Status of Genetic Resources of Forage Crops in India: A Review

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Dairy industry and animal rearing have opened up new market avenues and Indian farmers are taking up fodder production in a much bigger way. Forage crops occupy an important position across the world. For developing varieties resistant to various pests and diseases and to improve forage quality and quantity, there is a continuous need of diverse genetic resources. Acquisition of diverse and superior forage germplasm plays an important role in the development of varieties. Keeping this in mind, the Germplasm Exchange Division played the pivotal role and introduced a total of 13,181 accessions of forage crops into India mainly from Australia, Italy, USA, UK, Brazil, Germany, Egypt, Ethiopia, Bulgaria, Philippines, Singapore, Costa Rica, Zimbabwe, Japan, Russia and New Zealand. Most of the introduced germplasm was supplied to Indian Grassland and Fodder Research Institute and All India Coordinated Research Project on Forage Crops located at Jhansi, Uttar Pradesh. Some promising varieties introduced into India were directly used for cultivation. Forage species of *Sesbania rostrata, Sesbania aculeata, Pennisetum squalatum* and *Pennisetum pedicellatum* from different Institutes were registered for various traits and their seeds have been deposited for long-term storage in National Gene Bank. Details of trait specific germplasm, wild germplasm introduced and conserved in forage crops in India are highlighted.

Key Words: Forage crops, Germplasm introduction, Conservation

Introduction

India is an agricultural based country and about 70 per cent of its people live in villages. Their livelihood is dependent mainly on agriculture and animal husbandry. India holds one-fourth of the total cattle population of the world, but is highly deficient in various livestock products. The analysis of the situation revealed that one of the main reasons for the low productivity of our livestock is malnutrition, under-nutrition or combination of both, besides the low genetic potential of the animals (Anonymous, 2007). Global demand for meat, milk and other animal products is growing dramatically and so is our need for improved forages. There is a huge gap between demand and supply of all kinds of feeds and fodders in India as seen from the figures of availability, *vis-a-vis* the requirement of green-fodder crops, crop residues and concentrates (www.Krishiworld.com).

Forages comprise of grasses, legumes and other herbaceous species. Most forage grow in grasslands or produced by fodder crops and provided by fodder crop residues also as reviewed from literature (Bennett 1999, 2001 Bounejmate *et al.* 1999, Charlton 1981, Dhillon *et al.* 2001, Gladstones 1975, Maxted and Bennett 2001, Singh *et al.* 2006, Perry 1990, Plucknett *et al.* 1987, Williams 1983) and existent web sites of major forage genebanks at CIAT Columbia; ICARDA Syria; ILRI, Nairobi; CSIRO-Australia, IGER-UK, USDA-Fort Collins and EMBRAPA-Brazil.

Origin and Distribution of Forages

Grass Forages

Grasses belong to a wide range of genera and over 600 species are currently used for grazing and livestock feeds from about a total of 10,000 grass species that occur in the world. Grasses are distributed along the main climatic belts and are classified into major groups, the tropical grasses (Africa is the most important centre of variation in the Gramineae) (Clayton 1983) and the Mediterranean and temperate grasses (most current utilized grass species were originated from Eurasia, East Africa and South America) (Knight 1983). Wild species have been distributed widely into South America (*Brachiaria decumbens*) and Australia (*Stylosanthus* sps). They vary from annual to perennial or summer-growing to winter-growing ecotypes. Forage grasses are mostly used as cut fodder (often also using remaining from cereal food crops) or grazed pasture and also as harvested seed crops (generally from dual purpose food and feed crops). Over 1,500 species of legumes (from about a total of 17,000 legume species worldwide) can be used as forage, although only about 60 species have been developed and widely used as forages. Although forage legumes have been used for many years they have only been under cultivation for as little as 75 years. Tropical legumes are possibly originated from tropical forests and are currently found from the tropics to the Arctic regions, from high rainfall regions to deserts and from rocky slopes and sand dunes to swamps (Williams 1983). Sometimes

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they are also used for human consumption (i.e. crops with dual purpose for food and feed). The use of forage legumes is estimated to be as old as 11,000 years, with some species being first used as grain for human consumption and latter on switched to be only used for fodder or pasture, or vice versa (Mathison 1983).

Legume Forages

Globally several large, perennial, tropical grasses are grown for forages in various parts that include: Elephant grass (*Pennisetum purpureum),* cultivars of Guinea grass (*Panicum maximum)* and Guatemala grass (*Tripsacum laxum)*, annual tropical or hot-season grasses teosinte (*Zea mexicana),* Sudan grass (*Sorghum* x *drummondii),* Columbus grass (*Sorghum almum)* and Johnson grass (*Sorghum jwlepenset).* Forage legumes include pea (*Pisum sativum),* guar (*Cyamopsis tetragonaloba),* pigeon pea (*Cajanus cajan),* soybean (*Glycine max),* hyacinth bean (*Lablab purpureus),* cowpea (*Vigna unguiculata),* groundnut (*Arachis hypogaea),* and fenugreek (*Trigonella foenum-graecum).* Fodder cereals including oats (*Avena sativa* and *A. strigosa*, maize (*Zea mays*), sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum americanum*), barley (*Hordeum vulgare)*, rye *(Secale cereale*), proso millet (*Panicum miliaceun)* and finger millet (*Eleusine coracana)* and sugarcane *(Saccharum officinarum).* There has been a great expansion in the use of fodder oats recently, in sub temperate areas.

Other Forages

Perennial legumes used as fodder crops (Duke 1981, Frame *et al.* 1998) include alfalfa/lucerne (*Medicago sativa*), sainfoin (*Ollobrychis viciifolia)*, red clover (*Trifolium pratense)*, and Alsike clover (*Trifolium hybridum)*. Annuals and short-lived perennials include Egyptian clover (*Trifolium alexandrinum)*, crimson clover (*Trifolium incarnatum)*, Persian clover (*Trifolium resupinatum)*, sulla (*Hedysarum coronarium)*, vetches (*Vicia* spp.), Chinese milk-vetch (*Astragalus sinicus)*, seradella (*Ornithopus* spp.), sweet clover (*Melilotus alba*) and yellow sweet clover (*Melilotus officinalis)*. Root crops are also very important in humid temperate agriculture, but have been largely replaced by maize and grass silage. Besides, the members of the Brassicacae namely turnips (*Brassica rapa* var. *rapifera)*, swedes (*Brassica napus* var. *napobrassica)*, kale (*Brassica oleracea)*, cabbage (*Brassica chinensis*), (*B. oleracea),* forage radish (*Raphanus sativus)*, fodder beet (*Beta vulgaris)* and carrot (*Daucus carota*) also serve as important forage crops.

Arora *et al.* (1975) analysed the distribution pattern of Indian grasses, falling in seven phyto-geographic zones of India and concluded their distribution in tropical humid belt of south- western India for tropical types; north-west arid/semi arid belt and north-eastern moist belt for subtropical species and western Himalayan tract for the temperate species. Thus, these agroclimatic regions offer great opportunity for the collection of indigenous grasses as well as legume species for forages and pasture lands. This paper discusses the status of genetic resources of forage and fodder crops, the major issues related to their introduction, conservation and importance of their biodiversity.

Status of Introduction

The work on collection, introduction, domestication and utilization of fodder crops in India was initiated in 1970 in the PL-480 Scheme (Anonymous, 1984). To procure diverse genetic resource- promising genetic stocks, improved varieties and wild relatives international obligations for import and export of germplasm are observed. India is a party to relevant international agreement on access to PGR and sharing of benefit arising out of their use including Convention of Biological Diversity (1992) and International treaty on plant Genetic resources for Food and Agriculture (2001). As envisaged under the Treaty, the exchange of genetic resources of the Annex 1 crop of the Treaty (35 food crop genera and 29 forage crops) would be under the conditions of a standard material transfer agreement (SMTA) formulated by the Governing Body of Treaty in June 2006. The Treaty signifies wide international commitment that both traditional and modern technologies should serve humanity, in particular to alleviate hunger and promote sustainable development in developing countries (Anonymous 2007).

The national gene bank at NBPGR, New Delhi, conserves germplasm of forage crops including landraces, breeding lines, traditional varieties, released varieties, wild and weedy types, elite lines, improved cultivars and other genetic stocks at -18^{0}C for long term storage. As the forage grasses have low viability, therefore, the maximum viability limit in case of grasses is 20-40%. A minimum of 2000 seeds should be submitted in self-pollinated forage crops whereas 4000 seeds are required in cross pollinated crops. Seed moisture content should be in the range of 5-7%.

The germplasm introduced into India is being

multiplied, characterized, evaluated and conserved at different NBPGR regional stations located in different agro-climatic zones and also at Indian Grassland and Fodder Research Institute (IGFRI), Jhansi. IGFRI networks with its three Regional Centers and All India Coordinated Research Projects (AICRP) on forages with 18 coordinated centers under ICAR system and seven Regional Stations on Forage Production and Demonstration and one Fodder Seed Production Farm under Department of Animal Husbandry is the National Active Germplasm Site for forages. Significant headway has been made in varietals development at IGFRI, Jhansi. One hundred and eighty eight varieties of 30 fodder crops, range legumes and grasses(Annual Report, IGFRI, 1980-2008) have been released (Table 1) and notified through IGFRI. The function of the AICRP is to coordinate multi –location testing programmes at the national level for identification of appropriate varieties and production technologies for different agro-ecological conditions.

Status of Development of varieties of forage crops in

Table 1. Important high-yielding varieties of fodder crops

	(A) Northern region
Jowar (*Sorghum vulgare*)	
'J.S.-20', 'J.S.-29/1', 'J.S.-263', 'J3/53', 'Swarna', 'M.P. chari', 'S.L.-44', 'Pusa chari', 'Haryana chari'	Punjab, Haryana, Delhi
'T-3', 'T-4', '8B', 'M.P. chari', 'S-700', 'H1', 'H2', 'Rio'	Uttar Pradesh, (B) Western region
'Sundhia 1049', 'Chhastia 10-2', 'Dudhia'	Gujarat
'Red Khaki', 'Nilwa', 'Nandyal', 'M-35-1'	Maharashtra, (C) Central region
'Gwalior-82', 'Gwalior-304', 'Vidisha 60-1', '	Madhya Pradesh
Ujjain-6', 'Ujjain-8', 'J-195'	(C) Southern region
'K 3', 'Co 11', 'Co 18', 'Co 19', 'Rungu 1', 'M.P. chari'	Andhra Pradesh and Tamil Nadu
Maize (*Zea mays*)	
Hybrids-- 'Ganga-Safed-2', 'Ganga-3', 'Ganga-5', 'Ganga-7'	
Composites--'Jawahar', 'Amber', 'Kissan', 'Vijay', 'Sona', 'Vikram'	
Open-pollinated--'N.P. Yellow-2', 'K-41', 'Bassi', 'Jaunpur'	
'Emenillo de cuba', 'Kalimpong	West Bengal
Bajra (*Pennisetum typhoides)*	
'A-1/3', 'H.B.3', 'S-530', 'T-55' 'D 1941', '2291'	
Oat (*Avena sativa*)	
Early varieties--'Western-11'	
Mid-season varieties--'Kent', 'Craig', 'Afterlee', 'Green Mountain', 'A-17', 'Flaminagolds', 'Fulgham', 'Bamboo-966', 'IGFRI-Soil-3021', 'IGFRI-Soil-2688'	
Late varieties--'Algerian', '37/14', 'FOS-1/29', 'Kharsai'	
Cowpea (*Vigna sinensis*)	
'FOS-1', 'FOS-10', 'K-395', 'K-585', 'EC4216', 'IGFRI-S-450', 'IGFRI-S-457	Haryana, Punjab and Delhi
'Russian Giant', 'IGFRI-S-978', 'IGFRI-S-985', 'Russian Giant'	Uttar Pradesh and Karnataka
'E.C. 4216', 'Russian Giant', 'Chhrodi 14-20', 'Chhrodi 26-28'	Gujarat
'Co 1', 'Russian Giant', 'E.C. 4216'	Southern states
'Co 1', 'E.C. 4216'	West Bengal
Guar (*Cyamopsis tetragonoloba*)	
'FOS 1', 'FOS 2', 'E.C. 4216F.S. 277', 'IGFRI-S 212', 'No. 2'	Punjab, Haryana, Delhi, Uttar Pradesh
'Durgapura safed'	Rajasthan
Velvet bean (*Stizolobium niveum*)	
'IGFRI-S 2276-5'	Uttar Pradesh, Rajasthan, Andhra Pradesh, Madhya Pradesh and Haryana
Field bean (*Dolichos lablab* var. *lignosus*)	
'IGFRI-S 2214-II',--Broad leaf, erect	
'IGFRI-S 2218-1',--Medium leaf, decumbent	
Berseem (*Trifolium alexandrinum*)	
'Meskawi-Diploid', 'Pusa giant-Tetraploid', 'IGFRI-S-29-1', 'Chhindwara'	
Lucerne (*Medicago sativa*)	
'Type-8', 'Type-9' ,'Anand II', 'IGFRI-S-244', 'Moopa', 'IGFRI-S-54', N.D.R.I.-1	

(A) Northern region

Senji (*Melilotus parviflora*)
'FOS-1', 'F.S. 14', 'F.S. 18'

Methi (*Trigonella foenum graecum*)
'FOS-8'

Hybrid Napier
'Pusa Giant Napier', 'NB 21', 'EB 4', or 'Gajraj', 'N.B. 5', 'Coimbatore'

Sudan grass (*Sorghum Sudanese*)
'SS-59-3', 'G 287', 'Piper', 'J-69'

Dinanath grass (*Pennisetum pedicellatum*)
'Type-3', '10', '15', or 'IGFRI-S-3808', 'G-73-1', 'T-12', 'IGFRI-S-866-1'

Blue panicum (*Panicum antidotale'*)
'S-297'

Anjan or Buffel (*Cenchrus ciliaris'*)
'Pusa Giant Anjan', 'IGFRI-S-3108', 'IGFRI-S-3133', 'C-357', 'C-358', *Cenchrus glaucus*

Bird wood (*Cenchrus setigerus'*)
'Pusa yellow Anjan'

Marvel (*Dichanthium annulatum*)
'M-8', 'IGFRI-S-495-1', 'IGFRI-S-495

Mustard (*Brassica*) spp.
'Japan sarson', 'IM-98', 'IM-100', 'Laha 101', 'Chinese cabbage'

Stylos (*Stylosanthes*) spp.
Butterfly pea (*Clitoria ternatea'*)
'IGFRI-S-23-1', 'IGFRI-S-12'

Turnips
'Green Top', 'Purple Top', 'Kenshin--Kaba'

(http://www.krishiworld.com/html/for_crop_grass1.html)

India

Germplasm is a vital resource in generating new plant types having desired traits that help in increasing forage crops production and thus improve the level of nutrition for animal/ cattle population. Number of varieties were developed (Table 1) by ICAR in forage crops (Annual Report, IGFRI, 1980-2008; Annual Reports AICRP on Forage Crops 1980-2008) utilising exotic and indigenous germplasm. Some important varieties include Giant Bajra (evolved through a cross between Australian bajra and local bajra of *Pennisetum americanum*) Pusa Deenanath Grass a selection from African material of *Pennisetum pedicellatum;* Punjab Guinea Grass-1 an introduction from Australia under the name CPI-59985 of *Panicum maximum*, Nandi selection from African germplasm of *Setaria anceps;* Marwar Dhaman a clonal selection from exotic material EC017655 of *Cenchrus setigerus;* Marwar Anjan a clonal selection from exotic material EC14369 of *Cenchrus ciliaris;* Kent an introduction from USA of *Avena sativa*, UPO-90 a single plant selection from American material of *Avena sativa;* Mescavi and Fahl introductions from Egypt, BL-1 a selection from mescavi of *Trifolium alexadrium;* Kohinoor a selection from material obtained from Iran and UPC-5286 a single plant selection from germplasm line 5286 of *Vigna unguiculata* etc.

Exotic Introductions made in Forages

A total of 13,181 forage introductions were made by the Germplasm Exchange Division during last 33 years (Annual Reports, NBPGR, 1976-2008). Major genera introduced were *Agropyron, Amblyopyrum, Austialopyrum, Avena, Cliotoria, Cnidoscylus, Corymbia, Dasypyrum, Desmanthus, Desmodium, Elymus, Elytrigia, Eragrostis, Eremspyrum, Eucalyptus,Festuca, Enradia, Hordelymus, Lespedeza, Leymus, Lotus, Macroptilum, Medicago, Pascopyrum, Poa, Psarhyrostachys, Sorghum, Thinopyron, Trifolium* and *, Triticale* through its linkages with over 115 countries and eight IARC's.

A total of 10, 049 samples in sorghum (*Sorghum bicolor*) and 20,085 were introduced in pearl millet (*Pennisetum americanum*) for dual purposes. Many other important wild species of *Pennisetum* were also introduced from Nigeria, UK, USA and Zambia. In oats (*Avena sativa*), the genetic resources of grain and fodder types comprising of 1,827 accessions were procured. Several

promising introductions of fodder type were EC22017 and EC107536 from Australia, EC108586 and EC108602 from UK, EC10068 from Russia. Dual- purpose variety Rapida of oats from USA is suitable for malting industry. Another promising introduction Kent (from Australia) was released during 1970s. It has stiff straw, medium early and dual- purpose type and continues to be a popular variety. It was released directly as commercial variety. Another promising accession of oat used as donor for development of new variety PO-94 was a single plant selection from American material. This is a mulicut variety resistant to lodging, frost and shattering and also free from stem rust, crown rust, leaf blight and smut, grasshopper, cutworms, aphids and mites.

Trait Specific Introductions

Targeted and trait specific introductions, for nutritional quality and value addition are important. In the present scenario, where the access to germplasm is restricted due to many national and international treaties/ Acts, it is very important to search for and introduce trait specific germplasm for use in various crop breeding programmes. NBPGR continued its efforts and the trait specific germplasm introduced in forages in past ten years are presented in Table 2.

New Forage Crops and Wild Species Introductions

New forage crops and wild species introductions were also made at NBPGR. *Atriplex* sp. was introduced from

Table 2. Trait specific introductions in forage crops

Crop/EC No. and Source country	Traits	Distribution
Brachiaria hybrid variety Mulato EC 549024-25 USA	Stoloniferous growth, excellent forage production, vigorous regrowth, excellent palatability, drought tolerant, and produces forage round the year	IGFRI Regional Station, Dharwad, Karanataka
Deschampsia antarctica Antartic hair grass EC631954, Chile	New crop, native to Antarctica	Avesthagen Limited, Bangalore
Elytrigia repens EC586940 USA	Var. Eversett, advanced generation synthetic cultivar for high rhizome production ability to spread by rhizomes and used for land stabilization and reclamation	IGFRI, Jhansi
Medicago sativa EC499771-72 USA	Highly resistant to Aphanomyces root rot and northern root knot nematode, resistant to Phytopthora, pea aphid, spotted aphid and moderately resistant to Verticillium wilt, anthracnose race 1 and stem nematode, High forage yield under dry land condition	IGFRI, Jhansi
Medicago sativa EC596671 USA	Var. OK 190, unique combination of broad genetic base, resistance to blue alfaalfa aphid, spotted alfaalfa aphid & Phytopthora rot	IGFRI, Jhansi
Medicago sativa EC596673 USA	Var. OK 207, broad genetic base population provide resistance to blue alfa alfa aphid biotype BAOK 90 & spotted alfaalfa aphid	IGFRI, Jhansi
Medicago spp. EC271425-29, USA	Produce high forage, cold tolerant and resistant to aphids	IGFRI, Jhansi
Pennisetum typhoides ssp ***montana*** EC473259, USA	Potential for increase growth rate, resistance to rust, smut and leaf spot	NBPGR, Regional Station, Jodhpur
Trifolium pratense E560447-448, USA	Short internodes, plants usually present a rosette appearance but flower sparingly under long day conditions	IGFRI, Jhansi
Trifolium pratense EC578957, USA	Var. Freedom, free from pubescence, good for hay making as it permits faster drying and reduces dustiness	IGFRI, Jhansi
Trifolium pratense EC560447-448, USA	Short internodes, plants usually present a rosette appearance but flower sparingly under long day	IGFRI, Jhansi NBPGR RS, Bhowali
Triticale EC537921, Mexico	Hexaploid winter triticale, good forage quality	IGFRI, Jhansi
Triticale EC537922, Mexico	Hexaploid intermediate triticale, good forage quality	GCD, NBPGR
Triticale EC534274, USA	High yielding, superior forage quality	IGFRI, Jhansi
Triticale EC467937, Canada	Variety Bobcat, sprouting tolerant and resistant to stem rust and leaf rust	NBPGR, Regional Station, Bhowali

Tunisia for arid zones, it is a perennial, evergreen and salt tolerant. Promising introductions in *Atriplex* (Dhillon et al. 2001) include are *A.. halimus* (EC129767), *A. canescens* (EC129768) and *A. nummularia* (EC129766). Subabool (*Leucaena leucocephala)* was introduced from Australia, Philippines, Colombia, France, Malawi, Sierra Leone, UK and USA. This fast growing tree provides fodder, green manure and fuel and can withstand drought also. An introduction K-8 (EC124343) from Philippines performed well at Jodhpur for fodder purpose and variety EI Salvador (EC123866) from Australia proved superior for fodder and fuel. Other new species are *Brachychiton populneum* (drought tolerant, provides fodder and useful as wind breaker) from Tunisia, *Cassia sturtii* (fodder crop adapted to semi- arid habitats) and *Casuarina equisetifolia* (fodder for wastelands and alkaline soil) from Australia. Two new grass species introduced from USA for tropical and temperate areas are *Brachiara hybrid* and *Deschampsia antarctica,* respectively.

Wild species are generally more variable than the corresponding crop. Plant breeders utilize wild species mainly for sources of resistance to biotic and abiotic stresses as well as in breeding for genetic enhancement. NBPGR has introduced 986 wild forage species (Anonymous, 2007) in different forage crops. These genetic resources have been introduced with the efforts of scientist of NBPGR as well on requests from several scientists working at different research institutes, SAU's and other organization with R & D facilities. However, 11 genera of exotic wild forage germplasm representing 67 species have been introduced into India (Table 3).

Forage Germplasm Conservation

For conservation of PGR at national level, a network approach is being followed. It consists of the National Gene bank situated at the NBPGR headquarter, New Delhi, primarily responsible for conservation of collection on long-time basis for posterity and to support regeneration or restoration activities of active collections at National Active Germplasm Sites (NAGS). The germplasm introduced/imported into India is being multiplied, characterized, evaluated and conserved at different NBPGR regional stations located in different agro-climatic zones and also at Indian Grassland and Fodder Research Institute (IGFRI), Jhansi.

A total of four thousand five hundred and ninety four accessions of forage cereals (1167), grasses (1116), range legumes (1443), forage millets (781) and others (87) have been conserved at NBPGR in long term storage in the National Gene bank. The germplasm comprised of 4 species of of forage cereals, 63 species of grasses, 40 species of of range legumes, 20 species of forage millets and 19 species of others. Eighteen released varieties are also conserved in long term storage at National Gene Bank, NBPGR, New Delhi. The lists of released varieties and forage species conserved in NGB are listed in Table 4 and 5, respectively.

Registration of Germplasm

With the objective of giving credit to these scientists who have developed or identified promising experimental materials (including parent or inbred lines) or promising germplasm, and to facilitate flow of germplasm among the scientists working in the crop improvement programme,

Table 3. Wild species introduced in forage crops

Genera	Species
Agropyron	*A. cimmericum*
Brachiaria	*B. ruziziensis*
Clitoria	*Clitoria ternetea*
Desmodium	*D. intortum* and *D. uncinotum*
Elymus	*Elymus haffmannii*
Lotus	*L. conimbricensis, L. coribricensis, L. ornithopodioid, L. pendunoulatus, L. purshianus* and *L. uliginosus*
Macroptilium	*M. atropurpureum* and *M. axillare*
Medicago	*M. arabica, M. Ciliaris, M. coronata, M. intertexta, laciniata, M. littoralis, M. lupulina, M. minima, M. orbicularis, M. polymorpha, M. radiata, M. rigidula, M. rugosa, M. scutellata, M. tornata, M. truncatula, M. turbinate, M.liciruata* and *M.littoralis*
Melilotus	*M. indicus, M. messanensis, M. officinalis, M. segetalis,* and *M. sulcatus*
Stylosanthes	*S. scabra* and *S. viscosa*
Trifolium	*T. alpestre, T. angustifolium, T. arvense, T. aureum, T. baccarinii, T. balansaa, T. billardiari, T. campestre, T. clypeatum, T. dasyurum, T. diffusum, T. fomentosum, T. fragiferum, T. grandiflorum, T. incarnatum, T. lappaceum, T. leucanthum, T. ligusticum, T. michelianum, T. nigrescens, T. pilulare T. scabrum, T. squamosum, T. striatum, T. striatum* var. *spinescens, T. subterraneum* and *T. tomentosum*

Table 4. Status of Released Varieties in National Gene Bank

Botanical Name	Donor Identity	Var. No.
Avena sativa	SABZAAR, Jawahar Oat-1,OS-7,OS-6, JHO- 813, JHO- 816, JHO-2001-3,KENT, JHO 99-1,IC449066	10
Cenchrus ciliaris	IGFARI- 727, IGFARI-3108, IC526313	03
Chrysopogon fulvus	IGC 9903 (BUNDEL DHARSELU GRASS-1)	01
Cyamopsis-tetragonolobus	BUNDEL GUAR-1, BUNDEL GUAR-2, BUNDEL GUAR-3	*03*
Heteropogon contortus	IGHC 03-4	01
Medicago sativa	ANAND-3, ANAND-6, ANAND-2, ANAND-1, GAUL-1, GAUL-2	06
Panicum maximum	JHGG 04-01 (Bundel Guinea-2)	01
Pennisetum glaucum	GIANT BAJRA,IC526299	02
Pennisetum typhoides	GFB-1	01
Sehima nervosum	IGS-9001(Bundel Sain Ghes -1)	01
Stylosanthes hamata	PHULE KRANTI-95	01
Trifolium alexandrinum.	JAWAHAR BERSEEM-5, BL-180, CV.MASCAVI,	03
Sorghum bicolor	CO(FS)29, PC-23, PC-9, IGFARI/PC-23,C-10-2, S-1049, GFS-3, UTMCH1302(CSH 24 MF)H, ICSA467 (FEMALE), ICSA467 (MAINTAINER), PANT CHARI-6, SPV 1595 (CSV 18), SPH 1567, PMS28A (O PARENT OF SPH 1567)	14
Vigna unguiculata	UPC-607, C-30 (GFC-4), C-26 (GFC-3), C-14 (GFC-1),(GFC-2)	06
Zea mays	AFRICAN TALL	01

ICAR constituted Plant Germplasm Registration Committee (PGRC) with Deputy Director General (Crop Science) as the Chairman, to register such promising germplasm. NBPGR would be the nodal agency for registration of material which will receive applications, process the same and carry out the validation (if required). The decision of the committee must be finalized within one year of the submission of the proposal. In case the validation test by NBPGR is required, the proposal would be received at least two months prior to the normal crop sowing season i.e. Rabi and Kharif so that validation tests are made within the 1st crop season itself. In addition to long term storage of the registered material by NBPGR, working stock for supply to users would be maintained by the institution associated with the development of the material.

The information about registered germplasm is also published in Indian Journal of Plant Genetic Resources, various newsletters viz., ICAR Newsletter, NBPGR Newsletter and Seed News etc. to disseminate information among scientists. Thus, putting the information regarding these germplasm in public domain has become a mandatory requirement to safeguard the national resources with respect to intellectual property rights. The guidelines were developed for plant germplasm registration and were widely circulated among the scientists. Till 2009, seven forage species (15 accessions) have been registered for various traits as detailed in Table 6.

Conclusion

Conserving species biodiversity permits the conservation of a genetic heritage that might be necessary for future livestock production systems. International cooperation is necessary for efficient monitoring of forage crops, pasture and grassland genetic resources and their use. Many wild grassland species are not yet in gene banks; they remain widespread in low- input grasslands around the world and their contribution to animal feeding is important.

Introduction of wild relatives need to be emphasized for broadening of genetic base. The utilization of the genetic diversity is a critical factor in enhancing productivity on a sustainable basis. Though improved varieties have been released in forage crops, attention is required to register the unique forage germplasm for further utilization in breeding programmes. Emphasis should be on collections from areas left unexplored and having maximum diversity after the gap analysis. Based on available passport and evaluation data, and the information to be generated in future, enrichment of existing genepools and development of new pools for groups of important characters would be useful in easy and effective germplasm management and use. Awareness generation of the people at various levels (policy makers, scientific, administration, farmers etc.) about the value of PGR wealth and its protection is essential. Further, there is an urgent need to increase the interaction between plant breeders and PGR workers. The interface among different stakeholders is likely to bring

Table 5. List of Forage Species in the NGB

Acrachne racemosa Ohwi	*Canavalia ensiformis* (L.) DC
Ailanthus excelsa Roxb.	*Capillipedium hugelii* Stapf
Alloteropsis cimicina (L.) Stapf.	*Capillipedium parviflorum* Stapf.
Alysicarpus vaginalis Wall	*Cardiocrinum giganteum* Makino
Andropogon pumilus Roxb.	*Cassia rotundifolia* Pers.
Apluda mutica L.	*Ceiba pentandra* (L.) Gaertn.
Aristida adscensionis L.	*Celosia argentea* L.
Arthraxon prionodes (Steud.) Dandy	*Cenchrus biflorus*
Atriplex hortensis L.	*Cenchrus ciliaris* L.
Atylosia platycarpa Benth	*Cenchrus prieurii*
Atylosia scarabaeoides (L.) Benth.	*Cenchrus setigerus* Vahl
Avena fatua L.	*Chloris barbata* (L.) Nash
Avena sativa L.	*Chloris dolichostachya* Lag.
Boerhavia diffusa L.	*Chloris gayana* Kunth
Bothriochloa pertusa (L.) A.Camus	*Chrysanthemum morifolium* Ramat.
Brachiaria ramosa (L.) Stapf	*Chrysopogon fulvus* (Spreng.) Chiov.
Brachiaria setigera (Retz.) C.E.Hubb.	*Cichorium intybus* L.
Coix lacryma-jobi L.	*Echinochloa colonum* Beetle
Crotalaria retusa	*Echinochloa stagnina* P.Beauv.
Cyamopsis tetragonolobus (L.) Taub.	*Eleusine flagellifera* Nees
Cymbopogan martnii	*Elionurus royleanus* Nees ex A.Rich.
Cymbopogon flexuosus	*Eragrostiella bifaria* (Vahl) Bor
Cymbopogon jwarancusa Boiss.	*Eragrostis ciliaris* Link
Dactylis glomerata L.	*Eragrostis diarrhena* Steud.
Dactyloctenium aegyptium (L.) K.Richt.	*Eragrostis unioloides* Nees ex Steud.
Descuriana sophia	*Eriochloa procera (Retz.)* C.E.Hubb.
Desmodium Gangeticum DC.	*Eulalia argentea* Brongn.
Desmodium gyrens	*Festuca arundinacea*
Desmodium triquetrum	*Hackelochloa granularis* Kuntze
Desmostachya bipinatata Stapf.	*Heracleum candicans* Wall
Dichanthium annulatum Stapf	*Heteropogon contortus* (L.) Beauv. ex Roem. & Schult.
Digitaria adscendens Kunth Henrard	*Imperata cylindrica* (L.) P.Beauv.
Digitaria granularis (Trin.) Henrard	*Iseilema laxum* Hack.
Digitaria Pennata	*Kedrostis rostrata*
Dinebra retroflexa Panz.	*Lablab purpureus* (L.) Sweet
Dipsacus mitis	*Echinochloa colonum* Beetle
Acrachne racemosa Ohwi	*Canavalia ensiformis* (L.) DC
Ailanthus excelsa Roxb.	*Capillipedium hugelii* Stapf
Alloteropsis cimicina (L.) Stapf.	*Capillipedium parviflorum* Stapf.
Alysicarpus vaginalis Wall	*Cardiocrinum giganteum* Makino
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Apluda mutica L.	*Ceiba pentandra* (L.) Gaertn.
Aristida adscensionis L.	*Celosia argentea* L.
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Atriplex hortensis L.	*Cenchrus ciliaris* L.
Atylosia platycarpa Benth	*Cenchrus prieurii*
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Bothriochloa pertusa (L.) A.Camus	*Chrysanthemum morifolium* Ramat.
Brachiaria ramosa (L.) Stapf	*Chrysopogon fulvus (Spreng.)* Chiov.
Brachiaria setigera (Retz.) C.E.Hubb.	*Cichorium intybus* L.

Table 6. Registered germplasm in Forage species

Crop name	Collection Number	National Identity	Unique Traits
Panicum maximum	IG3/29/2-3(1)	IC567677 INGR09039	Triploid cytotype
	IG 04-164	IC567678 INGR09040	High production progenitor of ploidy series
	IG3/29/2-5(1)	IC567679 INGR09041	Pentaploid cytotype
	IG3/29/2	IC567680 INGR09042	Hexaploid cytotype
	IG3/29/2-8(1)	IC567681 INGR09043	Octoploid cytotype
	IG3/29/2-9(1)	IC567682 INGR09044	Nonoploid cytotype
Pennisetum glaucum	TetraA4; IG 08-03	IC567684 INGR09046	Tetraploid male sterile line with A4 cytotype
	TetraA1; IG 99-748	IC568548 INGR09047	Maintainer of Tetra A4 MS line
Pennisetum pedicellatum	Agros-4 INGR06018	IC546954 Octoploid cytotype 2n=72	
Pennisetum squamulatum	Apomictic cytotype INGR06017	IC546955 Apomictic cytotype 2n=56	
Sesbania aculeata	CSD 137 INGR04108	IC427827 High foliage and better sodicity tolerance	
	CSD 123 INGR06016	IC546953 Very early (120 days) and better tolerance to sodic soils	
Sesbania rostrata	TSR-1	IC296793 INGR01014	Photoperiod insensitive mutant, with long vegetative growth
Trifolium alexandrinum	PBL-123 INGR05017	IC524012 Purple Leaf and flower mutant	
Trifolium alexandrinum	Penta-1	IC567683 INGR09045	Pentafoliate mutant

out new useful forage genetic resources management alternatives.

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