ISSN: 2287-688X

Annals of
Plant Sciences

Volume 11, Issue 07 (2022) pp. 5252-5269

Research Article

# Ecological Importance and Economic Uses of Selected Native and Invasive Alien Grasses across Five Diverse Anthropo-Ecosystems in the Indian Dry Tropics

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**Abstract**

Due to a significant intrusion of alien grasses from different areas of the world, the vegetation in the dry tropical urban environments of India has seen a dramatic change that has had a significant impact on vegetation structure, ecological processes, and better adaptive potential. Grass species demonstrate a wide variety of environmental tolerance and taxonomic diversity, making them suitable as pioneer species in an ecosystem. The anthropogenic ecosystems of the Meerut district are home to a broad variety of foreign and indigenous grasses as a result of its distinctive topography, bioclimatic conditions, and quick development. The current ecological and taxonomical investigation of various habitats revealed the occurrence and their distribution of 32 species of grasses spread over 4 families, dominated by Poaceae (78.1%) followed by Cyperaceae (15.6), Juncaceae (3.1%), and Typhaceae (3.1%). These aliens' plants through successful naturalization homogenization of floristic structure. In conclusion, the present study revealed a heavy scale of intrusion (40.6%) by the weedy herbs dominated by American alien grasses (18.8%) followed by other continents (Europe, Asia, and Africa) into standing vegetation anthropic sites in urban regions in Indian dry tropics. Which is likely to alter the standing vegetation floristic structure with a larger abundance of alien flora. These grasses have been variously utilized as food, fodder, medicine gene resources, thatch, ropes, paper, traditional cosmetics, soil erosion management, and land reclamation as well as for environmental and societal purposes.

**Keywords:** *Ecology, Spikelet, Taxonomy, Plant invasions, Urban sprawl, Economic importance.*

## Introduction

Tropical ecosystems are thought to be very dynamic and biodiversity-rich, but due to the enormous amount of development taking place here, reports of their fragility are growing, particularly in and near urban and peri-urban ecosystems (Gupta and Narayan, 2011). Urban sprawl, a process that is becoming more common in modern cities and increases the urban edge, or the area where the city and nature come into touch, further raises the likelihood of invasive species spreading. Ecologists must therefore raise public awareness of the issues posed by invasive species in connection with illegal garden waste dumping, focusing in particular on garden owners (Rusterholz. *et al.,* 2012). The historical and most credible work on the classification and identification of grasses describes 242 genera and 1243 species from India (Bor, 1960). A literature study reveals the names of various researchers who carried out extensive research on grasses in the upper Gangetic plains (Duthie, 1883; Raizada, 1961, 1966; Uniyal. *et al.,* 1994; Singh, 2007; Khanna, 2017; Singh and Kumari, 2018;). Low, green, non-woody plants from the Poaceae family, sedge family (Cyperaceae), rush family (Juncaceae), and bulrush family (Typhaceae) make up the grasses. Many members of other flowering plant families resemble grass, but only the approximately 11,290 species and 707 genera in the Poaceae family are true grasses (Clayton. *et al.,* 2012). It is a sizable family of monocotyledonous flowering plants with

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DOI: http://dx.doi.org/10.21746/aps.2022.11.7.6

significant ecological and commercial significance. The angiosperms have a wide range of silica levels, with Poaceaeeae and macrophytes (Schoelynck. *et al.,* 2012) and other allied monocotyledonous commelinid families having the highest concentrations (Hadson. *et al.*,, 2005). Sedges are members of the Cyperaceae family of graminoid (grass-like), monocotyledonous flowering plants. With more than 5000 species spread across 90 genera, the family is enormous (Govaerts. *et al.,* 2007; Christenhusz. *et al.,* 2016). The Juncaceae family of flowering plants is commonly known as the rush family. It is composed of 8 genera and around 464 known species of herbaceous, monocotyledonous, slow-growing plants with rhizomes that externally resemble grasses and sedges (Christenhusz. *et al.,* 2016). A family of flowering plants known as the Typhaceae, they are characterized by having enormous marsh herbs with two ranks of leaves and a brownish compact spike of unisexual flowers.

Of all flowering plants, grasses are the most economically significant due to their nutrient-rich grains and role in soil formation. They also have the greatest global distribution and population. Every climatically suitable habitat that is tenable for the growth of plant communities contains a member of this category (Ahmad. *et al.,* 2010). Grasses provide human food, construction materials, furniture, cutlery, wildlife habitats, and feed for grazing animals. Some species are used as garden ornaments, grass for lawns and recreational areas, or cover plants for erosion prevention. The majority of grasses feature blade-like leaves, spherical stems with hollow joints, and fibrous root systems with numerous branches. There has been little attempt to investigate anthropogenic habitats concerning the success of the alien grasses' intrusion into the urban region. The present study aimed to examine the morphology, diversity, nativity, ecology, and uses of these alien and native grasses in different vegetation patches, across five diverse habitat conditions in a dry tropical urban region.

## Materials and Methods

### Location and Physiography

National Capital Region has witnessed a rapid upsurge in transportation due to developmental activities in the last 4-5 decades. Meerut is the second-largest city in Delhi (NCR), located at (28°57' and 29°02' N lat. and 77°40' and 77°45' E long.), its east and west boundaries are limited by the Ganga and Yamuna rivers. This district is mainly composed of alluvial soil sediments transported and deposited by river action (Ganga, Yamuna, and Hindon) from the Himalayan region. Meerut is a major agricultural region where sugarcane, wheat, maize, paddy, vegetables, and fruit orchards are cultivated in abundance. In recent years, the most explosive developmental activities have occurred in this region, many of which are prominent industries in the city are textile, tires, sugar, transformer, chemicals, pharmaceutical, distillery, paper, engineering, sports goods, and publishing. The study area has three major seasons: rainy (Jul-Oct), winter (Nov-Feb), and summer (Mar-Jun). Extreme dryness with an intensely hot summer (44.5°C) and cold winter (2.5°C) is the characteristic of its climate. Annual mean rainfall was 784.8 mm received mostly during monsoon (Jul-Oct). The daily relative humidity varied from 9 to 100%. Five permanent study sites representing diverse habitat conditions were selected for investigation in this study viz. (1) University campus (UC), (2) River bank (RB), (3) Brick kiln (BK), (4) Wasteland (WL), and (5) Road Side (RS).

### Floristic Survey

The floristic composition of five anthropogenic study sites was seasonally recorded for three years from April 2018 to March 2021 in a frequent manner. The collected grasses were identified on a morphological basis according to available literature (Bor, 1960; Sharma, 1980; Gaur, 1999; Singh, 2007; Clayton. *et al.,* 2012) and the regional flora of Duthie (1883). These species were listed alphabetically in tubular form with family, nativity, habitats, ecology, and also its uses. Names and families of listed

plant species were updated using the "Plants of the world online" (POWO) (https://powo.science.kew.org) taxonomic database. The nativity, ecology, and uses of these grasses have been confirmed from the published literature and online available database (Negi and Hajra, 2007; Khuroo. *et al.,* 2007; Reddy. *et al.,* 2008; Khanna, 2009; Singh. *et al.,* 2010; Joshi and Rawat, 2011; Sekar, 2012; Kumar and Bihari, 2015; Agrawal and Narayan, 2017; https://powo.science.kew.org, https://www.ipni.org, https://www.cabi.org).

**Table 1:** List of grass diversity recorded across five different anthropic habitats in a dry tropical urban region of Meerut, India

| Plant species | Family | Nativity | Habitats | Ecology | Uses |
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| *Avena sativa* L. | Poaceae | Asia | UC, RS | Soil improvement. | Major cereal for food products and it is fodder crop from ancient times. Since ancient times, it used to cure dry skin in cosmetics, beverage bases, and soil improvement. |
| *Cenchrus ciliaris* L. | Poaceae | India | UC | Control erosion, reclaim land, enhance the landscape, replant, conserve soil, and improve the soil. | As animal food, poison, medicine, gene resources, and environmental uses. |
| *Cenchrus setiger* Vahl | Poaceae | India | UC | Drought-tolerant, resistant to heat and cold, grows in a range of soils, sandy, sandy loam, stony, murram (Calcium carbonate) to alkaline. | Cut for feed, hay, or silage three to four times a year, produce on average 1-1.5 tonnes/hectare dry forage. Highly nutritious, especially beneficial for livestock that produces milk. |
| *Chloris barbata* Sw. | Poaceae | Tropical America | WL | Described as erect or stoloniferous, annual or perennial, roots at the nodes, propagates primarily by seed. It is a plant that prefers somewhat dry environments, frequents coastal areas, and appears to be resistant to | Animal food and medicinal use. |

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| | | | | salinity. | |
| *Coix lacryma-Jobi* L. | Poaceae | India | BK | 0-2000 m above sea level; stream sides and swampy areas; occasionally cultivated as a source of beads. | Utilized as animal feed, medicine, and invertebrate food, as well as for environmental and societal purposes. |
| *Cynodon dactylon* (L.) Pers. | Poaceae | India | UC, RB, BK, WL, RS | Artificial - terrestrial, forest and woodland, savanna, shrubland, native grassland | Used as animal food, poison, medicine (wound, relief to dysentery, piles, and cough), and environmental and social uses. |
| *Cyperus alopecuroides* Rottb. | Cyperaceae | Africa | RB, WL | Swamps, seasonally wet grasslands, and old cultivations; up to 1800 m above sea level. This grass reclaimed the saline soil. | Used as antibiotics, and its paste is applied for the treatment of cutaneous affections. Also used for thatching houses, sheds, mats, and packaging materials for transport. |
| *Cyperus compressus* L. | Cyperaceae | India | UC, RB, BK, WL | Annual weed that often grows in medium-sized to large patches in waste areas and rice fields. It spreads through seeds and rhizome fragmentation only very infrequently. | Used animal food, Ornamental plants, vegetables, essential oils medicine, and environmental uses. |
| *Cyperus difformis* L. | Cyperaceae | Tropical | BK, WL | Natural wetlands, local vegetation, | Used as food, |

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| | | America | | marshes, and flooded places may be affected. This fast-growing weed can quickly create dense colonies that smother native vegetation due to its intense seed output and high seedling density. | medicine, and gene resources. |
| *Cyperus iria* L. | Cyperaceae | Tropical America | RB, BK | Annual sedge that occasionally acts like a perennial. A big plant can produce up to 5000 offspring, and it reproduces from seed. These seeds go into secondary dormancy when stored in soil that is immersed, in darkness, or at a low temperature. | Used animal food and medicine. Stimulant, tonic, astringent, stomachic. |
| *Cyperus rotundus* L. | Cyperaceae | Europe | RB, BK, WL, RS | Due to its $C_4$ metabolism, *Cyperus rotundus* is reportedly more competitive. The development of a tuber's apical bud marks the beginning of its usual life cycle. The basal bulb forms when the tuber shoot expands and swells to generate an aerial shoot and roots from the basal bulb. | Used as animal food, poison, medicine (fever, dysentery, and stomach ache), and gene resources, it helps to bind the soil. Pharmaceutical companies use it to make diuretics, anthelmintics, and medications for fever, bronchial asthma, and coughs. |
| *Dactyloctenium aegyptium* (L.) Willd. | Poaceae | India | UC, RB, BK, WL, RS | Although it is a tasty pioneer weed grass found in disturbed areas (gardens, roadsides, and cultivated lands) throughout many tropical and subtropical nations. It grows from sea level to 2100 m in regions with 400-1500 mm of annual | Used as animal food, poison, medicine, gene resources, and environmental uses. In areas of |

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| | | | | precipitation. It can adapt to a variety of soil types but disturbed regions on the sand to sandy loam soils are where it excels. | Africa and India where there has been famine, it has been utilized as a cereal substitute. In Haryana, it serves as fuel, feed, and soil stabilizer to prevent erosion of sandy soils. |
| *Desmostachya bipinnata* (L.) Stapf | Poaceae | India | RB, BK, RS | Particularly on sodic and alkaline soils, the existence of *D. bipinnata* seems to have positive effects on the environment by increasing soil organic matter. It has been demonstrated that the physical, chemical and biological characteristics of sodic soil can be improved by combining this grass with agroforestry species. | Outstanding sand binder, preventing soil erosion, and revegetating lands in northern India. Used to make rough rope and brooms, and for fiber. The pulp can be used to make paper. Young shoots, which have a 6.75 percent crude protein content, make suitable food for buffalo in arid regions. It has medicinal uses as a diuretic, a mild stimulant, and a treatment for dysentery and urinogenital |

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| | | | | | problems. |
| *Dichanthium annulatum* (Forssk.) Starf | Poaceae | India | UC, BK | Thrives in dry to wet settings from sea level to 1600 m, with annual mean temperatures ranging from 12.5°C to 27.5°C and 300 to 1400 mm of mean annual rainfall. It is also suited to a wide range of soil conditions, from neutral to alkaline sand to heavy soil. It can withstand seasonal fire, salt, and poor drainage but not waterlogged conditions. | It is one of the most commercially successful fodder grasses, notably in India. It is frequently cultivated as hay and silage grass as well as pasture for grazing. Also used as medicine, gene resources, and utilized to restore degraded grasslands and control soil erosion on sloped areas. |
| *Digitaria sanguinalis* (L.) Scop. | Poaceae | India | UC, RB, BK, WL, RS | Late spring and summer-germinating annual $C_4$ plant. Large regions are covered by mature plants, which create a tuft or mulch 40-60 cm deep. For this species to emerge, the ideal conditions for temperature, soil moisture, and seed depth are 25-35°C, 80-100%, and 0-2 cm, respectively. | Used as animal food, medicine, and gene resources. In the Middle Ages, it was grown as a food crop and used as forage in pasture production. |
| *Echinochloa colonum* (L.) Link | Poaceae | South America | UC, RB, BK, WL | Typically found in moist, fertile soils where it grows quickly and produces a lot of beautiful foliage. Drought causes it to become prostrate and eventually die. For germination, it needed a fair amount of moisture. | Used as animal food, poison, medicine, gene resources, and environmental uses. One of the |

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| | | | | | best fodder grasses for milking cattle is cut three to four times throughout the wet season. The seeds are used as a substitute for rice in Rajasthan, India, where they are boiled in water. |
| *Eleusine indica* (L.) Gaertn. | Poaceae | India | UC, RB, BK, WL, RS | $C_4$ physiology and grows very quickly in direct sunshine. Shading this weed significantly decreased plant dry weight. Flowering is delayed by drought and low temperatures. Frost kills newly emerged plants. | It has functions in the environment, in society, as a toxin, as a medicine (dysentery, constipation), as food for animals, and as a treatment for unidentified medical illnesses. The whole plant is used for making ropes and mats. |
| *Eragrostis tenella* (L.) P.Beauv. Ex Roem. & Schult. | Poaceae | India | UC, RB, BK, WL | Widespread in the savanna biome and grows like a weed on moist sandy soils in disturbed areas like path sides, cultivated lands, river banks, lake shores, and coastal dunes: 0-1160 m | Used as animal food, and medicine. Grass that is good for grazing. |
| *Imperata cylindrica* (L.) P.Beauv. | Poaceae | Tropical America | UC, BK, RS | Disturbed ecosystems, including cultivated lands. | Soil erosion management, thatch, ropes, paper, traditional medicine, |

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| | | | | | cosmetics, and lan d reclamation. |
| *Juncus bufonius* L. | Juncaceae | Europe | BK | They frequently flourish in a variety of moisture conditions and on infertile soils. Most rushes are perennials, while a few, like *Juncus bufonius*, are annuals. | Used as animal food, medicine, and environmental uses. |
| *Megathyrsus maximus* (Jacq.) B.K.Simon & S.W.L. Jacobs | Poaceae | Asia, Africa | UC, RB, BK, WL, RS | It displaces natural native grasslands and other plants. Because it resists drought, it tolerates fire. In South-East Asia, long leaves serve as nesting material for birds like the Baya Weaver and as food for birds like Munias. They also serve as hiding places for smaller species and prevent soil erosion on slopes. *M. maximus* forms dense tussocks on a variety of soil types. | As animal food, medicine, and environmental uses. |
| *Oplismenus undulatifolius* (Ard.) P.Beauv. | Poaceae | India | UC | Perennial herbs, grow remarkably well in a variety of soil types, in wet, shady environments. | Antioxidant activity. |
| *Phalaris minor* Retz. | Poaceae | India | WL, RS | A plant that competes with many crops. Wheat has been adversely affected by *P. minor* root exudates. Below 5°C or above 30°C temperatures, no germination takes place. Its seeds survive under the anaerobic conditions produced by rice cultivation during the summer months in the Indo-Gangetic plains. | As animal food, medicine, and gene resources. |
| *Poa annua* L. | Poaceae | Europe | UC | It is widespread in tropical areas on a variety of agricultural soils and grassland, from lowland to mountain pastures (up to 1213 m altitude). It can withstand a variety of soil types and moderate to severe frost. | It offers some feed in very barren grassland. It has been developed in the USA in varieties specifically for use on golf tees and |

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| | | | | | greens, where it frequently predominates. |
| *Saccharum spontaneum* L. | Poaceae | Asia | UC, RB | Perennial plants can reproduce vegetatively (Rhizomes and stem fragments) or from seed. The callus hairs that create a parachute system help wind-borne seed dispersal. After the first rains of the rainy season in India, germination, and emergence take place in June or July. A xerophilous type grows on dry, sandy soils, and an intermediate form grows on loamy soils. | Used to make rope, matting, and brooms, hemp makes excellent thatching material and is an excellent source of feed. Paper made from pulp can be used for grease-proofing, writing, printing, and wrapping. It makes a superior mulching material due to its slow rate of breakdown. Countless therapeutic applications and priceless breeding resources. |
| *Setaria pumila* (Poir.) Roem. & Schult. | Poaceae | India | UC | Shrubland, and artificial- terrestrial. | Used as animal food, poison, medicine, and gene resources. |
| *Setaria verticillata* (L.) P. Beauv. | Poaceae | India | UC, RB, BK, WL, RS | Annual grass with $C_4$ physiology typically grows in full sunlight and is adaptable to a wide variety of soil types with low and high fertility, with a pH range of 6.1 to 8.0. | Used as animal food, poison, medicine, gene resources, and social uses. |

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| *Triticum aestivum* L. | Poaceae | India | WL | The altitude ranges from 2000 to 3000 m. | Most important economic plant, crop wild relatives may have desirable features that are used in breeding programs; they are also used in crafts and to decorate wooden items. |
| *Typha angustifolia* L. | Typhaceae | Tropical America | RB | Dominant competitors in wetlands, colonize areas newly exposed. | Rhizomes are edible and preserve starch grains. Its stems and leaves are used for ropes, mats, and baskets in northern India. Eaten by wetland mammals, birds use the seed hairs as nest lining. |
| *Urochloa lata* (Schumach.) C.E.Hubb. | Poaceae | India | RB | Saxicolous plants also grow in cultivated and disturbed soil. | Used as forages and accumulate a higher amount of heavy metal. |
| *Urochloa ramosa* (L.) T.Q. Nguyen | Poaceae | India | UC, RB, BK, WL, RS | Common in waste places and agricultural fields; clay, dry and wet sandy clay. | Antioxidant, anti-inflammatory, antimicrobial drug of natural origin. Source of chemotherapeutic agents in the treatment of |

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| | | | | | tumors. |
| *Urochloa reptans* (L.) Stapf | Poaceae | India | RB | Infest disturbed sites, degraded woods, coastal regions, river and creek beds, riparian woodlands, agricultural lands, and pastures, at elevations ranging from sea level up to 1500 m. | It's been used as animal food and medicine. |

*India category includes all those plants whose origin is in India as well as in any other country/continent at the same time.

Site code: UC-University campus; RB-River bank; BK-Brick kiln; WL-Waste land; RS-Road side.

*Chloris barbata*

*Cyperus alopecuroides*

*Cyperus difformis*

*Cyperus iria*

*Cyperus rotundus*

*Echinochloa colonum*


Photo plate showing the distribution of alien grasses, sedges, and rushes in diverse anthropo-ecosystems in Meerut, India

**Results and Discussion**

In the present study, a total of 32 monocotyledonous species distributed over 22 genera and 4 families were recorded across five different study sites (UC, RB, BK, WL, and RS) in the dry tropical urban region of Meerut. Similarly, the investigation carried out in the Amroha district reported 46 grass species (Singh and Kumari 2018), 65 species of grasses listed from Kishanpur Wildlife Sanctuary (KWLS) Uttar Pradesh (Katiyar. *et al*., 2022), 20 grass species in Kinnaur, Himachal Pradesh (Kumari and Saggoo 2015), and 30 grass species in Kanyakumari district, Tamilnadu, India (Sherin and Vimala 2018). The Poaceae (25) top dominant family accounted for (78.1%) followed by Cyperaceae (5), Juncaceae (1), and Typhaceae (1) grass species. The recorded grasses in terms of nativity belonged to seven different bio-geographic regions (Fig. 2). Among these, native grasses contributed about 59.4% and alien intrusion 40.6% in standing vegetation. The American continent contributed the largest number (18.8%) of exotic weedy herbs followed by other continents 9.4 % Europe, 6.3% Asia, and Asia-Africa, Africa (3.1% each), into standing vegetation anthropic sites in urban regions in Indian dry tropics. Some species of grasses are also invasive (Kumari. *et*

*al.*, 2016, 2018) in a study of Amroha district grasses, Uttar Pradesh.

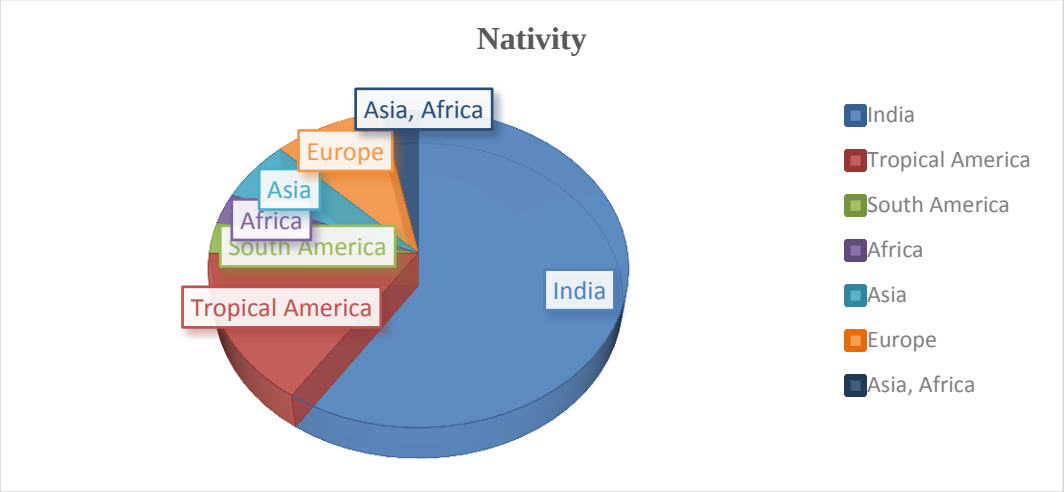


**Figure 2:** Nativity analysis of grasses across five diverse habitats in Indian dry tropics.

It demonstrates how alien grasses are encroaching on different urban habitats in the hot climate of India. This study also demonstrates that anthropo-ecosystems in Meerut, are occupied by foreign and indigenous grasses to India (Figure 2). This is not encouraging for the city and its land. The alien grasses and foreign plants that would flourish and prosper in the Indian dry tropical urban zone, if this circumstance persisted would cause the extinction of native grasses. Taxonomic studies of these grasses with their ethnobotanical use and utility are also documented (Mitra and Mukharjee 2009; Dashahre. *et al.*, 2020; Fatima. *et al.*, 2019). Under these conditions, it is important to grow as many kinds of grass of Indian ancestry as possible and to avoid introducing foreign plants into the country's various anthropo-ecosystems. This floristic study also revealed that the studied anthropic ecosystems are rich in weedy alien grasses in the standing vegetation. These alien and native grasses have been variously utilized as food, fodder, medicine, gene resources, thatch, ropes, paper, traditional cosmetics, some of the most economically significant flowering plants, soil erosion management, and land reclamation as well as for environmental and societal purposes (Singh. *et al.*, 2010; Sekar 2012; Kumar and Bihari 2015; Agrawal and Narayan 2017; https://powo.science.kew.org, https://www.ipni.org, https://www.cabi.org). Even though it would be difficult to survive without them, most of the grasses rarely draw attention even though some of them are quite ornamental. The ecological features of alien and native grasses are also examined as they adapt to various environmental conditions and vegetation patches, across five diverse habitat conditions in a dry tropical urban region (Table 1).

## Conclusion

The present ecological and taxonomical study revealed that the studied anthropic ecosystems rich in weedy alien and native grasses have been variously utilized as food, fodder, medicine gene resources, thatch, ropes, paper, traditional cosmetics, and soil erosion management, and land reclamation as well as for environmental and societal purposes.

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**Source of support:** Nil;
**Conflict of interest:** The authors declare no conflict of interests.

**Cite this article as:**
Yadav, C., Maneesh, K.L., Arvind, K. and Rup, N. "Ecological Importance and Economic Uses of Selected Native and Invasive Alien Grasses across Five Diverse Anthropo-Ecosystems in the Indian Dry Tropics." *Annals of Plant Sciences*.11.07 (2022): pp. 5252-5269.

DOI: http://dx.doi.org/10.21746/aps.2022.11.7.6