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Review Paper

PLANT GERMPLASM COLLECTING IN INDIA: PRESENT STATUS, GAPS IN COLLECTION AND FUTURE STRATEGIES

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There is a long tradition of plant germplasm collecting in India. Initially sporadic collection of indigenous germplasm of various crops viz., wheat, jute, tea, sugarcane, several legumes, rice, tropical forages, ornamental orchids and *Musa* were made. Later on cucumber and melons, minor millets and sesame, wild crucifers, wild rices, *Triticum compactum* and wild barley were collected in collaboration with USA, Japan, Canada and International Institutes such as IPGRI, IRRI, ICRISAT etc. In India, plant exploration and collection activities have been more systematized after the creation of the National Bureau of Plant Genetic Resources (NBPGR) in 1976. Prior to this, between 1946 to July 1976, a total of 31,235 germplasm collections comprising cereals, millets, legumes, oilseeds, vegetables, fiber yielding and other economic plants including wild relatives, were made. Prior to 1976, major exploration missions included multi-crop/ region specific whereas after 1976 till 1984, both multi-crop/ region specific and crop-specific surveys were made. This activity received greater impetus since 1985 and in the next 12-13 years i.e., upto 1998, emphasis was mainly laid on crop-specific collaborative explorations. Significant diversity in rice, wheat, maize, barley among cereals, buckwheat and amaranths in pseudocereals; sorghum, pearl millet, proso millet, kodo millet and finger millet in millets/ minor millets; pigeonpea, peas, chickpea, mungbean, uridbean, moth bean and rice bean among grain legumes; *Brassica*-oil yielding types, sesame, groundnut, castor among oilseeds; cotton and jute in fiber crops and medicinal plants etc. were sampled. In 634 explorations undertaken from August 1976 to May 1999, a total of 1,13,360 germplasm collections of economically important agri-horticultural crops and their wild relatives were made from different agro-ecological zones/ habitats. In this paper, the status of germplasm collection in India has been reviewed, gaps identified and future strategies have been discussed.

Key words: Plant Genetic Resources, exploration, status of collection, gaps in collection, landraces, cultivated plants, wild relatives

The native genetic resources in the Indian Gene Centre are distributed in eight phytogeographical/ agro-ecological zones and these exhibit preponderance of variable forms, landraces, primitive genotypes in different crops and their wild relatives. Crops in which rich diversity occurs in India include rice (*Oryza sativa* var. *indica* and several wild species), wheat (*Triticum aestivum*, *T. dicoccum*), barley (*Hordeum vulgare*), sugarcane (*Saccharum* species and allied genera), *Echinochloa*, *Panicum* species, *Setaria*, *Paspalum*, forage grasses, legumes (*Vigna radiata*, *V. mungo*, *V. aconitifolia*, *V. umbellata*, *V. unguiculata*, *Cicer arietinum*, *Cajanus cajan* and *Lablab purpureus*), several *Brassica* species, *Sesamum indicum*, okra (*Abelmoschus esculentus* and other allied species),

eggplant (*Solanum melongena* and related types), cucumber (*Cucumis sativus*), melons (*C. melo* and different sub species and varieties). *Citrus* species, banana and plantains (*Musa* species belonging to different genomic groups), jackfruit (*Artocarpus heterophyllus, A. integrifolia*), mango (*Mangifera indica*), aonla (*Phyllanthus emblica*), *Carissa carandus, Syzygium* species, jute (*Corchorus capsularis*), tree cotton (*Gossypium arboreum*), ginger (*Zingiber officinale*), turmeric (*Curcuma* species), taros (*Colocasia* and *Alocasia*), yams (*Dioscorea esculenta, D. alata, D. deltoides*), *Coleus* species, sword bean (*Canavalia*), velvet bean (*Mucuna* species), elephant yams and coconut (*Cocos nucifera*) particularly in Nicobar group of islands. Diversity also occurs in several fruits such as *Zizyphus jujube, Z. nummularia, Capparis decidua, Syzygium cumini, Myristica fragrans, Aegle marmalos* and several species of *Ribes, Rubus, Juglans, Pyrus* and *Prunus*.

The recent collection of wild species from the cold desert of the Lahaul-spiti areas in the Himalayas, such as *Cicer microphyllum, Linum perenne, Bunium persicum, B. bulbocastanum, Hyssopus officinale, Cymbopogon jawarancusa, Medicago minima, M. falcata, Astragallus* species, *Allium tuberosum, A. bakeri* and several other wild but potentially useful species clearly indicate that diversity in the Indian gene centre is larger than previously realized. We do not yet have any tangible data on the degree of genetic erosion or extinction of our own genepools due to lack of well articulated documentation of species diversity. The Vavilovian Indo-Malayan centre of origin included diversity in *Dioscorea, Citrus maxima, Musa* species and *Cocos nucifera*, but build up of diversity has been overlapping.

Plant exploration and germplasm collection is the most important activity in Plant Genetic Resources resulting in augmentation of available *ex-situ* germplasm. The ever increasing access to the wider range of genetic variability enhances the capability of plant breeders, biotechnologists and molecular biologists in the development of new strains/varieties possessing combination of valuable characteristics, adaptation to different environments and resistance to pests and diseases. Therefore, exploration and germplasm collection always included the collection of age-old landraces highly adapted to specific environmental conditions and possessing other desirable traits. Since 1945, several areas/regions in India and neighbouring countries (Nepal and Sri Lanka) have been surveyed and germplasm of local landraces, cultivars and their closely related wild species have been collected.

Plant exploration and collection activities have been more systematized after the creation of the NBPGR in 1976. Prior to this, between 1946 to July 1976, a total of 31,235 germplasm accessions comprising cereals, millets, legumes, oilseeds, vegetables, fiber yielding and other economic plants including wild relatives, were collected (Table 1). Prior to 1976, major exploration missions included multi-crop/region specific surveys while after 1976 till 1984, both multi-crop/region specific and crop-specific surveys were made. This activity received greater impetus from 1985 and in the next 12-13 years i.e., upto 1998, emphasis was mainly laid on crop-specific collaborative explorations. Significant diversity in rice, wheat, maize, barley among cereals; buckwheat and amaranths in pseudocereals; sorghum, pearl millet, proso millet, kodo millet and finger millet in millets/minor millets; pigeonpea, peas, chickpea, mungbean, urid bean, moth bean and rice bean among grain legumes; *Brassica*-oil yielding types, sesame, groundnut, castor among oilseeds; cotton and jute in fiber crops and medicinal plants etc. were sampled. In 634 explorations undertaken from August 1976 to May 1999, a total of 1, 13, 360 germplasm collections (Table 2) of economically important agri-horticultural crops

and their wild relatives were made from different agro-ecological zones/habitats. Under several Indo-International programmes, plant exploration and collection of specific crops and groups of crops were undertaken by IARI (in the erstwhile Plant Introduction Division) and NBPGR in collaboration with certain international organisations or with financial support from these organizations (Table 3).

Table 1. Indigenous germplasm collections made prior to the creation of the NBPGR

Period	Accessions	Crops
1946-1950	615	Cereals, millets
1951-1955	3,363	legumes, oilseeds
1956-1960	4,245	vegetables, fiber
1961-1965	4,470	yielding and other
1966-1970	1,902	economic plants
1971-1975	10,737	including wild
1976 upto July	560	relatives
Total Germplasm	31,235	

The details of collections made and areas surveyed are given below:

1 National efforts in Plant Germplasm Collecting

1. Rice (*Oryza sativa*)

Enormous diversity exists in rice in different agro-climatic conditions in India. Rice germplasm collection was initiated in 1948. Later on between 1971-76, the erstwhile Plant Introduction Division (now NBPGR) collected over 600 collections from North-eastern Hills and other regions. The collaborative efforts were accelerated with the establishment of NBPGR and till 1995, collection of over 12,900 accessions of cultivated and wild species was made. Areas surveyed included north-eastern hill region: Assam, Tripura and Sikkim (total 3477), all over Maharashtra (302), Andhra Pradesh (254), Jammu and Kashmir (203), Punjab (42), Himachal Pradesh (HP) (646), Haryana (116), Uttar Pradesh (UP) (549), Rajasthan (20), Gujarat (54), Madhya Pradesh (MP) (1741), West Bengal (WB) (264), Bihar (973),Orissa (2657), Karnataka (500), Tamil Nadu (383) and Kerala (557). Major emphasis had been to tap such areas where native diversity occurred and genetic erosion was evident.

Table 2. Explorations undertaken and gemplasm collected by the NBPGR (August 1976 to June 1998)

Year	Explorations Undertaken	Germplasm samples collected		
		Cultivated	Wild	Total
1976	4	1,987	1382	125
1977	6	5,099	24	5,123
1978	7	938	11	949
1979	11	4,256	54	4,310
1980	7	4,559	22	4,581
1981	16	6,031	271	6,302
1982	9	3,575	-	3,575
1983	9	3,000	-	3,000
1984	10	3,525	-	3,525
1985	25	8,008	55	8,063
1986	43	8,391	97	8,488
1987	44	7,115	178	7,293
1988	52	7,646	154	7,800
1989	59	12,503	934	13,437
1990	49	6,122	899	7,021
1991	57	5,854	996	6,850
1992-93	57	5,969	272	6,241
1993-94	21	1,580	175	1,755
1994-95	31	2,497	291	2,788
1995-96	16	997	511	1,508
1996-97	34	1,793	297	2,090
1997 (Apr. - Dec.)	24	2,318	286	2,604
1998	28	1,631	741	2,372
1999 (May)	15	1,560	-	1,560
Total	634	1,06,954	6,406	1,13,360

Table 3 : Germplasm collection in Indo-International programme

Year	Instt/programme	Crop(s)	Germplasm Collected	Areas covered
1967-1972	IARI/PL-480	Rice	6,730	NE States (India)
1965-1970	IARI/PL-480/Rockefeller Foundation	Sorghum	2,467	India
1965-1970	IARI/PL-480/Rockefeller Foundation	Maize	1,500	India
1965-1970	IARI/PL-480/Rockefeller	Pearlmillet	1,075	India
1966-1970	IARI/PL-480	Oilseed Brassicas & related types	2,100	India
1966-1970	IARI/PL-480	Cluster bean (vegerable & gum types)	942	India
1966-1970	IARI/PL-480	Legumes and grasses	8,926	India
1966-1970	IARI/PL-480	Pome & stone fruits/wild plants (*Prunus, Pyrus, Sorbus* etc.)	-	India
1989-1993	NBPGR/IPGRI	Maize	799	NE States (India)
1989-1993	NBPGR/IPGRI	Okra & eggplant	4,665	India, Nepal, Sri Lanka, Bangla Desh
1989-1993	NBPGR/IPGRI	Sesame	1,978	NW plains and South India
1987	ICAR/FAO (IPGRI)	Forage Sorghum	346	Kenya, Sudan, Ethiopia
1991	INDO-US AID	Wild Sunflower	144	USA
1992	INDO-US AID	Jojoba	75	USA
1992	INDO-US AID	Cucumber & Melons	586	Rajasthan & MP (India)
1992-1997	USIF-PL-480	Temperate fruits	386	NW & NE hills
1985, 1987 & 1989	NBPGR/Japan	Minor millets species	496	South India & coastal region
1992	NBPGR/Japan	Sesame	163	India
1992	NBPGR/Canada	Wild crucifers	25	Kumaon Hills (India)
1989-1996	NBPGR/IRRI	*Oryza* spp	342	Orissa, Bihar, WB, Kerala, UP (India)
1984	NBPGR/Australia	Wild herbaceous grasses & legumes	1000	Central, Deccan Peninsular India
1977, 1978	Indo-Soviet protocol	Wheat, cotton, rice, legumes, millets, okra, sesame, cassava, winged bean, walnut & filbert	7,300	Russia
1979, 1980	-	Deep water paddy & legumes	962	Mali, Nigeria
1980	FAO/IPGRI	Rice, maize, pearlmillet, sorhum, legumes, vegetables, tuber crops	3,922	Malawi & Zambia
1996, 1997	NBPGR/IRRI/IGKV	Wildrice, scented rice	342	Orissa, Bihar, UP, WB, Kerala
1988-1994	NBPGR/ICRISAT	Pearlmillet, groundnut, chickpea, pigeonpea, minor millet species	2,952	Karnataka, Gujarat, UP, Maharashtra, Tripura, Rajasthan

In collaboration with the West Asian Rice Development Agency (WARDA) in 1980, over 660 accessions of deep water paddy representing both var. *indica* and *glaberrima* were made from Mali and Nigeria. Rice growing areas in Haryana and foothills of UP were also surveyed along with Japanese team, 342 collections in different *Oryza* species viz., *O. officinalis, O. granulata, O. rufipogon, O. nivara* and *O. spontanea* were collected in collaboration with IRRI from northern parts of Orissa, northern and southern Bihar, W. Bengal, the coastal midlands and mountainous Ambasamudram and Gudalur areas in Kerala and from central and eastern UP.

2. Wheat (*Triticum aestivum, T. durum* and *T. dicoccum*)

Over 2,580 germplasm accessions were collected by the NBPGR from predominantly wheat growing areas in 22 districts of Madhya Pradesh; moderately moist conditions in eastern parts, drier regions of central Rajasthan and extremely dry situations in eastern and south-eastern parts of Rajasthan; semi dry situations in central and eastern coastal region of Gujarat, central and northern parts of Maharashtra including Vidarbha region representing dry hot situations and northern parts of Karnataka (12 districts) representing semi-dry to drier conditions. The other areas surveyed included UP hills, Tamil Nadu, Lahaul Spiti and Kinnaur region of cold arid Himalayas, Kargil and Zanskar region of Ladakh Himalayas; Baramula and Badgaon areas in Jammu and Kashmir. The collections from these areas represented diversity mainly in tetraploid wheats besides few collections of bread wheat while collections made from north-western, central and southern Uttar Pradesh represent bread wheat (*T. aestivum*). Sporadic collections were made from Nilgiri hills and Shimoga district of Karnataka where both hexaploid and tetraploid wheats are cultivated in kharif season. *T. sphaerococcum* was collected from grassy ravines in Mirzapur district of Uttar Pradesh.

3. Barley (*Hordeum vulgare*)

During 1976-98, expeditions and germplasm collections were undertaken in the Himalayan region particularly in the cold desert of Ladakh (J&K), Lahaul-Spiti, Kinnaur (HP) and Pithoragarh region (UP hills). Diversity for row number, grain-hullness, ear type, grain colour and weight, awned and awnless types in both hulled and hulless types has been built. Over 1,730 accessions have been assembled during the last two decades.

4. Maize (*Zea mays*)

Over 4,200 indigenous germplasm accessions of maize has been collected since 1976 to 1998 from north-western and N E hill region, central parts of Haryana, Lahaul and Spiti, Kullu and Bilaspur region of Himachal Pradesh; north-western and central pockets of Rajasthan; W. Bengal areas adjoining Sikkim; tribal hilly pockets of Orissa; plains of Telangana in Andhra Pradesh and central parts of Bihar extending to eastern parts of UP. Special mention may be made here regarding Sikkim primitive maize with 5 to 6 cobs per plant and thin small grains.

5. Grain legumes

Several exploration have been undertaken for germplasm collection of indigenously available diversity in different grain legumes especially in greengram, blackgram, lentil, pigeonpea, chickpea, peas, *Lathyrus*, mothbean, horsegram and cowpea besides vegetable types such as clusterbean, french bean, winged bean, etc. The programme on grain and forage legumes germplasm collection was also supported by PL-480 Scheme (9,868 accessions) and NBPGR/ICRISAT collaborative explorations for ICRISAT mandate crops (921 comprising chickpea-498, pigeonpea 420 and wild *Cajanus* spp.).

Since 1976 till date, 84 explorations have been carried out independently and in collaboration with ICAR Institutes and State Agricultural Universities (SAU's) and over 17,450 germplasm representing all grain legumes have been collected from different agro-ecological zones. The crop-wise indigenous diversity collected included blackgram (2168), greengram (2053), pigeonpea (1672), mothbean (623), chickpea (1601), pea (628), cowpea (3834), lentil (646), *Lathyrus* sp. (373), horsegram (458) and clusterbean (3316). Each of these is detailed below:

a. *Vigna* species

(i) Blackgram, Urid bean (*Vigna mungo*)

Several collection programmes for sampling native diversity in uridbean were initiated since 1948 in India besides special efforts made under PL-480 scheme when nearly 870 accessions were collected from central UP, Punjab, Bihar and adjoining areas. From 1976 till the present over 2,160 accessions have been assembled. Areas surveyed extensively included UP, north and south Bihar, Madhya Pradesh except south-eastern parts; Vidarbha, southern and interior Maharashtra including parts of coastal areas, northern Himachal Pradesh. In Rajasthan and Punjab, all areas have been explored while from hilly region of Orissa native variability of uridbean has been assembled. In all other regions except NEH region, seventy collections have been made. Other areas explored included parts of Lakshadweep, Gujarat, Tamil Nadu, Goa, Karnataka, Manipur, Tripura, Nagaland, Kerala and Sikkim.

(ii) Greengram, Mung bean (*Vigna radiata*)

Over 2,050 germplasm lines of mungbean have been collected from different agro-ecological areas. The areas included parts of Jammu; north-eastern districts of Punjab; all districts in Haryana except the central region; whole of Rajasthan and Gujarat; parts of Madhya Pradesh ; Bihar and Orissa ; north-eastern, western and coastal region of Maharashtra; southern districts of Karnataka and eastern Kerala. In Tamil Nadu, major areas have been surveyed.

(iii) Cowpea (*Vigna unguiculata*)

Almost all cowpea growing areas except J&K and NEH region have been surveyed and a total of 3,834 accessions were collected. Sporadic collections were also made from Assam, Meghalaya, Sikkim and Nagaland.

(iv) Mothbean (*Vigna aconitifolia*)

Moth bean germplasm has been collected extensively from all areas in Rajasthan and Gujarat and sporadically from Haryana, Tamil Nadu, Punjab, UP and over 1,800 germplasm accessions were assembled.

b. Lentil (*Lens culinaris*)

Over 1,290 accessions of lentil have been collected under PL 480 and ICAR schemes from Uttar Pradesh particularly in central and eastern parts and in northern districts of Himachal Pradesh and adjoining parts of J&K and Eastern MP from where collections were made thoroughly and in other northern states only scantly collections were made.

c. Chickpea (*Cicer arietinum*)

Chickpea genetic diversity occurs from the southern latitudes covering the regions upto about 40°N in plains and lower hills. Area surveyed included whole of Rajasthan and Orissa; northern and eastern Maharashtra, all of Gujarat except Kachchh and Bharuch region; eastern parts of Andhra Pradesh; southern districts of Karnataka and Tamil Nadu. In Bihar, excluding central parts comprising Patna and adjoining districts, all collections were made prior to 1976 under PL-480 scheme. In addition, 498 accessions of chickpea

were made from the arid parts of Rajasthan, UP, MP, Gujarat, Maharashtra, Telangana and Rayalseema region of Andhra Pradesh in collaboration with ICRISAT. Wild species of chickpea such as *Cicer microphyllum* which occurs at higher altitudes of Himachal Pradesh and J&K has already been collected from different ecological habitats; especially from Lari and Tabo areas in Lahaul and Spiti Himalayas.

d. Pigeonpea (*Cajanus cajan*)

Another important grain legume consumed on a large scale is pigeonpea and it is under cultivation in major parts of the country. NBPGR has made good efforts to collect germplasm from diverse sources and till date, over 1,600 accessions have been assembled. The areas surveyed included central and eastern Rajasthan, lower hills and entire eastern Uttar Pradesh and adjoining parts of Bihar including entire central Bihar, eastern MP and Orissa, entire region of Maharashtra, Andhra Pradesh and southern Karnataka and whole of Tamil Nadu and adjoining parts of Kerala and Eastern Gujarat. In addition, 420 collections were made from parts of Maharashtra and Rajasthan in collaboration with ICRISAT.

e. Peas (*Pisum sativum*)

Areas surveyed included parts of western Jammu and northern and western Punjab, central and N.E. Region of HP, Kumaon Himalayas and eastern UP, northern Bihar, eastern district in Rajasthan and sporadically in northern and coastal Andhra Pradesh and Tamil Nadu and over 680 accessions have been added.

f. Horsegram (*Macrotyloma uniflorum*)

Since 1976 till date, nearly 260 germplasm lines of in horsegram have been collected. The areas surveyed included northern district of HP, parts of western UP, southern Rajasthan, south-eastern parts of MP and northern parts of Bihar, northern districts of Orissa, few districts of eastern and western parts of Saurashtra in Gajarat. Also some diversity has been collected from northern Maharashtra and southern Karnataka, Kerala and Tamil Nadu.

g. *Lathyrus* species

Khesari (*Lathyrus* species) germplasm was collected extensively from parts of eastern, southern, central and north-eastern Himalayas in Uttar Pradesh and eastern Maharashtra and 373 germplasm lines were assembled. Sporadic collections were also made from Bihar and Andhra Pradesh.

h. Cluster bean (*Cyamopsis tetragonoloba*)

A total of 4,827 collections have been made in clusterbean from major areas of concentration of diversity in Rajasthan, Haryana, Gujarat, Uttar Pradesh and Madhya Pradesh.

6. Oilseeds

In 69 crop-specific/region specific explorations carried out for collection of different oilseed crops germplasm from agro-ecologically diverse terrains, in total over 6,900 accessions were assembled. Emphasis was given to collection of sesame (under an IPGRI funded programme), oleiferous brassicae, castor, linseed, groundnut (with ICRISAT), safflower and jojoba in USA (under the Indo-USAID progamme). Crop-wise details are as follows:

a. Oleiferous brassicae

Concerted efforts to collect germplasm diversity in *Brassica* have been more vigorously made in the later part of 1960's under PL- 480 programme and over 470 accessions were made. Efforts made by NBPGR in about 19 explorations

from 1976 - to date, yielded 2,369 accessions of *Brassica* sp. namely, *B. juncea, B. nigra, B. campestris* var. *yellow sarson, brown sarson, toria* and *B. tournefortii* including *Eruca sativa* from western Gujarat, Chambal valley and Chhattisgarh in MP; Jhalawar and adjoining parts in Rajasthan; parts of Haryana, UP, Karnataka, Tamil Nadu, West Bengal and Andhra Pradesh (mainly for *Brassica nigra*) and *B. juncea* from Arunachal Pradesh.

b. Sesame (*Sesamum indicum*)

Sesame has been collected from almost all parts of the country. Over 30 explorations have been carried out since 1976 by NBPGR and NBPGR-IPGRI collaborative programme and a total of 3,551 collections have been made. This includes over 90 accessions of wild *Sesamum* spp. viz., *S. indicum, S. mulayanum, S. malabaricum, S. radiatum, S. laciniatum* and *S. capense*. The areas of sesame variability collection included coastal and Telangana region in Andhra Pradesh, major areas in Karnataka, Kerala, north-west Tamil Nadu, northern Maharashtra, Saurashtra in Gujarat, Rajasthan, Madhya Pradesh, Bundelkhand and adjoining drier tracts of UP, parts of Assam, Tripura, Manipur, Mizoram and Nagaland.

c. Safflower (*Carthamus tinctorius*)

Although it is an introduced oilseed crop in India, which has adapted well and shows ecological variation in several morphological characteristics as well as in oil content, only two crop specific explorations have been conducted so far. Sporadic collections have been made in different parts of Bihar, Maharashtra, UP and MP and a total of 257 samples have been collected.

d. Groundnut (*Arachis hypogaea*)

Sporadic collections of the introduced groundnut crop have been made as only very little variation available in this crop. Mainly two types occur, spreading and bunchy types. There is some variability in respect of seed size, seed colour and number of seeds per pod. Oil content also varies with the types grown in different parts. A total of over 990 accessions have been collected, which include 490 collections made jointly by NBPGR and ICRISAT. Areas surveyed included parts of Satpura, Melghat areas in Maharashtra, Punjab, Tamil Nadu, Kerala, Karnataka, Gujarat, Orissa, MP, Bundelkhand and central UP.

e. Linseed (*Linum usitatissimum*)

Concerted efforts have not been made for collection of linseed germplasm, however, 479 have been made in several multi-crop explorations so far.

f. Niger (*Guizotia abyssinica*)

Niger is grown especially in Chhindwara, Betul, Seoni, and Hoshangabad as a sole crop and as mixed/border rows crop in Bihar, Maharashtra, Karnataka, Orissa and Bastar in Madhya Pradesh. Variations exist mainly in seed size and oil content. Over 210 collections have been made so far. Areas surveyed included parts of Orissa, MP, W. Bengal, S. Bihar, UP, Western Ghats and Maharashtra.

g. Castor (*Ricinus communis*)

Castor is cultivated as a sole crop only in Andhra Pradesh and Gujarat. Over 780 accessions have been assembled since 1976 through multicrop collecting expedition and two crop specific explorations. This also includes 196 collections made under PL-480 programme. Areas surveyed included central and western Rajasthan, Bihar, parts of Tamil Nadu eastern and central Gujarat, Bundelkhand region in UP, Haryana, Madhya Pradesh and Maharashtra.

7. Minor millets

In this group mainly, six crops are under cultivation in India viz., finger millet (*Eleusine coracana*), foxtail millet (*Setaria italica*), proso

millet (*Panicum miliaceum*), kodo millet (*Paspalum scrobiculatum*), little millet (*Panicum sumatrense*) and barnyard millet (*Echinochloa frumentacea*). The diversity available in these is enormous and much of it, has been collected in finger millet. In other minor millet crops, more areas needs to be surveyed to collect the available variability in the country. A total of 9,131 collections have so far been made.

8. Fiber crops

(a) Cotton (*Gossypium* sp.)

Since 1978, 14 explorations have been carried out and over 790 germplasm accessions have been collected. This includes germplasm of all the four species viz., *G. arboreum, G. herbaceum, G. hirsutum* and *G. barbadense*. Area explored included NEH region, Saurashtra and Kachchha of Gujarat, northern Karnataka and south coastal region and AP extending in Tamil Nadu. Besides coastal region in Orissa, parts of Jammu, Malwa and Nimar region in MP have also been surveyed.

(b) Jute, Mesta and Kenaf

Three hundred seventy five accessions representing diversity in cultivated and wild species of *Corchorus* have been assembled. The areas surveyed included Garo hills in Meghalaya, Mikir hills and Goalpara in Assam, Tripura, tribal pockets in Orissa, Bihar, Saurashtra and Kutch in Gujarat and parts of Rajasthan. A total of 200 samples represented by 90 collections in roselle (*Hibiscus subdariffa*), 49 in kenaf (*H. cannabinus*) were collected from parts of Telangana, Rayalseema and coastal Andhra Pradesh. 52 samples of sunhemp were also collected from Western Ghats in Maharashtra.

9. Spices and condiments

A total of 4,026 collections in different spice crops grown in India were made from different ecological zones. The germplasm collected included 570 accessions of ginger (*Zingiber officinale*) particularly from Kerala, Tamil Nadu, Karnataka and HP. In turmeric (*Curcuma longa*), 647 collections were made from Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu and Kerala. In case of black pepper (*Piper longum*), areas in Kerala, coastal Karnataka were surveyed and 486 accessions were collected. Other spices collected included *Cinnamomum* (70), coriander (61), nutmeg (6), betel (23), *Piper nigrum* (119) other *Piper* spp. (862), *Curcuma* sp. (277) etc. Most of these spices have been collected from southern states particularly from Kerala, Tamil Nadu and Karnataka (coastal region).

10. Vegetable crops

The Indian Gene Centre has rich diversity in vegetable crops. This diversity includes crops native to India such as eggplant, parval (*Trichosanthes dioica*), ridge gourd, sponge gourd, cucumber, *Colocasia* sp., elephant yam. India is also a centre of diversity for other vegetable crops i.e., okra, melons, chaote, chilli, *Cucurbita* sp., while diversity is appreciable in introduced crops such as tomato, french bean, cowpea, leafy Brassicae, amarantha, yam and in cucurbits - bottle gourd, bitter gourd, *Coccinea*, ash gourd, snake gourd and in bulbous crops like onion and garlic. In 48 explorations undertaken from 1976 till date, a total of 21,607 accessions of various vegetable germplasm have been collected from different agro-climatic zones. This germplasm represents several crop groups as outlined above.

Explorations have been mostly undertaken for vegetable crops in specific areas/regions. Under the NBPGR/IPGRI collaborative project for collection of okra, eggplant and related wild species from south Asia (India, Nepal, Sri Lanka and Bangladesh), 33 explorations were undertaken and 4,665 collections (1,184 cultivated okra, 613 of wild okra, 2,531 of eggplant and 337 of wild

Solanum species) were made. These have been collected from western region and north western Deccan plateau, northern hill and plains, north-eastern region including Orissa, West Bengal, Sikkim and hot arid zone. Severe genetic erosion was noticed in okra in northern India. Under Indo-USAID programme, in an exploration jointly undertaken by NBPGR and USDA scientists, 194 accessions of cucumber (*Cucumis sativus*), 236 of snapmelon (*C. melo* var. *momordica*), 156 of *C. callosus*, 24 of snake cucumber (*C. melo* var. *utilissimus*), 48 of other species were collected by surveying areas in parts of south-west MP and central and northern Rajasthan and parts of UP hills. Besides above crop specific explorations, germplasm of other vegetable crops also have been assembled representing tomato (227), chillies (1474), pumpkin (795), bottle gourd (664), bitter gourd (519), sponge gourd (566), ridge gourd (335), ash gourd (326), pointed gourd (over 300), ivy gourd (45), round gourd (49), watermelon (75), muskmelon (183), snake gourd (144), frenchbean (792), lablab bean (874), vegetable cluster bean (104), *Canavalia* (18), broadbean (20), cowpea (3834), garden pea (687), onion (576), garlic (334), *Colocasia* (510), elephant foot yam (777), potato (214), radish (79), *Trigonella foenum-graecum* (99), roselle (128), kenaf (120), cauliflower (23), spinach (45), cabbage (08), sweet potato (17), jackfruit and allied species (33).

These germplasm have been collected from the Indo-gangetic plains, north-eastern region, north-western Himalayas, eastern UP, Bihar, parts of Maharashtra, W. Bengal, Assam, peninsular region, tarai region in UP, Chhattisgarh region (MP), Vidarbha (Maharashtra) and sporadically in tribal dominated belts in central India, Orissa and adjoining Andhra Pradesh. Maximum diversity with respect to plant genotypes was collected in taro, greater yam and cassava. In taro, over 440 distinct cultivated, wild and weedy genotypes have been collected. Three hundred and fifty five distinct morphotypes in greater yam (*Dioscorea* sp.) and 2 distinct cultivars in elephant yam (*Amorphophallus campanulatus*) were collected from western ghats and Kerala/Tamil Nadu respectively, while other crops included lesser yam (*Dioscorea esculenta*) from Kerala, *Coleus parviflorus* (16), *Manihot* spp. (03) *Colocasia* sp. (55), elephant yam (128), sweet potato (25), arrow root (52), *Maranta* sp. (5), *Xanthosoma* (452), *Alocasia* (39) and *Canna* (39).

11. Fruit crops

Many fruit crops such as mango, *Citrus* and banana owe their origin to the tropical region of India. There are 39 valid species of *Mangifera*. Of these *M. andamanica, M. indica, M. khasiana* and *M. sylvetica* are found naturally occuring in India. *M. andamanica* (available in Andaman islands) requires immediate measure for protection. Of the 1,210 known samples of mango, the NBPGR has collected 132 collections from Orissa, 38 from Western UP. The *Citrus* assumes special importance in India since *Citrus* is considered to be native of south-east Asia. At present, total holdings of 653 accessions include 11 *Citrus* scions from Sasatgiri area of West Garo hills; Mimanganarang, Chinora, Sohgkwit (*C. macroptera*), Sohsying (*C. assamensis*), *C. limon* from Andhra Pradesh. Most of the wild forms of banana are acclimatized in and around south-east Asia and the Malay Archipelago. Twenty seven *Musa* species alongwith popular cultivar Nendran, Ngalipooran, Kunnan, Nuttavazhai, Matti were collected from N. Bengal and Sikkim. From Dibang valley, Lohit and Tirap (Arunachal Pradesh), 83 clones belonging to *M. acuminata, M. balbisiana, M. thompsonii, M. velutina* etc. were also collected.

Seventeen promising types in Ber (*Zizyphys mauritiana*) from Rajasthan, 154 from Satpura

ranges (MP), 17 from Haryana were also collected. Recently NBPGR has collected 35 samples of aonla (*Emblica officinalis*) from eastern UP and 8 from Madhya Pradesh. More variability exists in sub-mountainous region of Himalayas and some other states i.e., Vizag (AP), Anand and Nadiad (Gujarat), Panna (MP), Akola, Bhandara, Buldana, Chandrapur, Nagpur, Yeotmal (MS); Nilgiri hills, Salem (TN). These areas are still to be surveyed for the collection of diversity in above mentioned crops. Very little attempts were made for collection of bael (*Aegle marmalos*), jamun (*Syzygium cumini*) and tamarind (*Tamarindus indica*). Twenty four samples of bael from eastern UP have been collected.

Fifty collections of custard apple (*Annona* species) from low rainfall hilly terrain in Andhra Pradesh were collected. This includes 48 collection of *A. reticulata* and one each *A. atemoya* and *A. glabra.*

Temperate fruits viz., pomegranate (80), other fruits (236) viz., *Juglans*, hazelnut, chestnut, almond, apple, pear, apricot, peach, plum, lemon, avocado, kiwi fruit, persimon, blackberry were collected from UP and HP hills. Under USIF-PL 480 programme, 386 germplasm of various temperate fruits were also collected from HP, UP and parts of Darjeeling, Sikkim, Meghalaya and Arunachal Pradesh.

12. Forage crops

Under the PL-480 scheme, 8,926 collections were made in different forage legumes and grasses for food, fodder and soil conservation purposes. joint In Indo-Australian collection mission for wild herbaceous grasses and legumes mainly in central India, Deccan plateau and peninsular India, well over 1,000 accessions was collected. In addition, the NBPGR has collected 19 collections from Zanskar region of Ladakh Himalaya, 14 collection of berseem and oat from parts of Haryana and UP; 43 samples of lucerne from parts of Gujarat; 24 collections of forage grasses and legumes from Lahaul Spiti and Kinnaur (HP) and *Medicago falcata* from Ladakh Himalayas.

13. Medicinal plants

India is known for its rich wealth of diverse species used in medicine. Unlike other crops, collection of medicinal plants has been very meagre. Eighty collections of isabgol (*Plantago ovata*) from Gujarat; 140 in opium poppy from parts of Gujarat, MP and UP; 62 in palmarosa (*Cymbopogon martinii*) from MP and Maharashtra; 115 of vetiver (*Vetivaria zizanoides*) from Bharatpur (Rajasthan), Musanagar/Kannauj (UP) and tarai region (UP) were sampled. Over 550 germplasm lines of different medicinal plants from UP Hills and from Kerala and over 100 samples from Kanger valley reserve forest areas in Bastar (MP) were also added. Under G 15 project, 264 samples from Katarniaghat, Nishangarh and Lakhimpur, Rishikesh/Hardwar (UP) and from Kanger valley reserve forest in Bastar (MP) was also sampled.

14. Sugarcane (*Saccharum* species)

NBPGR jointly with SBI has collected 630 clones from N. Bihar, Sikkim and Arunachal Pradesh. These include *S. officinarum, S. barberi, S. sinense, Erianthus, Miscanthus, Narenga* and *Phragmites.*

15. Under-utilized plants

In winged bean (*Psophocarpus tetragonologus*), some collections were made from the peninsular region. Extensive collections were made in grain amaranth (*Amaranthus* sp.) and over 3,000 accessions were assembled from UP and HP hills, NEH region, Gujarat and Maharashtra, 200 collections were also made of Buckwheat (*Fagopyrum* sp.) from the same region. Over 500 collection of rice bean (*Vigna umbellata*) have been made from NEH region, Nepal and Sikkim. 48 collections of *Jatropha curcas* were made from coastal Maharashtra and Malwa region (MP).

16. Plantation crops

The estate crops like coffee, tea and rubber grown are traditionally considered as plantation crops. Besides coconut, arecanut, oil palm, cashew, cacao and spices with long life span and juvenile phase also come under this group. Some efforts have been made by other organizations to collect germplasm in this group. NBPGR has done only sporadic collections in these crops from coastal regions of Kerala, Karnataka and western ghats.

II Explorations for germplasm collection under Indo-International programmes

Plant exploration and collection of specific crops or group of crops were undertaken by certain institutes in India in collaboration with other organisations within India and from other countries

(i) Under PL-480 scheme

(a) **National Bureau of Plant Genetic Resources (the erstwhile Division of Plant Introduction IARI), New Delhi.**

Oilseed brassicas and related types	2,100
Clusterbean (for vegetable and gum types)	942
Legumes and grasses (for food, fodder and soil conservation purposes)	8,926

(b) **I.A.R.I., New Delhi**

Rice	6,730
Sorghum	2,467
Pearlmillet and others	1,075
Maize (in collaboration with PL-480/ Rockfeller Foundation)	1,500

(ii) Under NBPGR-IPGRI Collaborative programme

(a) Maize

A total of 799 germplasm accessions were collected from various parts of north-eastern states under three exploration trips. Areas where outstanding variability was collected include Assam (21), Meghalaya (184 collection from Khasi, Jaintia, Khilling hills and east and west Garo hills), Mizoram (99 from Aizawl, Kolasib, Zaunlawn, Sherkan etc.), Manipur (47 from Taberlong, Chandel, Senapati and More areas), Nagaland (2 collections from Kohima, Jaluki Pungiwa, Tenply areas), East and West Shillong Districts of Arunachal Pradesh (252 collections) and from Sikkim (122 collections from east, north and south Sikkim districts).

(b) Okra, eggplant and their wild relatives

During the NBPGR/IPGRI Collaborative project for germplasm collection of okra and eggplant and their wild relatives from South Asia, in total of 33 explorations were undertaken exclusively to collect existing variability in okra, eggplant and related wild species from India, Nepal, Sri Lanka and Bangladesh and 4,665 germplasm collections were made which includes 1,184 accessions of cultivated okra, 613 of wild okra; 2,531 of eggplant and 337 accessions of wild *Solanum* species. In general, severe gene-erosion was observed in okra as most of the landraces have been wiped out by "Pusa Sawani" and "Parbhani Kranti" cultivars. Nevertheless, landraces still exist with marginal farmers and certain tribal pockets. Thick short multiedged fruit types were predominant in southern region. Primitive landraces with tolerance to diseases and pests were collected from Orissa and eastern ghats. In the north- western region, particularly Rajasthan and adjoining areas, mostly hairy and multi-edged local types with tolerance to biotic stresses were prominent.

The Eastern Ghats were observed to be an important area for eggplant diversity. Good variability also existed in NE states. Some highly spiny and drought tolerant primitive landraces were collected from Assam. Many predominant landraces were assembled from tribal belts of MP,

Maharashtra and also from southern states. The Southern region has tremendous variability for wild *Solanum* species.

Striking variation in eggplant (175) was collected from north western, north central, eastern and south eastern Bangladesh. In Nepal, diversity in okra was observed in central tarai region and central parts of western region. *A manihot* ssp. *tetraphyllus* var. *pungens* are commonly found, *A. crinitus* was rare and restricted to forest areas. Local types in okra with significant variation were sampled from the Pokhra and Nepalganj areas.

c. Sesame

Collaborative field programme on exploration and collection of sesame germplasm and its wild related species and weedy forms from South Asia was undertaken by NBPGR with IPGRI support. Explorations were undertaken in north-western plains and lower hills, central plains and north-eastern region, western zone, Deccan plateau and southern areas of India. In addition, some explorations were also undertaken specifically for collection of wild species in southern zone. A total of 1,978 accessions of sesame germplasm represented by 1,884 accessions of cultivated forms and 114 accessions of wild/weedy types were collected in 22 explorations carried out in different zones in India. Seventy accessions of cultivated types, were assembled by surveying 12 regions in Bangaladesh in one exploration. BARI, Dhaka collaborated in this programme.

In north-western zone, comprising mostly plain areas and some lower hills, particularly in Himachal Pradesh, the variability found in different populations mainly confined from non-branching to profusely branched types with hairiness on all parts of the plant and medium bold capsules, with 4, 5 and 8 locules. These types are well adapted to the north-western plains. The major area is under cultivation of white-seeded genotypes. Only in a few pockets in hill and plains, black seeded varieties are grown. Internodal distance in different populations proved to vary and this is a useful character for crop improvement. In most of the collection sites, it was observed that sesame is cultivated as a sole crop, but sometimes it is grown mixed with other crops such as maize, sorghum, blackgram etc.

e. Forage sorghum in East Africa

An IPGRI sponsored exploration for collection of forage sorghum and its wild relatives was undertaken in Kenya, Sudan and Ethiopia and a total of 346 accessions of forage sorghum, derived mostly from the cultivated dual purpose *sativa*, and wild loose panicled genotypes and spontanea series of *Sorghum biolor* var. *bicolor* were collected. In total, 136 samples from Kenya, 106 from Sudan and 104 from Ethiopia were collected as well as 15 weedy/wild types.

(iii) Under Indo-USAID PGR PROJECT

a. Cucumber and melons collecting

Collection of landraces of cucumber and melons germplasm comprised 194 accessions of cucumber (*Cucumis sativus*), 236 of snapmelon (*C. melo* var. *momordica*), 156 of *Cucumis callosus*, 24 of snake cucumber (*C. melo* var *utilissimus*) 48 of other cucurbits species and vegetable crops. These samples were collected from 123 sites in diverse habitats of different parts of Rajasthan (especifically south-west, south-east and central parts), Madhya Pradesh (north west and central portion) and from Dehradun and Mussoorie hills in Uttar Pradesh Himalayas. A wide range of variability was observed particularly in cucumber, snapmelon and *Cucumis callosus* for various morphological and economic characters including tolerance to abiotic factors. North-western Rajasthan especially Jodhpur, Nagaur and Bikaner areas showed maximum variability for snapmelon germplasm. Populations of snapmelon were observed to be highly variable and widely

distributed (including on sand dunes). Locally adapted landraces of cucumber were more concentrated in south-west, south and central (**Balam Kakdi, Sawanariya** - local landraces) Rajasthan, Nalchha in Dhar, Malwa region (with **Balamkakdi**-local landraces) and in Bhikangaon/ Pati areas in West Nimar region (local **Bhus** landraces), small fruited Cucumis callosus has almost uniform distribution throughout Rajasthan and Madhya Pradesh, and an amazing diversity was collected. The landrace variation in arid Rajasthan is atuned to dry conditions and adapted under agro-ecological niches with acute water stress. In melons, germplasm varied in plant growth habit, fruit shape (globular, oblate, elliptical, ovate, elongated). Fruit ribs, fruit skin colour, secondary fruit skin colour, skin texture, in blossom scar, fruit length, width, fruit weight and flesh colour. Cucumber diversity varied in fruit shape, fruit skin colour, fruit skin mottling, colour of stripes fruit skin glossiness, fruit length/width, weight and in stemed and blossom-end fruit shape, flesh texture (smooth/grainy/soft) and in flesh colour.

b. Sunflower (*Helianthus* species)

Eight wild gendypes and species of *Helianthus* were collected from Great Central plains of USA viz., *H. annuus* (83), *H. petiolaris* subsp. *petiolaris* (25) *H. maximilianii* (15), *H. rigidus* subsp. *subrhomboideus* (8), *H. nuttallii* subsp. *nuttallii* (4) and subsp. *rydbirgii* (3), *H. grossoserratus* (3) *H. tuberosus* (3) and *H. pumilus* (1). This represented variability in plant height, habit, branching, head number and size, seed size, leaf size, shape and serration, presence/absence of bristle, flower and foliage colour resistance to various pests, diseases (rust and *Phomopsis*) and drought and presence of male sterility.

c. Jojoba (*Simmondsia chinensis*)

Seventy five collections (36 cultivated and 39 wild) were made from Arizona and southern California in USA representing variability in plant height, seed size and maturity.

(iv) Under USIF-PL 480 project

Three hundred and eighty six germplasm samples of various temperate fruit crops such as apple, pear, apricot, peach, plum, walnut, avocado, persimon, kiwi fruit and others were collected under the USIF-PL 480 project on collection of temperate fruits germplasm. The areas covered included Himachal Pradesh (Shimla, Chamba, Pangi, Lahaul and Spiti, Kinnaur, Sirmour, Bilaspur and Kangra districts), Uttar Pradesh (Tehri, Uttarkashi, Pauri, Almora, Pithoragarh districts) and parts of Darjerling (WB) Sikkim, Meghalaya and Arunachal Pradesh. Very good variability was sampled in these fruits crop with respect to plant height, branching pattern, maturity and fruit bearing potential. Variation in fruit shape, size, colour and fragrance was observed in apple, pear, apricot and *Sorbus* species. Striking variability in pear was sampled from Sikkim and Meghalaya whereas in *Prunus* and *Sorbus*, Tiga hills, Tonglu, Sandophu, in Darjeeling district. Dedehat area of Pithoragorh district has a very rich diversity in hazelnut material. In south Sikkim, *Corylus* spp. with very bold fruits; Bomdila for Kiwi fruit; *Malus* germplasm exhibited variation in Lachung and Jung area of north Sikkim; Tawang (Arunachal Pradesh) and Pangi area of Chamba district (HP); samples of walnut from Chakrata (UP) showed variation in fruit shape, size and colour.

(v) Minor millets collection with Japanese team

Three crop-specific exploration trips were undertaken for collection of minor millet species with Japanese Team during 1985, 1987 and 1989 and a total of 496 germplasm collections in different minor millet species were collected under the Indo-Japanese joint collection programme from parts of Karnataka, Tamil Nadu, coastal region

of Maharashtra and Orissa, Bihar, Madhya Pradesh and Andhra Pradesh. This includes several weedy or wild forms as well.

(vi) Under Indo-Australian mission

During a joint Indo-Australian plant exploration mission for wild herbaceous grasses and legumes mainly in central India, Deccan plateaus and peninsular India, over 1,000 accessions were collected. These represented mainly among legume, *Vigna, Desmodium, Alysicarpus, Zornia, Rhynchosia, Galactea, Cajanus, Indigofera, Teramnus, Stylosanthes, Heylandia, Pseudarthia, Smithia, Tephrosia, Crotalaria, Canavalia, Mimosa, Aeschynomene, Abrus, Clitoria;* among grasses : *Dicanthium, Bothriochloa, Chrysopogon, Sehima, Eremopogon, Panicum, Hyoparrhenia, Digitaria, Cymbopogon, Andropogon, Heteropogon, Setaria, Echinochloa, Thimeda, Chloris* and *Ischaemum.* Considerable variation occurred in grass species. Promising pasture legume included *Alysicarpus* species, *Vigna trilobata, Rhynchosia, Cajanus, Heylandia* sp, *Teramnus* spp., etc.

(vii) Rice collection by Japanese team

Rice growing areas in Haryana and foothills of Uttar Pradesh near Dehra Dun were surveyed and local rice variability was collected, alongwith Japanese team. The diversity represented for tillering potential and awned and awnless types.

(viii) Sesame germplasm collecting with Japanese team

With the support of the Japan International Cooperation Agency (JICA), a joint exploration for sesame germplasm collection was undertaken and 163 sesame samples were collected, of which 160 were truly cultivated, two were weedy and one was a wild species. The sampling sites included parts of Karnataka (Bijapur, Dharwad, Bellary, Raichur, Gulberga), Maharashtra (Pune, Solapur, Latur, Nanded, Dhule), Madhya Pradesh (Indore, Bhopal, Sagar) and Uttar Pradesh (Jhansi and Agra districts). In Maharashtra and Karnataka, sesame populations consisted of branched erect plant with one capsule at each internode in the leaf axil whereas in MP and UP, mainly non branching and multi capsule types were common. Leaves at lower nodes were usually tri-lobed. Mainly white seeded types were common. Black seeded types occurred as admixtures. In Raichur, in black-seeded types, both sweet and bitter types occurred. They use bitter geno type for medicinal purposes in addition to food and oil. A significant observation was that there was a large range of variation in internode distances in each of the individual plants.

(ix) Wild rice collection in collaboration with IRRI

Three hundred forty two samples in different *Oryza* species viz; *O. officinalis O. granulata, O. rufipogon, O. nivara, O. spontanea*, were collected in collaboration with IRRI scientists from the northern parts of Orissa, southern parts of Bihar and West Bengal, coastal midland and mountainous and Karayar (Ambasamudram) and Gudalur areas in Kerala; northern Bihar and eastern Uttar Pradesh. Abundant variability in wild and weedy relatives was sampled from Kerala. Good diversity was collected in *O. rufipogon* from foothills of the Himalayas (Terai region) around the Ghaghara river and *O. nivara* from salt affected soils in eastern UP with variation in plant type, plant height, panicle length, etc. Wild rices were abundant in the lowlands of Cuttack and Balasore areas of Orissa and west of Hooghly river in West Bengal. *O. nivara* is abundant in the Chhotanagpur plateau.

(x) NBPGR-ICRISAT collaborative germplasm collection programme

In total 2,952 collections were made in different parts of Karnataka, Andhra Pradesh,

Orissa, Malwa region (MP), Tamil Nadu, Kerala, Bihar, which include chickpea (498) from arid parts of Rajasthan, UP and MP Gujarat , Maharashtra Telangana and Royalseema region of Andhra Pradesh; pearl millet (1,022) from Rayalseema region (AP), Haryana, Tamil Nadu, NW Rajasthan and Haryana; Groundnut (490) from parts of Tamil Nadu and Kerala, Madhya Pradesh Uttar Pradesh; pigeonpea (420) from parts of Maharashtra, Rajasthan; minor millet species (108) from parts of Andhra Pradesh, Orissa, Bihar, Tamil Nadu, Orissa and in wild *Cajanus cajanifolia* (03) were found in Tripura and wild *Pennisetum* from Kumaon and Garhwal hills.

(xi) Other foreign explorations/collaborative explorations with foreign agencies

1. More than 7,300 collections of rice, legumes, millets, cassava, okra, sesame, *Hibiscus*, winged bean, mung bean, velvet bean, almond, filbert, walnut, cucurbits, *Capsicum* and tomato were added to the national collection by NBPGR scientists from Central Asian Republics of the former USSR, Mali and Nigeria (West Africa) and Zambia and Malawi (East Africa). The central Asian Republics of USSR, Republic of Kirgizia, Uzbekistan and Tadzikistan were surveyed for nuts; Mali and Nigeria for deep water paddy and legumes (over 300 accessions); 662 samples represented both var. *indica* and *glabberima* types in rice. In survey made to East Africa-Malawi and Zambia, 3,922 samples representing rice, maize, pearl millet, sorghum, finger millet, tuber crops, legumes, vegetables, *Amaranthus*, etc. were collected.

2. Under a joint collaborative exploration of NBPGR/GBPUA&T Pantnagar/Deptt. of Plant Science, Univ. of Alberta, Canada, wild relatives of *Brassica* sp. and wild crucifers namely, *Arabis, Barbarea, Capsella, Crambe, crysimum, Sisymbrium, Lepidium* and *Rorippa* were collected. Young shoots of *Crambe cordifolia* ssp. *kotschyana* locally called Pung, are consumed during famine. It is a tall robust herb with a few radical leaves and 3-5 seeds per plant, mainly used as food in cold arid tracts.

3. Scientists from outside countries have undertaken several exploration missions for example German scientists for collection of tropical forages; Royal Horticultural Society, UK for ornamental orchids; Simmond for *Musa*; Japanese botanist for collecting clones of *Rhea* and *Brassica* germplasm.

4. The Late Dr. H.B. Singh accompanied Howard S. Gentry of USDA to parts of Punjab and Shimla Hills during 1953 and Professor Van Soest of Holland to Kashmir and HP during 1959 for plant exploration. Similarly Dr. S.P. Mital accompanied de Von and Corbett of USDA to the Darjeeling hills in 1965. Dr. J.R. Witcombe of UK collected germplasm diversity in wheat, barley, maize, rice from north-western Himalayas. The collections also included *Triticum compactum* and wild barley from Ladakh.

III GAPS IN COLLECTION

(1) Rice

Areas for future collection include lower Assam, Manipur, Tuensang and Mon districts of Nagaland; West Kameng, east Kameng and Apatani plateau in Arunachal Pradesh, Sikkim; rainfed and water-logged coastal areas and Jaypore tract in Orissa; Rewa and hilly areas of Bilaspur

(MP); Kalahandi and Dhenkanal (Orissa) for scented rice; northern and coastal regions of Kerala and Andhra Pradesh for wild rice; hilly tracts of Shimoga and Chikmaglur districts in Karnataka and Son command area and areas around Patna (Bihar). It is also considered necessary to survey pockets of diversity for specific traits based on evaluation studies from where useful genotypes have already been identified. Accordingly, short statured types have to be searched in north Cachar, hills of Assam, Manipur and Arunachal Pradesh; glabrous husk forms from areas adjacent to Myanmar border in Manipur and Mizoram; *japonica* like forms from Kameng and Subansiri districts of Arunachal Pradesh. As regards disease and pests resistance and tolerance (i) tolerance to stem borer came from Meghalaya, Assam hills, Kamrup and Goalpara districts; Subansiri and Siang districts (Arunachal Pradesh) (ii) resistance source for gall midge and green leaf hopper were found in Garo, Mikir, Khasi and Jaintia hills and Kamrup district (iii) resistance sources to brown plant hopper occur in Mikir and N. Cachar hills (iv) resistant sources for blast are localized in Khasi, Jaintia and Mikir hill areas and bacterial leaf blight, source of resistance include Meghalaya, Kamrup and Goalpara districts in Assam. Since extensive hybridization has occurred in nature between cultivated and wild genotypes; pure *O. rufipogon* and *O. nivara* are now sporadic in natural/disturbed habitats and this necessitates specific efforts to collect these.

(2) Wheat

The Nilgiri hills in Tamil Nadu, Madanpalli hills in Andhra Pradesh for *T. durum* and *T. diccocum* and Garbhiyang valley in Pithoragarh district of Uttar Pradesh for genetically diverse landraces and possibly for forms resistant to rust particularly in *T. aestivum*. Belgaum, Raichur and Bijapur in Karnataka are to be surveyed for collection of native diversity.

(3) Barley

Most of the areas where barley is cultivated have already been surveyed and germplasm collection, only small drier pockets in the plains of Uttar Pradesh particularly in Mirzapur, Ghazipur, Sonbhadra, Banda, Hamirpur and adjoining areas and Rewari, Mahendragarh and Bhiwani districts in Haryana and high altitude areas in Sikkim need to be surveyed for collection of local landraces.

(4) Maize

Although the major areas of concentration of diversity in maize have already been surveyed, still Panchmahal hills (Gujarat), Singhbhum and Purnea (WB), Koraput, Kalahandi and Keonjhar (Orissa), Tarai area and Jaunpur (UP) are still to be surveyed for local germplasm diversity. Material resistant to stalky rot, downy mildews and stem borer are to be collected from pockets in Gujarat where local tribes cultivate maize.

(5) Grain legumes

(a) *Vigna* species

Further surveys need to be made particularly in Western Ghats region starting from Mount Abu to Nilgiri mountains as this region is the macro-centre of origin and diversity for this group of species. It is imperative to make serious efforts to collect as much variation as possible in *Vigna khandalensis*, a rare species with a very restricted distribution in disjunct hilly areas, particularly Purandhar hills (Purandhar hills can be developed as Gene Sanctuary for *Vigna khandalensis*), *Vigna trilobata* from Surtalai and Junagarh areas in Gujarat, *V. dalzelliana* from Kalimpong hills, *V. mungo* var. *sylvestris* from Purandhar hills and Lonavala areas; *V. radiata* from Jabalpur, Mandu Fort ruins, Khandala Ghat etc. and *V. hainiana* from outskirts of Jabalpur, Bandhavgarh and Sohagpur reserve forest and from Bastar tribal areas. Mothbean (*V. aconitifolia*) needs to be

collected from parts of Tamil Nadu, Kerala and Karnataka.

(b) Lentil

The areas need to be surveyed are parts of North Bengal, HP Hills, North Bihar, Vidarbha in Maharashtra and drier parts of Andhra Pradesh particularly in northern and central region.

(c) Chickpea

Areas to be surveyed include drier tracts of UP comprising Mirzapur, Sonbhadra, Jhansi, Jalaun, Etawah, Kanpur and adjoining area in Madhya Pradesh; central parts, northern parts of Karnataka (Dharwad, Bijapur and Belgaum) and adjoining Solapur, Osmanabad, Beed, Latur districts of Maharashtra; parts of Punjab and Haryana.

(d) Pigeonpea

The areas yet to be surveyed for collection of pigeonpea are in the districts of Mirzapur (UP) and Rewa, Sidhi, Gwalior, Morena, Bhind and Bundelkhand region and other adjacent districts in MP; northern districts (Nasik, Dhule) of Maharashtra and adjoining North Karnataka; parts of Bihar (south eastern districts).

(e) Pea

Hilly areas in Manipur, HP Hills, northern Bengal, parts of UP and MP have to be surveyed for garden pea and field pea germplasm.

(f) Horsegram

Khargaon, Jhabua, Seoni, Mandala, Bilaspur, Raigarh districts of MP, Vidarbha and Marathwada regions in Maharashtra and Koraput, Kalahandi and Bolangir districts of Orissa and drier parts of UP still need to be surveyed.

(g) *Lathyrus*

Local landraces in Khesari are still to be collected from parts of Bundelkhand, Baghelkhand (MP), eastern UP and adjoining northern Bihar and West Bengal.

(h) Clusterbean

Peninsular region is considered potential for vegetable types, which has not been explored yet.

(6) Oilseeds

(a) Oleiferous brassicae

Areas in Karnataka, Tamil Nadu, Arunachal Pradesh are to be surveyed more intensively for collection of *B. nigra* as these are more rich areas. Similarly Arunachal Pradesh needs to be explored for *B. juncea* (long leaf genotypes). Intensive collections are to be undertaken in MP particularly Chhattisgarh and adjoining areas for toria (extra early types).

(b) Sesame

Areas to be surveyed are Orissa and adjoining parts of West Bengal, Chhotangapur region of Bihar, Haryana and Himachal Pradesh. Different ecological niches viz., Deccan plateau, parts of Gujarat region, southern coastal region and north west region of Orissa, parts of Rajasthan, MP, Gangetic plains and Aravali ranges need to be surveyed for the collection of wild species of sesame.

(c) Safflower

More surveys to collect diversity in parts of Madhya Pradesh, Orissa and West Bengal need to be made.

(d) Groundnut

Only sporadic pockets such as Ambabhoona block of Sambalpur (Orissa), northern districts and lateritic belts of W. Bengal, lower hills and Dhaula Kuan region of HP, Solapur and adjoining areas in Maharashtra and eastern Gujarat remain to be explored for collection of local landraces.

(e) Linseed

Local variability need still to be collected from the Gangetic plains, eastern Vidarbha in

Maharashtra, Kangra and Hamirpur in Himachal Pradesh and from tribal pockets in MP.

(f) Niger

Tribal area of Bastar (MP), Melghat (Maharashtra), Chhotanagpur (Bihar), north coastal Telangana, southern parts of Maharashtra and adjoining areas in Karnataka and Andhra Pradesh need to be surveyed for collection of local landraces.

(g) Castor

In castor, local diversity is sporadic and has to be augmented from throughout the country particularly from peninsular region besides Andaman and Nicobar and Lakshadweep islands. The available landraces need to be collected.

(7) Minor millets

Cropwise areas for each of these minor millets still to be surveyed are Gujarat, HP, MP, Western Ghats (mainly in Maharashtra), northern Bihar, western UP and NEH region for finger millet; peninsular tribal zone and NEH region for foxtail millet; Bihar, UP, J&K and HP (upto 3000 m.) for proso millet and the eastern peninsular tract for barnyard millet.

(8) Fiber crops

In Cotton, pockets of diversity yet to be surveyed included Jammu and Kashmir region for cold tolerant genotypes, Nagaland, Manipur for coloured genotypes; Maharashtra and Telangana region of Andhra Pradesh for collection of local variants. Further collection of jute is to be made from parts of W. Bengal, Bihar, Orissa, NEH region.

(9) Vegetable crops

More important crops for which native diversity would still need more emphasis for collection include cucumber and other *Cucumis* species, pointed gourd (parval), yam, taro, sweet potato, chilli, muskmelon, lablab bean, *Trigonella* and winged bean. Priority areas for cucurbits will include Indo-gangetic plains, foothills of Himalayas, eastern peninsular tract, Kachchh areas in Gujarat, eastern ghats, Kodur and adjoining areas in Andhra Pradesh, more particularly in *C. melo* (musk melon) from Barabanki, Unnao, Lucknow, Baghpat, tarai, western UP, Chhotanagpur, West Bengal, Assam, Karnataka and Andhra Pradesh; *C. melo* var. *utilissimus* (Tar kakri) from throughout India, parval (*Trichosanthes dioica*) from Bengal plains and Assam valley; ivy gourd (*Coccinea* sp.) from NEH region; *Luffa* and *Lagenaria* from Indo-Gangatic plains, NW plains; snakegourd (*Trichosanthes anguina*) from southern peninsular tract and Kerala, Karnataka and adjoining pockets; lablab bean from eastern peninsular tract, Orissa, Goa and southwards; cassava from Kerala, Assam, Tripura, Andhra Pradesh, Tamil Nadu and Madhya Pradesh (tribal tract of Bastar); sweet potato from Bihar, Orissa, UP and West Bengal; *Dioscorea* spp. from A&N islands, Bihar, NEH region; *Amorphophallus* spp. from A&N islands, Andhra Pradesh and West Bengal; carrot (purple deshi types) need to be collected from south-east of Gujarat and adjoining Rajasthan.

(10) Fruit crops

The NEH region including Sikkim and North Bengal has to be surveyed for *C. jambhiri, C. macrocarpa, C. indica, C. latipes*; foothills of Himalayas for *C. megalaxicarpa* and *C. pseudolimon*. In south India, diversity of *C. pennivesculata* and *C. maderaspatana* has to be collected. *Musa bulbisiana* in NEH region adjoining Myanmar extending to West Bengal and hilly region of Orissa and *Pyrus baccata, P. pashia*, from Arunachal Pradesh and Nagaland, Manipur, Meghalaya need to be surveyed. Evergreen forms in pomegranate are to be sampled from parts of Rajasthan and Haryana. *Mangifera sylvetica* and the *M. khasiana* have their diversity in NEH region bordering Myanmar, dwarf types in Manipur and

polyembryonic forms from western coast and Goa need specific collecting. Considerable diversity occurs for jackfruit in UP, Bihar, eastern peninsular tract. Thirty three samples from Ranchi and around have been collected. Bread fruit is found in Lakshadweep and Andaman and need to be sampled. The western ghat region also has considerable variability both in *Artocarpus heterophyllus* and *A. lakoocha*.

Potential areas for future collection are Mairwa (Chhapra) in Bihar; Deoria, Basti, Mirzapur, Sonbhadra, Gonda, Agra, Lucknow (UP) for bael; Srirampur, Mahabaleshwar, Satara, Aurangabad (MS) and Deoria,, Pratapgarh, Allahabad and Varanasi (UP) for Jamun (Syzygium cumini); Aurangabad, Satara, Ahmadnagar (MS); Sagar, Jabalpur, Raigarh, Raipur, Shahdol (MP) and Punjaipulianpatti, Vridhachalam (TN) for tamarind.

Potential areas for collection of custard apple include Bhavnagar, Girnar hills (Gujarat), Sehore, Seoni, Betul, Multai, Bastar, Chhindwara (MP); Pune, Parbhani, Balaghat, Daulatabad (Maharashtra) and Aravali ranges in Rajasthan. These pockets are to be surveyed on priority basis.

Minor fruits are also valuable in the diet and thus both tropical and temperate types need to be collected. Temperate species/forms in *Rubus biflorus, R. fruiticosus, R. lineatus, R. nutans*; wild strawberry (*Fragaria nilgirensis*), *F. indica* from Sikkim, J & K, Nilgiri hills and *Vitis* sp. from S. India; other crops such as *Feronia limonea, Dillenia* from eastern ghat; western peninsular hills for *Carissa carandus, C. inermis* (*C. carandus* from Mt. Abu in Aravalli hills); *Grewia asiatica, G. subinaequalis* from central and S. India; *Morus* from peninsular region; *Eugenia* and *Syzygium* species in western peninsular tract remain also to be sampled.

(11) Forage crops

Deccan and peninsular region, parts of Rajasthan and Indo-gangatic plains need to be surveyed for collection of forage legumes and grasses.

(12) Medicinal plants

Bailadila reserve forest range and Abujhmarh areas in Bastar are the treasure house of medicinal plants. Adjoining areas viz., Sonpur, Bhairamgarh and Pakhanjoor in Bastar also need to be surveyed. Other interesting areas for collection include UP plains and hills; HP, Bihar, Orissa (especially Bhawanipatna, Bolangir, Phulbani, Malkangiri areas), Rajasthan, southern India, NEH region, Bababoodangir hills in Western Ghats.

(13) Sugarcane

Tarai region of UP, Brahmputra valley in Assam, hilly areas and areas bordering Myanmar, the foothills of western Himalayas particularly Shivalik hills and peninsular tract and Andaman and Nicobar islands assume greater importance and need to be surveyed for germplasm collection.

(14) Under-utilized crops

Some areas still need to be surveyed for collection of these crops. Rice bean is to be collected from parts of Orissa, Santhal Pargana (Bihar), NE hills; winged bean from parts of Kerala, Anjangaon Surji near Akot (Akola), NEH region; buckwheat from Bharmour and Manimahesh areas in Chamba (HP), Darjeeling and West Sikkim; amaranths from Gujarat; western Maharashtra, Kalahandi (Orissa) for grain type, Tripura and Manipur for stem type and eastern UP, Bihar, Assam, West Bengal and MP for leafy types; broad bean (*Phaseolus multiflorus*) from HP and UP hills, J&K, and Nilgiri hills, *Perilla* sp. from NEH region; taramira (*Eruca sativa*) from Dholpur, Morena, Bhind and Chambal ravines, drier parts of Haryana, Rajasthan and UP; chironji (*Buchanania lanzan*) from Chhattisgarh region,

Satpura hills (MP); Khirni from Bastar; Dhar, Jhabua, Nimar (MP) and eastern Gujarat; *Aesendra butyracea* (Chyura) - oil yielding plant from Pithoragarh, Almora and adjoining Nepal Himalayas; *Lepidium sativum* (Halim) - used as leafy vegetables from Palanpur area in Gujarat and Cleome viscosa (Hurhur) from UP hills.

(15) Plantation crops

Extensive surveys need to be done for coconut from Gujarat, A & N islands, Lakshadweep, Karnataka, Andhra Pradesh, Orissa, West Bengal, Tripura and Assam plains bordering Bangla Desh; arecanut (*Areca catechu*) from Attapadi region (Kerala) and NEH region; nutmeg (*Myristica fragrans*) from A&N islands, Kerala and NEH region; cashew nut (*Anacardium occidentale*) from parts of Goa, Orissa, Tamil Nadu, Andhra Pradesh, West Bengal and Mahrashtra; cacao (*Theobroma cacao*) from Idukki, Kottayam and Wynad districts of Kerala and adjoining Karnataka; black pepper (*Piper* sp.) from A&N islands, Lakshdweep and NEH region; clove (*Eugenia caryophyllata*) from Courtallum, Nagarcoil in Tamil Nadu; Cinnamon (*Cinnamomum zeylanicum*) from A&N islands, western ghats, Wynad plateau, Kerala, TN, Karnataka and NEH region; cardamon (*Elletaria cardamomum*) from parts of Kerala, TN, Karnataka and NEH region; turmeric (*Curcuma longa*) from parts of Bihar, MP, north Bengal hills, Assam and A&N islands; ginger (*Zingiber officinale*) from tarai region (UP), UP hills, western ghats, HP, MP and NEH region; large cardamon from parts of Sikkim, North Bengal, Kerala and NEH region; and Vanilla sp. from western ghats in Kerala.

(16) Wild relatives of crop plants

The wild relative of crop plants and related species are potentially of great significance in crop improvement, as a source of disease and pest resistance, stress tolerance etc. Following species need specific hunting; *Chionachne koenigii* from Western Ghats, Maharashtra and southwards tarai, Dehradun valley (UP); *Setaria sphacelata* from plain and hilly area all over India, more particularly from upper gangatic plains; *Trilobachne cookei* from western ghats in open scrub forest/along openings of forest; *Cajanus cajanifolius* from Mahendragiri; Belladilla range in Bastar; *Vigna* species from Konkan region of Maharashtra; *Vigna khandalensis* from disjunct hilly areas starting from Satpura in Gujarat to Mahabaleshwar in south (especially Purandhar hills); *Vigna trilobata* from Surtalai and Junagarh, western Himalayas, peninsular region particularly in western and eastern ghats; *Vigna dalzelliana* from Kalimpong hills, Khandala southwards, western ghats in Konkan; *V. mungo* var. *sylvestris* from Purandhar hills, Khandala ghat and Lonavala areas; *V. radiata* from tarai (UP), western and eastern peninsula, Shivalik hills, Jabalpur, Mandu Fort ruins, Khandala ghats etc.; *V. hainiana* from outskirts of Jabalpur, Bandhavgarh and Sohagpur reserve forests and from Bastar district; *V. grandis* from western ghats; *Chenopodium album* from upper Gangatic plain extending upto northern hills; *Citrullus colocynthes* from north- western plains and Gujarat; *Cucumis hardwickii* from foothills of Himalayas, Dehra Dun/Mussoorie; *C. sativus* var. *sativus* from parts of Gujarat, Cachar (Assam) and Khasi hills; *C. hystrix* from eastern plains to NE hills, Tura range in Meghalaya and Mishmi hills; *C. setosus* from eastern India and upper gangatic plains; *C. prophetarum* from Sirohi and Abu areas in Rajasthan; *C. callosus* from eastern/western ghats; *C. sativus* var. *sikkimensis* from Arunachal Pradesh/Sikkim, Nagaland and Manipur; *C. melo* var. *momordica* from Khasi hills and West Bengal; *Momordica cochinchinensis* from eastern Bihar, WB and central peninsular tract; *Trichosanthes bracteata* from Himalayan ranges, A & N islands, peninsular region; *T. cucumerina* (wild relative of *T. anguina*) sporadically from all over India; *Amorphophallus bulbifera* from Khasi hills, eastern Himalayas in Sikkim; *A. campanulatus* from Deccan plateau; *Dioscorea alata* from western

and NE Himalayas; *Brassica tournefortii* from western India and Himalayan region; *Carthamus oxycantha* from northern plains; *Cichorium endivia* from hills and plains of north and north-western India.

IV FUTURE THRUST

In future, the exploration and germplasm collection activities will be intensified on crop/trait specific collaborative explorations for (a) priority crops of national importance, (b) under-explored and un-explored crops/areas, (c) wild relatives of crop plants, (d) endangered economic species, (e) genes for biotic and abiotic stresses and other specific traits in the hot spot areas of diversity, and (f) under-utilized/lesser known crops of tribal importance. Systematic efforts will be made to analyse gaps in collection more precisely and cover the areas recommended by Crop Advisory Committees/Coordinated Crop Workshops/ Symposia etc. Under World Bank funded Jai Vigyan National Agricultural Technology Project (NATP) on Agro-biodiversity, it has been envisaged to undertake over 1100 explorations in mission mode manner in 5 years duration. This is a herculean task. Under NATP on Plant Biodiversity Programme, the NBPGR has already started accomplishing this task. It has involved effective participation of ICAR Crop based institutes/NRCs/Crop Coordinating Units/SAUs/ State Agriculture Departments/other national agencies and government organizations, research foundations, NGOs including defence department of Government of India. Depending on agro-climate, this task is being managed by ten different zones, located at New Delhi, Jodhpur, Shimla, Bhowali, Akola, Ranchi, Cuttack, Shillong, Hyderabad and Thrissur (Kerala). It is highly likely that the NBPGR will be able to accomplish survey and collection of fast eroding genetic resources and conservation of germplasm material in the form of seed/cutting/tissue and cell culture/. DNA fragments in seed/*in-vitro*/DNA Gene Bank/ Field gene bank/*in-situ*/on-farm sites.

A. The priority crops/specific areas for collection will include

SNo.	Crop/Specific trait	Areas to be explored
1.	**Cereals**	
	Rice (*Oryza sativa*)	Land race diversity
	Scented types	Tarai areas
	Short stratured types	North Cachar,Manipur and Arunachal Pradesh
	Glabrous husk forms	Along Myanmar border in Manipur
	Waxy endosperm types	Mizoram and Garo hills
	Japonica types	Kameng and Subansiri in Arunachal Pradesh
	Gall-midge and green Leaf hopper resistant	Garo, Mikir, Khasi, Jaintia hills
	Tungro virus tolerant	Assam, Meghalaya and Arunachal Pradesh
	Wild rices	UP, parts of Bihar, Orissa, Andhra Pradesh, MP etc.
	Wheat (*Triticum aestivum*)	
	Rust resistant	Pindari, Sundardhunga and Garbhiyang valley in UP
	T. durum & *T. dicoccum*	Nilgiri, Palani & Madanpalli hills Belgaum, Raichur and Bijapur Areas in Karnataka, parts of M.P. and Rajasthan.
	Maize (*Zea mays*)	
	Landrace diversity	Doon valley, Chakrata hills, Sikkim, Arunachal Pradesh, Meghalaya, Mizoram, Manipur, Nagaland, Tripura, Nilgiri hills etc., Himalayas, foothills of Jammu and Kashmir
	Resistant to stalky rot downy mildews and stem borer	Tribal areas in Gujarat, MP, Eastern Rajasthan
	Barley (*Hordeum vulgare*)	
	Landrace diversity	Ladakh, pockets in Lahaul/Spiti, Kalpa/ Sangla and UP hills, Sikkim, Himalayas, Arunachal Pradesh and small pockets in UP, Haryana, Rajasthan

2.	**Pseudocereals**	
	Buckwheat	Bharmour & Manimahesh areas in Chamba (HP) hills
	Amaranthus species	
	Grain type	Gujarat,Maharashtra (only localized pocket) uncovered sporadic pockets in HP and UP hills
	Leafy type	Eastern UP, Bihar, Assam, W. Bengal and MP
3.	**Millets/Minor millets**	
	Finger millet (*Eleusine coracana*)	Western ghats, Sikkim, north western to eastern Himalayas (mid-elevation)
	Kodo millet (*Paspalum scrobiculatum*)	Drier belt-MS, Gujarat, Bihar, Orissa, AP&TN
	Foxtail millet (*Setaria italica*)	Peninsular tribal zone and NEH region
	Little millet (*Panicum sumatrense*)	Eastern and Central peninsula,Orissa,Bihar,UP & MP
	Proso millet	Bihar,UP,J&K,HP (up to 3000 m)
	Barnyard millet	Eastern peninsular tract
4.	**Grain legumes**	
	Asian *Vigna species* (Cultivated local landraces and their closely related wild species)	Western Ghat,eastern Peninsula, north, Bengal, Orissa, UP, Bihar, Rajasthan
	Lentil & Pea	
	Local landraces	HP hills (Lahaul Spiti), north Bengal, parts of Madhya Pradesh, U.P. and Rajasthan
	Pigeonpea	
	Local landraces	Eastern UP, Bundelkhand, Madhya Pradesh, Bihar,parts of Orissa and Rajasthan
	Chickpea	
	Local landraces	Saline areas in Rajasthan and Gujarat,Gangetic and Indus plain (only unexplored pockets)
	Khesari (*Lathyrus*)	Eastern UP, northern Bihar, Madhya Pradesh, Maharashtra and pockets in W. Bengal.
5.	**Oilseeds**	
	Castor & *Jatropha*	All castor & *Jatropha* growing areas throughout the country
	Niger (All prevailing types)	Peninsular region
	Linseed	
	Local landraces	Gangetic plains & tribal pockets in Madhya Pradesh, Orissa and eastern Rajasthan
	***Brassica* species**	
	Native types	Eastern & western hill region, AP, MP, Orissa, Rajasthan and parts of UP and Bihar
	Groundnut	
	Local types	Parts of Orissa,lateritic belts in W. Bengal, Bachhau areas and Gujarat
6.	**Vegetables**	
	Cucumber	
	Local landraces	Indo-gangatic plains, sub-Himalayan tract, Western Ghats, eastern peninsular tract
	***Cucumis melo* and other *Cucumis* types**	
	Local landraces	Jammu & Kashmir, H.P. hills, Uttar Pradesh, Rajasthan, Karnataka, Andhra Pradesh
	Pointed gourd	
	Local landraces	Bihar,Bengal plains and Assam valley
	Ivy gourd (*Coccinia sp.*)	
	Local landraces	Eastern MP,W. Bengal and NEH region, Bihar, U.P.
	Luffa* & *Lagenaria	
	Wild & cultivated	Indo-gangetic plains,Tarai region,north eastern plains
	Snake gourd	
	Local landraces	Southern peninsular tract,Kerala
	Bitter gourd	UP, Bihar, Kerala, Karnataka and other pockets of diversity
	Cucurbita* & *Benincasa hispida	NEH region
	Cho-Cho (*Sechium edule*)	NEH region
	Lablab bean (*Lablab purpureus*)	

	Local landraces	Eastern peninsular, Orissa, Bihar, Gujarat, MS, Goa & Southward
	Sweet potato	
	Local landraces	Bihar, Orissa, UP & W. Bengal (only unexplored pockets)
	Colocasia	
	Local landraces	Kerala, AP, Orissa, Bihar, UP, W. Bengal and N.E. region, Kerala, Nilgiri and Annamalai hills
	Diocsorea	
	Local landraces	Andaman and Nicobar Islands, Bihar,NEH region
7.	Fiber crops	
	Jute,Kenaf & Mesta	North-eastern region, W. Bengal, Rajasthan, Bihar, Orissa, UP and HP
	Cotton	Chhattisgarh, Jammu, Nagaland, Meghalaya, Manipur and fine grid survey in other parts of country
8.	Forage crops	
	Legumes & Grasses	Extensive survey and collections in Himalayan region, Deccan and Peninsular regions, parts of MP and Rajasthan and Indo-Gangetic plains
9.	Tropical Fruits	
	Mango	
	Dwarf seeded types and Polyembryonic forms	Manipur, UP, HP, Bihar, Orissa, Maharashtra and Karnataka Ratnagiri areas, Western coast and Goa
	Annona spp.	
	A. raticulata	Deccan plateau, M.P., A.P., Karnataka, Eastern UP and Satpura hills
	A. diversifolia	
	A. muricata	
	Citrus species	Sikkim, N.E. region (Assam, Meghalaya, Manipur, Mizoram etc.), drier parts of north-west India, foothills of Himalayas and N. Bengal
	Musa species landraces	NEH along Myanmar border, W. Bengal, Orissa, Maharashtra
	Jackfruit (*Artocarpus* sp.)	Bihar, UP, Madhya Pradesh, Orissa, Tamil Nadu, Kerala, Goa, East peninsular tract, Andaman and Nicobar islands
	Pomegranate	
	Evergreen forms (Different shape,size of fruits)	N.W. plains, J & K, HP and UP hills
	Ber (*Zizyphus* species)	
	Z. mauritiana	Central and eastern UP and Maharashtra and Goa
	Z. oenoplia	Karnataka and Kerala
	Z. xylocarpa	AP, MP and Maharashtra
	Aonla (*Emblica officinalis*)	UP, MP and other pockets of diversity
	Tamarind	Orissa, Maharashtra, Madhya Pradesh, Uttar Pradesh, Karnataka, Goa etc.
	Moringa	Southern India
10.	Temperate Fruits and Nuts	
	Pyrus and *Prunus*	Temperate region (J&K, HP & UP hills, Sikkim and North Bengal)
11.	Medicinal and aromatic plants	UP plains & hills, Himachal Pradesh, Bihar, Sikkim, Orissa, Rajasthan, Madhya Pradesh (Bastar region) and southern India, N.E. region
12.	Lesser known/under utilized crop plants	
	Rice bean	NEH region,Sikkim,western and eastern ghats,Bihar and parts of Orissa,Santhal Pargana,W. Bengal
	Winged bean	
	Local landraces	Parts of Kerala,Vidarbha region in Maharashtra, Meghalaya, Manipur, Mizoram, Nagaland, Tripura, Assam
	Broad bean	Eastern UP & Bihar, Himalayan hills (Lahaul & Spiti), J & K
	Perilla	NEH region

Eruca sativa	Drier parts in Haryana, Rajasthan, Madhya Pradesh and Gujarat
Chironji (*Buchanania lanzan*)	Chhattisgarh region, Betul, Multai and Gawilgarh ranges in Satpura hills M.P.
Khirni (*Mimusops elengi*)	Bastar, Dhar, Jhabua & Nimar in MP
13. Wild relatives of crop plants	
Atylosia/*Cajanus* sp. & wild *Vigna* species	Western ghats, Konkan, tarai, Orissa and NEH region
	Western and eastern ghats, Himalayan region
Vigna grandis	Western ghats
Vigna mungo var. *sylvestris*	Khandala ghats and Konkan region
Vigna radiata var. *sublobata*	Tarai, western and eastern peninsula
Vigna dalzelliana	Western ghats
Vigna trilobata	W/E ghats, Western Himalayas, specific in Peninsular region
Chenopodium album	Upper Gangetic plains extending to n. Hills
Citrullus colocynthis	N/W plains
Cucumis hardwickii	Western Himalayan foothills
C. propheterum	N/W plains, Sirohi and Abu areas in Rajasthan
S. setosus	Eastern India & Upper Gangetic plains
Memordica cochinchinensis	Peninsular region, W. Bengal and NEH region
M. dioica	Central peninsular tract
Trichosanthes bracteata	Himalayan ranges, eastern India, A&N region
Amorphophallus spp.	Khasi Hills, Sikkim, W. Bengal
Dioscorea alata	Western and north eastern Himalayas
Brassica tournefortii	Western India, Himalayan region
Carthamus oxycantha	Northern plains, Haryana, Rajasthan etc.
Corchorus spp.	Assam plains and Tripura, Central peninsular tract, Upper Gangetic plains, Rajasthan and Gujarat
Ginger	Kerala, Western Ghats, Eastern Ghats , Goa etc.
Piper species	Kerala, N.E. region, Sikkim, UP and N.E. hills
Musa	South and eastern India

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