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SPECIAL EXPLORATIONS FOR THE COLLECTION OF CULTIVATED PLANTS AND THEIR WILD RELATIVES IN INDIA

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INTRODUCTION

Plant explorations for the cultivated plants and their wild relatives aim at the collection of genetic diversity of different species with a view to establish and analyse variation patterns, delimit, describe and analyse geographical trends, and interpret centres of variation, analyse evolution of plant species under natural and human selection, and identify suitable materials for use in crop improvement programmes. The diversity in the wild plants amounts to 250,000 species (Good, 1953) as against 640 species of the more important economic plants (Hodgson, 1961). Further, this diversity is concentrated in 37 floristic zones for the wild plants (Good, 1953) and 8 (Vavilov, 1950) or 12 (megacentres) centres of origin/diversity of cultivated plants (Darlington and Janaki Ammal, 1945; Zhukovsky, 1971). In the Indian sub-continent, the diversity of the wild plants is distributed in nine botanical regions (Chatterjee, 1939) and for the cultivated types also nine agro-ecological regions are generally recognised.

RELATIVE DISTRIBUTION OF CULTIVATED PLANTS

Zaven and Zhukovsky (1975) enumerated 167 families, which included 2297 species of cultivated plants. The most prominent families are Gramineae (359 species, 15.6%), Leguminoseae (323, 14.1%), Rosaceae (154, 6.7%), Solanaceae (100, 4.4%), Compositae (75, 3.4%), Myrtaceae (73, 3.2%), Malvaceae (67, 2.9%) and Labiatae (55, 2.8%). In India, 152 (6.6%, of 2297 species) cultivated plant species belonging to 46 families are reported (Zaven and Zhukovsky, 1975); the prominent families being Gramineae (27 species), Leguminoseae (23), Cucurbitaceae (9) and Zingiberaceae (9). Further, out of about 600 species listed by Vavilov (1950) pertaining to his 8 centres of origin of cultivated plants, 117 belong to the Indian gene centre. Besides, crops of other Vavilovian gene centres are also important and are presently grown in different agro-climatic regions of the country.

PATTERNS OF GENETIC DIVERSITY IN INDIGENOUS AND EXOTIC GERMPLASM

Indigenous cultivated plants have their companion wild-weed relatives growing in the same or adjacent fields. Such weed races serve as reservoirs of reserve germplasm, periodically injecting portions of it into the cultivated crop under conditions that would

most favour increase in variability, heterozygosity and heterosis (Harlan, 1965). Therefore, a plant explorer should collect besides the cultigen, its closely related wild-weed species and even the intermediate and introgression products because some of them may have the desired character combinations which plant breeders are looking for. Exotic cultigens after their introduction in India, were subjected to local and agricultural differences under different agro-climatic regions, in which they continued to be cultivated. Selection pressures under different situations have generated significant changes in their genetic constitution, resulting in the formation of several locally adapted races. These races need to be collected from different agro-climatic regions.

COLLECTION STRATEGIES

The basic source of genetic variability, on which the improvement of cultivated plants depends, is that which exists at present in advanced, locally adapted nondescript types and its wild or weed relatives (of cultivated plants). Further, most species of cultivated plants manifest extensive geographical variability and they also show extensive variability within populations. Thus, each species contains several genotypes. When the perspective of plant exploration is considered in this context, it becomes obvious that any collection could only be a small sample of the total variability. In contrast, it is easier to separate taxa of wild species based on distinct morphological characters even at the collection site/habitat. Thus, in the collection of cultivated plants, we are faced with the problem of how to assemble the maximum amount of genetically useful variability and still keep the sample size within practical limits. Information on the nature and extent of variability and its distribution within and between population spread over the geographical limits of cultivation of the species under consideration would be helpful. Further, presence of polyploidy, introgressive hybridization and other genetic features would indicate that as compared to individual collections field populations should be preferred and the prevailing variation of gene pools should be captured in the field by random or selective (subjective) sampling, or both. The technique varies, as discussed below:

a) *Seed crops*: Cereals, millets, grain legumes—field crops in general; collect from 100 individuals, per site, about 50 seeds (one or two panicles/inflorescences), per plant and pool in all this variation as a bulk sample. More morphotypes can be added to this bulk sample, and herbarium collections (with seed) of these types must be kept for future study. Similar approach is also needed for the collection of wild relatives, though seed collection per site in wild types would be comparatively less, because very often only sparse populations spread along distances would be available for sampling.

b) *Root and tuber crops* : Distinct morphotypes need to be sampled in different locations/villages. Diverse genotypes and even different species may be sampled this way; usually collection should be made every 25 km distance *enroute*, and supplement this variation further with seed collections. In the wild (related) types, collect 10-20 tubers in 100 × 100 m areas as a bulk sample, and supplement this by seed collection.

c) *Fruit trees* : Seeds (*Citrus*, papaya, mango), budwood cuttings (*Citrus*), or suckers (banana/*Musa*) are to be collected. In case of wild relatives, sample 10-15 individuals of each tree species (collecting seeds) in 10 ha area, as a bulk sample. Failing to collect seeds, cuttings, etc., one per tree (10-15 in all) in the above area may be collected. If populations occur in clumps, one sample per clump

and pooling of few clumps as a bulk sample is recommended. While following the above collecting procedures, when looking for materials possessing specific traits, selective sampling would alone be feasible. For collection of wild relatives, a prior information on areas of distribution, habitat, etc., is a prerequisite *i.e., Solanum, Abelmoschus, Vigna, Atylosia, Saccharum, Oryza* and *Prunus*. Further, exploration for collecting or sampling variability is to be planned keeping in view the ripening and seeding period of the economic plants.

In case of threatened species a few seeds, per plant may be pooled as a bulk sample from its distribution range to constitute a representative sample.

PAST EXPLORATIONS IN CULTIVATED PLANTS

The Plant Introduction programme was initiated in India about 30 years ago and through explorations conducted in different regions of the country, diverse germplasm of legumes, cereals, millets, oilseeds, vegetables, fibres, fruits and other economic plants have been built-up. Certain regions were identified as priority areas for exploration of the genetic diversity. Thus, during the last five years extensive genetic variability of various crops and their related species have been collected from the north-eastern region (Arora and Mehra, 1977). Besides these multicrop collections, specific crop explorations were also undertaken for oilseed Brassiceae, clusterbean, *Pennisetum, Sorghum*, maize, rice and ginger, and for herbage legumes and grasses. Specific areas possessing genetic diversity of these crops were surveyed.

Among the wild relatives, collections were made in *Saccharum* (Mukherji, 1949), *Oryza* (Govindaswami and Krishnamurthy, 1959), *Abelmoschus* (Pal *et al*, 1952), and by the Bureau staff particularly in *Vigna* wherein extensive variants have been collected from the Khandala Ghats, Maharashtra (*Vigna radiata* sub sp. *sublobata, V. dalzellii, V. grandis*). The Horticultural Division of IARI had also in the past (1960's) collected *Pyrus, Prunus* and other Rosaceous types from western Himalayas and the north-eastern region (Singh *et al*, 1974).

Among the outside agencies collections of forage legumes, *Desmodium, Indigofera* and others, were made by CSIRO, Australia. The National Institute of Agricultural Research, Hiratsuka (1962-64) collected clones of *Thea*, and the Tokohu University (in 1965), *Brassiceae* material and Simmonds (1956) collected *Musa* sp. from north-eastern hills (refer Singh *et al*, 1974). Recently Dr. Witcombe of the University college of North Wales, Bangor, U.K., has, through the International Board of Plant Genetic Resources, Rome, Italy, collected wheat and barley in the north-western Himalayas.

Apart from augmenting variability, the Bureau has been able to contribute towards studies on the origin and domestication of native types, particularly from the north-eastern hills—*Moghania vestita* and *Digitaria cruciata* (Singh and Arora, 1972 & 1973).

FUTURE STRATEGIES FOR EXPLORATION

In view of the large scale genetic erosion taking place in the wake of agricultural and horticultural advancement, primary emphasis is laid now on the collection of traditional land races (primitive varieties) mostly grown by the tribal inhabitants. Study and conservation of these land races possessing many useful attributes assume great importance. The regions/areas of exploration and economic plant's diversity planned to be collected are given in Table 1.

Besides, explorations for the collection of

TABLE 1 : AREAS FOR EXPLORATION OF CULTIVATED PLANTS

Region	Eco-climate	Tribal areas (States) to be explored	Tribal Blocks/Districts to be surveyed	Indigenous germplasm to be collected
1. North-eastern	Largely humid, subtropical to sub-temperate	Arunachal Pradesh, Assam Nagaland, Manipur, Mizoram, Tripura, Meghalaya, Sikkim and N. Bengal	Whole region (Manipur & Meghalaya are partly covered); more emphasis on Mizoram and other areas.	Rice, maize, barley, *Eleusine*, *Setaria*, *Panicum*; Sesame, *Brassica*; black gram, green gram, cow-pea, pigeon-pea, lentil, Soybean, ricebean, *Dolichos*, Goa-bean, buckwheat, amaranth; *Colocasia*, *Dioscorea*; kenaf, jute, cotton; citrus, Banana, Sugarcane.
2. Eastern	Humid-subhumid, sub-tropical	Orissa, Bihar	Orissa—Sundergarh, Koraput, Mayurbhanj, Kalahandi, Keonjhar; Bihar-Ranchi, Santal Parganas, Singhbhums, Hazaribagh, Palamau.	Rice, maize, sorghum, sugarcane, *Eleusine*, *Panicum*, *Setarid*; niger, sesame; black & green gram, cow-pea, *Dolichos* ricebean, pigeon pea.
3. Central	Humid-subhumid, chiefly subhumid, subtropical	Mainly Madhya Pradesh, also parts of Southern U.P. and E. Maharashtra	M.P.—Jhabua, Sidhi, Satna, Panna, Raigarh, E. & West Nimar, Surguja, Betul, Bastar, Bilaspur, Shadol, Chindwara, Raipur, Durg, Mandla; Bundelkhand region in U.P. : Amravati, Dhulia, Nanded, Chandrapur, Nasik in M.S.	Rice, maize, wheat, sorghum, sugarcane, *Eleusine* (*ragi*) and other minor millets; niger, sesame, safflower; black gram, green gram, cow-pea, pigeon pea, gram.
4. Western	Chiefly semi-arid	Gujarat, Rajasthan	Gujrat—Balsar, Sabarkantha, Panchmahala, Baroda, Broach, Danga, Surat, Banaskantha; Rajasthan : Banswara, Dungarpur, Udaipur.	Wheat, barley, sorghum, pearl millet; black & green gram, pea, cow-pea, moth bean; sesame, cotton.

Region	Eco-climate	Tribal areas (States) to be explored	Tribal Blocks/Districts to be surveyed	Indigenous germplasm to be collected
5. Southern	Chiefly humid, sub-humid tropical	Karnataka, Tamilnadu, Kerala, Andhra Pradesh	Karnataka—Shimoga, Chikmagalpur, Coorg; Tamilnadu—Nilgiris, North Arkot; Kerala—Palaghat, Kozhikode, Cannanore; A P.—Kurnool, Guntur, Cuddapah, Khammam, E. & W. Godawari & other agency areas.	Rice, sorghum, pearl millet, ragi (*Eleusine*), and other minor millets; *Dolichos*, cow-pea, horse-gram, *Phaseolus trilobus*, pigeon-pea, black & green gram; sesame, safflower.
6. North-western/ W. Himalayan	Chiefly temperate, Alpine.	U.P. hills, Himachal Pradesh, J. & K. (Chiefly cold arid tracts.)	M.P.—Chamba, Kinnaur, Lahul & Spiti, J. & K., Ladakh; U.P. hills-Uttarkashi, Chameli, Pittoragarh.	Wheat, barley, maize, buckwheat, amaranth, minor millets; *Brassica*; peas, lentil.

wild relatives of crop plants would be undertaken, covering especially four phytogeographical belts of the country, *viz.*,

a) The Himalayan region, particularly for Rosaceous taxa, *Pyrus, Prunus, Sorbus, Rubus, Malus, Fragaria* and others; wild types *Brassiceae, Umbelliferae, Cucumis, Pistasia, Ribes;* legumes like *Cicer, Trigonella, Lathyrus, Medicago, Trifolium;* grasses like *Agropyron, Elymus.* More variability for these taxa occurs in the western Himalayas.

b) The north-eastern region for tuberous types like *Dioscorea, Colocasia* and *Alocasia; Citrus, Mangifera, Musa* and low altitude *Prunus* types. Many cucurbits, *Trichosanthes, Momordica, Cucumis;* legumes, *Vigna, Mucuna* and *Canavalia,* and grasses, *Coix, Setaria;* occur in this tract. The region is rich in wild Zingiberaceae. Extensive variability occurs in *Vigna umbellata* as also of *Solanum* and *Abelmoschus* species (*i.e. A pungens, S. khasianum* and others). Wild forms in *Oryza* or related taxa also prevail. Other noteworthy types include *Thea, Corchorus, Vitis* & *Piper.*

c) The eastern ghats : Jeypore tract of Orissa and adjoining Madhya Pradesh, for wild forms in *Oryza;* wild *sem* (*Lablab niger*) and *Sesamum* (*S. prostratum*) occur here. Much variability prevails in *Saccharum.* Amongst others, *Dioscorea, Solanum, Musa, Mucuna* and *Abelmoschus* are important.

d) The western ghats are strikingly rich in legumes—*Glycine, Dolichos, Mucuna, Canavalia,* wild forms in *Cajanus* (*Atylosia lineata* and other species), black and green gram—*Vigna radiata* var. *sublobata,* with others—*Vigna* species, *V. trilobata, V. aconitifolia, V. grandis, V. dalzellii* occur in Khandala ghats, southwards. *Artocarpus, Curcuma, Zingiber, Musa, Dioscorea, Colocasia, Solanum, Piper, Vitis, Saccharum, Ziziphus, Cucumis, Abelmoschus* also prevail.

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