Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci.
https://doi.org/10.1007/s40011-024-01629-w

RESEARCH ARTICLE

Grass Flora of Porbandar District, Gujarat, India

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Received: 12 April 2023 / Revised: 23 June 2023 / Accepted: 4 April 2024

Abstract Grasses, with their remarkable abundance and ubiquitous presence, are among the most widespread and diverse group of flowering plants found in a variety of ecosystems. Grasses are members of the Poaceae (Gramineae) family and are integral to our daily lives, serving as a vital source of food, medicine, fodder for livestock, as well as playing a significant role in many other aspects. This article presents a checklist of grasses in Porbandar, a district located in the state of Gujarat, India. A total of 82 species of grasses were recorded, representing 48 genera under 13 tribes. Among the identified species, the dominant genera are *Setaria*, *Chloris*, *Eragrostis* and *Panicum*. The study also identified several threats to the survival of the grasses in Porbandar, such as habitat loss due to mining and urbanization, overgrazing, and the invasion of exotic plant species, and highlights the socio-economic utilization of the recorded grass species.

Significance Statement: Grass flora plays a significant role in our socio-economic development, providing valuable resources such as food, fodder, fiber, fuel, and medicine, as well as supporting essential ecosystem services like soil conservation and carbon sequestration. With its vast diversity, adaptability, and resilience, grasses are an integral part of our natural and cultural heritage, and their conservation and sustainable management are critical for ensuring the well-being of present and future generations. In this paper, we present a comprehensive checklist of grass species, highlighting their economic importance and traditional uses, and discuss the challenges and opportunities for their conservation and utilization in the context of global environmental change and development needs.

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Keywords Checklist · Grasses · Poaceae · Porbandar

Introduction

Grasses are a ubiquitous and diverse group of flowering plants that play a crucial role in the world's ecosystems. They are important for soil stabilization, carbon sequestration, and as a source of food, fodder, fuel, and fiber for human populations and wildlife [1]. However, grasses are often overlooked in studies of plant diversity, and their ecological and economic significance is not well recognized.

Porbandar district located in the western part of Gujarat, India, is known for its rich and diverse flora, including grasses. However, it can be observed from previous literatures [4, 10], that there has been limited research on the composition and distribution of grasses in the area, which limits our understanding of their importance and potential threats to their survival.

The aim of this study was to contribute to the growing body of knowledge on the grass flora of Porbandar by conducting a comprehensive survey to compile a checklist of grass species in the district. Additionally, it aimed to investigate the ecological and economic importance of grasses in Porbandar, including their role in soil conservation, livestock grazing, and traditional cottage industries. Also, highlighting the need for their conservation and management.

Study Area

Porbandar is a district located in the southwestern part of the Saurashtra Peninsula in Gujarat State, India (Fig. 1). The district is primarily agrarian, with agriculture and animal husbandry being the major occupations [2]. Porbandar is known for its rich and diverse flora, which play a critical

Published online: 15 June 2024

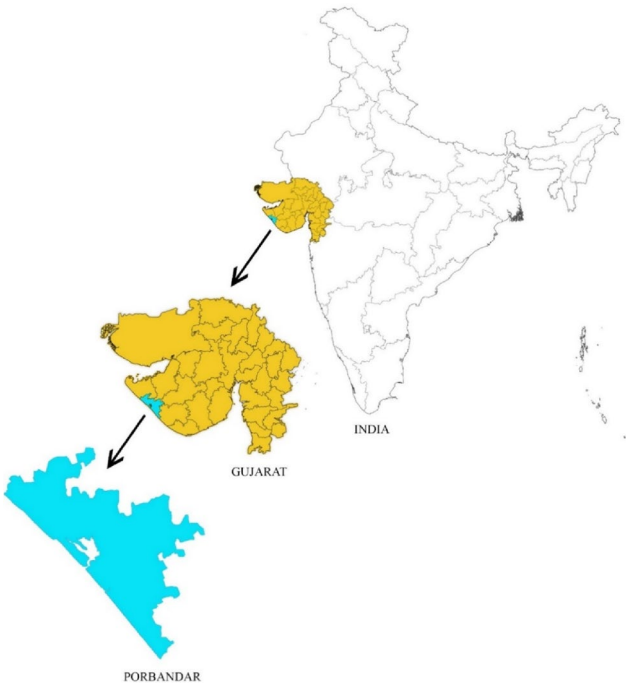

Fig. 1 Location map of study area

role in the local ecosystems and human well-being. Figure 2 shows the general vegetation in the different habitats.

The district is divided into three talukas, namely Porbandar, Ranavav, and Kutiyana, and is bounded by Devbhumi Dwarka district on the north, Junagadh district on the south, Rajkot district on the east, and the Arabian Sea on the west. The geographic area of this district is about 1,97,419 ha, which includes the important Barda forest [3].

Material and Methods

The study area was explored from July 2021 to March 2022, covering all three talukas of Porbandar. The frequent field trips were planned to collect plant specimens during their flowering and fruiting stages with the aim of obtaining a comprehensive understanding of the grass flora of Porbandar and ensuring that the maximum diversity of species was sampled. Plant specimens collected during the study were identified using various local floras, including those by Thaker, Shah, Bhandari, Bole and Pathak, and eFloras [4–8]. The most up-to-date nomenclature was confirmed using, World Flora Online website [9]. Information about scio-economic utilization was collected through interviews. All the herbarium specimens have been deposited in the Department of Life Sciences, Bhakta Kavi Narsinh Mehta University, Junagadh for future reference.

Results and Discussion

A total of 82 species were recorded from the area. These belongs to 48 genera of 13 tribes from 2 groups (Table 1). Figure 3 shows No. of Genera per Tribe.

The most dominant genus is *Setaria* (5 Species), followed by *Chloris*, *Eragrostis, Panicum* (4 species each), *Brachiaria, Cymbopogon, Dactyloctenium, Digitaria, Saccharum* (3 species each), *Arthraxon, Bothriochloa, Cenchrus, Echinochloa, Eleusine, Paspalidium, Pennisetum, Sorghum, Sporobolus, Triticum, Zoysia* (2 species each) and *Aeluropus, Apluda, Aristida, Avena, Bambusa, Chrysopogon, Cynodon, Dendrocalamus, Desmostachya, Dichanthium, Dimeria, Dinebra, Eremopogon, Eriochloa, Halopyrum, Heteropogon, Hordeum, Imperata, Ischaemum, Iseilema, Melanocenchris, Paspalum, Phragmites, Tetrapogon, Tragus, Urochloa and Zea* (1 species each). Figure 4 shows major genera with their no. of species.

A comparison between the grass flora of Porbandar district and that of Gujarat, as reported by Shah [5], revealed that 32% of the species found in Gujarat are also present in Porbandar district, while six species were newly recorded (Table 2). In addition, 20 species are newly recorded in Porbandar district when compared to the work of Nagar [10] (Table 3). Figure 5 Shows photos of the some newly recorded grass species compared to that of Nagar and Shah.

Socio-Economic Utilization

Grasses are the most important source of fodder for livestock, especially in the agrarian communities of Porbandar district. The present study recorded 82 grass species, out of which 23 were found to be highly palatable, 19 moderately palatable, and 33 species were least palatable. Additionally, seven grass species were deemed unpalatable (Table 1). Out of the 23 highly palatable species, it was found that 4 of them were being cultivated by local farmers for use as fodder, these include *Dichanthium annulatum, Panicum miliaceum, Pennisetum purpureum*, and *Zea mays*. The palatability of

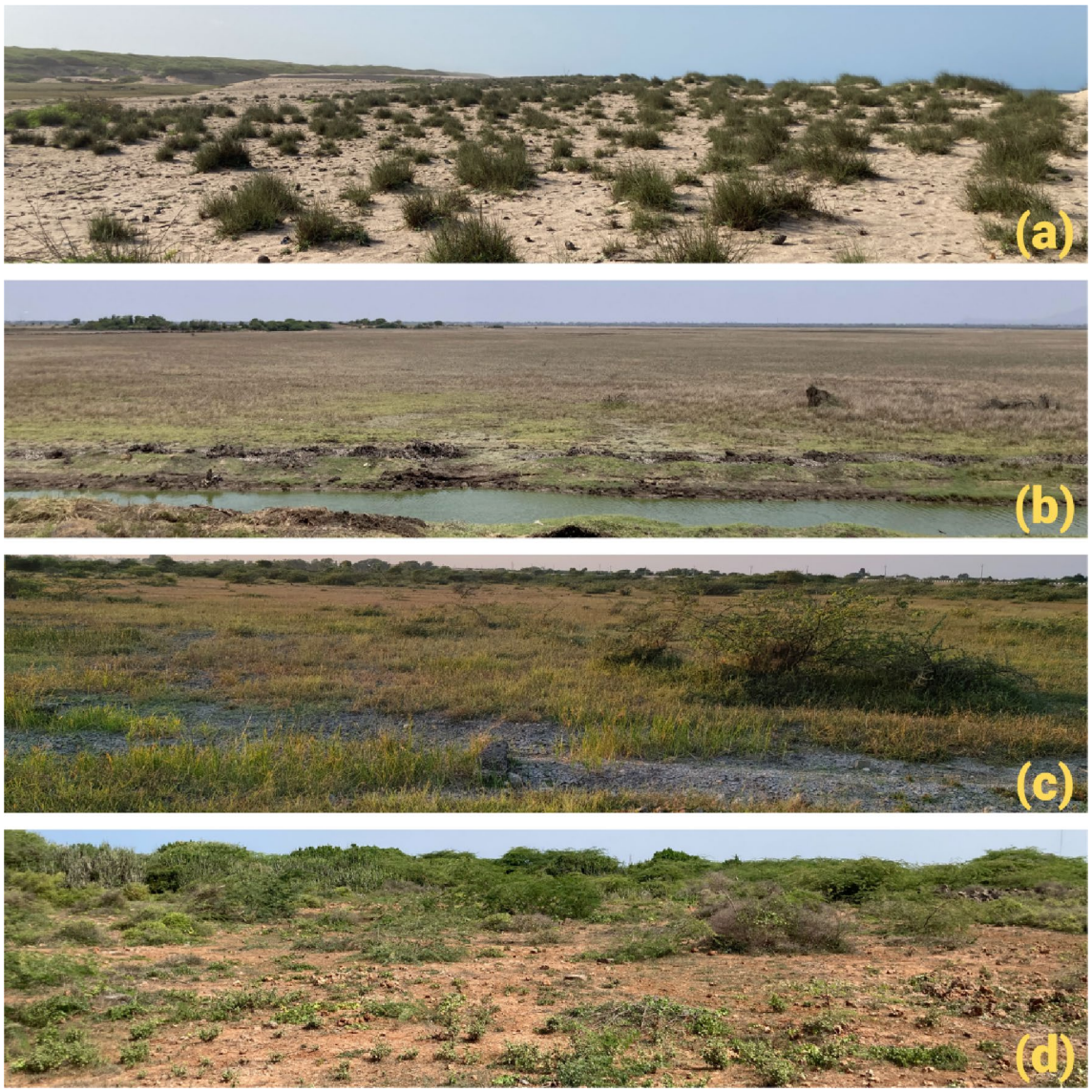

Fig. 2 Different habitats showing general vegetation (**a** Sandy Sea Shore, **b** Seasonal Grassland, **c** Wasteland d. Rocky area)

grasses is an important factor for the socio-economic utilization of grasses as a source of food for livestock. In fact, the nutritional value of grasses is crucial for the growth and productivity of livestock, making it an essential component of the animal husbandry sector.

Nine species out of the recorded 82 species are being cultivated as crops. These crops play a vital role in the sustenance of the rural population in the region and are an important source of income for small-scale farmers. These cultivated species include *Avena barbata, Eleusine coracana, Hordeum vulgare, Pennisetum typhoides, Saccharum officinarum, Setaria italica, Sorghum bicolor, Triticum aestivum,* and *Triticum dicoccum*.

Species with miscellaneous utilization (Fig. 6) include, *Zoysia japonica* used as a lawn grass. While *Cymbopogon citratus* is cultivated for the purpose of tea flavoring agent in home gardens. Grains of *Echinochloa colona* and *Echinochloa crus-galli* are edible and eaten during the fast. Farmers grow *Saccharum bengalense* and *Sorghum halepense* on the boundaries of agricultural fields to prevent soil erosion.

Table 1 Checklist of grass flora of Porbandar district

S. No.	Species name	Habitat	Distribution status	Collection no.	Palatability
1.	*Aeluropus lagopoides* (L.) Thwaites	SS	Very Common	49	Un-Palatable
2.	*Andropogon pumilus* Roxb.	WL	Uncommon	62	High
3.	*Apluda mutica* L.	WL, RS	Common	11	Low
4.	*Aristida funiculata* Trin. & Rupr.	WL	Common	2	Un-Palatable
5.	*Arthraxon lancifolius* (Trin.) Hochst.	WL, H	Common	56	Moderate
6.	*Arthraxon prionodes* (Steud.) Dandy	WL, RS, H	Common	82	Moderate
7.	*Avena barbata* Pott ex Link	CL	Uncommon	72	Low
8.	*Bambusa bambos* (L.) Voss.	CL	Common	81	Low
9.	*Bothriochloa glabra* (Roxb.) A. Camus	BR	Common	46	High
10.	*Bothriochloa intermedia* (R.Br.) A. Camus	WL	Common	24	High
11.	*Brachiaria eruciformis* (Sm.) Griseb.	WL	Common	13	High
12.	*Brachiaria ramosa* (L.) Stapf	WL, H	Very Common	21	High
13.	*Brachiaria reptans* (L.) Gatd. & C.E. Hubb.	CL, WL	Common	8	High
14.	*Cenchrus ciliaris* L.	WL	Common	9	High
15.	*Cenchrus setiger* Vahl	WL	Common	14	High
16.	*Chloris barbata* Sw.	WL	Very Common	33	Low
17.	*Chloris dolichostachya* Lagasca.	H	Common	69	Low
18.	*Chloris quinquesetica* Bhide	BR	Uncommon	70	Low
19.	*Chloris virgata* Sw.	WL	Common	1	Moderate
20.	*Chrysopogon fulvus* (Spreng.) Chiov.	H	Common	44	High
21.	*Cymbopogon citratus* (DC.) Stapf	CL	Common	71	Un-Palatable
22.	*Cymbopogon gidarba* (Buch.-Ham. ex Steud.) A.Camus	WL	Common	54	Low
23.	*Cymbopogon martinii* (Roxb.) Wats.	H	Very Common	80	Low
24.	*Cynodon dactylon* (L.) Pers.	WL	Very Common	31	High
25.	*Dactyloctenium aegyptium* (L.) Willd.	WL	Very Common	15	High
26.	*Dactyloctenium aristatum* Link	SS	Common	63	Moderate
27.	*Dactyloctenium scindicum* Boiss.	WL, H	Uncommon	64	Moderate
28.	*Dendrocalamus strictus* (Roxb.) Nees	H	Common	51	Low
29.	*Desmostachya bipinnata* (L.) Stapf	WL	Common	26	Un-Palatable
30.	*Dichanthium annulatum* (Forssk.) Stapf	WL, CL	Very Common	37	High
31.	*Digitaria bicornis* (Lam.) Roem. & Schult.	WL	Common	45	High
32.	*Digitaria ciliaris* (Retz.) Koeler	WL	Common	7	Moderate
33.	*Digitaria sanguinalis* (L.) Scop.	WL	Common	41	High
34.	*Dimeria ornithopoda* Trin.	MP	Common	23	Low
35.	*Dinebra retroflexa* (Vahl) Panz.	WL	Common	12	High
36.	*Echinochloa colona* (L.) Link	MP	Common	10	Moderate
37.	*Echinochloa crus-galli* (L.) P.Beauv.	MP	Common	39	Moderate
38.	*Eleusine coracana* (L.) Gaertn.	BR	Common	73	Moderate
39.	*Eleusine indica* (L.) Gaertn.	WL	Uncommon	32	Moderate
40.	*Eragrostis ciliaris* (L.) R.Br.	WL	Common	16	Moderate
41.	*Eragrostis tenella* (L.) Beauv. ex Roem. & Schult.	WL	Uncommon	22	Moderate
42.	*Eragrostis unioloides* (Retz.) Nees ex Steud.	MP	Common	48	Moderate
43.	*Eragrostis viscosa* (Retz.) Trin.	MP	Common	19	Moderate
44.	*Eremopogon foveolatus* (Del.) Stapf	H	Common	66	High
45.	*Eriochloa procera* (Retz.) C.E. Hubbard	MP	Uncommon	65	Moderate
46.	*Halopyrum mucronatum* (L.) Stapf	SS	Uncommon	50	Un-Palatable
47.	*Heteropogon contortus* (L.) P.Beauv. ex Roem. & Schult.	WL	Common	57	Moderate
48.	*Hordeum vulgare* L.	CL	Common	74	Low
49.	*Imperata cylindrica* (L.) P.Beauv.	MP	Uncommon	83	Low
50.	*Ischaemum rugosum* Salisb.	WL	Common	30	Moderate

Table 1 (continued)

S. No.	Species name	Habitat	Distribution status	Collection no.	Palatability
51.	*Iseilema prostratum* (L.) Andersson	MP	Common	36	Low
52.	*Melanocenchris jacquemontii* Jaub. & Spach	H	Common	34	Low
53.	*Panicum antidotale* Retz.	MP	Common	29	High
54.	*Panicum miliaceum* Blanco	CL	Uncommon	59	High
55.	*Panicum notatum* Retz.	BR	Uncommon	52	Low
56.	*Panicum psilopodium* Trin.	WL	Occasional	60	Low
57.	*Paspalidium flavidum* (Retz.) A.Camus	WL	Common	35	Low
58.	*Paspalidium geminatum* (Forssk.) Stapf	BR, BP	Common	47	Low
59.	*Paspalum distichum* L.	SS	Common	68	Low
60.	*Pennisetum purpureum* Schumach.	CL	Common	25	High
61.	*Pennisetum typhoides* (Burm.) Stapf&C.E. Hubb.	CL	Common	4	Low
62.	*Phragmites karka* (Retz.) Trin. ex Steud.	BR, BP	Common	28	Un-Palatable
63.	*Saccharum bengalense* Retz.	WL	Uncommon	43	Low
64.	*Saccharum officinarum* L.	CL	Common	55	High
65.	*Saccharum spontaneum* L.	WL	Very Rare	61	Un-Palatable
66.	*Setaria glauca* (L.) P. Beauv.	MP	Common	21	Low
67.	*Setaria italica* (L.) P. Beauv.	CL, WL	Common	78	Low
68.	*Setaria pallide-fusca* (Schum.) Stapf&Hubb.	WL	Occasional	18	Low
69.	*Setaria tomentosa* (Roxb.) Kunth	MP	Common	42	Low
70.	*Setaria verticillata* (L.) P.Beauv.	WL	Common	5	Low
71.	*Sorghum bicolor* (L.) Moench.	CL	Common	76	High
72.	*Sorghum halepense* (L.) Pers.	WL	Common	27	Low
73.	*Sporobolus diandrus* (Retz.) P.Beauv.	WL	Common	40	Low
74.	*Sporobolus fertilis* (Steud.) Clayton	WL	Common	5	Moderate
75.	*Tetrapogon villosus* Desf.	WL	Occasional	3	Moderate
76.	*Tragus mongolorum* Ohwi	WL	Occasional	6	Low
77.	*Triticum aestivum* L.	CL	Common	75	Low
78.	*Triticum dicoccum* Schrank ex Schiibil.	CL	Occasional	77	Low
79.	*Urochloa panicoides* P.Beauv.	WL	Occasional	17	High
80.	*Zea mays* L.	CL	Common	79	High
81.	*Zoysia japonica* Steud.	CL	Common	38	Low
82.	*Zoysia matrella* (L.) Merr.	SS	Common	53	Low

WL, waste lands; BR, bunds of river; MP, moist places; CL, cultivated lands; RS, road sides; BP, banks of ponds; H, hillocks; SS, sandy seashore

The juice made from *Saccharum officinarum* is a popular drink among locals during the summer months. A twig of *Dendrocalamus strictus* is planted in front of the house of the bridegroom for performing the marriage rituals. *Cynodon dactylon* and *Desmostachya bipinnata* are believed to be auspicious by the local Hindu communities. Children use the stem of *Phragmites karka* and *Sorghum bicolor* to make toys.

Threats

The grassland area in Porbandar district is rapidly declining due to both natural and human causes. Habitat destruction caused by mining (Fig. 7) and urbanization, as well as uncontrolled grazing, are the major anthropogenic threats to the grasses of district.

On the other hand, invasive or alien species are the most significant natural cause for the decline in population of

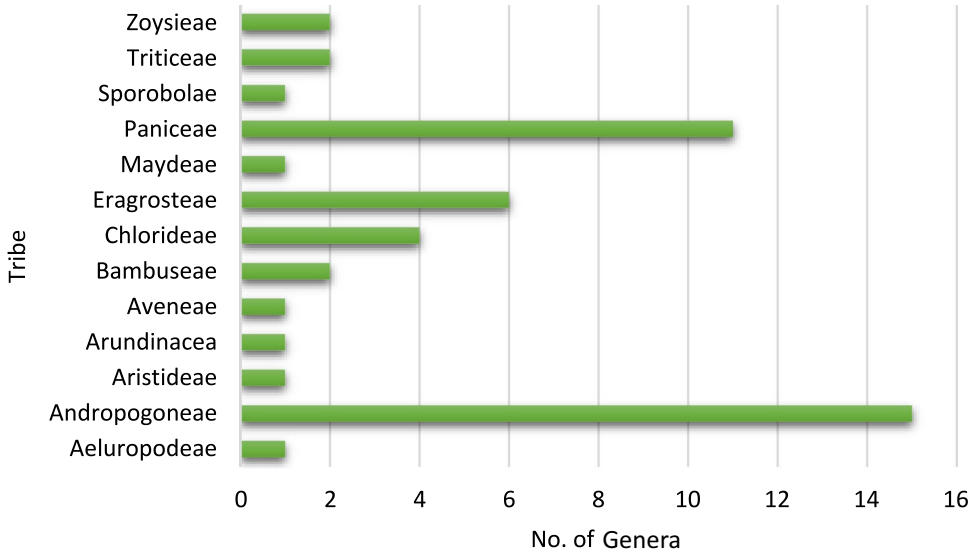

Fig. 3 Tribe and their no. of Genera in Porbandar district

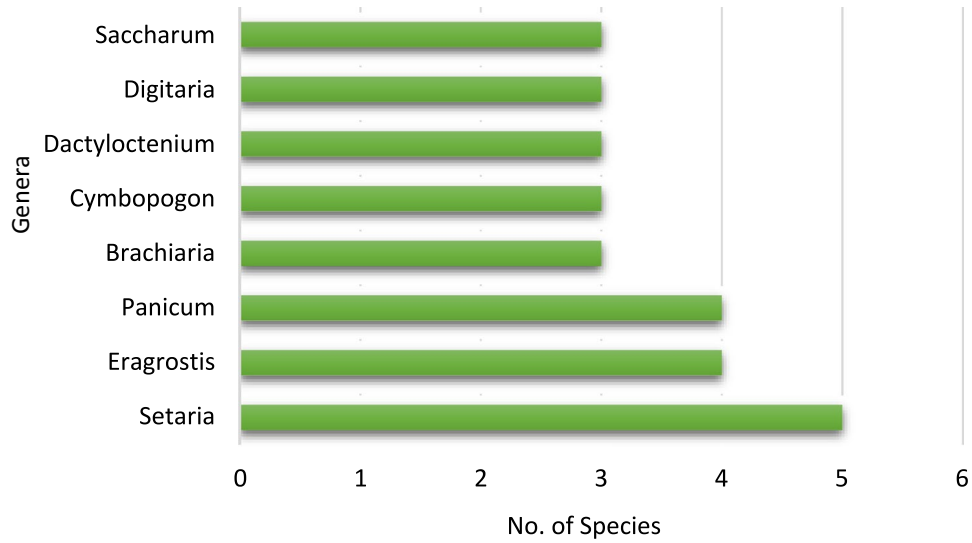

Fig. 4 Major genera with their no. of species in Porbandar district

Table 2 Newly recorded species (Compared with [5])

Sr. No.	Name
1.	*Avena barbata* Pott ex Link
2.	*Dactyloctenium aristatum* Link
3.	*Digitaria ciliaris* (Retz.) Koeler
4.	*Digitaria sanguinalis* (L.) Scop.
5.	*Triticum dicoccum* Schrank ex Schiibil.
6.	*Zoysia japonica* Steud.

grasses. In some cases, even non-invasive species can have negative impact on local plant communities due to environmental favorability. In Porbandar district, a total of five species have been reported to have a negative impact on grasslands which include:

Hyptis suaveolens: Alien and native to Tropical America.

Lantana camara (Dhanidariya): Alien and native to Tropical America.

Table 3 Newly recorded species (Compared with [10])

Sr. No.	Name
1.	*Andropogon pumilus* Roxb.
2.	*Avena barbata* Pott ex Link
3.	*Bothriochloa glabra* (Roxb.) A. Camus
4.	*Brachiaria reptans* (L.) C.A. Gardner & C.E. Hubb.
5.	*Chloris quinquesetica* Bhide
6.	*Cymbopogon gidarba* (Buch.-Ham. ex Steud.) A.Camus
7.	*Dactyloctenium aristatum* Link
8.	*Digitaria bicornis* (Lam.) Roem. & Schult.
9.	*Eleusine coracana* (L.) Gaertn.
10.	*Eragrostis viscosa* (Retz.) Trin.
11.	*Eriochloa procera* (Retz.) C.E. Hubbard
12.	*Panicum antidotale* Retz.
13.	*Panicum miliaceum* Blanco
14.	*Panicum notatum* Retz.
15.	*Panicum psilopodium* Trin.
16.	*Pennisetum purpureum* Schumach.
17.	*Setaria italica* (L.) P. Beauv.
18.	*Tetrapogon villosus* Desf.
19.	*Triticum dicoccum* Schrank ex Schiibil.
20.	*Zoysia japonica* Steud.

Parthenium hysterophorus (Gajar ghas): Alien and native to Tropical America.

Prosopis juliflora (Gando baval): Alien and native to South Africa.

Senna tora (Kuvadio): Non-Alien and native to Asia.

These invasive species, characterized by their aggressive growth and ability to outcompete native grassland plants, can lead to a reduction in grassland biodiversity. They form dense stands or monocultures, displacing native grasses and other plant species thus altering the overall structure and composition of the ecosystem. The loss of plant diversity can disrupt ecological balance and diminish the functioning and resilience of grassland ecosystems. These species also compete with native grasses and other plants for essential resources such as water, nutrients, and sunlight. This competition often results in the suppression of native vegetation, leading to a decline in productivity and the availability of forage for livestock. Livestock grazing can be hindered, affecting the livelihoods of farmers and ranchers and impacting agricultural productivity in grassland areas. *Parthenium hysterophorus* and *Senna tora*, can cause allergic reactions and health issues in humans and animals, impacting the well-being of those living in or near infested areas. Overall, the invasion of these species in grasslands can

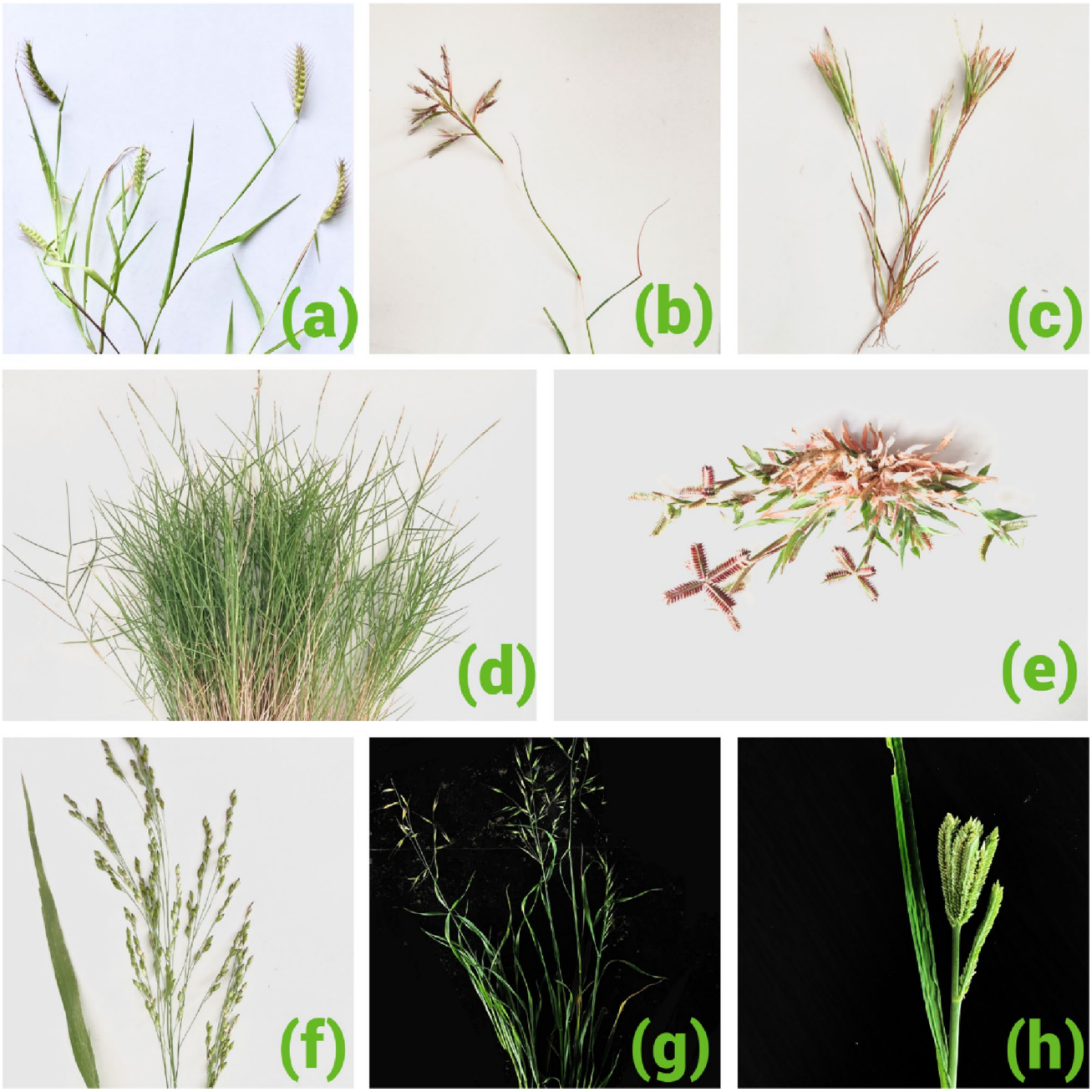

Fig. 5 Some newly recorded grasses after Nagar and Shah (**a** *Tetrapogon villosus*, **b** *Cymbopogon gidarba*, **c** *Andropogon pumilus*, **d** *Zoysia japonica,* **e** *Dactyloctenium aristatum*, **f** *Panicum miliaceum*, **g** *Avena barbata*, **h** *Eleusine coracana*)

Fig. 6 Some miscellaneous utilization of grass species by local communities (**a** Toys made of *Phragmites karka* and *Sorghum bicolor*, **b** juice made from *Saccharum officinarum*, **c** *Cynodon dactylon* in worship, **d** a twig of the *Dendrocalamus strictus* planted in front of the house of the bridegroom)

Fig. 7 Mining activity in the district

result in a range of negative impacts, including reduced biodiversity, altered ecosystem functioning, challenges for livestock grazing, altered soil properties, and potential health issues.

Conclusion

Grasses are a crucial component of the plant diversity in the Porbandar district and play a vital role in the livelihoods of local communities. The declining grassland area in the district due to natural and human causes could have significant implications. Further studies on the impact of these factors on the grassland ecosystem are needed to develop effective conservation strategies. Overall, the findings of this study can help in the development of sustainable grassland management practices and conservation policies in the region.

Acknowledgements The authors acknowledge Dr. Sandip Gamit, Assistant Professor, Department of Life Sciences, Bhakta Kavi Narsinh Mehta University, Junagadh for his constructive suggestions, guidance in technique, and mechanism for field visits. No conflict of interest regarding this manuscript.

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