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Theme 4. Biodiversity, conservation and genetic improvement of range and forage species
Sub-theme 4.1. Plant genetic resources and crop improvement

Legumes of forage value: their diversity and priority for collection in India

E. Roshini Nayar, Anjula Pandey, K. Pradheep, Rita Gupta
National Bureau of Plant Genetic Resources, New Delhi, India
Corresponding author e-mail: roshinienayar@yahoo.com

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Introduction

Indian subcontinent is a megacentre of agro-diversity. Legumes have a special place with several native crops and economically important species occurring along forest margins and openings, pastures, grasslands and grazing lands. Several are dual-purpose species for food and feed. However, herbage legumes though major components of grasslands and with a major role in their quality and improvement lack persistence as compared to grasses and their collection, maintenance and conservation assumes importance in the wake of change and loss of habitats of native species and introduction of new germplasm with forage potential. Establishing the correct identity of species is therefore a priority.

The major forage legume crops of India (Anon., 2013) belong to Tribes *Trifolieae- Trifolium*, *Medicago*, *Melilotus* among temperate legumes; *Phaseoleae- Vigna*; and *Indigofereae- Cyamopsis* tropical, subtropical and arid conditions (Arora and Chandel, 1972). These have a good representation of erect, spreading and viny species with potential for use as forage, soil improvement and use as green manure and often with non-toxic herbage and successfully grown over widely varying environmental conditions making this a morphologically variable and highly diverse germplasm resource. Collecting species of native and introduced species from these habitats that are in a state of flux is important for locating potentially important and unique diversity well adapted to the areas of occurrence.

Several species of forage legumes, both native and introduced (Nayar *et al*., 2014) were represented as reference specimens of plants collected from the wild or grown in experimental conditions at the National Herbarium of Cultivated Plants (acronym: NHCP). An initiative undertaken was to authenticate the identity of these, and work out characters that could be used for field identification.

Materials and Methods

Species of forage value (70) belonging to the genera of major legume crop genera were delineated through (a) screening floristic and monographic works, and databases related to plant genetic resources for priority species, diversity in morphology and habitats of availability and the characters that were an aid in confirming the identity of the species; (b) specimens of species, both native and introduced, that were suitable for use for identification were digitised using aflat-bed scanner and images of over 600dpi were created; (c) 'Taxon sheets' were developed for each species with information on taxonomy, classification, origin and distribution/ cultivation, characters important for identification, related species and genepool, both crop and wild; and (d) link of taxon sheets to images and part of it designated as reference material for the introduced germplasm of forage legumes (Nayar *et al.*, 2014) represented from experimental cultivation at the National Herbarium of Cultivated Plants (NHCP) were added to the institute website to make it available to a wide user base.

Results and Discussion

There were two groups of major forage legume crops in the Indian region- one was the predominantly temperate crops grown mainly for use as forage with diversity in the north western parts mainly belonging to Tribe *Trifolieae*, and the second comprised of dual-purpose legume crops of the arid and semi-arid regions representing Tribes *Phaseoleae* and *Indigofereae* (Table 1). These are predominantly species of the Mediterranean/ African regions. Tribe Trifolieae constituted a complex of related genera, namely *Trifolium* (250), *Medicago* (80), *Melilotus* (20) and *Trigonella* (50), mostly of the temperate regions of north western India extending to the plains. Several minor species were under cultivation or introduced for their potential value, providing diversity of species adaptable over a wider range of conditions (Table 1). These were a potential group for survey and collection of native and adapted diversity and representation in the global forage species collection. The taxon specific data and delineation of characters for identification were worked out for nearly 50 species occurring in India. Considerable diversity is represented (subgenera, sections and subsections) in *Trifolium* and *Medicago* (Table 1). The material represented diversity collected and introduced from major global germplasm collections (Figure 1). Furthermore for several variable species a wide range of diversity was represented (Table 2). All species without exception were reported to be escapes and widely naturalised in *Trifolium* and *M. sativa* and *M. polymorpha* were naturalised and introgressed with wild types. Whereas *Trigonella*

foenum-graecum (forage fenugreek) and *T. corniculata* were cultivated over hills and plains of north western parts, *Melilotusindicus* (Indian sweet clover) extended its cultivation from the temperate hills of north western region to northern, central and southern plains.

Vigna was important in the Indian region for both native and introduced diversity- *V. unguiculata* (cowpea) had a secondary centre of diversity for dual-purpose and vegetable types. Subgenus *Ceratotropis* (Asiatic *Vigna*), had maximum number of native domesticated species in the Indian subcontinent and the south eastern and Chinese-Japanese regions). Among these were *V.umbellata*, largest of Asiatic species in plant habit, leaves, inflorescence, flowers and seeds, and *V. trilobata* occurring wild in the dry tracts, and domesticated for forage and *Cyamopsis tetragonaloba* (Tribe *Indigofereae*), a transdomesticate of arid regions, cultivated for its gum with early types being favoured for forage (Dabas *et al*., 2006).

The forage legume crops of India were therefore mainly species introduced into the region. However, the regional conditions of adaptation were a important factor in their successful adoption as forage crops. The taxa introduced for example in *Medicago* were those that were well represented in global collections (Small, 2010). Furthermore, among these, particularly in the temperate taxa, diversity native to the region viz. *Medicago monantha* and *M. edgewortii* were not represented.

Table 1: Major forage legumes cultivated in India

S. no.	Classification	Crop species*	Related species	Others reported in India/ represented in NHCP
1.	Tribe *Trifolieae*: Subgenus *Trifolium*, Sect. *Trifolium*	*Trifolium alexandrinum* L. (Egyptian clover, Berseem)	4	8
2.	Subgenus *Trifolium*, Sect. *Vesicastrum*	*Trifolium resupinatum* L. (Persian clover, Shaftal)	5	Sect. *Trifoliastrum* (3), Sect. *Trichocephalum* (2), subgenus *Chronosemium* (2)
3.	Sect. *Medicago*	*Medicago sativa* L. (Alfalfa, Lucerne)	2	Sect. *Lupularia* (3), sect. *Orbiculares* (1), sect. *Spirocarpos* (10)
4.	Tribe *Trifolieae*	*Melilotus indicus* (L.) All. (Sweet clover, Senji)		6
5.	Tribe *Trifolieae*	*Trigonella foenum-graecum* L. (Fenugreek, Metha)		13
6.	Tribe *Phaseoleae* Subgenus Catiang	*Vigna unguiculata* (L.) Walp. (Cowpea, Lobia)		Subgenus *Vigna* (4), subgenus *Plectrotropis* (1)
7.	Tribe *Phaseoleae* Subgenus *Ceratotropis*	*Vigna umbellata* (Thunb.) Ohwi & Ohashi (Rice bean)		1
8.	Tribe *Indigofereae*	*Cyamopsis tetragonoloba* (L.) Taub.(Cluster bean, Guar)		
		8	11	54

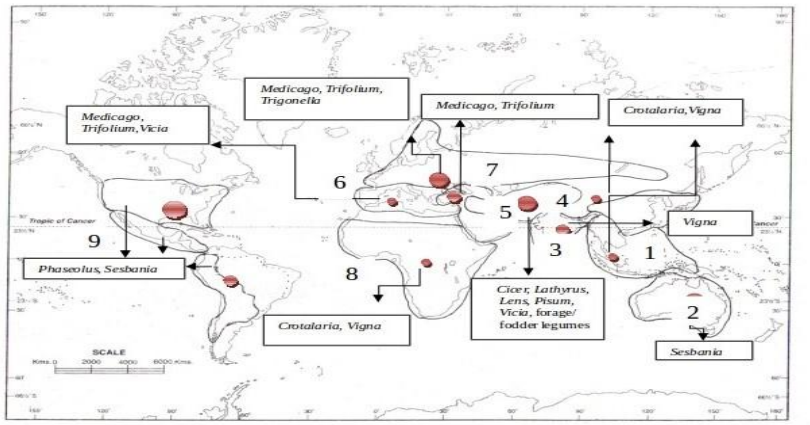
*Anon. 2013; Ali and Qaiser, 1999-2014; ARS-GRIN; Wu-Zhengi *et al*., 2010

Table 2: Characters of some major cultivated forage/ fodder legumes represented in NHCP

S. no.	Species	General characters	Characters of fodder/ forage types in NHCP
1.	*Trifolium repens*	Widespread cultivation in north-eastern, north western and southern hills and all over northern plains	Confused in experimental cultivation with species belonging to diverse Sections of Trifolium, especially in vegetative characters
2.	*Medicago doliata*	Wide range of variations in fruit spininess	Variations represented from spined and spiness forms, forms adapted to milder winters rom Australia, true Mediterranean types from Portugal
3.	*Medicago sativa*	Grown mostly as perennial forage species and highly variable related to wide area of cultivation.	Wild subsp. falcata, easily distinguishable by flower colour, and var. varia representative of hybrids with subsp. sativa important in north western high altitude areas
4.	*Medicago polymorpha*	Highly variable species, though a minor fodder species	Variants with few/ many flowers per inflorescence, pod short/long with few to many coils per fruit, smooth or few spiny, from USA, Australia and Portugal

5.	*Vigna unguiculata*	High inherent variability in cultivated and wild forms and highly responsive to habitat variation.	Pendulous pods, not inflated when young, late maturing types
6.	*Vigna trilobata*	Wide range of habitats and plant habit- spreading and colouration on plant; seeds edible (pilipesara) mainly in drier tracts of AP and Karnataka	Erect habit, and large size (upto 5 times the size of wild plants) of leaves and all vegetative parts, seed size remaining small
7.	*Vigna umbellata*	Largest size of plants, leaves and seeds, and highest production of flowers among Asiatic Vignas, especially in the north eastern region of India	Twining, indeterminate types predominant in cultivation
8.	*Cyamopsis tetragonoloba*	Cultivation for grain in northern plains more widespread earlier	Early flowering types occurring over the areas of cultivation "Ark" types were mainly used for fodder

Figure 1. Source regions of introduced germplasm and their centres of origin



Accessions introduced from a mega-diversity centre:
Less than 25 25 upto 50 50 upto 100 Over 100
Native region of introduced taxa vis-a-vis major centres of diversity: 1 Chinese region and Indo-Chinese-Indonesian region; 2 Australian region; 3 Hindustani region; 4 Central Asian region; 5 Near Eastern region; 6 Mediterranean region; 7 Euro-Siberian region; 8 African region; 9 North, Central and South American regions

Conclusion

To sum-up, the steps for focused build-up and use of species from a wide range of habitats of availability and use of this crop category are listed below:

- Native and introduced taxa as herbarium specimens and conserved seed samples: Diversity and changes therein following introductions viz. *Medicago sativa* changing naturally occurring populations of *M. sativa* ssp. *falcata*
- Identification of species and authentication of collected germplasm: Use of identification aids to locate variations and variants of potential value and adding them to the global PGR.
- Exploration and collection records: Arid regions, purported to have comparatively less native diversity (Arora and Chandel, 1972), equally important as high diversity regions for adding potentially important species to the genetic base of diversity of legume forage species. Recording information on habitat of availability vis-a-vis their indicator value of habitat quality.
- Conservation of germplasm: maintaining a working collection as well as conservation of the germplasm for future use.
- Introduction priorities: (a) Focused introduction for related wild species of major crops as a source of biotic and abiotic stress viz. *T. medium* related to *T. repens* and *Medicago sativa* ssp. *falcata*; (b) avoidance of weedy species such as *Calopogonium mucunoides* which adversely affect natural grazing lands.
- Biosystematic study: to establish genepools of native and introduced species as has been done for the major crop species of India and for forage species of the Mediterranean region.

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