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AN OVERVIEW OF THE INDIAN GRASSES AND THEIR SIGNIFICANCE

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ABSTRACT

The family Poaceae is one of the largest families of flowering plants. It comprises of about 20% of vegetation and is the most important family to mankind agriculturally, economically and ecologically. The economic importance of grasses in India is presently discussed.

Key words: Grasses, economic importance, Poaceae, India

INTRODUCTION

Grasses belong to the family Poaceae form a natural and homogenous unique group of flowering plants with remarkable diversity (Kabeer & Nair, 2009). Undoubtedly, Poaceae forms the most fascinating family and plays a significant role in the lives of human beings and animals (Mitra and Mukherjee, 2005). The value and culture of cereal grasses dates back to a period when man was emerging from wild beast stage (Gould, 1968; Ahmad et al., 2010). The members of this group are present in all conceivable habitats, suitable for the growth of plant communities, and in every climatic region (Mitra and Mukherjee, 2005). The family Poaceae or Gramineae is one of the largest and nearly ubiquitous families of monocotyledonous flowering plants and also known as grasses. It is fifth largest plant family of the world following the Asteraceae, Orchidaceae, Fabaceae and Rubiaceae. Poaceae includes the cereal grasses, bamboos and the grasses of natural grassland and cultivated lawns (turf) and pasture land. Grasses have hollow stems except at the nodes and narrow alternate leaves borne in two ranks. The lower part of each leaf encloses the stem, forming a leaf-sheath.

Grasses are the dominant vegetation in many habitats, including grassland, salt-marsh, reed swamp and steppes. They also occur as a smaller part of the vegetation in almost every other terrestrial habitat. Grass-dominated biomes are called grasslands. Grasslands include pampas, steppes, and prairies. Grasses provide food to many grazing mammals such as livestock, deer, and elephants as well as to many species of butterflies and moths. Many types of animals eat grass as their main source of food, and are called graminivores include cattle, sheep, horses, rabbits and many invertebrates, such as grasshoppers and the caterpillars of many brown butterflies. Grasses are also eaten by omnivorous or even occasionally by primarily carnivorous animals.

The grasses are represented with ca. 780 genera and around 12,000 species in the world (Christenhusz, and Byng, 2016). Grasslands such as savannah and plain where grasses are dominant are estimated to constitute 40.5% of the land area of the Earth, excluding Greenland and Antarctica. Grasses are also an important part of the vegetation in many other habitats, including wetlands, forests and tundra. The Poaceae are the most economically important plant family, providing staple foods from domesticated cereal crops such as maize (corn), wheat, rice, barley, and millet as well as forage, essential oils, medicinal importance, paper making, building materials (bamboo, thatch, straw) and fuel (ethanol) (Reynolds, 2016).

Grasses used as food resources:

Grasses are directly supply about 60% of the world's food for human consumption In the form of cereal grains. The principal cereals include Wheat, Rice, Maize, Barley, Oats, Sorghum and Rye. *Oryza sativa* (Rice) and *Triticum aestivum* (Wheat) are the staple diet for hundreds of millions of people and grown largely in the tropics, sub-tropics and temperate regions. Several grasses such as *Pennisetum typhoides, Setaria italica, Sorghum* spp., *Zea mays, Panicum miliaceum* are usually grouped together and termed "Millets" are grown in larger areas. The hill tribes of North-East India and South India cultivate *Coix-lacryma-jobi* and prepare a beer from the grains or eat them as a kind of soft food. *Hygroryza aristata* also utilized in a similar fashion. *Secale cereale* (Rye) and *Hordeum vulgare* (Barley) are cultivated at the higher altitudes and in parts of Himalayas become the staple cereal of the inhabitants. *Eleusine coracana* (Ragi, Finger millet) also one of the very common and more nutritious food grains in southern, western and northern India. The inhabitants of the area make this into cakes, soft foods and sweet meats. A beer is prepared from this grain by the hill tribes of the region. *Avena sativa, Panicum sumatrense, Paspalidium flavidum,* and *Paspalum longifolium* also have some value as food materials (Kabeer & Nair, 2009).

Apart from these, the grasses like *Digitaria cruciata* var. *esculenta* is rarely cultivated in the Khasi hills of North-East India for its grain and also as fodder. *Echinochloa frumentacea* is also cultivated in this region for preparing very potent beer. *Paspalum scrobiculatum* is cultivated in South India for food. *Panicum miliare* also one of the common cereal cultivated in South India. Some grasses such as *Arundinella setosa* var. *setosa, Leptochloa chinensis*, *Eragrostis tef, E. tremula, Brachiaria deflexa, Cenchrus biflorus, C. prieurii, Echinochloa crus-galli, E. stagnina, E. colonum, Dactylloctenium aegyptium, Hygroryza aristata, Ischaemum rugosum, Oryza rufipogon, Sccciolepis interrupta, Setaria pallide-fusca* and *S. glauca* also rarely cultivated in different parts of the world for food in times of scarcity (Bor, 1960).

Saccharum officinarum (Sugarcane) is commonly cultivated on large scale in different parts of India for its sugar content. It is one of the principal foods in India.

Grasses used as fodder:

Grasses not only provide food for humanity, but also provide nourishment in the form of cereal grains or forage for livestock and other herbivorous animals. One-third of Indian grasses are considered to have fodder value. Most of the grasses belong to the tribes Andropogoneae (30%), Paniceae (15%), and Eragrosteae (9%). Almost all grasses have some degree of fodder value. However, it is known that grasses that are more leafy are preferred by cattle.

The following grasses are reported to be the fodder grasses most favoured by cattle include *Alloteropsis cimicina, Andropogon ascinoides, A. lividus, A. pumilus, Arthraxon castratus, A. hispidus, A. lanceolatus, A. lancifolius, Arundinella pumila, Brachiaria distachya, B. eruciformis, B. semiverticillata, Cenchrus glaucus, Centotheca lappacea, Chloris barabata, C. virgata, Chrysopogon orientalis, C. polyphyllus, Coix aquatica, Cymboppogon gidraba, C. polyneuros, Cynodon barberi, C. dactylonm, Dicanthium caricosum, Digitaria longiflora, D. wallichiana, Echinochloa colonum, Enteropogon monostachyos, Eragrostis ciliaris, E. coarctata, E.gangetica, E. japonica, E. nigra, E, nutans, E. riparia, E. tef, E. tenuifolia, E. tremula, E. unioloides, E. viscosa, Eremopogon foveolatus, Eriochloa procera, Eulalia trispicata, Hemarthria compressa, Hygroryza aristata, Imperata cylindrica, Isachne globosa, Ischaemum indicum, I. pilosum, I. rangacharianum, Iseilema hackelii, I. prostratum, Leptochloa obtusiflora, Lophatherum gracile, Melanocenchris monoica, Microstegium ciliatum, M. nudum, Ophiuros exaltatus, Oplismenus compositus, O. undulatifolius, Oryza meyeriana, panicum curviflorum, P. psilopodium, paspalidium geminatum, P. punctatum, Paspalum distichum, P. vaginatum, Pennisetum galucum, P. polytachyon, Poa nemoralis, Polypogon fugax, Pseudechinolaena polystachya, Rottboellia cochinchinensis, Sacciolepis indica, S. myosuroides, Schizachyrium brevifolium, Setaria intermedia, Sporobolus maderaspatanus, S. piliferus, S. spicatus, Tetrapogon tenellus, Themeda tremula* and *Thysanolaena latifolia.*

The following are examples of grasses that can also be used as fodder include *Acrachne henrardiana, A. racemosa, Aleuropus lagopoides, Agrostis micrantha, A. stolonifera, Apluda mutica, Apocopis mangalorensis, Bothriochloa pertusa, Brachiaria ramosa, B. reptans, B. setigera, Cenchrus pennisetiformis, C. setigerus, Chionachne koenigii, Chloris wightiana, Chrysopogon fulvus, Coix lacryma-jobi, Dactyloctenium aegyptium, Dichanthium annulatum, Digitaria setigera, Echinochloa crusgalli, E. frumentacea, E. picta, Eleusine indica, Enneapogon schimperanus, Eragrostiella bifaria, Eragrostis amabilis, E. atrovirens, E. cilianensis, E. pilosa, Glyceria tonglensis, Hackelochloa granularis, Heteropogon contortus, Ichnanthus vicinus, Isachne miliacea, Ischaemum rugosum, I. timorense, Iseilema anthephoroides, Leersia hexandra, Leptochloa chinensis, L. neesii, Lolium temulentum, Manisuris myuros, Mnesithea laevis, Oryza rufipogon, Panicum brevifolium, P. miliaceum, P. paludosum, P. repens, P. sumatrense, Paspalidium flavidum, Paspalum conjucatum, P. scrobiculatum, Pennisetum pedicellatum, Perotis indica,*

Phalaris minor, Poa annua, Sacciolepis curvata, S. interrupta, Schizachyrium exile, Sehima nervosum, S. sulcatum, Setaria homonyma, S. italica, Sorghum spp., *Sporobolus coromandelianus, S. humilis* subsp. *minor, S. indicus* var. *flaccidus, S. indicus* var. *major, S. wallichii, Themeda cymbaria, T. quadrivalvis, Tragus roxburghii, Tripogon bromoides* and *Urochloa panicoides.*

Some grasses are preferred by cattle when they are young, these grasses include *Aristida adscensionis, A. funiculata, A. hystrix, A. mutabilis, Arundo donax* (young shoots), *Bothriochloa bladhii, Chloris inflata, Cymbopogon caesius, Desmostachya bipinnata, Digitaria stricta, Dinebra retroflexa, Leptochloa panicea, Lophopogon tridentatus, Melanocenchris jaquemontii, Setaria verticillata, Themeda triandra and Trachys muricata. Rough and rigid grasses like Arundinella nepalensis* and *Saccharum spontaneum* are readily eaten by cattle at the times of scarcity.

Apart from these, large number of introduced fodder grasses are known to be available. As Bor (1960) pointed out, as there are a large number of indigenous grasses which are highly nutritious and palatable there is not much of a need to introduce a large number of exotic grasses. Examples of introduced fodder grasses include *Andropogon gayanus, A. hallii, Anthoxanthum odoratum, Arrhenatherum elatius, Avena byzantina, A. fatua, Axonopus affinis, A, compressus, Brachaiaria brizantha, B, lata, Bromus catharticus, Bouteloua areistoides, B. curtipendula, B. gracilis, Bromus unioloides, Chloris gayana, Cynodon plectostachyus, Cynosurus cristatus, C. echinatus, Dactylus glomerata, danthonia semiannularis, Digitaria didactyla, D. pentzii, D. violescense, Echinochloa pyramidalis, Ehrharta abyssinica, E. calycina, E. capensis, E. erecta, E. longiflora, Eragrostis curvula, E. lehmanniana, E. plana, E. robusta, E. tef, Helictotrichon pratense, Hyparrhenia rufa, Lolium multiflorum, L. trmulentum, Melinis minutiflora, M. repens, Panicum antidotale, P. coloratum, P. laevifolium, P. maximum, P. plenum, P. stapifianum, Paspalum dilatatum, P. plicatulum, P. urvillei, Pennisetum clandestinum, P. hohenackerii, P. mezianum, P. purpureum, P. ramosum, P. setosum,Phalaris aquatica, P. arundinacea, Setaria megaphylla, S. paniculifera, S. sphaceleta, Sorghum halepense, Trichloris crinita, T. plurifera, Tripsacum dactyloides, T. laxum* and *Zea mays.*

Essential oils:

Aromatic grasses have traditionally been used in Indian and Chinese medicine because of their therapeutic properties and are also used in aromatherapy as an essential oil. A number of species of grass belonging to the genera *Cymbopogon, Vetiveria, Bothriochloa* and few others produce aromatic oils accumulate in tissues and are obtained by steam distillation. The oils are made up of a number of chemical compounds most of which are pleasantly scented and for this reasons are valued in perfumery trade. The oils of some species have a repute in native medicine. The most important genus in the area as a source of aromatic oils is genus *Cymbopogon.*

Lemon grass Oil

Cymbopogon flexuosus and *Cymbopogon citratus* are cultivated in hilly tracts for the extraction of lemon grass oil. Lemongrass was traditionally used in Indian medicine for the treatment of fevers and infectious diseases. It has powerful antiseptic and bactericidal properties. The essential oil is extracted by steam distillation from the chopped, fresh grass. The essential oil is used for headaches, muscle pain, indigestion, acne and fevers. In addition, lemongrass is used as an insecticide. These aromatic essential oils also find various uses especially in perfumery. Traditionally, tea made from having been widely utilized as antiseptic, antifever, antidyspeptic, carminative and anti-inflammatory effects. and also used as febrifuge, analgesic, spasmolytic, antipyretic, diuretic, tranquilizer and stomachic agent (Sawyerr, 1982, Viana et al., 2000, Negrelle and Gomes, 2007; Adejuwon and Esther, 2007; Tatiana et al., 2011).

Citronella oil

Citronella Essential Oil is extracted from *Cymbopogon nardus* and *C. winterianus* The greater quantity of Citronella oil produced in Ceylon id derived from *Cymbopogon nardus* and a smaller quantity is obtained from *C. winterianus* (Bor 1960). The oil is used in Chinese medicine for the treatment of rheumatism. Other traditional medicine uses for citronella include use in the treatment of digestive problems, fever, intestinal problems and menstrual difficulties. Citronella essential oil is also extracted by steam distillation of the fresh grass. It is commonly used as an insect repellent, although it is also used in aromatherapy for colds, flu, headaches, and oily skin. In traditional medicine, the oil has been used as an aromatic tea, vermifuge, diuretic, and antispasmodic. Citronella oil is commonly known for its natural insect repellent properties, although it has many uses in aromatherapy. It can be used as massage oil for aching joints and muscles. The oil can effectively be used in a nebulizing or humidifying diffuser for its insect repellent properties. Traditional use includes treatment of fever, intestinal parasites, digestive and menstrual problems. When mental illness has to be treated, Citronella can be clarifying and balancing. Combining it with Lemon oil can bring even more of a brightening effect to the mind (Wany et al., 2013).

Palmarosa oil

Another important oil from grasses is Palmarosa oil which is extracted from *Cymbopogon martinii* var. *martinii* . The Palmarosa oil is also traditionally used in Indian medicine for the treatment of infectious diseases and fevers, in addition to the treatment of bacterial infections of the intestine and as an aid to digestive problems. It also has extremely powerful antiseptic and bactericidal properties. Palmarosa was formerly known as "Indian/Turkish geranium oil" which gives rise to the confusion of some of its alternative names today. The essential oil is extracted by steam distillation of the fresh grass. It is used in aromatherapy for problems such as acne, dermatitis, skin care, stress, and intestinal infections.

Vetiver oil

Vetiver is well known for its extensive fibrous root system. The larger its root volume, the better is the capacity to conserve soil and soil moisture. Besides, larger root volume will also ensure higher root yield that has multiple economic value including that related to aroma and essential oil. Vetiver's essential oil also plays a big role in traditional medicines as well as in pest control. Vetiver oil used in perfumery is extracted from the aromatic roots of *Vetiveria zizanioides* and it is also used as a fixative in perfumery and in aromatherapy. Vetiver oil in recent years have been used to produce perfumes, creams and soaps.

Examples of other oil yielding grasses are *Cymbopogon caesius* (yields kachi grass oil), *C. jwarancusa* subsp. *olivier*i, *C. schoenanthus, C. clandestinus, C. polyneuros, C. virgatus, C. nervatus, C. pendulus, C. coloratus, C. travancorensis, Bothriochloa intermedia, B. intermedia* var. *punctata, B. kuntzeana, B. odorata, B. woodrowii, B. compressa, Capillipedium huegelii* var. *foetidum, Anthoxanthum odoratum, Indochloa oligantha, Melinus minutiflora, Polytrias amaura* etc., but oils of these species are of very little commercial value.

Paper industry

The enormous areas in India covered with coarse grasses. A considerable number of grasses have suitable for paper making. The following are the important grasses used in paper industry. *Aristida setacea* is used in making screens and frames for paper manufacture, citronella bagasse from *Cymbopogon nardus* is used for making paper pulp. *Heteropogon contortus*, *Saccharum arundinaceum, Saccharum spontaneum* etc. are also used in paper industry. Bagasse and leaves of *Saccharum officinarum* are also useful in making paper pulp. Recently, Reed canary grass (*Phalaris arundinacea*) has been identified as a potential for the manufacture of fine quality paper. The species like *Narenga porphyrocoma, Arundo donax, Phragmites karka, Themeda arundinacea, Themeda villosa, Sclerostachya fusca, Bothriochloa intermedia, Cymbopogon nardus, Erianthus ravennae* are rarely used for making paper. Grasses such as *Imperata cylindrica* and *Desmostachya bipinnata* also used in a mixture with pulp from other grasses. Bamboos and *Eulaliopsis binata* yield pulps with a suitable length of fiber are used largely in paper industry. All the species mentioned above can be used in admixture with bamboo or *Eulaliopsis* pulp to produce a satisfactory paper.

Lawn grasses

In plains and areas with low-level hills, *Cynodon dactylon* and *Zoysia matrella* are commonly used for lawn making. *Cynodon barberi* and *Panicum repens* are some of the other lawn grasses used. In drier areas of northern India, *Dicanthium annulatum, Bothriochloa pertusa* and others are used for making lawn. In high hills and heavy rainfall areas, *Axonopus compressus, A. affinis, Oplismenus burmanii, Pennisetum clandestinum* etc. are the usual lawn grasses. Other grasses like, *Agrostis stolonifera, Digitaria longiflora, Chrysopogon aciculatus, Paspalum conjugatum, Paspalum vaginatum, Poa nemoralis, Poa trivialis, Stenostaphrum secundatum,* and *S. dimidiatum* are also used with regular pruning to control inflorescence formation. A mutant variety of *Imperata cylindrica* with smaller purplish red leaves is at times used for making lawns in some places.

Some other introduced grasses which are used for making lawn include *Agrostis capillaris, A. tenuis, A. vinealis, Dactylis glomerata, Dectylactenium australe, Digitaria didactyla* var. *decalvata* (Australian Blue Coach Grass), *Festuca rubra, F. arundinacea*, *Lolium perenne, Phleum bertolonii, Zoysia japonica* (Korean grasses) and *Z. tenuifolia*.

Ornamental grasses

A number species of Poaceae are cultivated in gardens for their beautiful coloured inflorescence, their variegated leaves, their odd-looking flower heads or for their robust state combined with grace of stem and beauty of Inflorescence. The pink feathery panicles of Rhynchelytrum repens make it a most attractive. *Arundinella pumila* (plumose inflorescence), *Arundo donax* var. *versicolor* (striped leaves), *Arundo conspicua, Briza maxima* (large golden yellow colored nodding spikelets), *Cortaderia selloana* (dense and plumose golden yellowish inflorescence), *Melinis repens* (purplish red to whitish colored dense inflorescence), *Miscanthus nepalensis* (plumose inflorescence), *Pennisetum villosum* (cat tail like soft inflorescence), *Pogonatherum paniceum* (mini

bamboo like leaves), *Setaria palmifolia* (palmate leaves with nodding inflorescence) are some of the important grasses that are highly useful in ornamental gardens. Similarly *Arundo donax* is grown in gardens as a fence.

Some of other ornamental grasses include *Lagurus ovatus* (dense woolly panicles), *Lamarckia aurea* (golden overlapping spikelets), *Aira caryophyllea* (dainty panicles*), Lygeum spartum* (oddity inflorescence), *Phalaris paradoxa* var. *praemorsa* (clun like inflorescence), *Phalaris arundinacea* var. *picta* (plume like inflorescence), *Holcus mollis* var. *variegatus* (Variegated leaf) are cultivated in the gardens. Few species such as *Cortaderia selloana, Saccharum procerum, S. sikkimense, S. rufipilum, S. longisetosum* are cultivated in clumps.

Medicinal grasses

Roots of *Alloteropsis cimicina* are used in toothache. A lotion prepared from *Arundinella nepalensis* is used for healing wounds. A decoction of *Cynodon dactylon* is used as diuretic, rhizome parts of it are used in urino-genital troubles and leaf juice is supposed to cure ulcers. *Dactyloctenium aegyptium* has some reported medicinal value. *Echinochloa crusgalli* is used in spleen diseases and for checking haemorrhage. Roots of *Heteropogon contortus* are used as a stimulant and diuretic and commonly used for treating various poisonous bites. Ashes of *Pogonatherum crinitum* are used in skin diseases. The rhizome of *Agropyron repens* used as demulcent, diuretic and used internally for the treatment of catarrhal diseases of the genito-urinary tract in the form liquid extract or decoction. the latter is suitable for bladder sedatives and antiseptics. *Cymbopogon schoenanthus* is used in an infusion as a stomachic and the essential oil is useful in treating rheumatism. A decoction of this plant is given as febrifuge and besides its value as a diuretic and it is also promotes the dissolution of stones in the bladder. It is also reported for treating variety of diseases varying from gout, fever, cholera to coughs, leprosy, indigestion and haemorrhages . *Cymbopogon jwarancusa* is used as febrifuge and stimulant. It is also used for treating gout and rheumatism. The whole plant of *Cymbopogon jwarancusa* including roots is burnt and its infusions are given to the patient suffering from chicken pox. It is also mixed with mustard seeds to make the mustard oil aromatic. *Desmostachya bipinnata* is used in sacred Hindu ceremonies and also an ingredient of medicines used in dysentery and menorrhagia. The root paste of *Desmostachya bipinnata* along with milk is given orally against rheumatism. A decoction of the root of *Thysanolaena maxima* is used as a mouthwash during fever. *Triticum aestivum* is used as laxative, tonic and aphrodisiac. The grains of *Setaria intalica* are said to be diuretic and astringent and also used externally for treating rheumatism. The stem and roots of *Saccharum officinarum* used as diuretic, cooling and aphrodisiac. The flour prepared from *Hordium vulgare* is used with water as a common summer drink. It is used to cool the body and persons suffering from jaundice. It is also recommended for intestinal trouble, anaemia, erysipelas and leprosy. *Phragmites karka* is said to be useful in biliousness, urinary trouble, vaginal and uterine complaints and disease of the heart. The smoke of burning *Panicum antidotale* is used for fumigating wounds and as a disinfectant in smallpox. *Hackelochloa granularis* is given orally with sweet oil for treating enlarged spleen and liver. *Bothriochloa odorata* is said to be carminative and useful in bowel complaints in children (Bor, 1960; Kabeer & Nair, 2009).

Root decoction of *Cynodon dactylon* is given to cattle for respiratory diseases in different localities, while in Kanya Kumari district of Southern India, leaves of *C. dactylon* with coconut oil are used to cure skin diseases (Kingston, et al., 2009) and in Rajasthan its aqueous extract with sugar is given to persons suffering from nostril haemorrhage. Its root decoction is also given to cattle suffering from respiratory diseases. Its roots are kept in stores to keep away insects from wheat grains (Katewa, et al., 2001).

Roots of *Vetiveria zizanioides* are aromatic and are used as a remedy for various health problems. It is used for its antiseptic properties to treat acne and sores. In traditional medicine, it has the following therapeutic actions: diaphoretic, antiseptic, antispasmodic, depurative, rubefacient, sedative, stimulant (circulatory, production of red corpuscles), tonic and vermifuge (Lawless, 1995). Various tribes use the different parts of vetiver for many o f their ailments such as a mouth ulcer, boils, epilepsy, burns, snake bite, scorpion stings, rheumatism, fever, headache, etc. The Santhal tribe of Bihar and West Bengal use the paste of fresh roots for burns, snakebite and scorpion stings; decoction of the roots has been used as tonic for weakness. The Lodhas of West Bengal region use the root paste for headache, rheumatism and sprain; the stem decoction is used for urinary tract infection. The Tribals of Mandla and Bastaro of Madhya Pradesh use the leaf juice as anthelmintic. It is also used for boils, burns, epilepsy, fever, scorpion sting, snakebite and mouth sore. Root extract is used for headache and toothache. The tribals of Varanasi inhale the root vapor for malarial fever. The root ash is given to patients for acidity by the Oraon tribe. Likewise, there are many different applications of the plant for different ailments among different ethnic tribes in other parts of India (Jain 1991; Singh and Maheshwari 1983).

Miscellaneous uses

Brooms: *Aristida setacea* and *Thysanolaena latifolia* inflorescences are highly valuable for making brooms on a commercial basis. *Arundinella setosa* and *Eragrostis gangetica* are also used for the same purpose. *Desmostachya bipinnata* also commonly used as brooms in some areas.

Building materials: *Arundo donax* is used for light constructions. Bamboos, which are woody grasses, are put to innumerable uses in the tropics; the most important being in building construction. Large stems are used for house frames and scaffolding while smaller stems are split and interwoven for walls and floors etc. Containers, implements and baskets are among other articles made from bamboo and the shoots and grains of some bamboos are eaten. The dried leaves and stems of many grasses are used as thatch for house roofs.

Drought resistant grasses: *Andropogon hallii* is often cultivated in drought prone areas. *Chloris inflata* withstands drought and thrives well in alkaline soil. *Paspalum vaginatum* is salt tolerant and is grown in saline areas. *Pennisetum clandestinum* is grown in high hills because of its resistance to drought as well as high rainfall. *Echinochloa crusgalli* is useful for reclamation of saline and alkaline soils.

Flavouring curries: Leaf buds of *Cymbopogon citratus* are used for flavouring curries and leaves as a substitute for tea.

Fuel grasses: Dried *Spinifex littoreus* is used as fuel by fishermen. Dried cobs of Zea mays are also used as fuel.

Green manure: *Eragrostis unioloides* and *Isachne globosa* are reported to be used as green manure.

Hindu rituals: *Cynodon dactylon* culm part is used in religious ceremonies. *Desmostachya bipinnata* and *Imperata cylindrica* leaves are also used for certain rituals.

Industry: *Aristida setacea* and *Chrysopogon aciculatus* are used in brush industry. *Saccharum arundinaceum* culms are used for making screens and handles of brushes.

Insect and rodent repellants: *Melinis minutiflora* with its peculiar odour, is used as an insect and snake repellant. Inflorescences of *Setaria verticillata* are used to cover granaries as a rat repellant.

Ornaments, rosary etc.: Culm stalks of *Apluda mutica* are used in making hats. Stony fruits of *Chionachne koenigii* and *Coix gigantea* are used for making rosaries, bead curtains, ornamental trays, baskets and boxes. Beads of *Coix lacryma-jobi* are used as ornaments. Dried inflorescences of *Eragrostiella bifaria* are colored and used in making bouquets. Dry inflorescences of *Halopyrum mucronatum* and *Spinifex littoreus* (female inflorescence) are used in interior decorations. Roots of *Vetiveria zizanioides* are woven into fragrant mats, rugs and fans. Leaves of *Phragmites vallatoria* are used for mat making.

Soil binders: Following grass species are good soil binders, as they are either rhizomatous, stoloniferous or both and have remarkable root systems. On the sandy shores and saltpans species like, *Aeluropus lagopoides, Halopyrum mucronatum, Spinifex littoreus, Paspalum vaginatum, Sporobolus virginicus, Stenotaphrum dimidiatum* and *Zoysia matrella* help to stabilize moving sand. The common soil binders useful in plains, cultivated lands and riverbeds are: *Cenchrus biflorus, Cynodon dactylon, Cynodon plectostachyus, Desmostachya bipinnata, Eleusine indica, Iseilema hackelii, Panicum antidotale, Panicum repens, Paspalum distichum, Saccharum spontaneum, Sporobolus humilis subsp. minor, Sporobolus maderaspatanus, Trachys muricata, Tragus roxburghii* and *Vetiveria zizanioides.* In hilly tracks *Andropogon hallii, Arthraxon hispidus, Eleusine indica, Eragrostis curvula, Imperata cylindrica, Melinis minutiflora, Pennisetum clandestinum, Pennisetum hohenackeri, Pennisetum orientale, Tripogon bromoides* and *Tripsacum laxum* can be successfully used to fight erosion and to stabilize the soils.

Thatching: Leaves of *Andropogon polyptychus*, *Aristida mutabilis, Arundo donax, Cymbopogon caesius, Garnotia exaristata, Imperata cylindrica*, *Phragmites vallatoria, Saccharum spontaneum* etc. are used as thatching materials. *Arundinella nepalensis, Desmostachya bipinnata, Pseudanthistiria heteroclita, Themeda cymbaria* etc. are also used for this purpose.

Sugar production: About half the world's sugar is produced from Sugarcane, a tropical lowland grass. Important by-products of Sugarcane are molasses, rum and biogases. The latter is used as fuel and in the manufacture of fibre-board and paper. In some countries like Brazil, alcohol produced from cane sugar is mixed with petrol as a fuel for motor vehicles. Power alcohol produced from grain or cane is a possible renewable energy source.

Alcohol production: Alcoholic beverages such as beer are made from a fermented cereal grain such as barley. Whisky, gin and vodka are produced by distillation of fermented grain.

Other Products:

The hollow stem *Arundo donax* and *Phragmites karka* are used for making pens, musical instrument and also used to make baskets and its stem along with leaves is used in roof thatching. The long, narrow and stiff leaves of *Eulaliopsis binnata* are used for making ropes. It is also used for making Chabies that are used for keeping food and brooms locally called which is sold in the market. The leaves and stem of *Saccharum bengalense* are used for thatching huts for animals, and for making baskets. Its stem is also used for making pens.

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