

**BOTANICAL SOURCE AREAS OF WILD HERBAGE LEGUMES IN INDIA**

R. K. ARORA\* and K. P. S. CHANDEL\*\*

**ABSTRACT**

*This paper is an appraisal of the herbage legumes available on the Indian sub-continent. The distribution of the tropical, sub-tropical and temperate types is discussed. The tabulated analysis of about 35 genera and their species met within different phyto-geographical regions of the country indicates three main botanical source areas of herbage legumes in India: 1. the humid tropical region of the western Ghats for Atylosia, Canavalia, Dolichos, Phaseolus, Vigna, Smithia, Glycine, Alysicarpus, Crotalaria, Indigofera and Rhynchosia 2. the sub-tropical zone of Assam and adjoining tract for Desmodium, Teramnus, Mucuna and Pueraria, and 3. the Western Himalayan range from Kashmir eastwards for Lespedeza, Trigonella, Vicia, Lathyrus, other Trifolieae and some frost resistant types like Astragalus and Caragana.*

**INTRODUCTION**

Legumes, like grasses, are of great importance as herbage plants. The value of some of these like lucerne was known as early as 470 B.C. (Klinkowski 1933).

For forage, soil improvement, conservation and related studies, the non-toxic herbaceous Papilionaceae have been exploited—especially the erect, suberect and viny species in tribes Trifolieae, Loteae, Hedysareae, Viciae and Phaseoleae e.g. *Trifolium*, *Medicago*, *Phaseolus* and *Vigna*. In contrast to these, the occurrence of toxicity in other tribes like Genisteae and Galegeae, has restricted their use (Whyte 1958) though the members like *Crotalaria*, *Indigofera*, *Tephrosia*, and *Astragalus*, possess many useful agronomic features. More emphasis on plant exploration to discover non-toxic types is obviously required.

A review of literature (Sundraraj 1967) indicates that in the past most of the herbage plant collecting expeditions have been carried out by FAO, CSIRO, USDA, the South Pacific Commission and a few other agencies, and the collection programmes have been concentrated in the Mediterranean and the South American regions. The Asiatic region has unfortunately been neglected, although it contains a rich diversity of forms, especially of the tropical legumes. Peninsular India, particularly the humid tropical belt, is particularly important. Exploration for the collection of indigenous legume resources in this area is thus of great importance.

As the legumes are very widely distributed in different geographical zones of India, it is imperative that in the exploration programmes emphasis should be on the discovery of habitats or areas in which variability is concentrated so that collections of a wide range of genetic material of different species, ecotypes etc. is possible. It was hoped that the study reported here would provide needed information on:—

- a) The botanical source areas of herbage legumes in India and their potentialities for the supply of germplasm.
- b) The distribution pattern of the plant material available in different regions of the country.
- c) The location of the specific material in a particular region.

---

\*Botanist (Exploration), Division of Plant Introduction, Indian Agricultural Research Institute, New Delhi.

\*\*Assistant Botanist, Division of Plant Introduction, IARI, New Delhi.

- d) The identification of types which are adaptable to wider ecological amplitude e.g. species common to the Himalayas and the south Indian hills like *Parochetus communis*.

### THE BOTANICAL SOURCE AREAS

Though over 400 species (belonging to 60 genera) occurring in India are viny, erect herbaceous, or shrubby types, only about one-third of this number may have a growth form which enables them to be evaluated for agronomic and other useful traits. Most of these belong to genera which have already shown some promise (Cooke 1958; Duthie 1960; Gamble 1957; Haines 1961; Sundararaj and

TABLE 1  
*The distribution of wild herbage legumes in different botanical regions of India*

Genera	No. of species:	No. of species in the different botanical regions						
		1	2	3	4	5	6	7
<b>1. Chiefly tropical/subtropical:</b>								
Alysicarpus	12	8	9	7	7	7	5	5
Atylosia	16	8	13	2	6	5	4	4
Canavalia	4	3	4	1	2	1	1	1
Clitoria	3	1	2	1	2	2	1	1
Crotalaria	82	42	55	5	21	45	6	14
Desmodium	44	15	22	4	17	34	17	15
Dolichos	5	3	5	1	2	2	2	2
Glycine	2	1	2	—	—	1	1	—
Heylandia	1	1	1	1	1	1	—	—
Indigofera	44	26	22	12	18	14	6	15
Mucuna	10	3	5	1	4	7	6	2
Phaseolus	9	3	9	2	4	7	3	2
Pueraria	7	1	1	1	3	5	5	3
Rhynchosia	23	10	17	5	5	7	3	4
Rothia	1	1	1	1	1	1	—	—
Sesbania	4	2	4	2	3	1	1	2
Smithia	13	4	12	1	3	5	4	4
Stylosanthes	1	1	1	—	—	—	—	—
Teramnus	3	1	1	1	1	3	1	1
Vigna	6	1	4	—	1	4	3	1
Zornia	1	1	1	1	1	1	1	1
<b>2. Chiefly temperate:</b>								
Astragalus	36	—	—	2	—	1	6	33
Caragana	6	—	—	—	—	—	1	6
Cicer	1	—	—	—	—	—	—	1
Hedyselum	4	—	—	—	—	—	—	4
Lathyrus	6	—	—	—	1	1	1	6
Lespedeza	13	1	1	—	2	6	7	11
Lotus	1	—	—	—	—	—	—	1
Medicago	5	—	—	1	2	2	3	5
Melilotus	3	1	1	2	2	2	2	3
Parochetus	1	—	—	—	—	1	1	1
Trifolium	4	1	3	—	—	1	2	3
Trigonella	7	—	—	2	4	1	1	5
Vicia	7	1	1	1	2	2	2	6

Regions 1 to 7 are: 1, Decan; 2, Malabar; 3, Indus Plain; 4, Ganges Plain; 5, Assam; 6, Eastern Himalayas; 7, Western Himalayas.

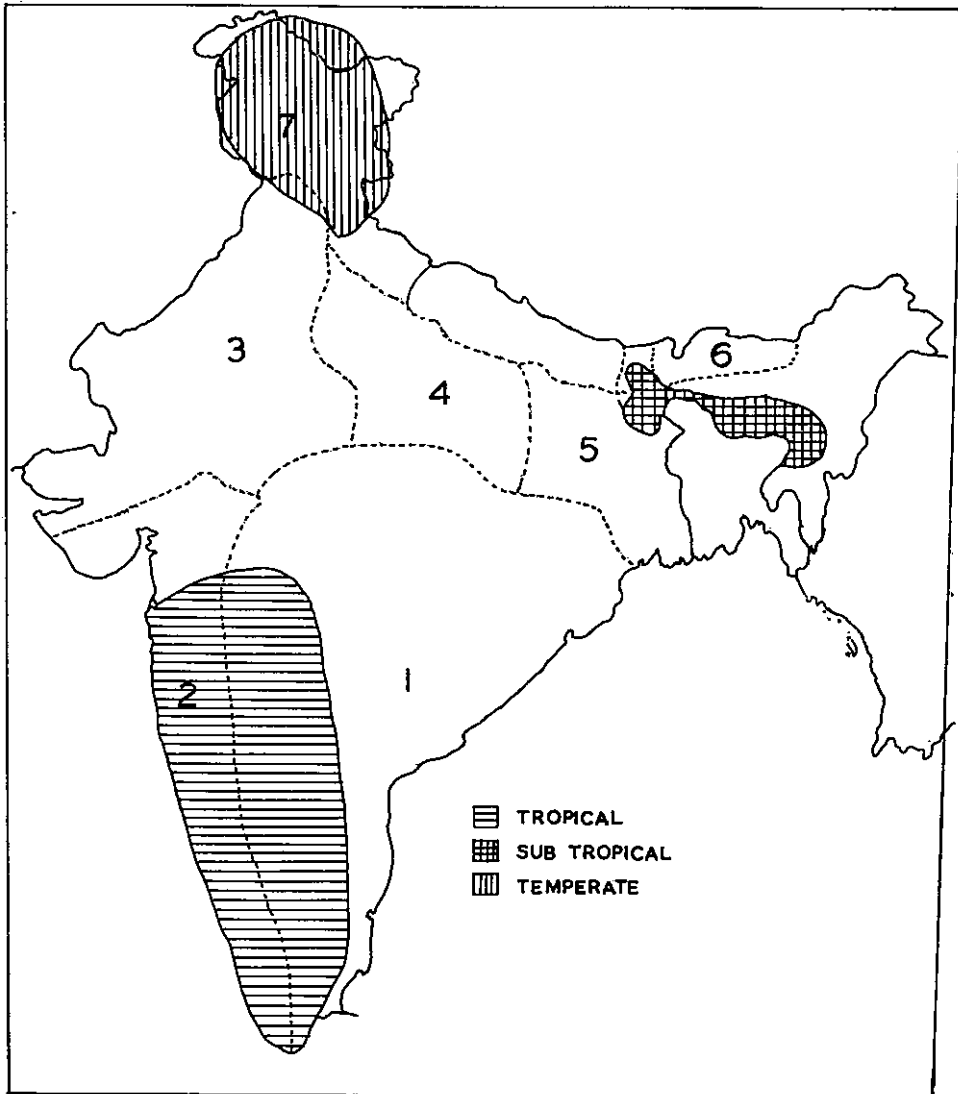


FIGURE 1

Important regions for herbage—legume exploration in India

## TROPICAL

*Alyosia, Crotalaria, Phaseolus, Vigna, Smithia, Canavalia, Rhynchosia, Indigofera, Glycine, Dolichos, Desmodium;*

## SUBTROPICAL

*Pueraria, Teramus, Mucuna, also Desmodium, Vigna, Phaseolus;*

## TEMPERATE

*Medicago, Melilotus, Trifolium, Cicer, Lathyrus, Hedyselum, Vicia, Astragalus, Caragana and Lespedeza (for phytogeographical zones 1-7 refer text or Table 1).*

Balasubramanyan 1959; Maheshwari and Singh 1965). Following the phytogeographical zones of Chatterjee (1939), seven regions have been recognized namely, 1, Deccan; 2, Malabar; 3, Indus plain; 4, Gangetic plain; 5, Assam; 6, Eastern Himalayas; and 7, Western Himalayas. The number of species available in each zone, for each genus is shown in Table 1, which indicates the botanical source areas of herbage legumes in India. A centre of distribution of tropical types is the humid tropical region of peninsular India, particularly zone 2. For the subtropical legumes, zone 5, particularly the Assam tract, and for the temperate types mainly zone 7 of the Western Himalayas—are important regions (Fig 1). There is a paucity of legumes in zone 3. About half of the genera are common to all the zones, and the wide distribution of these genera/species obviously offers opportunities to collect legumes which are widely adaptable e.g. *Crotalaria*, *Alysicarpus*, *Desmodium*.

### AVAILABILITY OF TEMPERATE SPECIES

Maximum variability for temperate legumes can be located in the western Himalayas between 1000-4000 m. Most of the species of *Vicia*, *Lathyrus*, *Lespedeza*, *Trigonella* and others, occur here between 1200-3000 m; some like *Melilotus officinalis* and *Medicago falcata* around 3600 m, and quite a few *Caragana* and many *Astragalus* spp. (e.g. *A. rhizanthus*) have their limit as high as 5000 m. Figure 2 illustrates the altitudinal range of various genera which were considered sufficiently promising to warrant study.

There is a rich legume flora in the bushy alpine habitats or other exposed sites like clearings in the *Rhododendron/Quercus* or pine—mixed vegetation. In the Siwalik foot hills these legumes may be associated with Sal (*Shorea robusta*) stands, but some may occur as forest undergrowth (e.g. *Lespedeza* spp.).

Exclusive to the western Himalayas are the viny legumes *Vicia tenera*, *V. tenuifolia*, *V. pallida* and *V. rigidula*; spreading types like *Vicia tetrasperma*, *Trifolium fragiferum*, *Trigonella gracilis*, *T. pubescens*, *Cicer soongaricum*; and erect herbaceous members like *Trifolium pratense*, *Melilotus officinalis*, *Medicago falcata*, *M. minima*, *M. orbicularis*, *Lespedeza juncea*, *L. elegans*, *L. dubia*, *L. floribunda*, *L. tomentosa* and *L. stenocarpa*. In comparison the eastern temperate belt has few localized species e.g. *Lespedeza elliptica* and *L. thomsonii*. However, quite a few species exhibit a broad range of distribution with types available both in the western and eastern Himalayas. Spreading species like *Trigonella emodii*, or erect types like *Lespedeza gerardiana*, *L. eriocarpa*, *L. speciosa* and *Lotus corniculatus* are present.

While the above legumes are found mainly in the Himalayan range, a few of them also occur elsewhere in the tropical hills at higher elevation. Of particular interest is *Parachetum communis* which occurs in the Himalayas between 1600-2700 m, and in the Nilgiris and Palni hills in South India at altitudes around 1600

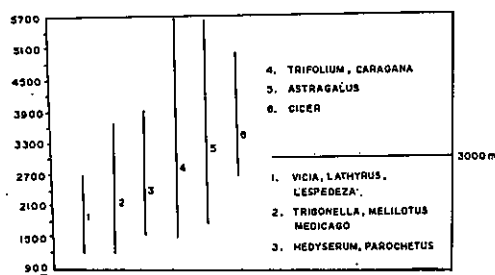


FIGURE 2

Altitudinal range of important temperate herbage legumes in the Western Himalayas.

m. *Trifolium repens* and *Lespedeza sericea* also occur here, and help to form the high quality natural forage of the area. Elsewhere in the tropical hills of the central peninsula *Lespedeza sericea* and *L. macrostyla* occur at a lower elevation (1000 m).

A variable pattern of distribution is shown by a few species which occur in the plains as well as in the Himalayas. Particularly prominent among these in the upper Gangetic region are *Lathyrus aphaca*, *L. sphaericus*, *Vicia hirsuta*, *V. sativa*, *Melilotus indica*, *M. alba*, *Medicago lupulina*, *M. denticulata*, *Trigonella corniculata* and *T. incisa*. Most of these exhibit a wide ecological range and occur in northern India as weeds of cultivated lands during the winter period.

Apart from the temperate genera discussed above, there are a few species of tropical-subtropical legumes also distributed in the Himalayas. These are viny species like *Rhynchosia falconeri*, *R. himalensis*, *Atylosia grandiflora* and *Pueraria strachyii*; and erect herbs like *Alysicarpus meeboldii* and *Crotalaria incana*.

The number of species available in most of the genera mentioned above has been given in Table 1, together with their occurrence in different botanical zones. The maximum number of these genera are found in the western Himalayas. Certain genera like *Melilotus*, *Medicago*, *Trifolium*, *Trigonella*, *Lespedeza* and *Vicia* contain useful forage species. Exploration should concentrate on collecting the maximum range of variability in these genera from habitats which are as diverse as possible. The collecting of ethnobotanical information on the usage of other legumes would be equally important. A survey of the alpine habitat for frost resistant non-toxic types in *Astragalus*, *Caragana* and *Hedyselum* would be worthwhile.

#### AVAILABILITY OF SUBTROPICAL SPECIES

Most of the subtropical species are confined to the humid region of Assam and its neighbourhood, which covers the West Bengal mountainous tract and extends to the eastern Himalayas. Most of the legumes here occur between 600-1500 m. The material can be located in forest clearings, other secondary habitats and exposed sites. In the lower mountainous ranges much of the material occurs in sal-mixed or evergreen forests and in higher elevations in pine-mixed or *Rhododendron/Quercus* mixed forests. Here, the most important genera are *Desmodium*, *Teramnus*, *Mucuna*, *Pueraria* and *Vigna* and also to a lesser extent *Dunbaria*.

Exclusively confined to the Assam region are viny species like *Mucuna macrocarpa*, *Atylosia elongata* and *Clitoria mariana*, and the erect species, *Crotalaria occulta*, *C. assamica*, *C. capitata*, *Desmodium griffithianum*, *D. khasianum*, *D. dicoccum* and *D. racemosum*. A comparatively large number of species extends further into the eastern Himalayas e.g. *Teramnus flexilis*, *Pueraria thomsonii*, *P. peduncularis*, *Mucuna bracteata*, *Vigna dolichoides* and *Phaseolus velutinus*. Still others have a wider range of distribution and besides occurring in the Assam/eastern Himalayas region, also occur in the western Himalayas. These are the viny *Pueraria wallichii* and erect herbaceous to shrubby *Desmodium oxyphyllum*, *D. sequex*, *D. podocarpum*, *D. laburnifolium*, *D. floribundum*, *Crotalaria humifusa*, *Indigofera bracteata* and *I. dosua*.

A few subtropical legumes are distributed elsewhere in peninsular India e.g. viny species like *Mucuna nivea*, *M. imbricata*, *M. monosperma*, *Vigna pilosa*, *V. luteola*, *V. clarkei* and erect ones like *Crotalaria acicularis*, *Desmodium confertum*. These occur chiefly in Assam/eastern Himalayas, but some, like *M. capitata* and *Pueraria phaseoloides* also occur in the western Himalayas. A few however are confined either to the eastern peninsular region e.g. *Crotalaria tetragona*, *Desmodium gyoides* or to the western peninsula e.g. *Teramnus labialis*.

The number of species available in most of the genera considered above is given in Table 1. Primary emphasis should be given during exploration to the collection of diverse types of *Teramnus*, *Pueraria* (preferably non-woody), *Mucuna*, *Vigna* and *Desmodium*.

## AVAILABILITY OF TROPICAL SPECIES

Tropical legumes occur mainly in peninsular India, which is an extremely large tract with great variation in climate and physiography, caused by the numerous mountain chains which traverse it—the western Ghats, eastern Ghats, Vindhyan and Satpura ranges and the Aravallies. The plain undulates and rises to a maximum elevation of 2200 m in the western Ghats. This area consists mainly of the botanical zones 1 and 2 of the western peninsula and 3 and 4 of the central peninsula. The leguminous flora occurs in exposed habitats or as forest undergrowth; most of the viny types are found in scrubby forests. The area in western India supports a moist deciduous teak-mixed or evergreen forest vegetation, and either a teak/sal-mixed vegetation or an evergreen growth, in the central region.

The western Ghats region is particularly suitable for such a study of the distribution of the smaller genera like *Geissaspis*, *Stylosanthes*, *Canavalia*, *Leptodesmia*, *Glycine*, *Atylosia*, *Phaseolus*, *Vigna*, *Smithia*, *Dolichos* and *Tephrosia*. The larger genera like *Crotalaria*, *Rhynchosia* and *Indigofera* occur chiefly as undergrowth in deciduous/evergreen forests though as is pointed out below, some of these are confined to grasslands or evergreen forests, called sholas, on higher hills (1600 m) e.g. Nilgiris.

In the Nilgiris and the surrounding area are found viny species like *Rhynchosia filipes*, *R. velutina*, and *Vigna wightii* and many erect herbaceous undershrubby forms; herbaceous species like *Smithia gracilis*, *Crotalaria peduncularis*, *Alysicarpus beddomei*, *Indigofera vestita*, *Desmodium gardneri*; shrubby species like *Atylosia candollei*, *Crotalaria rubiginosa*, *C. tecta*, *C. fulva*, *C. pulcherrima*, *C. grahamiana*, *Desmodium rufescens* and *Leptodesmia congesta* and spreading species like *Crotalaria evolvuloides* and *Indigofera pedicellata*.

There are other species which occur in the mountainous ranges of Maharashtra, extending southwards in the western Ghats, but unlike the above group these are distributed in the plains and hills of low altitude (about 1000 m). Found there are viny species: *Vigna bournae*, *Canavalia virosa*, *Dolichos bracteatus*, *D. ciliatus*, *D. biflorus*, *Atylosia rostrata*, *Phaseolus grahamianus*, *P. pauciflorus*, *Glycine javanica*, *Mucuna gigantea*, *M. hirsuta*, *M. atropurpurea*, *Rhynchosia densiflora*, *R. nummularia*, *R. acutilissima*, and *Desmodium biarticulatum*; herbaceous erect species like *Indigofera echinata*, *I. triquetra*, *I. tenuifolia*, *I. subulata*, *I. marginulata*, *I. parviflora*, *Smithia purpurea*, *S. setulosa*, *S. capitata*, *S. pycnantha*, *Crotalaria triquetra*, *C. willdenoviana*, *C. quinquefolia*, *C. lutescens*, *C. salicifolia*, *C. dubia*, *C. nana*, *Desmodium rotleri*, *D. dolabrifolium*, *D. scalpe*, *D. rotundifolium*, *D. gardneri*, *Alysicarpus belgaumensis*, *A. pubescens*; shrubby species: *Stylosanthes mucronata*, *Atylosia lineata*, *A. sericea*, *A. geminiflora*, *Phaseolus grandis*, *Crotalaria speciosa*, *C. heyneana*, *C. leptostachya*, *C. semperflorens*, *C. subperfoliata*, *C. lunulata*, *C. paniculata*, *C. laevigata*, *C. digitata*, *C. laburnifolia*, *C. lanata*, *Rhynchosia beddomei*, *R. suaveolens*, *R. heynei*, *Desmodium parviflorum*; and spreading species like *Indigofera endecaphylla*, *Smithia bigemina*, *Crotalaria biflora*, *C. bifaria*, *C. globosa*, *C. filipes*, *C. vestita*, *C. stocksii*, *C. trichophora*, *C. hirta* and *Sesbania procumbens*.

A few species of wide distribution occur in the western as well as in the central peninsula, these include the viny *Atylosia albicans*; erect species like *Indigofera glandulosa*, *Crotalaria linifolia*, *C. chinensis*, *Desmodium diffusum*, *Rothia trifoliata*, *Rhynchosia cana* and the spreading species *Alysicarpus tetragonolobus*, *A. longifolius*, *A. hamosus* and *Heylandia latebrosa*.

There are quite a few legumes which apart from peninsular India occur in the western Himalayas. These are the viny species *Phaseolus sublobatus*, *Atylosia crassa*, *Rhynchosia capitata*; the erect herbaceous or shrubby species; *Alysicarpus monilifer*, *A. bupleurifolius*, *Crotalaria mysorensis*, *C. retusa*, *C. verrucosa*, *C.*

*sericea*, *C. albida*, *Indigofera astragalina*, *I. pentaphylla*; and the spreading species *Crotalaria hirsuta* and *C. prostrata*. Still others occur in western and eastern Himalayas—viny species like *Vigna capensis* *Dolichos falcatus*, *Rhynchosia rufescens*; erect species *Crotalaria humifusa*, *Desmodium laxiflorum*, *D. pulchellum*, *D. triquetrum*, *D. cephalotes*, *D. gyrans*, and spreading species like *Desmodium parvifolium*. Only a few of the western peninsular species occur elsewhere in the Assam/eastern Himalayas region e.g. the viny species: *Atylosia barbata*, *Glycine pentaphylla*; the erect ones like *Crotalaria trifoliatum*, *Desmodium heterophyllum*, *D. reniforme*, and the spreading species like *Smithia blanda*.

The other group of tropical legumes is distributed mainly in the central peninsula. Some species here are confined to the drier tracts being prominent in Rajasthan. Found here are the viny species *Rhynchosia arenaria* and *R. rhomboidea*; the erect shrubby *Crotalaria burhia* and the spreading *Indigofera hochstetteri*. Others occur widely in the plains and sub-mountainous central India—viny species *Atylosia cajanaefolia*, *Rhynchosia bracteata*; erect species like *Indigofera angulosa*, *I. paucifolia*, *Desmodium spirale* and spreading species like *Trigonella occulta*, *T. hamosa* and *Desmodium brachystachyum*. In the mountainous ranges occur species which also occur in the Himalayas. These are *Crotalaria ferruginea* and *C. alata* in Assam/eastern Himalayas, and *Crotalaria tetragona*, *Alysicarpus parvifolius*, *Indigofera trifoliata*, *I. atropurpurea*, *I. viscosa*, *Desmodium latifolium* and *Smithia ciliata* in Assam/eastern and western Himalayas, and a few elsewhere confined to western Himalayas e.g. the viny species *Rhynchosia viscosa*, *Atylosia platycarpa*; erect species *Crotalaria albida*, *Phaseolus adenanthus*, *Indigofera gerardiana* and *Desmodium gangeticum* and spreading ones like *Alysicarpus rugosus*.

There are only a few species that are very widely distributed all over India. Prominent among these are the viny species: *Rhynchosia minima*, *Clitoria ternatea*, *Atylosia scarabaeoides*, *Phaseolus aconitifolius*, *Pueraria tuberosa*, *Mucuna pruriens*; the erect shrubby species: *Crotalaria medicaginea* and *Indigofera trita*, and spreading herbaceous species: *Zornia diphylla*, *Desmodium triflorum*, *Indigofera linifolia*, *I. enneaphylla*, and *Alysicarpus vaginalis*.

Table 1 gives the number of species of tropical genera which we find in the different botanical regions. Maximum diversity is available in the western Ghats. Primary emphasis should be laid in collecting all variability dispersed over a wide range of altitude and latitude in this region, particularly in *Alysicarpus*, *Crotalaria*, *Desmodium*, *Dolichos*, *Atylosia*, *Smithia*, *Indigofera*, *Glycine*, *Heylandia*, *Phaseolus*, *Vigna*, *Rhynchosia*, *Canavalia* and *Zornia*.

### SOME GENERAL CONSIDERATIONS

The herbage legume should preferably be fast growing and generally non-woody, should seed well, and if required for green manure should dry in the field and rapidly decompose into organic matter. They should also be free from pests and diseases. A combination of such characteristics has gone in the selection of types widely used now on the Indian sub-continent e.g. *Crotalaria juncea*, *Trifolium alexandrianum*, *Cyamopsis tetragonoloba*, *Dolichos biflorus* and a few others.

Most of the work in the development of new herbage legumes for the tropical/subtropical regions has been done by C.S.I.R.O., Division of Tropical Pastures in Australia with the result that many new species of legumes are now in use e.g. *Lotononis baniesii* (Bryan 1961), Siratro or *Phaseolus atropurpureus* (Hutton 1962), Phasey bean or *Phaseolus lathyroides* (Evans 1971), Kudzu or *Pueraria thunbergiana*, Centro or *Centrosema pubescens*, Stylo or *Stylosanthes humilis*, and *Glycine javanica* (Davies 1970). To these may be added *Dolichos lablab* cv. Rongii and *D. axillaris* cv. Archer which are tolerant to drought and cold, and *Phaseolus*

*actifolius*. Most of these have now been introduced in India. *Lespedeza striata*, *L. stipulata*, *L. sericea* and *L. cuneata* are being grown in U.S.A. for hay and forage (Bailey 1949).

While temperate legumes can withstand cutting, grazing etc. there are few tropical legumes which can persist under grazing and cutting conditions, even among the prostrate types, and persistence is a major problem with these species. Bryan (1969) has shown that *Desmodium intortum* and *D. uncinatum* can withstand grazing and perform well under cutting. These species have found a place in sown pastures without needing any improvement by selection and breeding and now cover thousands of acres in Australia (Bryan, *loc. cit.*).

The wide range of indigenous legumes available in the Asiatic region deserves further study. It would be desirable to collect ethnobotanical data to aid the search for non-toxic species and this can be profitably achieved through plant exploration. The need for an internal survey in this region has been pointed out by Sastrapradja (1970). In India, the Plant Introduction Division in the Indian Agricultural Research Institute has been engaged in such a task (Anon. 1970), and much useful material has been collected and evaluated.

It is hoped that this paper will be found helpful in initiating collection programmes by internal agencies and outside organizations like CSIRO, Australia, which are interested in discovering new herbage resources or in supplementing the existing variability of widely distributed species from this region.

#### REFERENCES

- ANON (1970)—Collection, maintenance and assessment of indigenous genetic stocks of grasses and legumes for fodder, forage, food and conservation purposes. P.L. 480 Report., Plant Introduction Division, Indian Agricultural Research Institute, New Delhi.
- BAILEY, L. H. (1949)—Manual of cultivated plants, MacMillan Company, New York.
- BRYAN, W. W. (1961)—*Lotononis bainesii* Baker; a legume for subtropical pastures. *Australian Journal of Experimental Agriculture and Animal Husbandry*. 1: 4-10.
- (1969)—*Desmodium intortum* and *D. uncinatum*—a review. *Herbage Abstracts*. 39: 183-91.
- CHATTERJEE, D. (1939)—Studies on the endemic flora of India and Burma. *Journal Royal Asiatic Society of Bengal Science*. 5: 19-67.
- COOKE, T. (1958)—The Flora of the Presidency of Bombay (Reprinted Edition) Vol. 1., Botanical Survey of India, Calcutta.
- EVANS, T. R. (1971)—Species for coastal pastures—their strengths and weaknesses. *Tropical Grasslands*. 5: 45-50.
- GAMBLE, J. S. (1957)—Flora of the Presidency of Madras (Reprinted Edition) Vol. 1., Botanical Survey of India, Calcutta.
- DAVIES, J. G. (1970)—Pasture development in the subtropics with special reference to Taiwan. *Tropical Grasslands*. 4: 7-16.
- HAINES, H. H. (1961)—The Botany of Bihar and Orissa (Reprinted Edition) Vol. 2., Botanical Survey of India, Calcutta.
- HUTTON, E. M. (1962)—Siratro—a tropical pasture legume bred from *Phaseolus atropurpureus*. *Australian Journal of Experimental Agriculture and Animal Husbandry*. 2: 117-25.
- KLINKOWSKI, M. (1933)—Lucerne, its ecological position and distribution in the world. *Imperial Bureau of Plant Genetics, Herbage Plants*. Bulletin No. 12: 61 pp., Aberystwyth, Great Britain.



- MAHESHWARI, P., and SINGH, U. (1963)—*Dictionary of the Economic plants in India*. Indian Council of Agricultural Research, New Delhi.
- SASTRA-PRADJA, S. (1970)—Genetic conservation in Indonesia. *Plant Introduction News Letter*. 24: 16.
- SUNDARARAJ, D. (1967)—F.A.O. Technical conference on Exploration, Utilisation and Conservation of plant genex resources— Exploration and collection of tropical forage plants: 19 pp., F.A.O., Rome, Italy.
- SUNDARARAJ, D., and BALA SUBRAMANYAM (1959)—*Guide to the Economic Plants of South India*. Amudha Nilayam Private Ltd., Madras.
- WHYTE, R. O. (1958)—Plant Exploration, Collection and Introduction F.A.O., Agric. Studies 41, F.A.O., Rome, Italy.

(Accepted for publication June 18, 1972)