



Unique Winter Grasses of Southern Haryana: Potential Agents for Soil Stabilization

Sharma Yogesh¹, Singh Nidhan^{2*} and Chandran Manoj³

¹ Department of Botany, Kurukshetra University, Kurukshetra, Haryana

² Department of Botany, I.B. (PG) College, Panipat, Haryana

³ Indian Forest Services (Retd.), FLS

*Corresponding Author: nidhansinghkuk@gmail.com

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ABSTRACT

Southern Haryana, encompassing the semi-arid sandy plains and Aravalli outliers, supports a distinctive assemblage of winter-active grass species with potential ecological significance for soil stabilization and desertification prevention. This floristic study documents 21 ecologically important winter-active grass species recorded from southern Haryana during field surveys conducted between July 2019 – August 2021, and ongoing surveys since January 2024. Winter-active grasses persist during the lean dry season and provide critical ecosystem functions including soil binding, reduced erosion, maintenance of primary productivity, and provision of forage for herbivores. This baseline floristic data provides foundational information for future ecological research and conservation planning in the vulnerable semi-arid region of southern Haryana, adjacent to the Thar Desert. Multidisciplinary research involving genomic, physiological, and soil science studies is recommended to establish the quantitative roles of these species in ecosystem restoration. The findings align with India's Aravalli Green Wall initiative, which targets restoration of 1.1 million hectares of degraded Aravalli land by 2027 using site-specific native species.

Keywords: Poaceae, Grasses, Desertification, Soil Stabilization, Haryana

INTRODUCTION

The Poaceae family, commonly known as the grass family, represents one of the most evolutionarily advanced and species-rich angiosperm groups, ranking as the fifth most specious family (Hodkinson and Parnell, 2007a, b; Hodkinson, 2018). Originating in the Early Cretaceous period, approximately 101-113 million years ago (Gallaher *et al.*, 2022), long predating human existence (Tuttle, 2025), grasses have been inextricably linked with human civilization. Beyond their direct utility to humans, grasses are fundamental to the structure and function of numerous global ecosystems. In grassland ecosystems, grasses are foundational species that drive primary productivity and shape habitat architecture (Liu *et al.*, 2024). Their ecological significance is particularly amplified in arid and semi-arid regions, where they are pivotal for maintaining stability and combating desertification (Giri *et al.*, 2023). A primary mechanism for this is their

role in soil stabilization; the characteristically dense and fibrous root systems complemented with tillering and tufted growth of many grasses bind soil particles, enhance water infiltration, and improve moisture retention, while the above-ground canopy mitigates the erosive impact of wind and rain (Ojija, 2024; Giri *et al.*, 2023; Salem, 1991). Moreover, grasses in these environments exhibit remarkable adaptations to water scarcity, such as high water-use efficiency often associated with C4 photosynthesis.

Southern Haryana, encompassing districts of Hisar, Bhiwani, Mahendragarh, Rewari, and Gurugram, falls within the arid to semi-arid zone and is characterized by undulating sandy plains and outliers of the Aravalli range. A significant geological and ecological feature in this region is the Dhosi Hill, an isolated remnant of an extinct volcano on the Haryana-Rajasthan border. These hills, along with the non-agricultural lands in surrounding plains, are having predominantly scrublands-kind of vegetation with significant grass cover, peaking during the monsoon. However, the limited precipitation from western disturbances supports a distinct assemblage of winter-active grasses. These grasses assume heightened ecological importance during the lean winter and subsequent dry pre-monsoon period by providing forage, binding soil vulnerable to erosion, and thus playing a role in combating desertification processes that threaten this region adjacent to the Thar Desert. The soil erosion is the leading cause of reducing soil fertility and desertification in this region. Certain anthropogenic activities specific to the region of southern Haryana are resulting in increased soil erosion viz., extensive mining and intensive agriculture. Understanding the composition and adaptations of such specialized grass communities is crucial for developing effective regional conservation strategies. Therefore, the present study aims to provide a floristic documentation of the unique winter grass species found in the areas of southern Haryana. It further seeks to highlight their potential ecological significance, particularly concerning their adaptations to the local climatic and edaphic conditions and their desertification prevention roles in the ecosystem, thereby providing baseline data for future ecological research and conservation planning in this vulnerable region.

MATERIALS AND METHODS

The present work done in the southern region of Haryana is a part of the broader research project of the authors dealing with floristic studies of the Poaceae in Haryana. The territory of the state was divided into four zones based on prevalent phytogeographic and climatic conditions, to organize and make the field surveys efficient. These are: (a). North-eastern Zone, dominated by the features of Siwalik Hill tracts and contains semi-evergreen and deciduous forests; (b). Central Zone, dominated by the features of the alluvial plains and contains primarily the agricultural lands, grasslands and riverine belts; (c). Western Zone, dominated by features of the *Bagar* and undulating sandy plains, with semi-arid desert-like conditions, saline soils and drought-resistant flora; (d). Southern Zone, dominated by features of the Aravalli outliers and associated plains in foothills, known for scrub vegetation and xerophytic conditions.

Field surveys are being conducted regularly to all four zones across the territory of the state since January 2024, during all seasons throughout the year. Moreover, preliminary field surveys were conducted in southern Haryana during the period of July 2019 to August 2021. The data collected from field constitutes the digital photographs of the plants, the physical herbarium specimens, and the related information about ecological and phenological aspects of the grasses. The dried grass specimens were further studied for detailed morphological characters in laboratory, under a stereo microscope. The descriptions were written for major morphological observations made in field surveys and laboratory dissections, using conventional terminologies found across published literature and web-databases (Bor, 1960; eFloras, GrassBase, Delta Databases).

Based on the data collected, and the descriptions prepared eventually, the grasses were first identified by consulting expert opinions. The identities were later authenticated by consulting published literature (Bor, 1960; Jain *et al.*, 2000; Kumar, 2001) and examining herbarium specimens available online on certain databases (Indian Virtual Herbarium (IVH); Plants of the World Online (POWO), Kew Science, GBIF, and Jstor Global Plants).

RESULT AND DISCUSSION

Over 60 species of grasses were recorded in total from various habitats, including sandy dunes, wastelands,

grazing fields, fallow lands, and cultivated field margins from southern Haryana. These grasses exhibited considerable variability in morphology, habitat preference, and seasonal occurrence, reflecting

the adaptive strategies of grasses in semi-arid ecosystems. Certain ecologically important grasses were found to be growing through crucial months of winter season, which are enlisted in Table 1 below:

Table 1: Ecologically important grasses recorded during the study

Sr. No.	Grass Species	Habitat	Flowering / Fruiting	Voucher Specimens	Place(s) of Collection
1	<i>Aegialina pumila</i> (Domin) Quintanar & Barberá	Wastelands & agricultural fields; sandy soil.	January – April	Yogesh Sharma #211	Kuksi (Mahendragarh).
2	<i>Aristida adscensionis</i> L.	Wastelands, roadsides, disturbed hill slopes.	August – February	Yogesh Sharma #186, #209, and #368	Meerpur (Rewari), Badkhal (Faridabad), Shahbazpur & Dosi Hill (Mahendragarh).
3	<i>Aristida funiculata</i> Trin. & Rupr.	Open hill slopes.	August – March	Yogesh Sharma #193, #376 and #377	Dosi Hill (Mahendragarh)
4	<i>Aristida mutabilis</i> Trin. & Rupr.	Wastelands & disturbed areas.	August – February	Yogesh Sharma #228 and #577	Adampur (Hisar), Sisar Khas (Rohtak).
5	<i>Bothriochloa bladhii</i> (Retz.) S.T.Blake	Open hill slopes and disturbed foothills.	Throughout the year	Yogesh Sharma #195, #252 and #400	Madhogarh & Dosi Hill (Mahendragarh), Ghamroj Hills (Gurugram).
6	<i>Bothriochloa pertusa</i> (L.) A.Camus	Open hill slopes, wastelands & disturbed areas.	June – March	Yogesh Sharma #185, #196 and #197	Shahbazpur & Dosi Hill (Mahendragarh).
7	<i>Cenchrus setigerus</i> Vahl.	Roadsides, wastelands & hill slopes.	August – March	Yogesh Sharma #374	Meerpur (Rewari), Badkhal (Faridabad), Shahbazpur & Dosi Hill (Mahendragarh).
8	<i>Chrysopogon fulvus</i> Chiov.	Open hill slopes and disturbed foothills.	August – March	Yogesh Sharma #431 and #458	Sohna and Ghamroj hills (Gurugram)
9	<i>Cymbopogon commutatus</i> Stapf	Disturbed hill slopes.	January – October	Yogesh Sharma #213 and #214	Madhogarh Fort Hills (Mahendragarh)
10	<i>Dactyloctenium scindicum</i> Boiss.	Agricultural fields, roadsides, wastelands, foothills; sandy soils.	August – February	Yogesh Sharma #284, #401 and #564	Madhogarh Fort Hills (Mahendragarh), Sirohi-Kot Hills (Faridabad), Barwala (Jind), Siwani (Bhiwani)
11	<i>Dichanthium foveolatum</i> (Delile) Roberty	Open hills & disturbed hill slopes.	July – March	Yogesh Sharma #198, #212 and #391	Badkhal (Faridabad), Madhogarh & Dosi Hills (Mahendragarh), Ghamroj Hills (Gurugram).
12	<i>Eragrostis atrovirens</i> (Desf.) Trin. ex Steud.	Roadsides and lands near water canals.	August – January	Yogesh Sharma #570 and #571	Near Adampur (Hisar), Near Singhani (Bhiwani)
13	<i>Eragrostis tremula</i> Hochst. ex Steud.	Wastelands & agricultural fields.	August – February	Yogesh Sharma #226	Sisar Khas (Rohtak).
14	<i>Heteropogon contortus</i> (L.) P.Beauv.	Wastelands & open hill slopes.	August – February	Yogesh Sharma #205 and #206	Meerpur (Rewari), Badkhal (Faridabad), Shahbazpur & Dosi Hill (Mahendragarh).
15	<i>Ochthochloa compressa</i> (Forssk.) Hilu	Wastelands & disturbed hill slopes.	June – March	Yogesh Sharma #184 and #565	Barwala (Jind), Shahbazpur (Mahendragarh).
16	<i>Saccharum spontaneum</i> L.	Wastelands.	August – December	Yogesh Sharma #345	Sirohi-Kot Hills (Faridabad).
17	<i>Sehima nervosa</i> (Rottler) Stapf	Open hill slopes.	August – March	Yogesh Sharma #202	Dosi Hill (Mahendragarh).
18	<i>Sporobolus helvolus</i> (Trin.) T.Durand & Schinz	Roadsides, wastelands & agricultural fields.	Throughout the year	Yogesh Sharma #178	Mandoli (Charkhi Dadri), Narnaul (Mahendragarh), Hisar
19	<i>Sporobolus marginatus</i> Hochst. ex A.Rich.	Wastelands, disturbed areas & roadsides.	July – February	Yogesh Sharma #281 and #411	Badkhal Lake (Faridabad), Hisar city outskirts.
20	<i>Tetrapogon tenellus</i> (J.Koenig ex Roxb.) Chiov.	Open hill slopes, wastelands & disturbed areas.	August – February	Yogesh Sharma #384 and #403	Madhogarh & Dosi Hills (Mahendragarh), Ghamroj Hills (Gurugram).
21	<i>Tripidium bengalense</i> (Retz.) H.Scholz	Wastelands & roadsides	October – February	Yogesh Sharma #601 and #602	Meerpur & Aakera (Rewari).

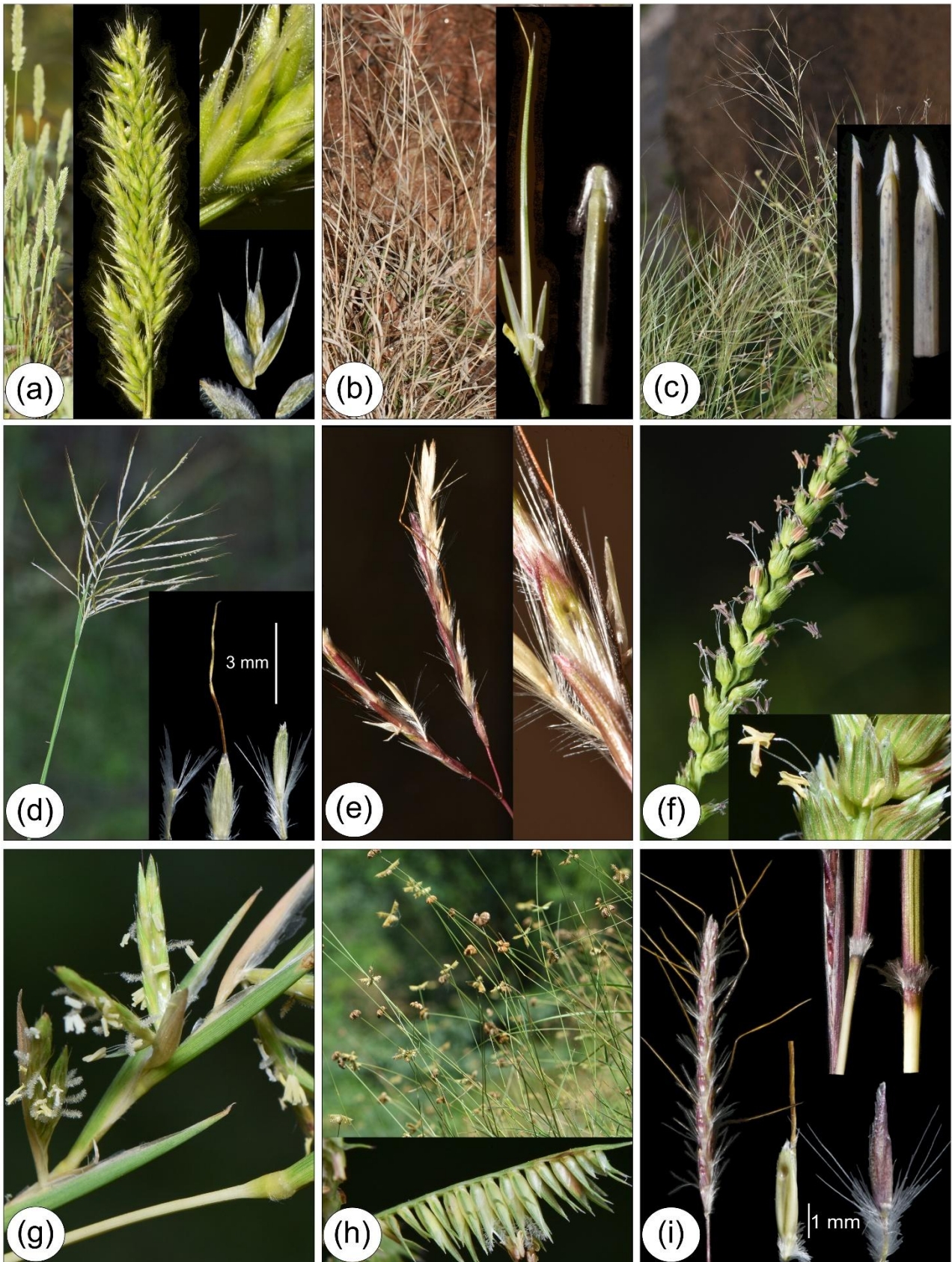


Plate 1: (a) *Aegialina pumila*, (b) *Aristida adscensionis*, (c) *Aristida funiculata*, (d) *Bothriochloa bladhii*, (e) *Bothriochloa pertusa*, (f) *Cenchrus setigerus*, (g) *Cymbopogon commutatus*, (h) *Dactyloctenium scindicum*, (i) *Dichanthium foveolatum*.

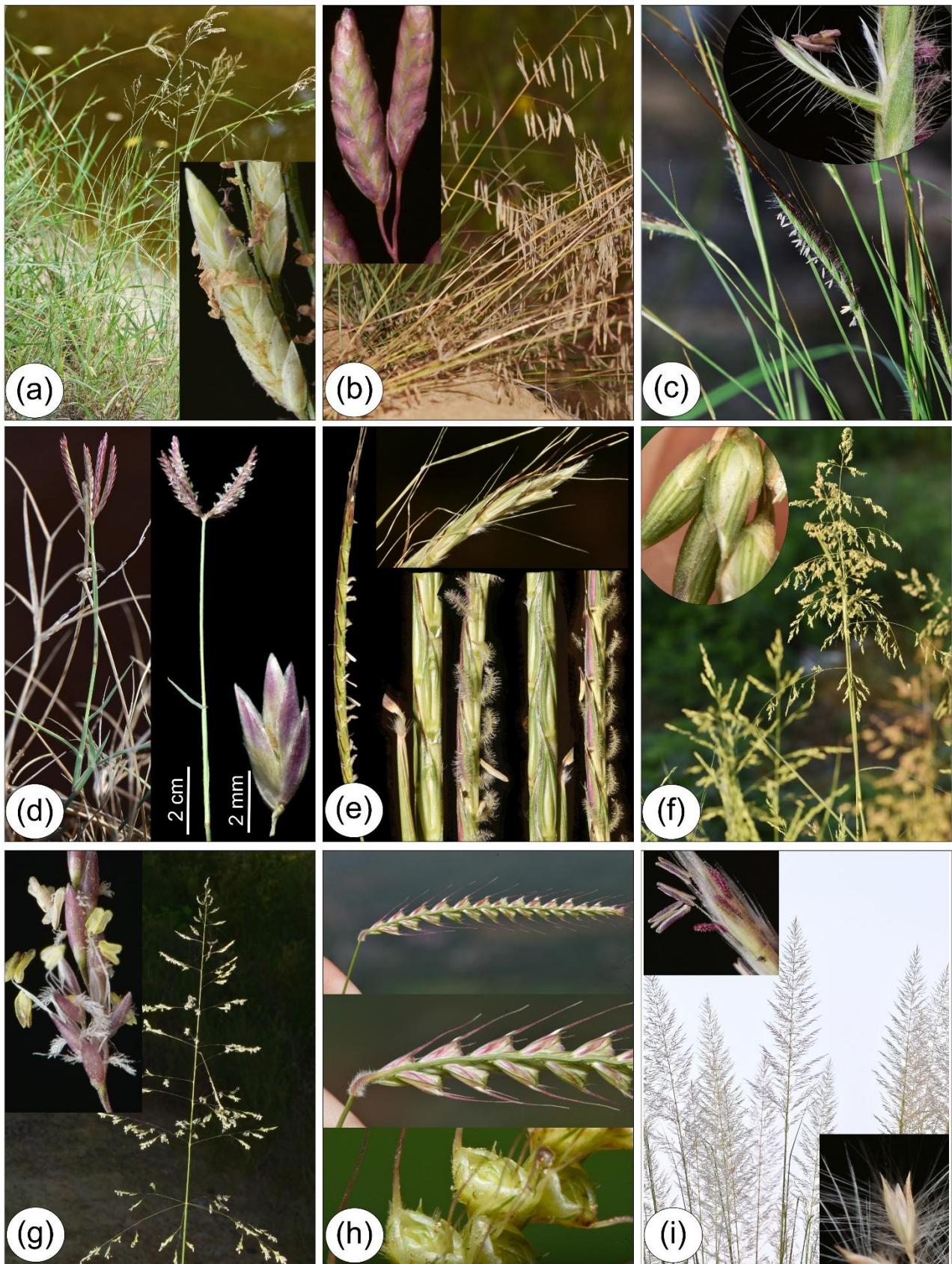


Plate 2: (a) *Eragrostis atrovirens*, (b) *Eragrostis tremula*, (c) *Heteropogon contortus*, (d) *Ochthochloa compressa*, (e) *Sehima nervosa*, (f) *Sporobolus helvolus*, (g) *Sporobolus marginatus*, (h) *Tetrapogon tenellus*, (i) *Tripsidium bengalense*.

DISCUSSION

Desertification poses a serious and growing threat to southern Haryana, as highlighted by satellite and field data. ISRO's Desertification and Land Degradation Atlas (2021) noted that about 8.2% of Haryana's land, around 3.6 lakh hectares, had "degraded to become more arid" by 2018–19. This trend has accelerated over the last two decades, with degraded area increasing by 0.5–0.6% in each ISRO reporting cycle. Wind erosion was identified as the main driver, affecting roughly 3.4% of the state's land. This degradation, which involves loss of vegetation, declining soil fertility, and poor groundwater recharge, threatens both agricultural productivity and water security. If unchecked, the southwestern districts (e.g., Gurugram, Rewari, Mahendragarh, Mewat, Hisar) are at serious risk of desertification.

Several interconnected factors are accelerating this trend. The degradation of the Aravalli hills, a natural buffer against the Thar Desert, is especially concerning. Deforestation and illegal mining in the Aravallis have stripped the vegetation and porous soils that once trapped sand and recharged aquifers. Scientists link much of the state's desiccation to such quarrying. Meanwhile, over-intensive agriculture, monocultures in former grasslands, fuelwood harvesting, and expanding infrastructure have further weakened the soil's resilience (Singh, 2000). Climate stressors, including erratic monsoons and severe heatwaves (exceeding 45–50°C), intensify soil drying and hinder vegetation recovery. By disrupting the Aravalli's water-absorbing geology, two critical environmental processes are compromised: groundwater recharge is impeded, and Haryana's interior is left vulnerable to hot, dusty southwest winds that raise temperatures and lower aquifer levels.

Grasses play a vital role in combating these processes. Their dense, perennial root systems act as biological armor against wind and water erosion. In arid regions, native grasses "bind the soil from being blown away" (Gupta & Sharma, 1971), cutting erosion rates drastically. Meta-analyses show that grass barriers can double infiltration rates and reduce sediment loss by 40–60%. In one study, planting grasses improved infiltration twofold and reduced soil carbon loss by over 80% (Mandal et al., 2017). By slowing runoff and trapping organic matter, grasses gradually rebuild soil

structure. They also provide fodder and habitat, offering ecosystem services that persist even in degraded landscapes (Gupta & Sharma, 1971; Mandal et al., 2017). Through rapid root turnover, they also contribute significantly to soil organic matter (Giri et al., 2023). Consequently, these resilient plants form the primary forage base that supports both wild and domestic herbivore populations in such water-limited landscapes (Giri et al., 2023; Gibson, 2009). Both native and cultivated perennial grasses have been effectively used in land rehabilitation efforts worldwide. For example, in Kenya's semi-arid rangelands, reseeding degraded areas with *Cenchrus ciliaris* and *Eragrostis superba* led to substantial increases in biomass and soil carbon, reversing degradation trends (Mganga et al., 2021; Mbaabu et al., 2020). In northern China's Horqin Sandy Land, native grasses are reported to be effective in stabilizing sand dunes and halting desert expansion. Similarly, vetiver grass (*Vetiveria zizanioides*), though not native, has been widely adopted in tropical regions for slope stabilization due to its exceptionally deep root system and tolerance of harsh conditions (Truong & Loch, 2004). These global examples affirm that grasses are not only cost-effective natural tools for soil conservation but also vital agents in sustainable dryland ecosystem restoration.

The ecological importance of grasses extends into the winter months, especially in arid and semi-arid landscapes. During this period, when overall plant growth is typically suppressed by low temperatures and limited moisture, certain cool-season or winter-active grass species can become vital. These grasses provide essential green forage when other resources are scarce, sustaining local herbivore populations (Gibson, 2009). Their persistence, even with reduced photosynthetic activity, contributes to carbon fixation and maintains a baseline of primary productivity (Liu et al., 2024). Furthermore, winter grass cover aids in soil moisture conservation by reducing surface evaporation and helps stabilize soil against erosional forces. Their continued life processes, including nutrient uptake and subsequent decomposition, ensure the continuity of nutrient cycling and organic matter input, sustaining vital ecosystem functions during an otherwise quiescent period (Gibson, 2009). Our fieldwork for studying grasses in the southern Haryana suggests that local winter-active grasses contribute significantly to stabilization, especially during dry months. While limited literature exists on

Haryana's grass flora, their roles are consistent with patterns in other arid systems. Winter-growing grasses form vegetative cover when soils are otherwise exposed. Echoing reports from arid Rajasthan, their foliage traps dust, roots stabilize thin soils, and even in dormancy, they preserve biological activity (Gupta & Sharma, 1971). These grasses likely enhance moisture retention and nutrient cycling during dry seasons. In our surveys, grass-covered areas showed noticeably lower erosion and better moisture than barren patches. Though detailed agronomic data are still needed, evidence supports that winter grasses act as ecosystem engineers — stabilizing slopes, enriching soil, and providing critical seasonal fodder (Gupta & Sharma, 1971; Mandal *et al.*, 2017).

To unlock their full potential, multidisciplinary research is essential. Genomic and transcriptomic studies could reveal how native grasses tolerate drought and cold. Research on model species shows that desiccation tolerance often involves activation of seed-like gene networks under stress, including epigenetic regulation (Pardo *et al.*, 2020). Applying this to southern Haryana's grasses may identify novel resilience traits. Concurrently, physiological studies could assess water-use efficiency, osmolyte levels, and root hydraulics. Soil science should examine how these grasses alter microbial communities, texture, and organic carbon levels. Biochemical assays can detect compounds protecting cells during low-moisture winters. Such integrated research would guide grass selection, breeding, and bio-fertilizer development for effective restoration (Pardo *et al.*, 2020).

This grass-based approach aligns with India's Aravalli Green Wall initiative, launched in 2023 to restore 1.1 million hectares of degraded land across Haryana, Rajasthan, Gujarat, and Delhi. Haryana's plan alone targets nearly 25,000 hectares through native species planting and soil-water conservation. The initiative emphasizes using 15–20 site-specific native species, including grasses. Grassland restoration is explicitly part of the plan, aiming to improve soil fertility, water availability, and climate resilience. These goals mirror the functions we observed: soil anchoring, infiltration enhancement, carbon retention, and buffering against climatic extremes. In essence, by restoring foundational grasses, the Green Wall seeks to rebuild the Aravalli's role as a natural shield against the desert. Ensuring the success of this strategy will

require scientific understanding, adaptive management, and sustained monitoring of these grasses in Haryana's changing landscapes.

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Conflict of interest

The authors declare no competing interests.

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Correspondence and requests for materials should be addressed to **Singh Nidhan**

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