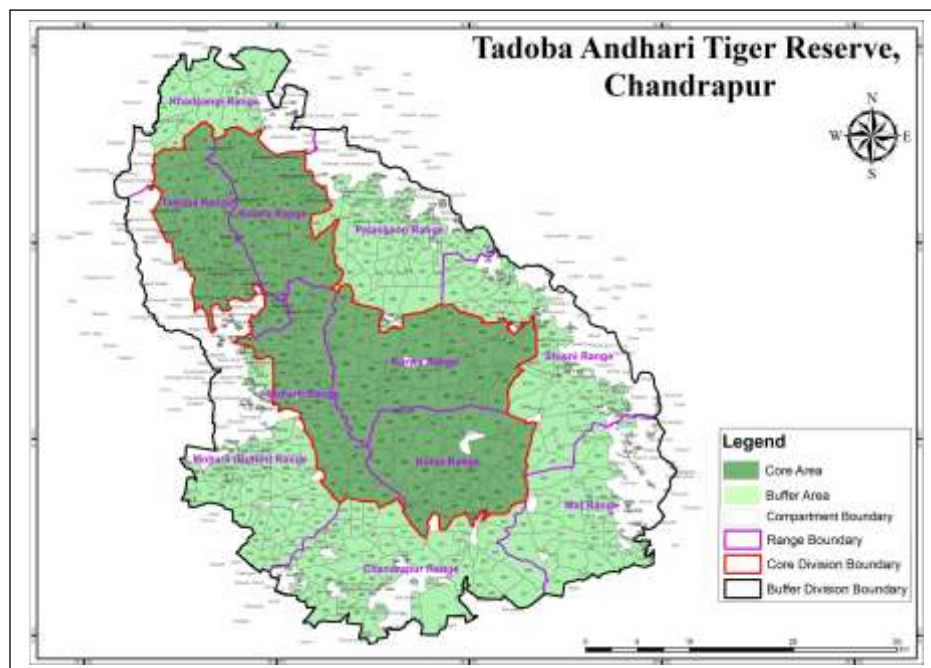
- Tadoba National Park
- Andhari Wildlife Sanctuary
- Buffer and peripheral areas notified under the Tiger Reserve

The reserve is managed as per the guidelines issued by the National Tiger Conservation Authority (NTCA) and the Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India.

3. Climate and Rainfall

The climate of Tadoba–Andhari Tiger Reserve is tropical monsoonal, characterized by hot summers, a distinct monsoon season, and mild winters. The southwest monsoon generally commences in June, during which the reserve receives the majority of its annual rainfall.

The average annual rainfall in the reserve is approximately 1,275 mm, which plays a crucial role in sustaining forest vegetation, grasslands, water bodies, and overall habitat productivity essential for prey species and large carnivores, particularly the tiger (*Panthera tigris*).



□ (Source: Field Director office, TATR.)

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oil as an Edaphic Factor in Grassland and Habitat Management

Soil constitutes a key edaphic determinant influencing the distribution, composition, and productivity of grasslands within the Tadoba Andhari Tiger Reserve (TATR). Soil formation in the reserve is governed by parent material and underlying geological formations, while soil physical and chemical properties are shaped by

weathering processes, climatic conditions, and site-specific factors such as slope and drainage.

The soils of TATR exhibit considerable variation in colour, including red, black, yellow, white, and mixed black–white soils, which reflect differences in mineral composition, organic matter content, and moisture regime. These variations have a direct bearing on grass species distribution, palatability, and seasonal biomass production.

Soil texture in the reserve ranges from sandy, silty, loamy, and clayey soils to mixed textures such as sandy-silt, clay-loam, and loam. Soil texture strongly influences water-holding capacity, aeration, nutrient availability, and root penetration, thereby determining the establishment and persistence of grassland communities. Clay and clay-loam soils with higher moisture retention generally support productive grasslands with soft and palatable fodder species, whereas sandy soils are prone to rapid drainage and support sparse or coarse grass cover.

Soil moisture occurs in different forms, namely hygroscopic, capillary, chemically combined, gravitational, and percolation water. The availability of soil moisture for grass growth is

primarily governed by soil texture and structure, which in turn affects phenology, regeneration, and biomass production of grasses.

From a habitat management perspective, soil texture and moisture regime act as fundamental ecological drivers shaping grassland productivity and habitat quality for ungulate prey species. Therefore, soil assessment and texture-based site selection are essential prerequisites for grassland development, restoration, and enrichment activities within TATR. Management interventions such as selection of appropriate grass species, soil moisture conservation measures, and site-specific grassland improvement practices should be aligned with existing soil characteristics to ensure sustainable habitat enhancement.

Rainfall, Temperature and Humidity data of last five-year 2021- 2025 Tadoba Andhari Tiger Reserve.

Year	Rainfall in mm	Temperature		Humidity in %
		Maximum temperature (0°C)	Minimum temperature (0°C)	
2025	1370	43	30	60- 83
2024	1285	44	29	55-85
2023	1275	45	28	54-87
2022	1270	44	30	53-88
2021	1280	45	29	58-86

METHODOLOGY

The present study was conducted in the grasslands of Tadoba Andhari Tiger Reserve (TATR), one of the well-managed Protected Areas and Tiger Reserves of Maharashtra State, India. Tadoba Andhari Tiger Reserve represents a significant landscape of Central Indian forests and grassland ecosystems, playing a vital role in wildlife conservation and habitat management.

To investigate grassland vegetation and associated edaphic and environmental factors, systematic field surveys were carried out across different grassland sites located within major ranges of the reserve. The survey covered grasslands from Moharli Range, Kolara Range, Kolsa Range, Karwa Range, and Tadoba Range,

selected to represent variation in topography, soil characteristics, and management regimes.

FIELD SURVEY AND SITE SELECTION

Regular field visits were undertaken to identify representative grassland patches suitable for detailed investigation. During each visit, topographical and geographical data were recorded, including latitude, longitude, and elevation, using a Global Positioning System (GPS) instrument for precise location mapping of each selected grassland site.

SOIL SAMPLING AND ANALYSIS

Soil samples were collected from selected grassland sites to assess physical and chemical soil properties influencing grassland productivity

and fodder quality. Samples were collected from the surface layer using standard procedures, placed in polythene bags, and properly labelled with site details for laboratory analysis.

The following soil parameters were analysed using standard methods and instruments:

- Soil colour was determined using the Munsell Soil Colour Chart (Munsell, 1920).
- Soil texture was analysed using soil sieves to determine the proportion of sand, silt, and clay.
- Soil moisture was measured using a Soil Tensiometer.
- Soil pH was determined in the laboratory using a digital pH meter.
- Soil temperature was recorded using a soil thermometer.

Environmental and Climatic Parameters

Along with soil parameters, environmental and ecological data were recorded during each field visit to understand their influence on grassland vegetation dynamics:

- Atmospheric humidity was measured using a hygrometer.
- Atmospheric temperature was recorded during field observations.
- Average rainfall data for each range were obtained from the Tadoba Andhari Tiger Reserve Field Office, based on records from rain gauge measurements.

OBSERVATIONS:

The Moharli Range is characterized by the predominance of red and black soils with clay-loam textures, generally acidic to slightly acidic in reaction (pH 4.1–6.4), and exhibiting relatively high soil moisture content (59–85%). These fine-textured soils possess high water-holding capacity, supporting dense grassland vegetation

and productive meadows such as Palasgaon, Sonegaon, and Dewada. Such edaphic conditions promote sustained herbaceous growth and enhance forage availability for ungulate prey species.

In the Tadoba and Kolara ranges, fertile black soils with loam-clay combinations dominate, exhibiting moderate acidity to near-neutral pH and consistently favourable moisture regimes. These soil conditions facilitate efficient nutrient retention and support vigorous grass cover in important grassland patches and meadows, including Jamni, Navegaon, and Khutwanda, thereby contributing significantly to prey base sustenance.

The Kolsa Range exhibits a heterogeneous soil mosaic comprising red-white, red-black, and brown soils with sandy-silt-clay admixtures. This variability reflects differential drainage characteristics and moderate to good soil moisture status, resulting in a patchwork of grassland types and diverse microhabitats that enhance habitat heterogeneity.

In contrast, parts of the Karwa Range are characterized by sandy and white soils with poor moisture retention, particularly in areas such as Piperheti, where vegetation density and productivity are comparatively low. However, adjoining grasslands in Andhari and Karwa areas, underlain by black and red-brown loamy soils, show improved moisture availability and higher biomass production.

Overall, the dominance of clay- and loam-rich soils across the Tadoba-Andhari Tiger Reserve ensures effective water retention and nutrient cycling, while localized sandy patches contribute to ecological heterogeneity. This edaphic diversity plays a crucial role in determining grassland distribution and productivity, sustaining herbivore populations, and thereby enhancing the ecological stability and carrying capacity of the tiger reserve.

Table : Tadoba Andhari Tiger Reserve, Chandrapur , Maharashtra State
Soil color, texture, pH .

Sr. No.	Range TATR		Grassland title	Colour	pH	Tem p. (0°C)	Textur e	Soil moistur e%
A	Moharli Range	1	Sonegaon	Red	6.38	28.8	Clay , loam , sand	70 %
		2	Palasgaon	Red	5.2	28.8	Clay , loamy	85 %
		3	Palasgaon	Black	4.12	28.8	Clay , loam	85 %
		4	Gosai bodi	Black	5.9	28.6	Loam , clay	65 %
		5	Palasgaon	Black	4.12	28.8	Clay , loam	75 %
		6	Palasgaon	Black	4.8	28.5	Clay , loam	72%
		7	Palasgaon N 20° 16' 20" E 79° 21' 21"	Black	5.56	28.8	Clay , loam	78 %
		8	Asthkoni meadow	Black	5.59	28.9	Loam , clay	59 %
		9	Dewada	Black	4.67	28.8	Loam , clay	60 %
		10	Dewada N 20° 8' 27" E 79° 24' 44"	Red	4.87	29.2	Silt clay	64 %
B	Tadoba Range	1	Katezari N 20 16 28" E 79 20 37"	Red , brown	5.27	28.8	Clay , loamy	Good %
		2	Khutwanda N20 46 23" E79 20 30"	Black	6.2	28.8	Clay , loam	Good %
		3	Sonegaon	Black	5.9	28.9	Black	Good %
		4						
C	Kolara Range	1	Jamni grassland N20 20 21.5" E79 20.17 75"	Black fertile	6.4	28.7	Loam , clay	Good %
		2	Navegaon Meadow N 20 24 53.3" 79 16 59.1 "	Black	4.33	29.8	Loam , clay	Good %
		3	Jamni meadow N 20 20 16.8" E 79 20 26.5"	Black soil	4.95	28.5	Loam , clay	Good %
		4	Jamni gaathan	Brown black	5.1	28.8	Clay , silt	Moderat e %

		5	Pandharpau ni meadow	Brown	4.63	28.7	Clay loan silt	Moderat e %
		6	Pandharpau ni meadow	Brown	4.33	28.4	Clay loan silt	Moderat e %
D	Kolsa Range	1	Kolsa grassland N 20 09 49.2” E79 29 52.7”	Red - white	5.79	28.6	Sandy more Silt clay	Moderat e%
		2	Kolsa gaothan N 20 09 48.6” E79 29 52.6”	Brown	6.27	28.5	Brown	Less %
		3	Kolsa grassland N 20 09 35.5” E79 29 25.4”	Red - white	4.79	28.8	Clay, Loam	Good %
		4	Kolsa grassland N 20 10 17.8” E79 29 52.7”	Red - Black	4.79	28.5	Clay, Loam and silt	Good %
		5	Kolsa grassland Comp. No. 83	Red - Brown	4.9	28.8	Clay, silt	Good %
		6	Kolsa grassland	Black	6.13	28.8	Clay, loam	Good %
E	Karwa Range	1	Sukali bodi (Piperheti) N20 11 31.9” E79 31 11.9”	Red	5.11	29.2	Clay silt	Moderat e %
		2	Piperheti	White sandy	5.3	28.3	Sandy soil	Very less %
		3	Andhari grassland N 20 11 47 E 79 23 16”	Black	6.4	29.8	Clay loamy	Good %
		4	Karwa grassland N 20 16 23.7” E79 27 46.2”	Red - brown	4.78	29.5	Loam and silt	Good %
		5	Rantalodi Rehabilitate d Village – Near lake area soil sample. N 20 12 51.0” E 79 28 49.1”	Black	4.6	28.8	Loam clay	Good %
		6	Rantalodi Rehabilitate d Village- Cultivated land soil sample	Brown	4.8	22.7	Loam clay silt	Good %

			N 20 13 55.6"					
			E 79 27 09.3"					
	7	Kinhi Nala meadow	N 20 15 59.2"	Red brown	5.65	28.9	Clay silt	Moderate %
			E 79 26 50.2					



RED SOIL



BLACK SOIL



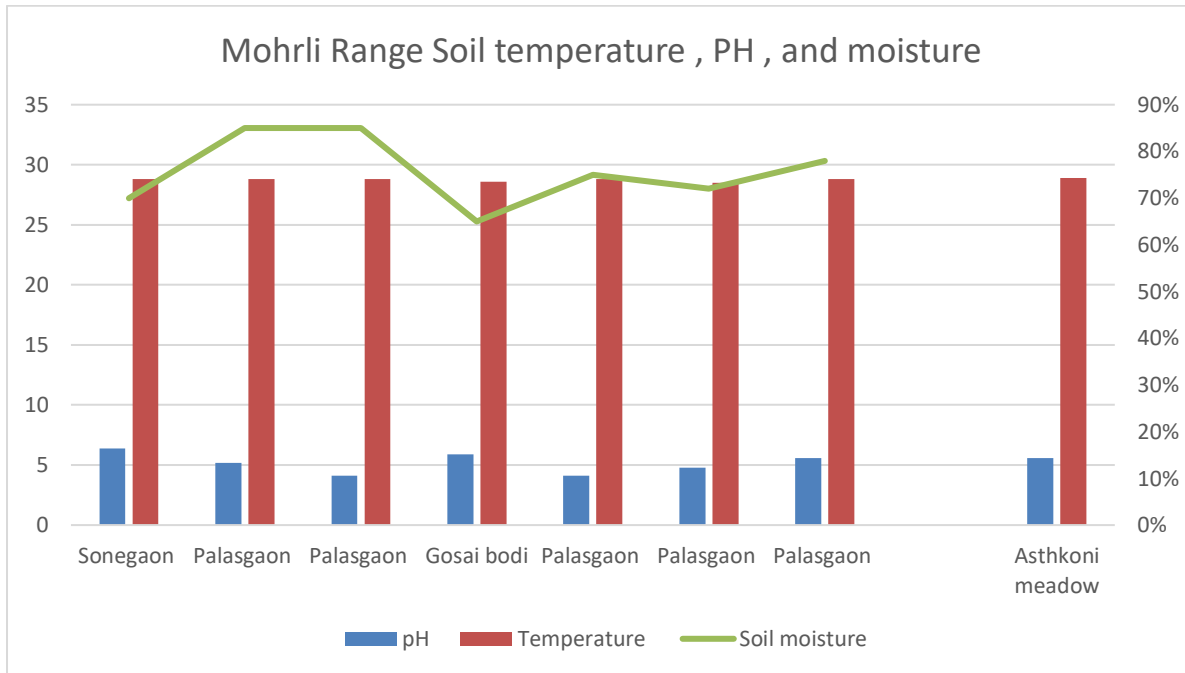
SANDY SOIL



BLACK SOIL



LOAMY BLACK SOIL



RESULT:

- Sandy Soil (Coarse texture): Have large pore spaces, resulting in excellent drainage and aeration, but low water and nutrient retention. Grass species that are more drought-resistant or can adapt to nutrient-poor conditions, such as some *Cenchrus ciliaris*
- Clay Soils (Fine texture): Have small, dense particles that provide high water and nutrient retention but can lead to poor drainage, waterlogging, and low oxygen levels if compacted. Some specific grass species (e.g., *A. mutica*, *A. funiculata*) are adapted to these clay-rich, potentially saline environments, and fine-textured soils generally support higher overall grass biomass in certain contexts due to better nutrient status.
- Loam Soils: Considered ideal for most plant growth, including many cultivated grasses, as they offer a good balance of drainage, aeration, and water/nutrient retention.

Soil Colour :

Soil colour is an indicator of other soil properties, primarily organic matter content and drainage, which indirectly affect grass distribution.

Black soil with good moisture and water holding capacity : Grasses distribution – *Iselima laxum* , *Cynodon dactylon* Pears , *Dinebra retroflexa* (Vahl) , *Echinochloa colonum* (L), *Vitiveria zizanioides* (L) , *Panicum antidotale* , *Paspalum scorbiculatum* , *Chionachne koenigii* (Spreng.) , *Echinochloa colonum var. arabica* (Steud.) A.Chev, *Andropogon pumilus* Roxb, *Imperata cylindrica* (L), *Ischaemum pilosa* (Klein ex Willd), *Paspalum canare* (Stcut), *Sacciolepis indica* (Willd) , *Euilalia trispicata* (Schult)

Red – murmi soil - *Thelepogon elegans* Roth ex Roem, *Apluda mutica* L., Sp. Pl. 1, *Digitaria abludens* (Roem & schult) , *Dicanthium annulatum* (Forssk) , *Digitaria abludens* (Roem & schult), *Heteropogon contorus* (L), *Oplismenus burmannii* (Retz), *Oplismenus compositus* (L), *Pennisetum pedicellatum* (Trin), *Paspalidium flavidium* (Retz), *Rottbolia cochinchinensis* (Lour), *Sehima nervosum* (Rott), *Sehima sulcatum* (Hook), *Setaria intermedia* (Roem) , *Setaria tomentosa* (Roxb) , *Setaria italica* (L) , *Setaria pumilla* (Poir), *Setaria verticillata* (L), *Sporobolus coromandelianus* (Retz), *Sporobolus indicus* (L) , *Themeda triandra* L., *Themeda quadrivalvis* (L),

Tripogon jacquemontii (Stapf), *Cymbopogon martinae* Wals, *Chloris barbata* Sw.(syn. *Chloris inflata*), *Chloris virgata* SW. , *Chrysopogon fulvus* Spreng.

Rocky strata: *Arachne racemosa* (Heyne ex R.& S.) , *Aristida funiculata* Trin. and Rupr. Sp. Gram. Stip, *Arthraxon lanceolatus* (Roxb.) Hochst , *Arthraxon lancifolius* (Trin.) Hochst , *Arthraxon hispidus* (Thunb.) , *Arundinella pumila* (Hochst.ex A. Rich.) Steud , *Arundinella setosa* Trin , *Cymbopogon martinae* Wals , *Melanocenchis jacquemontii* Jaub. Spach.

Sandy soil: *Aristida setacea* Retz , *Aristida funiculata* Trin. and Rupr. Sp. Gram. Stip , *Dendrocalamus strictus* (Roxb.) Nees , *Dactyloctenium aegypticum* L , *Dactyloctenium indicum* Bioss , *Eleusine indica* (L) , *Saccharum spontaneum* (L) , *Chrysopogon aciculatus*(Retz.) Trin..

- **Moist soil** - *Coix aquatica* Roxb. , *Coix gigantean* Roxb. , *Coix lacryma jobi*-L, *Iselima laxum* , *Cynodon dactylon* Pears , *Vitiveria zizanioides* (L) , *Panicum antidotale*, *Panicum sumatrense* (Roth ex.), *Bothriochloa bladhii* Retz., *B. intermedia* (R.Br.) A.Camus,

Grasses growing in shade with moist soil.

Chloris gayana Kunth., *Chloris dolichostachya* Lag.,), *Oplismenus burmannii* (Retz), *Oplismenus compositus* (L), *Oplismenus compositus* (L.) [P. Beauv](#) , *Echinochloa lanceolata* (Retz.) Roem. & Schult., *Oplismenus burmannii* . (Retz.) [P. Beauv](#).

Effect of soil moisture on grasses bio-mass:

Grasses with more biomass – *Themeda quadrivalvis* (L), *Bothriochloa bladhii* Retz., *B. intermedia* (R.Br.) A. Camus, *Heteropogon contorus* (L), *Vitiveria zizanioides* (L), *Pennisetum pedicellatum* (Trin), *Dendrocalamus strictus* (Roxb.) Nees *Coix aquatica* Roxb. , *Coix lacryma jobi*-L

Soil moisture, nutrients play important role in palatability of grasses and biomass, these grasses are very useful for wildlife habitat management.

DISCUSSION:

Role of Soil (Edaphic Factors) in Grassland Management for Tiger Reserves

Soil is a critical edaphic component of the grassland ecosystem and plays a decisive role in determining the structure, composition, productivity, and seasonal dynamics of grasslands within Tiger Reserves. The physical and chemical properties of soil directly influence grass phenology, morphology, biomass production, and fodder quality, thereby affecting the availability of forage for wild herbivores and the overall prey base for tigers.

Grasslands constitute an important habitat element for sustaining populations of soft-feeding and coarse-feeding ungulates. Soil characteristics such as colour, texture, structure, moisture regime, temperature, water-holding capacity, and nutrient status govern the distribution, palatability, and nutritional value of grass species across different grassland patches in both core and buffer areas.

Black soils with a higher proportion of clay and loam exhibit superior moisture retention and nutrient availability and generally support the growth of soft, palatable grasses with higher biomass and fodder value. Such grasslands contribute significantly to forage availability for key prey species and are therefore of high management priority.

In contrast, murumi and red soils, characterized by lower clay content, reduced water-holding capacity, and lower soil moisture, support coarse-textured grasses with moderate palatability and comparatively lower biomass. Similarly, sandy soils, due to poor moisture retention and low fertility, predominantly support coarse, non-palatable grasses with limited fodder value, making them less suitable for intensive habitat improvement without soil and moisture interventions.

The palatability, productivity, and seasonal availability of grasses are thus primarily regulated by soil physical properties, including texture, moisture regime, temperature, and water-holding capacity. Accordingly, in Tiger Reserve habitat management, particularly in grassland development and restoration programmes, soil assessment should form the baseline activity prior to any intervention.

As per habitat management principles followed under Tiger Conservation Plans, grassland management interventions shall be planned based on detailed soil physical property analysis, using appropriate field and laboratory

instruments. This approach will enable site-specific grassland restoration, enrichment of palatable fodder species, sustainable prey base augmentation, and long-term ecological stability of grassland habitats within Tiger Reserves.

CONCLUSION :

Role of Soil (Edaphic Factor) in Grassland Management of Tiger Reserves

Soil is a major edaphic factor in forest ecosystems, and grasslands form an important component of these ecosystems. For effective grassland management in Tiger Reserves, soil analysis is essential, as soil characteristics directly influence grass composition, productivity, and nutritional quality, which in turn affect wildlife habitat.

1. Loamy soils are considered ideal for grassland development. These soils provide a balanced combination of good drainage, aeration, and adequate water and nutrient retention, supporting the growth of many soft and palatable grass species.
2. Soil colour serves as an important indicator of various soil properties such as moisture status, organic matter content, and mineral composition.
3. Soil texture influences the distribution of soft and coarse grasses. Fine-textured soils generally support soft and palatable grasses, whereas coarse-textured soils favour coarse and less palatable species.
4. In undulating terrain or hilly topography, red-coloured soils often indicate well-drained conditions and are commonly associated with the dominance of coarse fodder grasses.
5. In moist areas near water bodies such as lakes, ponds, and streams, soils with high moisture availability support amphibious or amphiterrestrial grasslands, characterized by the abundance of soft and highly palatable grass species.
6. The physical and chemical properties of soil—including texture, structure, moisture, pH, and nutrient status—determine grass biomass, growth rate, height, softness or coarseness, and overall nutritional value.
7. Therefore, grassland management in Tiger Reserves is a vital component of wildlife habitat management, as it ensures sustainable forage availability

for herbivores and contributes to the stability of the forest ecosystem.

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