

Genetic Diversity of Legume Species and Their Utilization in Vietnam

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Abstract

Due to the wide range of latitude and complicated topography. Vietnam is very rich in plant genetic resources, of which legumes are widespread and economically important. After a series of studies, Vietnamese breeders and researchers have evaluated a large number of legume accessions. Based on the resulted, it became possible to proceed to the selection, induce mutations and breed several legume varieties and lines that can meet various requirements of production and environmental protection.

Despite the great success in their utilization, since many legume species have not been properly studied, they remain non-or under-utilized. To preserve and use the legume genetic resources in Vietnam, more concerted efforts on the part of the researchers, as well as close cooperation and collaboration with various organizations in the world are required.

Natural conditions and economic importance of legume development in Vietnam

Vietnam is a small country. With 330,000 km² of territory curving as an S letter stretching over 1,600 km from 8° 23' to 23° 22' North there are diverse climatic conditions: tropical, subtropical as well as temperate in the high mountains of the northern, central and southern parts of the country. In general Vietnam is typically a tropical and monsoon country, where winter is distinctly a dry season. In the northern plains the cold winter lasts from November to April, the average temperature being 16°C.

The northeast winter monsoon often causes drizzling rains from February annually. In this region the summer is very hot with abundant precipitation caused by serious storms and typhoons. Generally speaking the climate in North Vietnam is similar to that in South China. In the southern plains, the climate is more or less moderate with an average temperature of 25-30°C. Rainfall ranging from 1,600 to 2,000 mm is common for most of the regions. In some years we can notice 3 seasons: the first is (similar) equivalent to the summer (May-October) (hot and wet), the second is the winter (November-February) (dry and relatively cold), the last occurs from February to April (dry and hot). The climate in central Vietnam is a transition from the northern climate to the southern one. In general it is colder than in the South and there is no distinct difference between wet and dry season; with such a wide range of climatic conditions, Vietnam is very rich in plant species, of which the legumes grow all the year round.

Geographically Vietnam is located in Southeast Asia. As it is connected with many important centers of diversity of legumes, main legume species of the world are distributed there.

The order *Fabales* with 3 main families consisting of 650 genera and 18,000 species is a remarkably diverse and valuable repository for mankind. However in Vietnam the legume species have not been fully explored and used in an appropriate manner. There are food legumes (soybean, groundnut, species belonging to the genera *Phaseolus*, *Vigna*, etc.) which provide an important and chief source of protein amounting to 20% of daily protein requirement of the people. The legumes carry a nitrogen fixation micro-organism system in their nodules that plays an important role in soil fertility improvement. Major-

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ity of other legumes are climbers, bushes and forest plants with different uses: forage, medicine, green manure, fast-growing timber for soil erosion control, precious wood, paper material, lacquer, dye, ornamental plants, nectar for bee-rearing, etc. In spite of their great economic potential, thousands of legume species have not been systematically investigated, characterized and effectively used. To preserve these valuable genetic resources we have to consider the importance of exploration collection, conservation, evaluation and utilization of germplasm as common strategies for the protection of the present ecological environment. To fulfil these objectives, besides the joint efforts of our researchers and managers, we need collaboration and support from foreign countries and international organizations. This report describes the diversity of legume genetic resources in Vietnam.

Characteristics of classification and botany of legume species in Vietnam

1 Classification and botany

According to the common system of classification, the order *Fabales* is divided into 3 families:

Family *Caesalpinaceae*: 2,800 species

Family *Mimosaceae*: 2,800 species

Family *Fabaceae*: 12,000 species (490 genera)

According to the present knowledge, these 3 families can be united in one family *Fabaceae* with the following characteristics.

Family *Caesalpinaceae*: the flowers are zygomorphic, bisexual, forming scarce, inflorescences, for example *Caesalpinia sappan dolonix regia*, *Cassia* spp., *Erythrophloeum fordii*, *Sindora* spp, *Albizia lebbek*.

Family *Mimosaceae*: the flowers are actinomorphic, bisexual, often pentamerous sometimes tetramerous, small and sessiles forming spherical racemes or spikes, for example *Leuceana* spp., *Mimosa* spp, etc.

Family *Fabaceae*: it is the largest in the *Fabales*, the flowers often form racemes at the branch tip or at the leaf axils, the flowers are irregular (zygomorphic) pentamerous, bisexual with distinct standard, wings and keel.

The roots of legumes often show well-developed nodules. The pods have a very unique shape and usually shatter at ripening.

2 Origin of legume species in Vietnam

As shown above, Vietnam has a favorable geographical location with diverse climatic conditions conducive to growth and development of legumes. Therefore we can find in Vietnam almost all the main legume representatives originating from 9 centers of diversity in the world:

1. The Indo-Malaysia Center: Vietnam is located in this center, where species of *Stizolobium* have their primary origin.
2. The China Center: Origin of cultivated soybean (*Glycine max mer* (L)), wild soybean (*Glycine ussuriensis*), redbean (*Phaseolus angularis*), French bean (*Phaseolus vulgaris*), China bean (*Vigna sinensis*), wild mungbean (*Stizolobium hassjco*).
3. The Hindustan Center: Origin of chickpea (*Cicer arietinum*), pigeon pea (*Cajanus cajan*) mungbean (*Vigna radiata*), black gram (*Vigna mungo*), Redbean/ricebean (*Vigna umbellata*), teparybean (*Phaseolus acutifolius*) catjang bean (*Dolichos biflorus*), lablab (*Dolichos lablab*), jackbean (*Canavalia ensiformis*), swordbean (*Canavalia gladiata*), yambean (*Pachshizus erosus*), wingedbean (*Psophocarpus tetragonolobus* yardlongbean/chinabean (*Vigna chinensis*), trigonella (*Foecum graccum*), guar or chisterbean (*Cyamopsis psoralepides*).
4. The central Asian Center: Origin of pea (*Pisum sativum*), broad bean (*Vicia faba*), lentil (*Lens esculenta*), mungbean (*Vigna viditata*), black gram (*Vigna mungo*), chick pea (*Cicer arietinum*).
5. The Near East or the Persian center: Origin of grass pea/vetchling (*Lathyrus sativus*), lupin (*Cupinus pilosus*), lucerne (*Medicago sativa*), lentil (*Lens esculenta*), pea (*Pisum sativum*), *Trigonella foecum graccum*.
6. The Mediterranean center: Origin of lupin (*Lupinus pilosus*), pea (*Pisum sativum*), broadbean (*Vicia faba*).
7. The Abyssinian center: Origin of cowpea (*Vigna unguiculata*), jackbean (*Canavalia ensiformis*), swordbean (*Canavalia gladiata*), lablab (*Dolichos lablab*), broadbean (*Vicia faba*).
8. The Central American center: Origin of whitebean/limabean (*Phaseolus lunatus*).

9. The South American Center : Origin of groundnut (*Arachis hypogea*), white bean or limabean (*Phaseolus lunatus varmacrosperrmus*).

Besides, there are many other legume species that have considerable economic importance, but their origin is not clearly understood (Appendix 1).

3 Distribution of legume species in Vietnam

Groundnut, mungbean, yardlongbean, pigeon pea and some *Dolichos* spp. as lablab require a high temperature between 20 and 40°C. They occur all over the country.

Pea, French bean, broad bean, chickpea, lentiletc require a temperature ranging from 10 to 30°C or less. They are usually grown in high mountainous regions with moderate conditions, or in the northern provinces during winter and winter spring seasons.

Soybean consists of a large number of groups and varieties. In Vietnam, the soybean varieties adapted to the tropical climate are grown all the year round in the southern and central parts. In the northern provinces they are grown in summer. Also in the North, the soybean varieties originating from temperate regions are usually grown in winter. We can find wild soybean varieties all the year round in the midland and mountainous areas.

Economically important legume groups in Vietnam

1 Food legumes

1. Grain legumes

1) Soybean (*G. max* Mer L.)

Investigations and evaluation of international soybean collections in Vietnam. In the world today, 15 countries are conserving large soybean collections, namely Taiwan, Australia, China, France, Nigeria, India, Indonesia, Japan, South Korea, North Korea, South Africa, Sweden, Thailand, USA and SNG with a total of 45,035 accessions (Sunmorjeld and Roverte,1985).

In Vietnam according to the data of the Vietnam Agricultural Science Institute (INSA) 4,188 accessions were evaluated during 1986-1990, of which 200 were local varieties. We can say that soybean varieties are from VIR. Only in 1987 were 600 accessions introduced and in 1989 659 accessions were imported. These varieties have different origins mainly from AVRDC and IITA.

Sixty characteristics were observed and recorded : botanical, biological, ecological, economic characters and resistance to pests and diseases.

Taxonomically, these varieties belong to cultivated soybean (*Glycine max* (L.) merr.). However, 2 accessions show a crawling stem and belong to the semi-wild *G. ussuriensis*.

Growth type : there are 3 types of growth : determinate, indeterminate and semideterminate. The varieties with determinate and semideterminate types of growth account for 80% of tested varieties.

Flower color : there are two main colors white and purple. Besides, there are also intermediate colors.

Leaflet shape : 13 types were observed, 3 leaflet leaves are common. However, in some varieties there are 4 or 5 leaflet leaves.

Leaf color : dark green and light green.

Stem color : green, green with anthocyanin pigmentation during growth and ripening.

Stem hair color : maroon reddish, yellow reddish and white.

Pod color : sandy bright, yellow brown, light dark and grey brown.

Hilum color : brown, black, green, yellow.

Eye color : white.

Growth duration : 9 groups can be distinguished. Very early and early groups : 61 to 70 day, for example variety Shire Tairai (61 days), varieties ISZ 16 and K 5376 (62 days) and Norodia, K 6777, Ontario and A 9 (64 days). The very early group consists of 87 accessions with representatives as Violetta, K 7071 Paterson 90 A. The early group comprises 397 accessions and the medium group 423 accessions.

Plant height varies from 20 to 70 cm. Three accessions with the lowest plant height of 20-25 cm are K493844, K 493841 and K 9139. There are 328 accessions with a plant height of 40-50 cm.

Number of filled pods/plant varies from 20 to 40. Two hundred ninety three accessions produce less than

20 pods (DB 2822, K 4594, K 1502); 116 accessions produce 40-60 pods, 22 accessions give 60-80 pods, only 15 samples give more than 80 pods, for example JS 200, AGS 94, AGS 11 etc.

1000 seed weight 95 accessions have a 1000 seed weight of less than 95 g, 353 accessions reach values of 120-140 g, for example K. 9118, French No. 4, K 493885, 143 accessions have a 1000 seed weight of 160-180 g. Out of 629 accessions only 38 samples, such as No 614129, 514-135 etc. have a 1000 seed weight of more than 200 gram.

Seed weight/ plant : among the investigated collections, 175 samples produce 3 g of seeds per plant, 283 samples produce 3-5 g/ plant, 320 accessions produce 5-9/plant, 117 accessions produce 9-15 g/ plant, 12 accessions give more than 15 g/ plant : AGS-111 (16.6 g), Williams (18.7) line 138 (18.9 g).

Response to day length : out of 233 accessions that were evaluated for this character, 105 accessions did not respond to day length (photoperiod sensitivity). These are valuable sources for breeding soybean varieties with broad adaptation ability that can be grown in various seasons.

Some representatives are mandarin (from Peru), F. 1-2 (from Brazil), K 9015 (from Madagascar), So Toko (from Laos), DT 84 and DT 90 (Vietnam).

Resistance to rust : from 1986 to 1989, the research institutions evaluated 1,000 accessions for resistance to rust under natural and artificial conditions. Under natural conditions 113 varieties and 21 lines appeared to have a high resistance. In the disease stimulation plots only 7 varieties and 4 lines were highly resistant. In one source, under artificial conditions only 6 varieties and 3 lines proved to be resistant. In multi-source under artificial conditions, the number of resistant samples was reduced to 1 variety and 1 line. As a result 2 varieties and 1 line were identified as the most resistant ones (AGS-70, JS-20 and VK 2-5). Three moderately resistant accessions are Taiming 4, PI 181561. Newsealand. These varieties and lines are a valuable gene, sources for breeding soybean varieties for resistance to rust disease in Vietnam.

From diverse genetic resources of soybean, our researchers have conducted selection, mutation and sexual hybridization to develop new varieties that can meet production requirements.

(1) Breeding and selection of spring soybean

Spring is the main growing season for soybean, usually giving a high yield. However as it is also the most favorable season for pest and disease development, to meet the requirements of spring growing a variety must have an acceptable yield (more than 2 ton/ ha) and be resistant to main pests and diseases. During 1985-1990 our breeders developed 10 new varieties accepted by producers (Table 1).

(2) Breeding and selection of summer soybean

Summer season begins from the end of May and lasts until August. Temperature usually varies from 30 to 36°C. A summer soybean variety must be tolerant to high temperature and produce a high yield under summer conditions. There are 3 distinct soybean-growing areas in summer.

Summer soybean on soil after harvest of spring secondary crops : these kinds of fields cover considerably

Table 1 Soybean yield and components in some medium promising varieties in spring crop (1985-1990)

Variety	Origin	Duration (day)	Protein (%)	Oil (%)	Grain (Ton/ ha)	Yield (%)
1 DT74	Vietnam	115	40.5	22.3	2.0	100.0
2 AK04	INSA	100	39.6	23.2	3.2	160.0
3 AK05	INSA	100	42.4	21.7	2.9	145.0
4 DT80	Vietnam	105	43.2	22.4	2.6	130.0
5 VX 9-1	INSA	98	37.6	23.0	1.9	95.0
6 VX 9-2	INSA	98	37.0	23.3	2.4	120.0
7 VX 9-3	INSA	98	40.0	22.7	2.4	120.0
8 DT83	Vietnam	98	40.0	22.0	2.4	120.0
9 DT84	Vietnam	100	40.2	21.0	2.4	120.0
10 M103	INSA	100	39.0	23.0	2.3	115.0
X		101	39.7	22.4	2.4	121.5

large areas, for which a growing duration of 90-100 days is required. We have selected some varieties such as DH 4, M 103, DT 83 and DT 84 that fulfill the above-mentioned requirements of summer season.

Summer soybean on soil between two rice seasons: for this kind of soil, the growing season is highly restricted and requires very early varieties, the varieties selected for this area are Cuc Habac, Lo Habac, Cuc Vang, Cuc Mattrang and EK (Table 2).

Summer soybean in the mountains and midlands: this area is large. The two varieties Dau Lang and DT 80 with a growing duration of 120-145 days and resistance to high temperature are suitable for these areas.

(3) Breeding and selection of winter soybean

In Vietnam winter soybeans are grown on two types of soils:

On the soil of dry secondary crops: this soil is rich and fertile. It is usually free after maize or groundnut cultivation in mid-September, when the winter soybeans can be sown. The winter soybean varieties must be tolerant to low temperature. The varieties V 74, DT 78, Hill, VX 93, AK 04 are quite suitable for this kind of soil (Table 3).

On the soil after two rice seasons: the area under this soil type is very large. Research efforts have re-

Table 2 Soybean yield components in some promising varieties in summer crop (1985-1990)

Variety	Origin	Duration (days)	Heat tolerance	Seed (ton/ha)	Yield (%)
1 Cuc Habac	Vietnam	76	good	1.55	100.0
2 Lo Habac	Vietnam	76	good	1.85	119.4
3 Cuc vang	Vietnam	78	good	1.60	103.2
4 Cuc mattrang	Vietnam	76	good	1.53	98.7
5 EK	Vietnam	77	good	1.45	93.5
6 DH 4	Vietnam	90	good	1.75	100.0
7 M103	Vietnam	100	good	1.80	102.8
8 DT83	Vietnam	100	good	1.95	111.4
9 DT84	Vietnam	110	good	1.92	109.7
10 Dac lang	Vietnam	145	good	2.06	117.7
11 DT80	Vietnam	105	good	1.76	100.6

Table 3 Soybean yield and componens in some promising varieties in winter-crop (1985-1990)

Variety	Origin	Duration (days)	Cold tolerance	Seed (ton/ha)	Yield (%)
1 V74	INSA	120	good	2.0	100.0
2 Hill	USA	115	good	1.4	70.0
3 DT78	INSA	112	good	1.9	95.0
4 VX9.3	INSA	100	good	2.1	105.0
5 AK04	INSA	100	good	2.3	115.0
6 Cuc	INSA	78	medium	1.6	80.0
7 Fiskeby	Swede	79	medium	1.8	90.0
8 AK02	INSA	75	good	2.0	100.0
9 AK03	INSA	85	good	2.5	125.0
10 AK05	INSA	95	good	2.8	140.0
CV%		0.9		21.7	
LSD 0.05		1.6		0.6	

sulted in the selection of many early varieties, with strong resistance to cold with a high-yielding potential. Short duration rice varieties were also selected for harvest as early as around September 20. Soybean sowing from 25, September to 5, October is successful. The total production in rice equivalence increased from 10 to 15-17 ton/ ha/ year.

2) groundnut

(1) Investigations and evaluation of international groundnut collections

Since 1984, INSA has studied and investigated 1,271 introduced accessions of groundnut from 40 countries in the world and 100 local varieties. Other research institutions such as Legume Research and Development Centre, Food Crops Research Institute, South Vietnamese Agricultural Research Institute, Institute of Agricultural Genetics have also investigated and evaluated groundnut collections following the descriptors of VIR, IBPGR and ICRISAT, 1978.

Classification characteristics: Majority of varieties belongs to subspecies *fastigiata*-Spanish type. The rest belongs to subspecies *Hypogea virginia* type.

Morphology: all the varieties in the collections are annual. There are 6 types of growth habits:

Procumbent-1, procumbent-2, semi-procumbent-1 (decumbent-1), semi-procumbent-2 (decumbent-2), semiprocumbent-3 (decumbent-3) and erect. Types of pod beaks: absent, slight, moderate and prominent.

Pod constriction may be absent (0), slight (3) moderate (5), deep (7) and very deep (9).

Growth duration: for the majority of the varieties, the growth duration varies from 121 to 130 days (group No-5). The group No-1 includes those with a growth duration of less than 90 days (Li, Giay, Tainam). The second group (91-100 days) consists of one variety: Cuc Nghe An. Group No-3 (101-110 days) consists of 4 varieties: 1-4017, 4018, 4019 and 4021. Group No-4 (111-120 days) of 10 varieties, group No-5 of 158 varieties, group No-6 (131-140 days) consists of 132 varieties, and No-9 (more than 166 days) of 2 varieties.

Yield: the number of filled pods per plant varies from 5 to 36. Most varieties have 10-14 filled pods. Samples with many pods are I-4499, 4082, K 1502, ICG 56015, 86055, 56017, V 79, K 480, K 637 and ZCG 56060.

100 pod weight varies from 118 to 182 g: The lowest 100 pod weight is recorded in the varieties Cuc Nghe An, ICG 56060, 56050, the highest 100 pod weight (160-182 g) was produced by the following representative varieties I. 1805, I. 2868, K. 640 and K. 647.

100 seed weight varies from 25 to 55 g: The variety ICG 86015 has highest 100 seed weight (48-55 g), followed by F 248-25.

Seed/pod weight ratio varies from 69 to 81%: In the local variety Tram Xuyen the ratio reaches 69%. The varieties BS 2, ICG 56017, 56050, 56070, V 79, K 68 show a ratio of 70-75%, in the others such as K 464, 546, 646, 11806 the ratio is 80%.

Pod yield/m² varies from 120 to 280 g: The samples producing 200-250 g/m² are V 75, BS 2, K 827, I 962, ICGU 56017, 56015 and F 248-25.

Resistance to pests and diseases: the accessions showed various degrees of susceptibility to diseases. Three diseases appearing to be most important are rust (*Duccinia arachidis* speng), black spot (*Cercospora personatum* Berk and Curd) and early leaf spot (*Cercospora arachidicola*). The varieties most resistant to rust are EG-PN-U, IPB-PN-48-90, CBM-PM-4, EG-PN-18, K. 488918, CUC, 75/16 (scores 1-2), those resistant to early leaf spot are I 4498, K. 1026, VPL-PN 2 (score 3) and F 4480, I. 4498 and CUC 75/16 (score 2).

Most of the varieties are strongly resistant to sucking insects, but very susceptible to leaf eating ones. Only few varieties such as K 488918, CB 1-PN-4 appear to be resistant.

Biochemistry: The oil content varies from 48 to 56%. Some varieties have a high oil content such as 79-85, BG 78, BK 78 (53-54%). Local varieties have a 50% oil content. The highest oil content (56%) was recorded in the variety Craxnodarnet-13. High ratio of oleic/ linoleic acids was observed in the local variety Red Bacgiang.

The results of the studies carried out enable to select the groundnut accessions with valuable characteristics such as resistance to low temperature (for early sowing in spring season in the northern provinces), drought tolerance at early stage (especially in those with small leaflets).

(2) Breeding and selection of groundnut for intensive farming areas

On the basis of the utilization of groundnut genetic resources in Vietnam and through breeding, selection, mutation, small and large scale trials, during 1986-1990, many varieties were released with high and stable yield, high resistance to pests and diseases, good adaptation to the respective intensive farming areas, where the producers require varieties that can give a yield of 2.7 to 3.3 ton/ha. The results of the study showed that the varieties V 75, B 5000, tram Xuyen, 1660, V 79 and particularly Senlai 75-23 and 79-85 can meet the requirements of the farmers in intensive farming areas (Table 4).

(3) Breeding and selection of groundnut varieties for multiple cropping region

One important task is to select short duration varieties for sowing in additional season after two main crop seasons. In the northern provinces the producers prefer the varieties such as Red Bac Giang, Cuc Nghe An, Sen Nghe An, giay Nam Dinh and cluster arachis, while in the South the farmers like Ly, Giay and Mokat (Table 5). These varieties show a growth duration from 85 to 110 days and give a high yield.

3) *Vigna* species(1) Green gram (*Vigna radiata*)

Green gram ranks third in economic importance after soybean and groundnut. For many years the introduced and local collections of green gram have been tested and evaluated in various institutions.

INSA has evaluated 2521 accessions since 1986: growth duration varies from 60 to 80 days, 4 samples show a duration of less than 60 days, for example K 6358 and K 6559.

Most of the varieties show a 61-75 day duration accounting for 62.6% which 25 varieties have a duration of more than 80 days, for example K 11580. The number of branches on the main stem varies from 1 to 5, K 11471 and K 11493 show the layer branch number. Testa color varies from yellow green, gray green, yellow, black to brown, 50% of the accessions have yellow green testa such as DX 01, CF 814, Mo Hau Giang, 3.9% have black testa such as K 11501 and K 17501 (India). The number of filed pods/plant varies from 4.2 to 9.7. The largest number was recorded in two varieties DX 46 and K 14189; the smallest number was observed in K. 13777. 100 seed weight varies from 42 to 72 g, the varieties V 3484 and V 1381 show a 100 seed weight up to 72 g.

Utilizing the genetic resources of green gram, the Vietnamese breeders have selected 8 varieties which originated in Vietnam and can be grown several times a year. The yield ranges from 1 to 1.4 ton/ha. The seeds have a high quality meeting the requirements of local consumption and export (Table 6).

Table 4 Groundnut yield and its components of some medium varieties (1986-1990)

Variety	Origin	Pod/plant	100 Seed weight (g)	Shelling (%)	Pod yield (Ton/ha)	(%)
1 V75	INSA	10.1	49.7	73.5	2.61	100.0
2 Trang dia	"					
3 phuong	"	11.9	41.3	71.9	2.01	77.0
4 B5000	"	10.0	55.9	70.9	2.60	99.6
5 FrH 82-5	"	10.5	53.5	73.9	2.51	96.1
6 Tram xuyen	"	11.2	56.0	70.7	2.75	105.4
7 1660	"	8.8	57.3	70.9	2.77	106.1
8 V 79	"	10.4	51.8	70.0	2.79	106.9
9 1686	"	7.8	53.4	73.8	2.52	96.5
10 BG 78	"	9.2	57.6	69.7	2.25	86.2
11 BH 78	"	10.2	53.0	68.6	2.56	98.0
12 Senlai 75-23	"	9.1	55.4	71.7	3.38	129.5
13 79-85	"	11.2	41.3	75.9	3.34	127.9
14 Sen Nghe an	"	13.0	35.6	74.9	2.28	87.1
CV%					0.21	
LSD 0.05					0.32	

Since 1985 some introduced varieties have been evaluated and 8 varieties with a high yield and resistance were selected (Table 7).

(2) Yardlong bean (*Vigna unguiculata* subsp. *cylindrica*)

Genetic resources of yardlong bean in Vietnam are abundant and diverse. 1000 seed weight varies from 80 to 180 g. Particular attention is paid to the high protein content (21.8–25.12%). They afford a diverse and cheap source of food in many rural areas (Table 8).

(3) Black gram (*Vigna mungo*)

It is widely cultivated in Vietnam, next to green gram. Its grains can be used as food, or for making cakes, soft drinks. It has many branches originating near the plant foot. Stems are erect and semiclimbing. The mature pods are dark brown, the seeds have a black testa.

(4) Cowpea (*Vigna unguiculata*)

It has semi-climbing stems, purple flowers, the mature pods have a white cover, the seeds are grey, 1000 seed weight is 80 g.

(5) China bean (*Vigna sinensis* var. *sesquipedalis*)

It has climbing stems, long pods (30–40 cm) a thick flesh, green young pods, mature pods are white, 1000 seed weight ranges from 95–90 cm. White-hilum *Vigna* from Cao Bang shows a 1000 seed weight of 175 g and the grains are edible.

Table 5 Groundnut yield and components in some promising early varieties in Vietnam (1985–1990)

Variety	Origin	Pod/plant	100 seed weight (g)	Shelling (%)	Pod yield (ton/ha)	(%)
1 Sen Nghe an	VN	18.0	55.6	75.9	2.28	108.6
2 Cuc Nghe an	VN	19.0	42.4	78.5	1.76	83.8
3 Giay N. Dinh	VN	20.0	44.0	82.0	1.80	85.7
4 Do B. Giang	VN	15.8	43.5	69.7	2.20	104.7
5 Lac chum	VN	21.0	53.0	79.6	2.10	100.0
6 Ly (VMD)	VN	15.5	39.9	72.5	4.2	140.0
7 Ly Tay Ninh	VN	14.4	32.2	71.5	3.2	106.6
8 Ly Song Be	VN	12.5	31.9	66.5	3.2	106.6
9 Giay	VN	12.8	33.0	70.0	3.0	100.0
10 Mo Ket	VN	13.0	34.9	72.0	3.2	106.6

Table 6 Some mungbean varieties of Vietnam selected and popular in production

TT Variety	Duration (day)		Yield (ton/ha)
	Spring	Summer	
1 Moc tieu Hanoi	70–75	62–65	1.0–1.2
2 Moc Trungchau	72–75	60–65	1.1–1.3
3 Mo Hai duong	78–80	62–66	1.2–1.3
4 Vang tach	65–70	55–60	1.0–1.2
5 Mo Tho xuan	73–76	62–65	1.1–1.3
6 Mo An giang	70–75	60–65	1.2–1.4
7 Mo Hau giang	72–75	62–65	1.2–1.4
8 Mo Hanoi	75–80	65–68	1.1–1.3

Table 7 Yield of some foreign promising mungbean varieties in Vietnam

TT Variety	Origin	Average yield (ton/ha)	Highest yield (ton/ha)
1 044	VC27683	1.3-1.5	2.0-2.3
2 HL89E 3	IPBM79- 9 -82	1.0-1.3	1.8-2.0
3 G87- 1	AVRDC	1.2-1.4	1.8-2.0
4 VX87E 2	VIR	1.2-1.4	2.2-2.4
5 V87-13	VC3178A	1.1-1.2	1.8-2.0
6 V87-41	VC3061A	1.0-1.2	1.5-1.7
7 No. 7	VC 3664A	1.3-1.5	1.6-1.8
8 No. 8	VC 3738A	1.2-1.4	1.5-1.7

**Table 8 Protein content of yardlong bean seed in Vietnam
(Le Thi Xuan, 1983)**

Variety	100 Seed weigh (g)	Protein content (g/100 g)
1 Dau dai trang, ronden Cb 1	95	21.87
2 Dau dai trang, do Cb 2	80	22.12
3 Dau dai trang Thai binh	98	25.12
4 Dau dai mat cua	82	23.18
5 Dau dai trung quoc	85	23.87
6 Dau dai do	90	23.62
7 Dau dai den	100	23.87
8 Dau dai trang Lang son	180	—
9 Dau dai nau CB 3	175	—
10 Dau dai dua	95	—
11 Dau dai ao	135	—

4) *Phaseolus* species(1) French bean (*Phaseolus vulgaris*)

It gives young pods that can be used as vegetable, seeds are used as food, stems are climbing, semi-climbing or determinate, 1000 seed weight ranges from 25 to 30 g.

(2) Rice bean (red bean) (*Vigna umbellata*)

It is an annual plant, 30-100 cm high, with many lateral branches, semitwining. The vine is 100-200 cm long, grains are yellow, brown, black, maroon, straw-yellow or mottled. The white hilum is protruding off the seed coat and curling around its margins. This is a particular characteristic that enables to distinguish this species from other small seed *Phaseolus* species. The plant is growing with cotyledons buried in the ground. This species provides both seed and green manure and is good for soil covering.

(3) Lima bean (*Phaseolus lunatus* L.)

It has a thin stem twining and climbing with sparse pubescence. Under natural conditions, it is considered to be a perennial crop. Seeds are used as food for man, stems and leaves are used for soil covering and green manure.

5) Other important grain legume species

Pigeonpea (*Cajanus cajan*) is a bush plant, annual or perennial 0.6 to 3.6 m high. It is usually grown in waste lands, giving grains for man, green manure, medicine or can be used for producing red stick lac. Pigeonpea shows a very high drought tolerance, but it has not been properly studied.

Local varieties show a long growth duration. They are often grown on the hills for covering soil and

rearing stick lac-producing organisms or are intercropped with cotton. Recently we have tested short duration pigeonpea varieties in order to release them for production in food crop rotation systems. The first results are encouraging (Table 9).

Winged bean (*Psophocarpus tetragonolobus* (L.) D. C) is rich, contributing to solving protein deficiency problems in developing countries. In 1983-1987 we evaluated 620 accessions and selected 6 varieties with high yield (more than 2 ton/ ha). They are Binh Minh, Long Khanh, Chim Bu, HL 86-3, HL 86-6 and HL 86-7. The protein content in the seeds varies from 32.2 to 36.9%, oil content 14.8-19.1% and minerals 3.85-4.45% (Hoang Kim 1986) (Table 10).

Sword bean/ jackbean (*Canavalia ensiformis* (L.) D. C.) is a temperate legume with vigorous growth and high yield. The grains rich in protein are used for food. The stems and leaves are used as green manure or forage. It is a perennial plant, up to 10 m high.

Lablab (*Dolichos lablab*) is a climber or bush, with purple flowers. The green pods are used as vegetable, the grains are used for food. Lablab shows a wide range of adaptation. Besides its food value, it can be used as ornamental plant, or for animal feed and green manure.

Broad bean (*Vicia faba* L.) has an erect stem 0.6-1 m high, non- or slightly branched. The flowers are white or purple with black spots. Broad bean is widely grown in the mountainous regions for getting food and feed grains.

Pea (*Pisum sativum* L.) has been introduced to Vietnam since a long time, the green pods are used as vegetable.

Stizolobium is an annual or perennial plant. Stems are 10 m long with round transection white hairs. The flowers are white, purple or greenish. The pods are 5-15 cm long with thick hairs, grayish green or black. This is a drought-resistant species that can be grown for soil covering, green manure and food grains.

Catjang bean (*Dolichos biflorus*) is an annual or perennial plant with herb-stem or forming a small bush, partly procumbent. The grains are used for food, leaves and stems for green manure and soil covering.

Table 9 Pigeonpea growth and development in Vietnam (Ngo The Dan, 1990)

Local	Sowing season	Number of varieties	Duration (day)	Plant height (cm)	Yield (Ton/ha)
Vinh phu	Spring-89	14	110±18	144	—
Hanoi	Spring-89	10	83± 4	52	1.30
Hai hung	Spring-88	4	180±22	162	1.98
	Summer-88	4	130±18	160	1.50
Thuan hai	Dry -89	16	106± 5	110	2.00
	Rain- 89	16	108± 7	128	1.50

Table 10 Six wingedbean promising varieties for sole cropping and inter-cropping cultivation (Hoang Kim, 1983-1986)

No. Variety	Origin	Duration (day)	Seed yield (Ton/ha)*	Protein content (%)**	Oil content (%)**
1 Chimbu	Tanchine	135	2.2	32.2	19.1
2 BinhMinh	Vietnam	161	2.4	34.3	15.1
3 Longkhanh	Vietnam	184	2.1	34.1	14.9
4 HL86- 3	Vietnam	138	2.6	36.9	14.8
5 HL86- 6	Vietnam	156	2.3	36.2	14.9
6 HL86- 7	Vietnam	154	2.9	34.8	16.1

* Yield average of 4 testys

** Analysed in Prague in 1987

2. Root legumes

Yam bean (*Pachychizus erosus*) is a climber, 5 m high, with white or purple flowers, wide adaptation, high yield, drought tolerance. The roots are economically important as food source.

Kudzu (*Pueraria thomsoni benth*) is a climber 10 m long. The roots can be as long as 2 m and heaving (up to 30 kg). Roots are used to produce starch. The yield can reach 7.5 ton/ha. The protein content is 11%. Wild kudzu is used for soil covering, green manure and animal feed.

3. Perennial legumes providing fruits

Tamarind (*Tamarindus indica*) belongs to the family Caesalpiniaceae: It has a woody stem, beautiful shape. The tree may reach a height of 25 m, giving good quality wood. Tamarind was introduced to Vietnam long ago. It is grown not only for ornamental purpose but also for getting fruits and high quality wood.

Cetaronia siliqua also belongs to the family Caesalpiaceae with a beautiful shape, woody stem more than 10 m high. It is an ornamental plant, but the fruits are used for food and animal feed.

2 **Fabales species for green manure, soil covering, forage**1. *Crotalaria funcea*

It is grown for getting fibers, green manure and for soil fertility improvement.

2. Perennial plants

- 1) *Leucaena leucocephala*
- 2) *Cassia* spp.
- 3) *Desmanthus virgatus*
- 4) *Gleditchia triacanthos*
- 5) *Sesbania grandiflora*
- 6) *Acacia auriculiformis*
- 7) *Acacia mangium*
- 8) *Albizzia chinensis*

3 **Fabales species for wood**

- 1) *Sesbania grandiflora*
- 2) *Acacia auriculiformis*
- 3) *Acacia mangium*
- 4) *Calliandra calothyrrus*
- 5) *Albizzia*
- 6) *Dalbergia sissoo*
- 7) *Enterolobium cyclocarpum*
- 8) *Mimosa scabrella*
- 9) *Pithecolobium saman*

4 **Fabales species with other uses**

1. Some species producing rare and precious timber

- 1) *Dalbergia cochinchinensis*-Family Fabaceae
- 2) *Dalbergia bariensis*-Family Fabaceae
- 3) *Sindora cochinchinensis*-Family Caesalpiniaceae
- 4) *Erythrophloeum fordii* Family Caesalpiniaceae

2. Laque-producing species :

- 1) Lacquer from seeds : tamarind, *Prosopis*.
- 2) Lacquer from bark : *Sesbania grandiflora*, *Acacia auriculiformis*

3. Source of tannin, dyes and industrial materials

- 1) For stick lac rearing : *Cajanus cajan*
- 2) For dye : *Indigofera tinctoria*

4. Source of aromatic materials

Acacia farnesiana can give essential oil from flowers.

5. Medicinal plants

Thirty species belonging to *Fabaceae* were found to have a medicinal value (Appendix 1).

1) *Glycyrrhiza glabra* : Roots are sweet and used as medicinal material, or as antipyretic

2) *Desmodium cephalotes*

3) *Erythrina indica* : A good tranquilizer

4) *Milletia tibithyochtona* : From seeds, rotenon is extracted and used to produce pesticides.

5) *Milletia* spp. : The plants are grown for timber but from bark we can extract an active component that causes lethal effect on flies and mosquitoes.

6) *Cassia tora* : Seeds are a good tranquilizer.

6. Ornamental legumes :

1) *Delonix regia* has red flowers, a beautiful canopy shape. It is grown along roadsides and in the parks.

2) *Bauhinia* spp. have a thick foliage and beautiful flowers.

3) *Erythrina indica*.

Conclusions and suggestions

1. Vietnam has abundant and diverse genetic resources of legumes species, with a great potential for meeting the requirements of people.
2. It is necessary to continue to promote investigations, evaluation, classification and conservation of legume genetic resources in Vietnam and to recommend an appropriate strategy for exploitation of economically valuable legume plants.
3. It is important to develop a close cooperation and/or collaboration with Governmental and non-governmental organizations. Sources of funds must be found to support research and conservation of legume genetic resources in Vietnam.

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Discussion

Riley, K. (IBPGR) : What is the extent of diversity of forage legumes and fodder legumes in Vietnam and what is the priority to collect and/or conserve these species?

Answer : Vietnamese scientists have collected a limited amount of forage and fodder legumes up to now, in contrast to food legumes such as soybean, mungbean, groundnut, pigeon pea, etc. In future we plan to collect forage and fodder legumes in greater amount.

Appendix 1 List of some economically important legume species in Vietnam

Entry No.	Scientific name	Vietnamese name	English name	Uses	Distribution
1	<i>Abrus presatorius</i>	cam thao day		medicine	wild
2	<i>Antheropnum pieraii</i>	hot mat			wild
3	<i>Arachis hypogea</i>	lac	groundnut	food, oil	cultivated
4	<i>Astragalus membranaceud</i>	hoang ky		medicine	introduced
5	<i>A. mongholicus</i>	hoang ky			introduced
6	<i>Cajanus cajan</i>	dau trieu	pigeon pea	food, laque	cultivated
7	<i>Cassia tora</i>	thao quyet		medicine	
8	<i>Canavalia gladiata</i>	dau lua	swordbean	medicine	
9	<i>Cicer arietinum</i>	dau mo ket	chick pea	food, green	
10	<i>Crotalaria mucronata</i>	luc lac ba la tron		green manure	wild
11	<i>Derris eplliptaca</i>	cay thuoc ca		source of rotenon	
12	<i>Desmodium heterophyllum</i>	Ba che		curing fever	
13	<i>Desmodium gangeticum</i>	thoc lep		curing snake	
14	<i>Dolichos lablab</i>	dau van	lablab	food, manure	cultivated
15	<i>D. styracifolium</i>	kim tieu thao		medicine	wild
16	<i>D. triquetrum</i>	co binh		medicine	
17	<i>Erythrina indica</i>	vong nem		tranquillizer	
18	<i>Glycine soja</i>	dau tuong	soybean	food	cultivated
19	<i>Glycyrrhiza glabra</i>	cam thao		heat-relieving	
20	<i>Indigofera tinctoria</i>	cham		dye	wild
21	<i>Lablab vulgaris</i>	dau bach dien		food, medicine	cultivated
22	<i>Melilotus suaveolens</i>	nhau huong		medicine	wild
23	<i>Milletia ichthyochtona</i>	than mat		medicine	wild
24	<i>Milletia spp</i>	co giai		timber, control of flies	cultivated
25	<i>Milletia spectose</i>	cat sam		tonic	wild
26	<i>Pachyrhizus erosus</i>	cu dau	yambean	food insecticide	cultivated
27	<i>Pisum sativum</i>	dau Halan	pea	food	cultivated
28	<i>Phaseolus vulgaris</i>	dau tay	french bean	food	cultivated
29	<i>Vigna angularis</i>	dau do nho	azukibean	medicine	introduced
30	<i>V. umbellata</i>	dau nho nha	rice bean/ red bean	food, medicine	cultivated
31	<i>Psophocarpus tetragonolobus</i>	dau rong	winged bean	food manure	—
32	<i>psoralea corylifolia</i>	pha co chi		medicine	wild
33	<i>Dueraria thomyisoni</i>	san day	kudzu	food medicine	cultivated
34	<i>Sesbania grandiflona</i>	so dua		ornamental	—
35	<i>Sophora flavescens</i>	kho sam		medicine	—
36	<i>Sophara saponica</i>	hoe		rice in vitanim D	wild
37	<i>Tamariudus indica</i>	Me	tamarind	timber, food	cultivated
38	<i>Stizolobium spp</i>	dau meo		food, manure	cultivated
39	<i>Vicia faba</i>	dau rong ngua	broadbean	food	—
40	<i>Vigna mungo</i>	dau den	blackbean	food, medicine	—
41	<i>Vigna sinensis</i>	dau dua	china bean	food	—
42	<i>Vigna radiata</i>	dau xanh	green gram	food, medicine	—