



NBPGR

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NBPGR

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2001**



National Bureau of Plant Genetic Resources

New Delhi - 110 012

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This report includes unprocessed or semi-processed data, which would form the basis of scientific papers in due course. The material contained in the report therefore may not be made use without the written permission of the Director, National Bureau of Plant Genetic Resources, New Delhi except for quoting it for scientific reference.

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ACRONYMS

AFLP	Amplified Fragment Length Polymorphism	ICRISAT	International Crops Research Institute for Semi-Arid Tropics
AICRP	All India Coordinated Research Project	IFPGR	International Fund for Plant Genetics Resources
ARIS	Agricultural Research Information System	INIBAP	International Network for the Improvement of Banana and Plantain
AVRDC	Asian Vegetable Research and Development Center	INPGRS	Indian National Plant Genetic Resources System
BARC	Bhabha Atomic Research Center	IPGRI	International Plant Genetic Resources Institute
CBD	Convention on Biological Diversity	IC	Indigenous Collection
CGIAR	Consultative Group on International Agricultural Research	ISPGR	Indian Society of Plant Genetics Resources
CGRFA	Commission on Genetic Resources for Food and Agriculture	ITK	Indigenous Traditional Knowledge
CIAT	International Center for Tropical Agriculture	IUPGR	International Undertaking on Plant Genetic Resources
CIMMYT	International Maize and Wheat Improvement Center	LTS	Long Term Storage
CIP	International Potato Center	MTA	Material Transfer Agreement
CMS	Cytoplasmic Male Sterility	MTS	Medium Term Storage
CPGR	Commission on Plant Genetic Resources	NAAS	National Academy of Agricultural Sciences
CSCNRVC	Central Sub-Committee on Crop Standards, Notification and Release of Varieties of Agricultural Crops	NAGS	National Active Germplasm Sites
CSIR	Council of Scientific and Industrial Research	NARS	National Agricultural Research System
DARE	Department of Agricultural Research and Education	NATP	National Agricultural Technology Project
DBT	Department of Biotechnology	NBPGR	National Bureau of Plant Genetic Resources
DFID	Departmental Fund for International Development	NGO	Non-Governmental Organization
DPPQ&S	Department of Plant Protection, Quarantine & Storage	NHCP	National Herbarium of Cultivated Plants
DRDO	Defense Research and Development Organization	NRC	National Research Center
EC	Exotic Collection	PEQN	Post-Entry Quarantine Nursery
FAO	Food and Agricultural Organization	PGRFA	Plant Genetics Resources for Food and Agriculture
GATT	General Agreement on Tariffs and Trade	SAU	State Agricultural University
GHU	Germplasm Handling Unit (of NBPGR)	STMS	Sequence Tagged Microsatellite Site
GPA	Global Plan of Action	TRIPS	Trade Related Intellectual Property Rights
IARC	International Agricultural Research Center	UPOV	The International Union for the Protection of New Varieties of Plants
IARI	Indian Agricultural Research Institute	USAID	United States Agency for International Development
ICAR	Indian Council of Agricultural Research	WIEWS	World Information and Early Warning System
ICARDA	International Center for Agricultural Research in the Dry Areas	WTO	World Trade Organization

PREFACE

The National Bureau of Plant Genetic Resources is the flagship of India's PGR management. Established in 1976 with its headquarters in New Delhi at Pusa campus has a network of 11 regional stations located in different agroclimatic zones of the country. Since its establishment, NBPGR has responded very dynamically to the needs, challenges and opportunities of Indian agrobiodiversity and adjusted its mandate, plans and programmes accordingly.

The NBPGR is strengthening its frontier key areas of PGR management such as national database and its networking with national active germplasm sites (NAGS), molecular characterization of promising genotypes, registration of plant material, introduction of elite genotypes, phytosanitary and biosafety measures, and development of core collections and utilization of PGR. National containment/ quarantine facility for transgenics established at New Delhi will be efficiently used for safe introduction and utilization of genetically modified organism/ transgenic material.

Timely implementation of mission mode sub-project on plant biodiversity under the National Agricultural Technology Project (NATP-PB) by the Council with World Bank assistance has resulted in greater emphasis on collection of indigenous plant biodiversity from remote areas with active participation of cooperators and grassroots level workers. Human resource development component in this project has helped in creating PGR awareness among the scientists and farmers. Evaluation of the collected germplasm at identified sites and the conservation of pest free material in National Genebank is also going on simultaneously and the progress is highly satisfying. Under this project NBPGR through its 11 regional stations in collaboration with several organizations including SAUs, NGOs, and State Agricultural Departments has adopted and implemented programmes and policies that recognize men and women farmers' knowledge and experience for the sustainable management of agrobiodiversity and enhanced food, nutritional and health security. The project has built a platform for action among partners by seeding ideas, supporting learning and capacity building and providing opportunities for discussion in areas related to biodiversity.

It is a pleasure to place on record my sincere thanks and gratitude to Secretary, Department of Agricultural Research and Education & Director General, Indian Council of Agricultural Research; Deputy Director General (crop sciences) and the National Director, National Agricultural Technology Project for providing necessary guidance and support to fulfil the mandate of the NBPGR. I wish to express my sincere appreciation to all the scientists, technical, administration and supporting staff members of the Bureau for their dedicated efforts and cooperation in carrying out the functions and activities of the NBPGR.

Special mention has to be made to the efforts of Dr. Arjun Lal and the editorial team in compiling and editing the document, which deserve appreciation.

EXECUTIVE SUMMARY

The NBPGR continued its leadership role in plant genetic resources management in the country. Significant achievements made during 2001 in plant exploration and collection, germplasm, introduction from abroad, quarantine inspection and release of healthy germplasm evaluation, maintenance, documentation and conservation of germplasm in national genebank are summarised hereunder.

EXPLORATION AND COLLECTION OF GERmplasm

At the national level, 242 explorations were undertaken covering various regions in zone I to zone X under the NATP-PB project and 14803 collections were made comprising agrihorticultural crops and their wild relatives. Out of these, 82 explorations were undertaken by the NBPGR and made 7310 collections of cultivated plants, and their wild relatives. Remaining 160 explorations were undertaken by various cooperators from Zone I to Zone X. Special efforts were made to collect endangered medicinal and aromatic plants from Panwali, Bugyal and Tehri Garhwal. Under germplasm rescue mission, 12 explorations were undertaken in Sardar Sarovar dam catchment areas in MP, Gujarat and Maharashtra and 2118 collections were made with some rare collections of medicinal plants, landraces of paddy, sorghum and mothbean. A total of 704 herbarium specimens, 200 seed samples and 22 economic products were added to national herbarium of cultivated plants (NHCP). A checklist of scientific names including 477 names of cultivated plants was prepared for publication.

Some important landraces of paddy viz. Kalon, Jiri, Begumi, Ukhyal, Gyassu, Laldhan,

Ruthadhan, Kishan Mangora, Sundaru, Kalan and Kathuzala were also collected from Sirmour district. Wild relatives of crop plants like *Oryza*, *Vigna*, *Cajanus*, *Alyosia*, *Sesamum*, *Solanum*, *Allium*, *Saccharum*, *Crotalaria*, *Musa*, *Pyrus*, *Rubus*, *Citrus*, *Curcuma* and *Zingiber* were collected from various parts of India.

GERMPLASM EXCHANGE

During the period under report 94,811 samples were imported from 35 countries which included germplasm as well as trial materials of different agricultural and horticultural crops. Requirements for germplasm from abroad were met by arranging material from different Indian sources and 100 samples were sent to 11 countries. On request received from research workers in the country, 10608 samples of germplasm of diverse crops were supplied to various users for crop improvement programmes.

Promising introduction from abroad for specific traits

- *Avena sativa* (EC 469501-03) from USA: Combined resistance to brown rust, high grain yield, thin hulls
EC 473800-801 from USA: Variety Chapman and Florida with high grain and forage yield, early maturing
- *Hordeum vulgare* (EC 473169) from USA: Consistent and high degree resistance to barley stripe rust
EC 473921 from USA: Large grain and high protein, resistant to stripe rust
- *Oryza sativa* (EC 472985-3073) from Philippines: CMS and maintainer lines
EC 469595-97 from Philippines: Line with

- wide compatibility gene CP-SLO-17
 EC 470264-84 from Philippines: Breeding lines from Basmati crosses and new plant types
 EC 477711-725 from Philippines: New plant types
 EC 478048-51 from Philippines: Sticky rice (Glutinous types)
- *Pennisetum typhoides* (EC 469936-945, 470391-397) from Nigeria: Early maturing, drought tolerant and dual purpose types
 - *Pennisetum typhoides* ssp *mentana* (EC 473259) from USA: Potential for increasing growth rate, resistance to rust, smut and leaf spot
 - *Sorghum bicolor* (EC 482670-97) from USA: Male sterility and fertility restorer lines. Immediate application for basic research on effect for plant colour, pericarp colour, high quality grain for food and fodder
 - *Triticum durum* (EC 478016-17) from USA: Varieties AC Pathfinder and AC Navigator resistant to loose smut race T26
 - *Triticum aestivum* (EC 481176-76) from USA: Variety Prowes and Prowes 99, superior baking quality, resistance to cyst nematode (EC 467256-65) from Mexico: Improved resistance to Septoria leaf blotch and leaf rust (EC 467680) from USA: with excellent survival and broad disease resistance (EC 467720) from USA: Variety Scholar, red spring wheat, high protein, good yield, resistant to diseases (EC 477993) from USA: Superior bread making quality, high yield potential, resistance to stem rust
 - Tritosecale (EC 467937) from Canada: Variety Bobcat sprouting tolerant and resistant to stem rust and leaf rust
 - *Zea mays* (EC 468257-285) from Mexico: Early maturing and drought tolerant lines (EC 469504) from USA: Sweet corn, insect resistant (EC 466914-15) from USA: Sources of resistance to leaf feeding by corn borer and army worm (EC 470106-280) from Mexico: High sugar content, green cob for roasting, elite lines
 - *Glycine* sp (EC 473111-138) from Taiwan: Rust resistant and wild perennial lines
 - *Glycine max* (EC 483041-61) from USA: Lines resistant to foliar feeding, insect stem canker, high protein, genetic male sterility, low trypsin inhibitor lines, rust resistant, drought tolerant.
 - *Glycine max* (EC 468377-629) from USA: Lines with rust resistance, root knot nematode resistance, drought and heat resistance. Soybean mosaic virus resistance, low lipoxygenase, multiple foliar disease resistant downy mildew resistance (EC 478225) from USA: Resistant to soybean cyst nematode (EC 473265-3288) from Taiwan: Vegetable purpose types and rust resistant lines
 - *Phaseolus vulgaris* (EC 467266) from Canada: High yielding, early maturing cultivar
 - *Arachis hypogaea* (EC 470030) from Sudan: Bunch variety bold seeded
 - *Brassica nigra* (EC 472729-2738) from Germany: Genotypes resistant to *Alternaria blight*
 - *Saccharum* sp (EC 467345-433) from Thailand: Wild species *Saccharum spontaneum*
 - *Coriandrum sativum* (EC 467681-7690) from USA: Long duration types
 - *Hippophae rhamnoides* (EC 468632-33) from Russia: High Vitamin C content
 - *Ribes* sp. (EC 469984-95) from USA: Different species viz., *R.formosum*, *R.lobii*, *R.bracteatum*, *R.roezlii*, *R.wolfii*, open pollinated, *R.aireum*, *R. Alpinum*, *R.pentlandii*, *R. Tristeeklatt*, *R.burefense*
 - *Rubus* sp. (EC 469946-59, 469996-470014) from USA: Different varieties with improved characters viz. Columbian, Darraw, Smooth stem, Eldorado IDX, Burbank thornless,

Austin thornless. Different *Rubus* species- *R. ikenoensis*, *R. flageilaris*, *R. minisculus*, *R. kawakami*, *R. lasiostylus*, *R. precox*, *R. echinatus*, *R. erythroops* OP selection, *R. grabowskii* (*thrysoideus*), *R. canascens* (*tomentosus*), *R. chingii*, *R. plicatus*, *R. hillii*, *R. bogotensis*, *R. megalococcus*, *R. collumellaris* and *R. briaceus*

- *Vaccinium* sp. (EC 469960-82, 470016-23) from USA: Different varieties with improved characters -Grover, Pacific, Rubel, Stanley, Weymouth, Cabot, Blomidon, Olympia, Angola, Bounty, Koralle, Cape fear, Northland, Ornablue and Red Pearl and *Vaccinium* species- *V. hirtum*, *V. fuscatum* (*artococcum*), *V. parvifolium*, *V. myrtilus*, *V. macrocarpon*, *V. neilgherrense*, *V. amoenum* NC 95-6-1

PLANT QUARANTINE ACTIVITIES

At the headquarters, New Delhi, 86,224 samples of different crops were received through Germplasm Exchange Unit for quarantine clearance. Out of these 85,892 samples were imported and the rest 332 were meant for export to various countries. These samples included true seeds, rooted plants, cuttings, rhizomes, suckers, bulbs, nuts and tissue culture plantlets. The detailed quarantine examinations revealed that 374 samples were infested with insects/mites including 112 with hidden infestation; 162 samples were found infested with nematodes and 213 were found infected with plant pathogens. Seventy-seven samples of soybean found infected with downy mildew fungus (*Peronospora manshurica*) were rejected and destroyed. Seventy samples of tomato and 32 samples of pepper germplasm were subjected to prophylactic seed treatment with 10% tri-sodium orthophosphate to prevent the introduction of new strains of tobamoviruses through seeds. Six hundred seventy two infected/infested samples were salvaged through fumigation, hot water treatment (HWT), X-ray radiography, pesticidal

dip, ethyl alcohol wash and mechanical cleaning. Phytosanitary Certificates were issued for sixteen consignments of material meant for export. A total of 11 samples of transgenic crops were received after clearance certificate for import from DBT. Out of these one sample of *Brassica* was found infected with pathogenic seed-borne fungi.

At the Regional Station, Hyderabad a total of 13,647 samples consisting of 4,209 import samples (from 13 countries) and 9,581 export samples were processed for quarantine clearance and a total of 150 phytosanitary certificates were issued. Several pathogens of quarantine importance were intercepted. A total of 655 import samples were found infested/infected with pests/pathogens, and 503 samples salvaged. One hundred and fifty two samples comprising pearl millet (1) and groundnut (151), infected with *Pyricularia oryzae* and *Burkholderia solanacearum* could not be salvaged and hence rejected. In export, 324 samples were rejected due to quarantine pests/pathogens. Quarantine service was extended to 20 organizations in South India.

GERMPLASM EVALUATION AND MAINTENANCE

A total of 11,281 accessions of various agricultural crops viz.: cereals (6159), legumes (1792), oil seeds (668), vegetables (1726), medicinal and aromatic plants (399) and under utilized crops (356) were grown for characterization, evaluation, regeneration, multiplication and maintenance at experimental farm, Issapur. One hundred and eighty one horticultural crops were also maintained in the field genebank. Promising accessions for various agro-morphological characters were identified. Two accessions of pea namely NBP-1 and NBP-2 have been promoted to AVT of AICRP on MULLaRP crops. Evaluation for quality attributes/value added traits also resulted in

identification of promising accessions. Phytochemical study of various M&AP has also been undertaken. The minimal descriptors lists for characterization and evaluation of vegetable crops was developed and brought out in book form.

At Thrissur, 6858 accessions belonging to 26 crops, their wild relatives, medicinal and aromatic crops, minor fruits, miscellaneous vegetables, tropical fruits and exotic introductions were maintained in field genebank. A total of 2426 accessions of NATP-PB and pre-existing materials were characterised. Rambutan, Kokam and Indian gooseberry have been identified to have potential for diversification of horticulture in this part of the country. Two accessions of Malabar tamarind and one accession of jackfruit were identified as promising for registration.

At Shimla, 1757 germplasm accessions of field crops (maize, amaranth, buckwheat, chenopod, French bean, adzuki bean, ricebean, finger millet) and 257 germplasm accessions of fruit crops (apple, peach, pear and apricot) were evaluated for various agro-botanical characters.

At Jodhpur, in the kharif season, 3895 accessions of crops comprising castor (75), cowpea (369), *Cucumis* spp. (606), guar (1353), mothbean (513), mungbean (613), pearl millet (89), til (395) and tumba (82) were sown for characterisation, multiplication and rejuvenation. In addition, NATP material received was also sown for characterisation. In rabi, 521 accessions of *Triticum* spp. were sown for characterisation and multiplication. All the crops sown were screened for disease tolerance. Germplasm of 15,206 accessions of agricultural, horticultural and plants of economic importance were maintained.

At Hyderabad, 1103 accessions of different agri- horticultural crops comprising brinjal, chillies, blackgram, finger millet, maize, sorghum, tomato and other agri-horticultural crops and wild

species were sown/ maintained for evaluation/ rejuvenation/ multiplication.

At Akola, 7536 accessions were grown for regeneration and maintenance while 1921 accessions for evaluation and characterization. Promising accessions were identified for yield and other attributes.

At Bhowali, a total of 400 accessions of temperate and sub-tropical fruits were maintained in field genebank while 1147 accessions of various agricultural crops collected from Uttaranchal were grown for seed increase and characterisation.

At Cuttack, a set of 1760 accessions of cultivated rice were screened for submergence tolerance under natural conditions and the same accessions will be further screened under artificial condition. Out of 1760 accessions, 16 accessions were identified as promising for desirable attributes.

CONSERVATION OF GERmplasm

A total of 31,431 germplasm accessions of various crops were received for long-term conservation in the National Genebank. Of these 16,141 were processed and added to the base collection (at -20°C). Monitoring of stored germplasm (902 accessions), updating of passport data (8924 accessions) and identification of duplicates (2057) were carried out. Evaluation of viability and vigour under different storage conditions showed that ultra-dry seeds of neem retained over 80 per cent viability at different temperatures for a period of 48 months. Similarly, in chickpea, safflower, niger, groundnut, sesame and castor drying below 6 per cent moisture content prolonged longevity at ambient temperature. Various pre-treatments were worked out to enhance germination in species of medicinal plants viz., *Achyranthus*, *Costus*, *Randia*, *Mesua* and *Argemone*.

TISSUE CULTURE AND CRYOPRESERVATION

A total of 1196 accessions of different tuber and bulbous crops, spices, plantation and new industrial crops, fruits, medicinal, aromatic and rare/endangered plants were maintained *in vitro* and sub-cultured at regular intervals and conserved under culture room conditions as well as at low temperature. Attempts continued towards devising suitable plantlet regeneration and conservation protocols in different species. *In vitro* cultures of *Allium* sp., *Piper colubrinum* and *Simmondsia chinensis* were processed for cryopreservation whereas cryopreservation and subsequent plantlet regeneration was achieved in *Dioscorea floribunda* and *D. deltoidea*. Regarding studies on genetic stability, comparison of RAPD profiles between *in vivo*- and *in vitro*-conserved germplasm of *Curcuma* was done and no significant variation was observed between the two. A total of 4043 accessions of orthodox, intermediate and recalcitrant seed species was conserved in the cryobank.

DNA FINGERPRINTING

AFLP analysis of barley, pearl millet, *Sorghum*, pigeonpea, mungbean, soybean, safflower, cotton, chickpea, mango, cashew, citrus, neem, banana and vetiver was carried out. During the year, a total of 494 cultivars were fingerprinted in these crops. RAPD analysis was carried out on 17 pearl millet, 37 *Sorghum*, 31 pigeon pea, 37 chickpea, 34 chillies and 19 cashew cultivars and selected accessions.

OTHER ACTIVITIES

- Meetings of the Institute Management Committee, Research advisory Committee, Staff Research Council and Institute Joint Staff Council were held timely to review the progress of work related to PGR activities and planning strategies to strengthen various activities and infrastructure.
- The scientists, research associates and technical staff from the headquarters and regional stations participated in a number of international and national conferences, seminars, workshops, trainings and summer institutes related to PGR management.
- Several distinguished scientists, farmers, administrators, policy makers and students visited the National genebank, DNA Fingerprinting labs, plant quarantine glasshouses and tissue culture labs at Headquarters, New Delhi and field gene banks at Issapur, Akola, Bhowali, Ranchi, Shimla, Shillong and Thrissur.
- Four training programmes were organized on various aspects of PGR management including specialized training in DNA Fingerprinting. One national workshop at New Delhi and ten zonal workshops (one at each zonal coordinating centre under NATP-PB) were conducted to review the progress of work and finalize the technical programme. More than 1500 farmers/ grass root level workers participated in biodiversity fairs organized by ten zonal coordinating centers for creating PGR awareness.

INTRODUCTION

The National Bureau of Plant Genetic Resources, commonly known as NBPGR was established by the Indian Council of Agricultural Research (ICAR) in 1976 with its main campus at New Delhi. Being the nodal organization in India it has the national mandate to plan, conduct, promote and coordinate all activities concerning plant exploration and collections and also for safe conservation and distribution of both indigenous and introduced genetic variability in crop plants and their wild relatives. The Bureau is also vested with the authority to issue Import Permit and Phytosanitary Certificate and conduct quarantine checks on all seed materials and plant propagules (including transgenic material) introduced from abroad or exported for research purposes.

The Bureau has a network of 11 regional stations/base centers and an experimental farm at Issapur village (about 45 km west of Delhi) that provide access to representative agro-ecological situations in the country. It has strong linkages with leading crop-based Institutes, National Research Centers, All India Coordinated Crop Improvement Projects, State Agricultural Universities and other stakeholders. NBPGR also works in close collaboration with several international institutes/organizations through memoranda workplans developed under bilateral/multilateral agreements. The Bureau not only provides genetic resources to on-going crop improvement programmes to sustain continued advances in agricultural productivity and stabilize production, but also conserves them safely to meet needs of future generations.

Organizational set-up

The Director, NBPGR is overall in-charge of administration, research management and

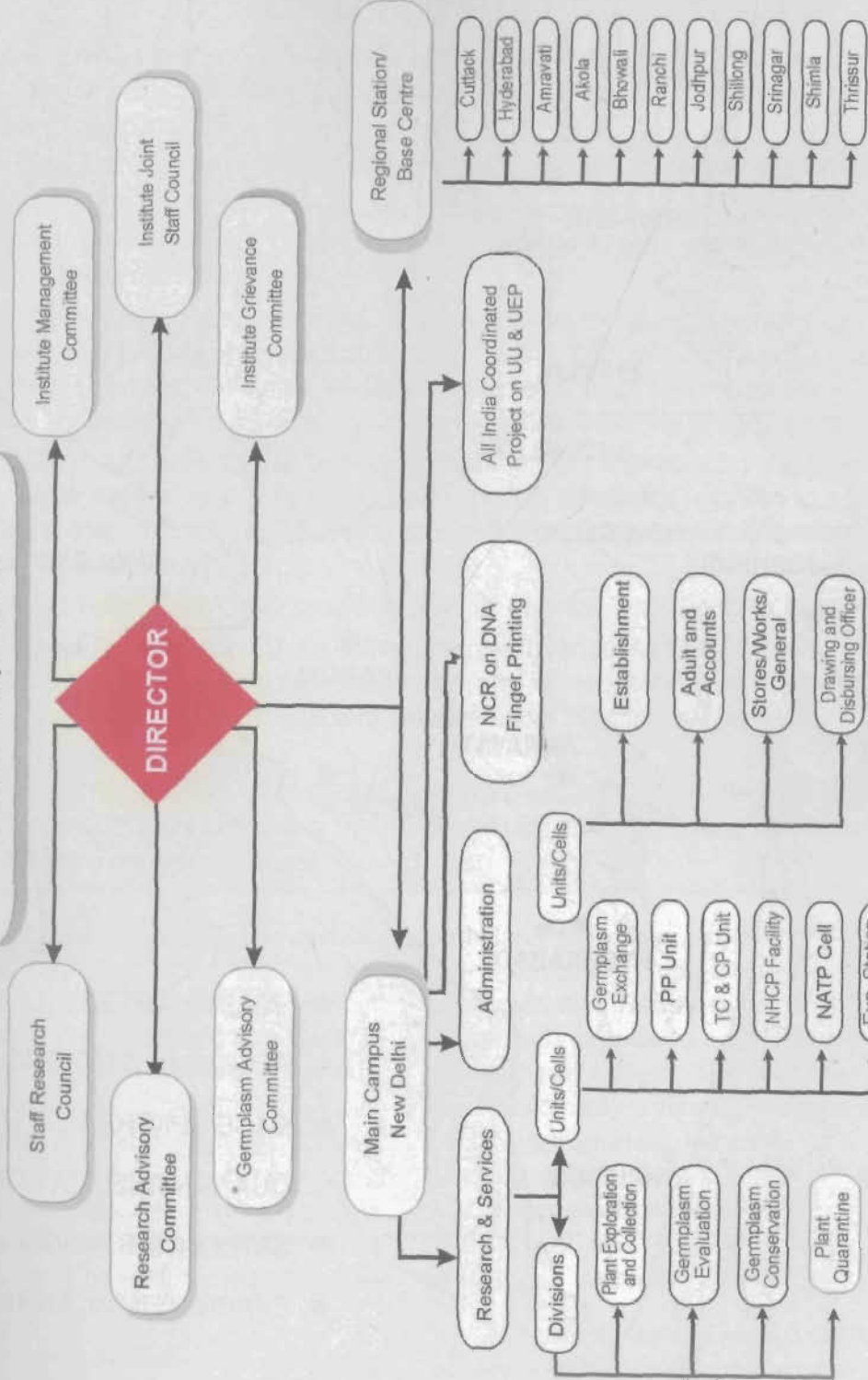
coordination. The Institute Management Committee, Research Advisory Committee and the Staff Research Council play important roles. The Bureau functions through its four main Divisions, namely i) Plant Exploration and Collection, ii) Plant Quarantine, iii) Germplasm Evaluation and iv) Germplasm Conservation. The Bureau has units of Germplasm Exchange, Tissue Culture and Cryopreservation (TC&CP), Agricultural Research Information System (ARIS) and Project Planning and Monitoring (PPM).

A Principal Scientist/Senior Scientist heads each Division/unit. Other centralized services include units of Administration & Management, Purchase, Stores & Maintenance, Audit & Accounts, Security and Library. Regional Stations/Base Centers, headed by a Principal Scientist/ Senior Scientist, are located at Shimla, Bhowali, Shillong, Jodhpur, Ranchi, Amravati, Hyderabad, Thrissur, Srinagar, Ranchi and Cuttack. It also houses NRC on DNA Fingerprinting, an All India Coordinated Research Project on under-utilized plants, National Agricultural Technology Project (Plant Biodiversity) and Household and Nutritional Food Security Project. The total sanctioned staff strength is 504 comprising 128 scientific, 127 technical, 78 administrative and 171 supporting staff.

National genebank

The Indian National Genebank was established by the council of NBPGR to conserve national heritage of germplasm collections in the form of seeds, vegetative propagules, tissue/cell cultures, embryos, gametes etc. Based on experiences gained from working with a built-in cold storage

**Indian Council of Agricultural Research
Division of Crop Sciences**





MANDATE

- To plan, conduct and coordinate plant explorations for collection of diversity in germplasm of cultivated plants, their wild relatives and naturally occurring species of economic importance.
- To undertake introduction and exchange of plant germplasm for research purposes.
- To examine seed and plant propagules under exchange for the presence of associated pests and pathogens and also to salvage healthy material from the infected/infested/contaminated samples.
- To undertake and promote characterization, evaluation and documentation of plant germplasm collections of agri-horticultural crops and their wild relatives. Develop and operate National Database for storage and retrieval of information on PGR, farmer's knowledge, innovations, practices and ethonobotanical knowledge.
- To undertake and promote conservation of plant genetic resources on a long-term basis employing *in vivo*, *in vitro* and cryopreservation techniques and also to assist *in situ* and on-farm conservation of land race diversity in collaboration with national/international organizations.
- To conduct basic research for providing a sound scientific back up to its services.
- To act as sole repository of all notified/released varieties/cultivars along with herbarium specimens and relevant information, also as repository of original/parental lines (material) of patented (protected) varieties under the joint seal (importer, PPA, NBPGR).
- To undertake teaching of plant genetic resources leading to M.Sc. degrees linked with PG School, IARI and also to organize suitable training programme at the national, regional and international levels.

vault obtained from UK in 1983, four modules (two units of 100 m³ and two of 176 m³ capacity) were installed for long-term storage of seeds of orthodox species kept in laminated aluminum foils at -20°C after drying them to 5% moisture content. Stand-by diesel generator backs up electric supply. Vegetatively propagated clonal materials and recalcitrant species are being maintained under field conditions backed up by tissue culture repositories. The Bureau has a strong programme on *in vitro* conservation and cryopreservation.

The new genebank facility commissioned in 1997 has 13 modules, each with a storage capacity of 76000 samples. One of these modules is used for medium term storage of active

germplasm collections and the rest for base collections under long-term storage. Its cryopreservation facility contains six liquid nitrogen tanks (cryo-tanks), each containing 1000 litres of liquid nitrogen. These six cryo-tanks have a total capacity to store 0.25 million samples. Thus the new genebank has a total capacity to store 1.25 million samples. This is one of the most modern genebanks in the world.

Indian national plant genetic resources system (INPGRS)

NBPGR is gradually developing and strengthening the national plant genetic resources system by linking up the National Base Collection (kept under long-term storage at NBPGR) with 40 National Active Germplasm Sites responsible for different

crops where germplasm collections are evaluated and multiplied under filed conditions, backed by medium-term storage facilities. The Research Advisory Committee and Germplasm Advisory Committee for different crops advise the Bureau regarding improving the capability, efficiency and effectiveness of its services.

International collaboration

NBPGR implements workplans developed under MoU between ICAR and IPGRI. FAO and IPGRI also sponsor regional training courses on conservation and utilization of genetic resources of local crops of agricultural importance in South Asia and adjoining regions to be conducted by NBPGR.

Besides working closely with IPGRI, NBPGR also collaborates actively with the International Agricultural Research Centers (IARCs) like ICRISAT, IRRI, ICARDA and CIMMYT. It exchanges plant germplasm with more than 80 countries and implements work plans developed under bilateral, regional and international agreements.

Training programmes and information services

The Bureau organizes advance training programmes focusing on scientific procedures for collecting, exchange, quarantine, biosafety, DNA Fingerprinting, evaluation, documentation and conservation linked to use of plant genetic

resources. Major accomplishments of its scientists are published in Annual Reports, NBPGR Newsletter and Plant Introduction Reporters are brought out quarterly. Crop Catalogues, based on computerized data, are also developed and published. Bureau's library at Headquarters specializes in information dealing with plant genetic resources and also subscribes to 50 foreign and 53 national journals.

Post-graduate teaching programme

Since academic session 1997, Bureau is undertaking teaching in Plant Genetic Resources leading to M.Sc. degree linked with Post Graduate School, IARI, New Delhi.

Extension services

Bureau organizes Kisan Diwas/field days for Rabi and Kharif crops and distributes seeds/planting material alongwith relevant literature on technical know-how for raising crops and management of PGR. Under the National Agriculture Technology Project- Plant Biodiversity (NATP-PB), special emphasis has been given to create PGR awareness among grass root level workers, tribal people, and farmers (particularly women) by organizing biodiversity fairs in villages. Students on educational tours from State Agricultural Universities are invited to visit national genebank, DNA Fingerprinting, tissue culture and quarantine labs, plant quarantine glass houses/ containment facilities at New Delhi.

1. DIVISION OF PLANT EXPLORATION AND COLLECTION

Summary: At the national level, 242 explorations were undertaken covering various regions in zone I to zone X under the NATP-PB project and 14803 collections were made comprising agrihorticultural crops and their wild relatives. Out of these, 11 explorations were made by the headquarter, New Delhi under zone VII covering parts of Haryana, UP, MP, Punjab and Rajasthan and 444 collections were made. Special efforts were made to collect endangered medicinal and aromatic plants from Panwali, Bughal, Tehri Garhwal. Under germplasm rescue mission, 12 explorations were undertaken in Sardar Sarovar dam catchment areas in MP, Gujarat and Maharashtra and 2118 collections were made with some rare collections of medicinal plants, landraces of paddy, sorghum and mothbean. 704 herbarium specimens, 200 seed samples and 22 economic products were added to national herbarium of cultivated plants (NHCP). A checklist of scientific names including 477 names of cultivated plants was prepared for publication.

1.1 Exploration and collection of germplasm

Exploration and collection of germplasm material of crops and their wild relatives, particularly from unexplored areas is one of the major activities of NATP-PB project. A total of 14,803 accessions

of different agri-horticultural crops (11309) and their wild types (3,494) were collected. The zone-wise details of the collected germplasm is given as below:

Eleven multi-crop and crop specific explorations were undertaken from Headquarters

Table 1: Explorations undertaken and germplasm collected by various zones

Zone	Region	Explorations undertaken	Accessions collected
I	Arid region	39	1078
II	South west coastal region	39	1426
III	Humid/ moist tropical east coastal region	13	580
IV	North-eastern hill region	19	2034
V	Central Himalayan region	9	1103
VI	North-west Himalayan & high altitude region	16	1120
VII	North-west plains	47	2441
VIII	Sub-tropical/sub-humid region	16	1276
IX	Central Indian region	11	247
X	South-east coastal region	21	1380
	Special Exploration Mission in Sardar Sarover Dam area	12	2118
TOTAL		242	14803

during this period to the parts of Haryana, Uttar Pradesh, Madhya Pradesh, Punjab and Rajasthan and a total of 444 collections of different agri-horticultural crops were made. Diversity in cultivated (323) and wild types (121) included

cereals (119), vegetables (39), millets and minor millets (35), pulses (37), oilseeds (111), horticulture and fruit crops (62), medicinal and aromatic plants, spices and condiments (29) and other crops (12). Crop diversity explored and

collected during the explorations undertaken is briefly described as follows.

1.1.1 Collection of M&AP, oilseeds, pulses and vegetables from Haryana and Rajasthan:

A total of 31 accessions comprising *Cichorium intybus* (kasni 29), castor (1) and *Allium* (1) were collected from Gurgaon, Rewari, Jhajjar districts of Haryana and Alwar district of Rajasthan. Nine accessions comprising mustard (4), toria (2), taramira (1), wild pea (1) and wild lentil (1) were collected from parts of Haryana and Rajasthan. The tall, bushy and spreading types in *Cichorium intybus* having fodder and medicinal value were collected from Haryana.

1.1.2 Collection of cereals, millets, vegetables, pulses, fodder crops from Punjab, Haryana and Rajasthan:

A total of 31 accessions comprising of *Sorghum* (2), pearl millet (2), spongegourd (3), okra (3), bottlegourd (3), bittergourd (1), ridgedgourd (3), chilli (1), snapmelon (11), clusterbean (1) and cowpea (1) were collected from Amritsar, Ferozpur, Faridkot, Muksar districts of Punjab; Sirsa, Hissar, Mahendergarh districts of Haryana and Churu district of Rajasthan.

Seven accessions of *Cichorium intybus* (kasni 2) and chickpea (5) were collected from Mahuwa, Hindaun City, Rajasthan. A total of 16 accessions comprising wheat (1), maize (6), pearl millet (1), chickpea (1), wild sunflower (1), yellow mustard (1), ber (1), siris (1), amaranthus (1), *Dioscorea deltoidea* (1) and colocynth (1) were collected from Dausa, Karoli, Bharatpur, Sikar and Jaipur districts of Rajasthan.

1.1.3 Collection of millets, cereals, oilseeds, vegetables, fibre and pulses:

A total of 157 accessions comprising rice (108), bottlegourd (1), kenaf (1) kodomillet (8), foxtailmillet (7), wheat (2), oat (1), bajra (1), mustard (2), urad (1), guar (1), *Lentil* (1), arhar (2), carrot (1), bittergourd (1), lauki (1), daincha (1), barnyardmillet (8), finger millet (6), and pea (3)

were collected from Ghaziabad, Meerut, Bagpat, Muradabad, Rampur, Bareilly, Hardaoi, Sitapur, Lakhimpur, Pilibhit, Badayun, Bulandsher districts of Uttar Pradesh.

1.1.4 Collection of oilseeds, pulses from Haryana, Rajasthan, Madhya Pradesh:

A total of 132 accessions comprising mustard (91), taramira (5), soybean (2), castor (1), chickpea (8), lentil (5), pea (3), pigeon pea (1), beans (1), *Vicia faba* (2), chilli (3), toria (2), water melon (1), coriander (1), okra (1), *Hibiscus* sp. (1), tobacco (1), tendu (1), *Vitex nigundo* (1) and *Acacia catechu* (1) were collected from Haryana and Alwar, Bharatpur, Dausa, Karoli, Swaimadhapur, Dholpur districts of Rajasthan and Morena, Etawa, Sheopur, Shivpuri, Datia, Gwalior and Bhind districts of Madhya Pradesh.

1.1.5 Collection of medicinal and aromatic plants from Chitrakoot hills and south eastern of Uttar Pradesh:

A total of 66 accessions of medicinal and aromatic plants were collected belonging to different genera and species. The plants were collected from sandy, mountainous and near the river tributaries. The species were mostly root and tuber bearing plants of medicinal value.

Different species of *Chlorophytum*, *Curculigo* (kali musali) particularly, *Chlorophytum aurandinaceum* (safed musali), rare medicinal plants were collected from Godawari hills of Chitrakoot area. The important collection represented the root and plant material is of a rare, parasitic plant, *Alactra parasitica* var. *chitrakootensis* which grows on the root of *Vitex nigundo* (Nirgundimul). It is highly priced and rare medicinal plant in good demand.

1.1.6 Collection of threatened and endangered medicinal and aromatic plants from Tehri district of Uttaranchal:

A total of 47 accessions

of threatened and endangered medicinal and aromatic plant species were collected from Panwali Bugyal (alpine meadow) located at an altitude of 3600 m above msl. Some of the important endangered species collected were *Aconitum balfourii*, *A. heterophyllum*, *Podophyllum hexandrum*, *Nardostachys grandiflora*, *Picrorhiza kurrooa*, *Orchis latifolia*, *Polygonatum verticillatum*, *Angelica glauca*, *Bergenia strecheyii*, *Skimmia laureola* etc. The population of these species is degrading at faster rate from their natural habitat because of their high demand in pharmaceutical industries.

1.1.7 Collection of vegetables and wild relatives from Chinnar Wild Life sanctuary: A total of 115 germplasm accessions belonging to 21 species of cowpea, chillies and beans were collected. In brinjal and tomato, distinct types and forms and *Abelmoschus angulosus* ssp. *purpurens*, *Mangifera indica* (truly wild), *Brachystema swarupa* and wild edible tuber were collected.

1.1.8 Collection of medicinal and aromatic plants from Jharkhand and West Bengal: A total of 36 accessions comprising *Asparagus racemosus* (4), *Curculigo orchioides* (4), *Costus speciosus* (white-1), *Costus speciosus* (red-3), *Curcuma aromatica* (4), *Urginea indica* (2), *Hemidesmus indicus* (narrow leaf - 2), *Hemidesmus indicus* (broad leaf 1), *Dioscorea* sp. (2), *Smilax macrophylla* (2), *Andrographis paniculata* (2), *Gardenia turgida* (1), *Catharanthus roseus* (white-1), *Catharanthus roseus* (pink 1), *Gymnema sylvestre* (1), *Vitis* sp. (1), *Abroma angusta* (1), *Leucus aspera* (1), *Ocimum* sp. (2) were collected from east Singhbhum, west Singhbhum districts of Jharkhand and Bankura, Midnapore, Purulia district of West Bengal.

Among the collected species *Curculigo orchioides*, *Asparagus racemosus* and *Dioscorea*

sp. were the most frequently available species recorded from the area.

1.1.9 Collection of vegetable and fruit germplasm from Uttar Pradesh, Kumaon and adjoining Garhwal Hills, Uttaranchal, and Madhya Pradesh: A total of 190 accessions of vegetables were collected from parts of Nainital, Almora and Pauri in Kumaon and Garhwal hills, Uttaranchal. In chironjii (61) were collected from Jhansi, Lalitpur district of Uttar Pradesh, Panna, Mandla, Satna, Pachmari, Sagar, Tikamgarh districts of Madhya Pradesh.

Diversity observed in pumpkin (*Cucurbita moschata* and *C. pepo*), bottlegourd (*Lagenaria siceraria*), ridgedgourd (*Luffa acutangula*), bittergourd (*Momordica charantia*), cucumber (*Cucumis sativus*) was mainly for fruit size, shape, colour and weight. Good variability in other crops such as garlic, spinach, meetha karela, fenugreek, Chinese cabbage, chilli, snakegourd, onion and lablab bean was also observed. Considerable diversity was collected in soybean (locally called bhat), horsegram, cowpea, ricebean, blackgram and pegionpea for seed shape, size and colour. Reduced cultivation of *Perilla frutescense* was observed in the area of collection.

1.1.10 Collection of *Vigna* spp. and *Sesamum* and their wild relatives from Uttaranchal, Himachal Pradesh, Orissa, Chattishgarh, Madhya Pradesh, Tamil Nadu and Kerala: A total of 63 accessions mainly wild species comprising of *Cucumis* spp. (13), *Vigna* spp. (34), *Sesamum* spp. (7), *Atylosia* sp. (1), *Abelmoschus* sp. (5) and *Solanum* sp. (3) were collected from Uttaranchal, parts of Himachal Pradesh, Amarkantak, Jabalpur, Chhindwara, Hoshangabad, Bhopal districts of Madhya Pradesh, Cuttack, Bhubaneshwar, Puri, Berhampur, Rayagada, Koraput, Malkangir districts of Orissa and Jagdalpur, Bastar, Raipur, Bilaspur districts of Chattishgarh.

Important wild relatives represented from diverse habitats were *Cucumis hardwickii*, *Vigna trilobata*, *V. hainiana*, *V. vexillata*, *V. umbellata*, *V. radiata* var. *sublobata*, *V. radiata* var. *setulosa*, *V. delizilliana*, *Abelmoschus manihot* ssp. *tetraphyllus*, *A. ficulneus*, *Solanum indicum*, *Solanum khasianum* and *Sesamum mulayanum*. Important landraces of *Vigna unguiculata*, *V. mungo* and natural hybrid of *Cucumis sativus* and *C. hardwickii* were also collected.

Besides *Vigna trilobata* (4) and *Citrullus colocynthis* (4) were collected from Kanyakumari district of Tamil Nadu, Trivandrum and Alapuzha districts of Kerala.

1.1.11 Rescue collecting in Sardar Sarovar and adjoining catchment areas in the states of Gujarat, Madhya Pradesh and Maharashtra: Due to construction of Sardar Sarovar dam on Narmada river, a large area will be submerged leading to 245 villages inundated partially or fully. An alarming situation due to backwater will affect large catchment areas covering three major rivers and many tributaries in Maharashtra, Madhya Pradesh and Gujarat. Due to an adverse affect on the plant resources in these areas there is fear of genetic erosion. During November-December 2001, 12 exploration trips were conducted and a total of 2118 germplasm lines in different crops were collected under mission mode program (Table 2). The germplasm includes landraces, local varieties and drought tolerant material in different agricultural and horticultural crops.

These 2118 accessions included cereals and pseudo-cereals (348), millets (295), pulses (356), oilseeds (113), vegetables (466), medicinal & aromatic plants (227), spices and condiments (8), and others (232).

The germplasm was collected from farms, farm stores, garden, wild habitats and forest areas. The root and tuber bearing plants of medicinal value namely, *Chlorophytum* (Safed

Musali), *Curculigo* (Kali Musali), *Hemidesmus* (Annantmoll) collected are of rare in nature. Collection includes small fruit size of pumpkin having pink skin colour and early type of urdbean. Some of the interesting variability observed was in paddy for rarely cultivated local landrace Shal, Kaldhan, Bhaduri (dwarf type), Bakhia (Scented, tall type), white seeded Sathee makki (matures in 60 days), reddish grain type Tigarya local land race in wheat, Bhaduri-early type, Dhani jowar-tall type, Kantodi primitive cultivar in sorghum, small grain type in pearl millet, minor millets like kodomillet, little millet and foxtail millet, reddish tinged grain type in barnyard millet, Mungthee landrace with small grain type in mothbean and bold seeded mungbean.

A wide range of variability was observed for various agro-morphological and economic characters including tolerance to biotic factors in amaranthus, bottlegourd, chickpea, chilli, jowar, maize, mungbean, pigeonpea, pumpkin, smooth gourd, soybean, rice and sesame,

The adjoining parts of hilly tract forest area are rich in economic plant wealth due to unique climatic conditions. The hilly tracts of forests were rich in root and tuber bearing medicinal plants. The area explored was also rich in aromatic plant diversity like, *Ocimum*, *Hemidesmus*, *Centella* etc. Crops like, paddy, maize, jowar, pigeonpea, urdbean, cotton were in general cultivation. The land races of these crops were available in remote areas.

During exploration trip, it was observed that due to declaration of submergence areas in and around Indira Sagar Dam, about 50-60 per cent population of the region is about to migrate to other localities from their established settlements. The farmers of entire region were generally growing improved varieties crop like cotton, pigeonpea, paddy, wheat etc. Under rainfed conditions, however a few farmers having large holdings were growing some of the landraces in

Table 2: Germplasm collections from Sardar Sarovar Dam and adjoining catchment areas

Major area	Sub-Team and Areas covered	Total collections made
South-west of Sardar Sarovar Dam	Areas in Gujarat state situated South of Narmada river	220
	Nandurbar district in Maharashtra situated South of Narmada river	426
	Dhule district in Maharashtra situated South of Narmada river	188
North-east of Sardar Sarovar Dam	Indore and Dhar districts in Maharashtra North of Narmada river	165
	Dhar district in Madhya Pradesh situated North of Narmada river	110
South-east of Sardar Sarovar Dam	Jhabua district in Madhya Pradesh situated North of Narmada river	90
	Parts of West Nimar - Barwani Dist. in M P situated South of Narmada river	177
	Parts of West Nimar-Khargon District in M P situated South of Narmada river	162
	Parts of East Nimar- Khandwa Dist., of M P situated South of Narmada river	100
North-west of Sardar Sarovar Dam	Narmada and Vadodara districts in Gujarat situated Right Bank of Narmada river	127
	Narmada districts in Gujarat situated Left bank of Narmada river	306
	Remaining parts of Narmada and Vadodara districts in Gujarat situated North of Narmada river	47
	Total collections	2118

millet, minor millets and pulses for their own consumption.

1.2 National Herbarium of Cultivated Plants (NHCP)

A total of 926 samples were processed and included in the herbarium after authentication and indexing. These included 704 herbarium specimens, 200 seed samples and 22 economic products. The herbarium holdings amounted to 14, 673 herbarium specimens. These were representative of 3,083 species belonging to 1,216 genera and 227 families. Some important additions are listed in the table below.

During the year, major collections added were of cultivated and wild cucurbits from parts of Madhya Pradesh and Uttar Pradesh, peas from Haryana, spices from Kerala, legumes from Andhra Pradesh, chillies from Punjab and several species from the Valley of flowers in Uttar

Pradesh, Maharashtra, Tamil Nadu and Kerala.

Taxonomic and variability studies were taken up on *Crotalaria juncea*, *Plumbago zeylanica*, *Enicorstemma littorale*, *Galium aparine* and *Crescentia cujete* from Delhi and Uttar Pradesh. Crop plants of India- a check-list of scientific names including 477 cultivated plant species was finalised and sent for publication.



Mucuna nigricans collected from Narmada Nagar forest area in Khandwa, M P



Watery rose apple, *Syzygium roseum*



Elacocarpus macrocesus

Additions of some new taxa to the NHCP

Family	Species
Anacardiaceae	<i>Pistacia integerrima</i> Stew
Apiaceae	<i>Bupleurum lanceolatum</i> Wall.
Asteraceae	<i>Inula grandiflora</i> Willd.
Asteraceae	<i>Saussurea obvallata</i> Wall. ex C. B. Clarke
Berberidaceae	<i>Berberis osmastonii</i> Dunn.
Cornaceae	<i>Cornus oblonga</i> Wall.
Ericaceae	<i>Rhododendron campanulatum</i> D. Don
Lamiaceae	<i>Coleus amboinicus</i> Lour.
Lauraceae	<i>Cinnamomum pauciflorum</i> Nees
Lauraceae	<i>Cinnamomum malabathrum</i> Batka
Myrtaceae	<i>Syzygium aromaticum</i> L.
Myrtaceae	<i>Syzygium stocksii</i> Gamble
Piperaceae	<i>Piper mullesua</i> D. Don
Rosaceae	<i>Pyrus microphylla</i> Wall.
Tiliaceae	<i>Grewia gamblei</i> Drum.
Zingiberaceae	<i>Curcuma pseudomontana</i> Grah.
Zingiberaceae	<i>Zingiber macrostachyum</i> Dalz.
Fabaceae	<i>Cajanus albicans</i> (W. and A.) Van der Maesen
Fabaceae	<i>Rhynchosia heynei</i> W. and A.
Lauraceae	<i>Cinnamomum travancoricum</i> Gamble
Lauraceae	<i>Cinnamomum sulphuratum</i> Nees
Piperaceae	<i>Piper trichostachyon</i> Miq.
Rosaceae	<i>Fragaria daltoniana</i> J. Gay
Zingiberaceae	<i>Curcuma leucorrhiza</i> Roxb.
Zingiberaceae	<i>Curcuma kannanorensis</i> Ansari and Nair

Research Projects (Project Leader; Associates)

- 1 Exploration for the collection of agri-horticultural crops, maintenance of herbarium, biosystematics and ethnobotanical studies (S. S. Malik; Umesh Srivastava, E. Roshini Nayar, Anjula Pandey, K. C. Bhatt).
 - 1.1 Exploration for the collection of genetic resources of cultivated crops and their wild relatives (S. S. Malik; Umesh Srivastava).
 - 1.2 Analysis of genetic diversity and elucidation of species relationships in *Cucumis* species complex using morphological, biochemical and molecular markers to relate with collection and conservation strategies (Umesh Srivastava; Gunjit Kumar).
 - 1.3 Exploration for the collection of medicinal and aromatic plant diversity from different phytogeographical regions (K. C. Bhatt; N. Dixit, D. R. Pani).
 - 1.4 National Herbarium of Cultivated Plants (NHCP); Establishment, maintenance, build-up and taxonomic studies on crop plants (E. Roshini Nayar; Anjula Pandey).

2. DIVISION OF GERMPLASM EVALUATION

Summary: A total of 11281 accessions of various agri-horticultural crops viz.; cereals (6159), legumes (1792), oil seeds (668), vegetables (1726), medicinal and aromatic plants (399) and under utilized crops (356) were grown for characterization, evaluation, regeneration, multiplication and maintenance. One hundred and eighty one horticultural crops were also maintained in the field genebank. Promising accessions for various agro-morphological characters were identified. Two accessions of pea namely NBP-1 and NBP-2 have been promoted to AVT of AICRP on MULLaRP crops. Evaluation for quality attributes/value added traits also resulted in identification of promising accessions. Phytochemical study of various M&AP has also been undertaken. The minimal descriptors lists for characterization and evaluation of vegetable crops was developed and brought out in book form. A total of 9538 seed samples were supplied to different institutes for use in crop improvement programmes through germplasm exchange unit.

2.1 Evaluation for agromorphological traits

A total of 11281 accessions of various agrihorticultural crops (Table 1) were sown in the field at NBPGR Experimental Station, Issapur and in PEQ area at headquarters. Germplasm accessions of different crops were raised in single to three observation rows in an augmented block design alongwith suitable checks. The data were recorded on a set of descriptors for characterization and preliminary evaluation.

Promising accessions identified in different crops: The promising accessions for various attributes viz., earliness, pod length, high seeds per pod and high yield potential etc. were identified (Table 2).

Promising germplasm included in varietal trials of AICRP: Two promising accessions of pea germplasm namely NBP-1 (NWP,CZ) and NBP-2 (CZ) have been promoted to AVT-1(dwarf) of AICRP on MULLaRP crops.

2.2 Maintenance and evaluation of core collection

The core sets of mungbean and sesame were extensively evaluated for biotic stresses/quality/agronomic traits and parental lines with specific traits were identified for use in intercrossing.

2.3 Genetic enhancement in sesame

More than 120 selected progenies of 12 crosses

have been advanced up to F4 generation and 57 promising selections were tested at four locations, namely Delhi, Issapur (Delhi), Dharwad and Amravati. Selected F3 bulks of 12 crosses of sesame were grown at NBPGR Regional Station, Cuttack in rice fallows during spring-summer 2001. Selection of superior plant progenies was done for further advancement and testing under multilocation trials.

2.4 Genetic enhancement in mungbean

Fifty nine selected F3/F4 progenies were tested at four locations, namely Delhi, Issapur (Delhi), Dharwad and Amravati. A trial of selected diverse parental lines and crossed progenies of mungbean was grown at NBPGR Regional Station, Cuttack in rice fallows during spring-summer 2001. Selection of superior plant progenies was done for further advancement and testing under multilocation trials

2.5 Maintenance of wild species germplasm and its use in interspecific hybridization

The wild species germplasm of *Sesamum* and *Vigna* collected during 1999 and 2000 and maintained at NBPGR Regional station Thrissur, UAS Dharwad and Delhi is also being used in interspecific hybridisation.

Table 1. Germplasm evaluated/ maintained during 2001

Botanical name	No. of accessions	
	Evaluated	Regenerated / Maintained
<i>Triticum aestivum</i>	3441	147
<i>Hordeum vulgare</i>	1567	151
Triticale	49	-
<i>Secale cereal</i>	4	-
<i>Zea mays</i>	800	-
<i>Vigna unguiculata</i>	252	120
<i>Vigna mungo</i>	370	-
<i>Pisum sativum</i>	210	600
<i>Lens culinaris</i>	196	44
<i>Brassica</i> spp.	640	28
<i>Solanum melongena</i>	200	-
<i>Lycopersicon esculentum</i>	-	579
<i>Allium cepa</i>	71	-
<i>Allium sativum</i>	645	-
<i>Beta vulgaris</i>	-	30
<i>Lagenaria siceraria</i>	-	6
<i>Brassica chinensis</i>	-	8
<i>Coriandrum sativum</i>	-	46
<i>Luffa acutangula</i>	-	108
<i>L. cylindrica</i>	-	21
<i>Cucurbita moschata</i>	-	5
<i>Momordica charantia</i>	-	5
<i>Cucumis melo</i> var. <i>momordica</i>	-	1
<i>Praecitrullus vulgaris</i>	-	1
<i>Punica granatum</i>	-	49
<i>Citrus</i> spp.	-	17
<i>Psidium</i> spp.	-	14
<i>Morus</i> spp.	-	4
<i>Emblica officinalis</i>	-	4
<i>Carissa</i> spp.	-	3
<i>Cordia myxa</i>	-	1
<i>Pyrus</i> spp.	-	12
<i>Prunus</i> spp.	-	5
<i>Aegle marmelos</i>	-	10
<i>Mangifera indica</i>	-	3
<i>Zizyphus</i> spp.	-	11
<i>Malus</i> spp.	-	2
<i>Gladiolus hybrida</i>	-	40
<i>Dandrathena grandiflora</i>	-	6
<i>Vetiveria zizanioides</i>	-	130
<i>Cymbopogon martinii</i> var. <i>motia</i>	-	55
<i>Cymbopogon flexuosus</i>	-	3
<i>Aloe barbadense</i>	-	50
<i>Andrographis paniculata</i>	15	-
<i>Urginia indica</i>	-	22
<i>Tinospora cordifolia</i>	-	30
<i>Ocimum basilicum</i>	25	-
<i>Psoralea corylifolia</i>	10	-
<i>Mucuna pruriens</i>	21	-
<i>Withania somnifera</i>	-	4
<i>Asparagus racemosus</i>	-	5
<i>Acorus calamus</i>	-	15
<i>Chlorophytum borivillianum</i>	-	2
<i>Curculigo orchioides</i>	-	4
<i>Tecomella undulata</i>	-	1
<i>Mimosa pudica</i>	-	1
<i>Cissus quadrangularis</i>	-	2
<i>Centella asiatica</i>	-	2
<i>Piper longum</i>	-	2
<i>Vicia faba</i>	170	-
<i>Amaranthus</i> spp.	-	15
<i>Vigna umbellata</i>	-	56
<i>Sesbania</i> spp.	100	-
<i>Crotalaria juncea</i>	15	-

Table 2. Promising accessions for different traits identified during 2001

Crop	Accession Number	Promising Traits
Cowpea	IC 276938	Early maturity (70 days)
	IC 219871, IC 259105, IC 287428,	Pods per plant (75)
	IC 253271	Pod Length (>43cm)
	EC 20584, IC 58905	Seeds per pod (>8)
Urd	IPU 99-237, A-C1	Early maturity (>80 days)
	IPU99-237,A-C2	Pod per plant (>80)
	TV99-293,STY-2801	Pod length (<5.3cm)
	A-C1,IPU99-89	Seeds per pod (>8)
Lentil	IC 267114,IC267089,IC267090	Days to 50% flowering (<58days)
	IC267130, IC248957	Pods per plant (>200)
Pea	IC26767	Day to 50% flowering (58days)
	IC 267587	No. of pods/plant (187)
	IC 267144, IC267135	Pod length (>9 cm)
	IC 287153, IC267142	First pod picking (<90days)
	IC 267155, IC267127	100 seed weight (>35g)
Fababean	EC 117753, EC 329654,	No. of pods per plant (>140)
	IC 867639	
	EC 32649, EC 107220, EC 32604,	Plant height (>100cm)
	EC 354984	
Brinjal	EC 384565,EC 379246, IC 90806,	High fruit yield
	IC 90031, IC136287	
	IC 90922, IC 90047, IC 90970,	Field resistance to <i>Phomopsis</i> blight
	EC 384565	
Ridgegourd	IC 21331, EC 284339	Long and straight fruit
	EC 284339, IC 92618	High yielding
Spongegourd	IC 92624, IC 92704, IC 92741,	High yielding
	IC 276391,IC 276523	

2.6 Evaluation for quality/ value added traits

Total oil and erucic acid content of crucifer species: Total one hundred and fifty *Brassica* collections consisting of *Brassica juncea* (53), *B.napus* (7) *B.campestris* var. yellow sarson (26), *B.campestris* var. toria (12), *B. campestris* var. brown sarson (7), *B.carinata* (5), *B.nigra* (2), *B.juncea* ssp *rugosa*, (22), *B.chinensis* (1), *B.rapa* (13), *Sinapsis alba* (1) and *B.tournefortii* (1) were analysed to establish their total oil and erucic acid content (Table 3). Promising accessions containing low erucic acid content were identified (Table 4)

NBPGR, New Delhi were studied for their protein content (%N X 6.25). Protein content of the

collections varied with in the range of 21.9-29.2%. Promising accessions identified with more than 27% protein were: IC 201674 (29.2%), IC 201751 (28.6%), IC 208354 (27.4%), IC 208326 (27.7%), IC 208329 (27.0%), IC 208330 (27.3%).

Protein content of Pigeonpea germplasm: Nine pigeonpea germplasm collections maintained at Cuttack, Regional station of NBPGR were studied for their protein content (% N X 6.25). Protein content of the collections varied within the range of 18.3-23.4% and IC 259944 was found to be promising with 23.44% protein content.

Protein content of Lentil germplasm: One hundred and fifty eight lentil germplasm

Table 3 : Total oil and Erucic acid content in different crucifers

Crucifer Species (No. of accessions)	Oil (%)		Erucic Acid (%)	
	Range	Mean	Range	Mean
<i>B.juncea</i> (53)	32.1-47.4	39.2	22.8-50.0	43.8
<i>B.napus</i> (7)	42.3-46.5	44.2	1.01-42.5	11.9
<i>B.campestris</i> var. yellow sarson (26)	41.5-47.8	45.4	46.3-56.2	51.6
<i>B.campestris</i> var. toria (12)	41.7-46.9	44.0	44.3-50.6	46.1
<i>B.campestris</i> var. brown sarson (7)	41.7-46.9	44.2	26.6-48.8	43.9
<i>B.nigra</i> (2)	31.0-47.4	39.2	37.0-46.6	41.8
<i>B.carinata</i> (5)	32.6-38.0	36.1	37.2-48.8	42.1
<i>B. tournefortii</i> (1)	-	31.9	-	49.6
<i>Sinapis alba</i> (1)	-	40.9	-	45.9
<i>B. chinensis</i> (1)	-	44.9	-	38.0
<i>B.juncea</i> ssp <i>rugosa</i> (22)	38.2-43.5	40.4	41.5-51.6	47.8
<i>B.rapa</i> (13)	40.2-44.9	42.5	21.1-48.6	43.0

Table 4 : Promising accessions containing low erucic acid (<40%) content

Collection	Species	Erucic Acid content (%)
EC 400056	<i>B.campestris</i> var. brown sarson	26.6
EC 367885	<i>B.juncea</i>	33.6
EC 399291	<i>B.juncea</i>	25.3
EC 386794	<i>B.juncea</i>	22.8
IC 94448	<i>B.juncea</i>	37.6
EC 400805	<i>B.rapa</i>	21.1
EC 400806	<i>B.rapa</i>	24.0
EC 401469	<i>B.chinensis</i>	38.0
IC 241659	<i>B.carinata</i>	37.0
EC 302448	<i>B.napus</i>	20.5
EC 386738	<i>B.napus</i>	4.1
EC 399915	<i>B.napus</i>	1.0
EC 399918	<i>B.napus</i>	3.6
EC 399916	<i>B.napus</i>	7.4
EC 366271	<i>B.napus</i>	3.7
EC 400054	<i>B.nigra</i>	37.0

collections maintained at Evaluation Division of **Protein content of Cowpea germplasm:** Fifty four cowpea germplasm collections grown at Issapur of NBPGR, New Delhi were analysed to establish their total protein concentration (%N X 6.25). Protein content of the collections varied within the range of 23.20-27.74%. Following promising accessions with more than 27% protein were identified: JJK-01/46 (27.74%), JJK-01/86 (27.65%), JJK 01/15 (27.61%).

Protein content of Pea germplasm: Sixty-three pea germplasm collections grown at Issapur farm

of NBPGR, New Delhi were analysed for total protein concentration. Protein content of the collections varied within the range of 18.9-29.4% and 25.3% being the mean value. Promising collections (EC 381866 and EC 398598) with more than 27% protein in the seed were identified.

Oil and protein concentrations of wild Horsegram (IC-212722) germplasm collection: Protein and oil content were established for the seeds of the wild horsegram belonging to new species of *Macrotyloma sar-garhwalensis*. Seed contains 38.37±1.03%

crude protein. More than 95% of the total nitrogen belongs to protein nitrogen. Contribution of albumin-globulin, glutelin and residual protein fraction to the total seed protein amounts to 75.27%, 17.52% and 7.19% respectively. Combine albumin globulin protein (Lowry's protein) fraction of the wild horsegram seed protein contains 16.82% nitrogen in comparison to 18.10%, 15.82%, 16.81% and 16.42% nitrogen found present in similar part of the three cultivated lines (SK-2001, VLG-1, Raipur Local) and standard protein respectively studied under similar condition. True seed protein content of 34.88% in the wild horsegram line was about two times higher than the other horsegram lines.

This wild horsegram collection also contains $10.85 \pm 0.16\%$ ether extracted materials in

comparison to 0.80-1.47% materials found in other control lines.

Analysis of Chilli germplasm: Twenty nine chilli germplasm collections received from Assam University, Silchur, were analysed for their oleoresin and capsaicin concentration. Range of variation for above mentioned traits and their mean value is given below:

Trait	Range	Mean
Oleoresin (%)	5.2-20.1	10.0
Capsaicin (%)	0.11-0.70	0.35

Two hundred and forty chilli collections grown at Bhowali Regional Station of NBPGR were analysed for quality traits. Range of variation of the attributes and their promising lines for various traits is given below: (Table 5)

Table 5 : Promising accessions identified for various traits in chilli

Trait	Range	Promising Line
Colour value	1116-11,827	P-1718 (11,827)
Oleoresin (%)	9.9-26.5	MN-57 (26.5), N-1615 (24.5), NIC 20893 (25.4)
Capsaicin (%)	0.141-1.360	NIC 19943 (1.36), EC 382081 (1.16), EC 388996 (0.957)
Seed (%) of the fruit	15.4-70.0	IC 119232 (15.4), EC 388994 (16.24), EC 345641 (21.53)
Seed Oil (%)	14.0-35.0	NIC 23788 (35.0), P1258 (32.08), EC 43739 (31.09)

2.7 Phytochemical evaluation of medicinal and aromatic plants

Aromatic plants: The aromatic plants received from Experimental Station, Issapur and collected during explorations were analysed for their active constituents. (Table 6)

Some of the accessions namely IC 319688 (0.41%), IC 319701 (0.37%) and IC 319704 (0.46%) in *Alpinia galanga* and IC 319746 (0.95%), IC 319759 (1.02%) and IC 319760 (1.02%) in *Curcuma caesia* were found promising for essential oil content.

Five samples of *Mentha arvensis* var. kosi received from IARI were analysed for their physico-chemical constants viz. specific

gravity (range 0.8207 to 0.8929), optical rotation (range -34.75° to -36.12°) and refractive index (range 1.4520 to 1.4530). All the oils were found to be soluble in 2 volumes of 70% ethyl alcohol.

Thirteen samples of essential oils viz. *Artemisia annua*, *Artemisia nilagirica*, *Cymbopogon flexuosus*, *Lavandula officinalis*, *Thuja orientalis*, *Hedychium spicatum*, *Valeriana jatamansi*, *A Citrus aurantium*, *Citrus jambhiri*, *Juniperus communi*, *Pinus roxburghii*, *Cedrus deodara*, *Pistacia integerrima* and 4 samples of *Pelargonium graveolens* received from Bhowali Regional Station were analysed for their aroma constituents over GLC.

Medicinal Plants: Medicinal plants analysed for

their active constituents are given below (Table-7)

Development of calibration curve on HPLC:

An active constituent (Diosgenin) of anti-fertility drug was isolated and purified from *Costus* sp. The melting point of this compound was recorded as 208-209° C, which was in confirmation with reported literature. Further confirmation of the compound – Diosgenin is being done by IR and NMR techniques. A standard curve has been developed on HPLC for analyzing the plant samples containing diosgenin e.g. *Smilax macrophylla*, *Helicteres isora* and *Costus speciosus*.

2.8 Inventorizing medicinal plant resources of India

A list of 735 medicinal plants has been prepared for inventorization.

2.9 Effect of plant density and planting system

Effect of plant density and planting system on growth and yield was studied. It was found that 45 X 30 cm plant spacing recorded significantly higher tuber yield (16.52 t/ha) in *Asparagus racemosus* (Satavar), 150 x 120 cm spacing gave higher root yield (27.44 t/ha) in *Balliospermum montanum* (Danti), 60 x 45cm spacing gave yield of 160 kg/ha in *Ipomoea pestigrades* (Panchpatri) and 3 x 2.5 cm has recorded higher plant growth in *Tecomella undulata* (Rohitika).

2.10 Development of Agro-technique

Ocimum basilicum (IC 112548) has been identified as a rich source of methyl chevicol (85.57%). This accession was also studied for its harvest management, which revealed that the harvesting at full bloom gave higher herbage, essential oil yield and methyl chevicol content. The nutritional requirement is yet to be investigated. Hence a trial with different levels

of NPK (K is constant) combination was laid out in RBD with three replications. The trial is at an experimental stage.

2.11 Augmentation of germplasm

A total of twenty four accessions (11 accessions of 5 *Vigna* species, 7 of *Cucumis hardwickii*, 3 of *Sesamum mulaynum*, and 1 each of *Atylosia* sp., cultivated sesame (*S. indicum*) and a natural hybrid of *C. sativus* and *C. hardwickii*) were collected from foot hills of Uttaranchal and parts of Himachal Pradesh.

A total of thirty nine accessions (23 accessions of 8 *Vigna* species, 5 of two *Cucumis* species, 3 of *Sesamum mulaynum*, 5 of three *Abelmoschus* species and 3 of two *Solanum* sp. were collected from Orissa, Chhatisgarh and M.P.

Forty-six samples of medicinal and aromatic plants and 201 samples of agricultural crops including medicinal plants were collected from Jharkhand area and Maharashtra (Nandurbar) respectively.

A total of one hundred fifty seven accessions of medicinal and aromatic plants were collected from South and South eastern parts of UP (66 accessions), Panwali Bugyal and Kalagarh areas of Tehri and Pauri districts in Uttaranchal (47 accessions), Vadodara Dabhoi, Sunkhera, Chhota Udaipur, Tanakhala & adjoining areas of Sardar Sarover Dam submerged areas in Gujarat (24 accessions) and from Indira Sagar Dam submerged areas in Khandawa (MP).

2.12 Documentation of information on plant genetic resources

Minimal descriptors of vegetable crops was developed and published. The descriptor lists for 36 fruit crops has been finalised and is in the final process of publication. Computerisation of information on passport data of about 14,000 accessions of various agri-horticultural crops

Table 6 : Essential oil content of various aromatic plants

Crop name	Source samples	No. of content analysed	Essential oil range (%)
<i>Alpinia galanga</i>	Shillong Reg. Strn.	28	0.11 - 0.46
<i>Curcuma caesia</i>	Shillong Reg. Strn.	24	0.50- 1.02
<i>Cymbopogon martini</i>	Issapur Farm	55	0.21- 0.73
<i>Mentha arvensis</i>	IARI	30	0.53- 0.68
<i>Curcuma aromatica</i>	Jharkhand	4	0.60- 1.30
<i>Hedychium spicatum</i>	Shimla Reg. Strn.	2	0.70- 1.18
<i>Ocimum sp</i>	Jharkhand and Vadodara	3	0.094- 0.47
<i>Anisomeles ovata</i>	Jharkhand	1	0.062
<i>Vitex negundo</i>	Jharkhand	1	0.50
<i>Ocimum basilicum</i>	Issapur	5	0.033- 0.056
<i>Skimmia laureola</i>	Pawali hills	2	0.40 - 0.60
<i>Acorus calamus</i>	Pawali hills	2	0.57 - 0.76
<i>Valeriana jatamansi</i>	Pawali hills	1	0.80
<i>Nardostachyc jatamansi</i>	Pawali hills	1	0.71
<i>Hemidesmus indicus</i>	Pawali hills	2	0.07-1.00
<i>Coleus barbetus</i>	Pawli hills	1	0.24
<i>Eulophia campestris</i>	Pawali hills	1	1.50
<i>Mentha longifolia</i>	Pawali hills	1	0.30
<i>Elsholtzia sp.</i>	Pawali hills	3	0.23-0.47
<i>Celastrus paniculatus</i>	Jharkhand	1	32.4 (fixed oil)

received through exploration under NATP is being done.

The ARIS Unit continued its efforts for centralised PGR database development which included allotment of IC numbers to 35000 collections made under mission mode NATP-PB project and computerisation of three lakh exotic germplasm accessions introduced through NBPGR since 1940. ARIS unit is also helping in maintenance of local area network at the headquarters, and updating of multimedia presentation about NBPGR activities incorporating the latest figures and facts. As partner of the Integrated National Agricultural Resources Information System (INARIS), NBPGR has been identified to develop database

on plant genetic resources in the country.

2.13 Seed Supply

Utilization of germplasm of various crops by breeders and other workers in the country for crop improvement programme is an important aspect in sustainability of crop production. During the period under report a total of 1525 seed samples of various crop groups; cereals (146), legumes (435), vegetables (245), oil seeds (638), M&AP (29) and others (32) were supplied to more than 84 research workers of ICAR Institutes, State Agricultural Universities and other research centers engaged in crop improvement programmes. Also 8013 seed samples of exotic wheat, barley and triticale were

Table 7: Analysis of active constituent of medicinal plants

Crop Name	Source constituent	Active samples	No. of analysed	Range(%)
<i>Mucuna pruriens</i>	Issapur	L-dopa content	18	2.54-3.37
<i>Catharanthus roseus</i>	Jharkhand	Total alkaloid content	1	1.024
<i>Swertia chirata</i>	Pawali hills	Total bitter content	2	1.91- 2.12
<i>Picrorhiza kurroa</i>	Pawali hills	Total bitters	1	0.626

supplied to 44 indentors.

2.14 Germplasm holding in medium term storage

A total of 8424 accessions of various fieldcrops: cereals (1423), pulses (2453), vegetables (1394), oil seeds (2218), medicinal and aromatic plants (136) and under utilised crops (800) were maintained in medium term storage during the period under report (Table 8).

2.15 Germplasm field day

Field day for Rabi crops was organised on 27 February 2001 and another for wheat, barley and triticale was organized on 27 March 2001. Scientists from various ICAR institutes, SAUs and other organisations participated in the same and selected material as per their requirements.

Table 8: Active Germplasm Holding in MTS

Crop Group	Crop Name	No. of Accessions	Grand Total
Cereals	Maize	874	1423
	Wheat	265	
	Barley	284	
Legumes	Pea	451	2453
	Cowpea	1000	
	Lentil	250	
	Mung	164	
	Urd	350	
	Guar	238	
	Oilseeds	<i>Brassica</i>	
Sunflower	178		
Sesame	340		
Vegetables	Brinjal	300	1394
	Tomato	588	
	Methi	250	
	Radish	98	
	Bottle gourd	74	
	Chinese Cabbage	45	
	Onion	39	
	Medicinal and Aromatic plants	<i>Ocimum</i>	
<i>Mucuna</i>	30		
Poppy	53		
<i>Psoralea</i>	19		
<i>Andrographis paniculata</i>	15		
<i>Catharanthus roseus</i>	5		
Underutilized Crops	Rice bean	454	800
	Faba bean	230	
	<i>Amaranthus</i>	16	
	<i>Sesbania</i>	100	

Research Projects (Project Leader; Associate)

1. Characterization, maintenance, cataloguing of wheat and barley germplasm stocks (Dinesh Kumar).
2. Characterization, multiplication, conservation and utilization of exotic wheat and barley cultivars grown in post entry quarantine isolation nursery (Dinesh Kumar).
3. Augmentation of maize germplasm, its maintenance, evaluation and characterization (N. K. Gautam; A. K. Sharma)
4. Genetic resources programme on pulse crops, their evaluation, documentation and maintenance (S. Sardana; I. P. Singh, N. K. Gautam, Poonam Suneja).
5. Augmentation of genetic resources of guar, its evaluation, documentation, maintenance and utilization (B. S. Phogat; S. Mandal, R. C. Agrawal).
6. Genetic resources programme on oilseed crops, particularly sunflower and oleiferous brassica; their evaluation, characterization and maintenance (Ranbir Singh; Shashi Bhalla)
7. Genetic resources programme on vegetable crops, their evaluation, documentation and maintenance (V. K. Dholal; K. K. Gangopadhyay, Gunjeet Kumar, Ashok Kumar).
8. Building up of germplasm of horticultural crops, their establishment, multiplication, evaluation, documentation and maintenance (K. K. Gangopadhyay, Gunjeet Kumar, V. K. Dholal).
9. Building up of germplasm of forage crops, their exploration, introduction, evaluation characterization and maintenance (I. P. Singh).
10. Computer-aided genetic resources information programmes (R. C. Agrawal; R. K. Mahajan)
11. Establishment of value-added rich plant genetic resources evaluation (S. Mandal; Sangita Yadav).
12. Studies on medicinal plants for improvement in yield and quality (S. K. Pareek; Ashok Kumar, Jitender Kumar).
13. Studies on aromatic plants for improvement in yield and quality (S. K. Pareek; Jitender Kumar).
14. Exploratory and adaptability studies on new introductions in medicinal plants at Delhi (S. K. Pareek; Ashok Kumar, Jitender Kumar).
15. Genetic resources programme on plants of minor economic importance for food, fodder, fibre, hydrocarbon, and industrial value (B. S. Phogat; G. D. Sharma, Vandana Joshi, R. S. Rathi).
16. Development of core set representing sesame germplasm collection through statistical approach (R. K. Mahajan; I. S. Bisht, T. R. Loknathan, Z. Abraham, D. C. Bhandari).
17. Evaluation and identification of resistant genetic resources in pulses against pulse beetle (P. L. Premi)
18. Evaluation and identification of resistant genetic resources in pulses against important insects and mites under pesticide free condition, with emphasis on viruses and vectors, fruit and shoot borers and fruit flies (P. L. Premi).
19. Compilation of resistant genetic resources in agri-horticultural and medicinal crops of the world against insects, mites and nematodes (P. L. Premi).
20. Genetic enhancement of crop species with particular reference to sesame and mungbean (I. S. Bisht; K. V. Bhat, Suman Lakhanpal, T. R. Loknathan, Z. Abraham, N. Dikshit, D. B. Parakh, Shashi Bhalla, Babu Ram).
21. Production of Breeder/ nucleus/ quality seeds of various crops and multiplication of promising genetic stocks of vegetatively propagated plants (B. S. Phogat; I. P. Singh, Gunjeet Kumar, K. K. Gangopadhyay).

3. DIVISION OF GERmplasm CONSERVATION

Summary: A total of 31,431 germplasm accessions of various crops were received for long-term conservation in the national genebank. Of these 16,141 were processed and added to the base collection (at -20°C). Monitoring of stored germplasm (902 accessions), updation of passport data (8924 accessions) and identification of duplicates (2057) were carried out. Evaluation of viability and vigour under different storage conditions showed that ultra-dry seeds of neem retained over 80 per cent viability at different temperatures for a period of 48 months. Similarly, in chickpea, safflower, niger, groundnut, sesame and castor drying below 6 per cent moisture content prolonged longevity at ambient temperature. Various pre-treatments were worked out to enhance germination in selected medicinal plants viz., *Achyranthus*, *Costus*, *Randia*, *Mesua* and *Argemone*.

The main responsibility of the division is conservation of seeds of various agricultural and horticultural crops under long-term storage (-20°C). Also, the voucher specimens of introduced accessions are maintained for reference in the medium term storage module. In addition, the registration of potentially valuable germplasm and conservation of released varieties from the National Agricultural Research System (NARS) are the other major activities of the division. The research efforts are directed towards exploring the seed storage behaviour in hitherto unexplored species, and identification and implementation of factors that prolong the storage potential of seeds, and maintain the genetic integrity of conserved germplasm.

3.1 Germplasm augmentation

A total of 31,431 germplasm accessions of various agricultural and horticultural crops were received for long-term conservation at the national genebank. A total of 16,141 accessions of various crops qualified for conservation as per the international genebank standards and were stored as base collections at -20°C . These include cereals (6207), pseudocereals (369), millets (4,566), minor millets (125), fibres (51), oilseeds (2079), grain legumes (1,371), vegetable (236), spices (484), forages (31), fruit crops (49),

medicinal and aromatic plants and narcotics (90), released varieties (441) and genetic stocks (8). The details of various accessions received and added in various crops is listed in Table 1. The total number of base collections in the national genebank has increased to 2,09,493 (Table 2).

3.1.1 Germplasm received at handling unit

The germplasm handling unit (GHU) received 20,472 accessions from 309 explorations conducted during this period. Of these, 18,807 accessions have been kept as voucher specimens in the medium-term storage module. The 364 'recalcitrant' seed accessions and 44 accessions of vegetative propagules were forwarded to Tissue Culture and Cryopreservation Unit (TCCU) for maintenance in the cryobank and in the *in-vitro* repository, respectively. A total of 3,300 accessions with sufficient seed quantity (i.e., 2,000 seeds for self-pollinated crops and 5,000 seeds for cross-pollinated crops) were transferred to long-term modules as base collection. To ensure pest-free conservation 2,011 accessions mainly of pulse crops were screened for pests as well as hidden infestations, in the Plant Quarantine Division, out of which 211 were rejected while the rest were salvaged and appropriately stored.

Table 1 : Germplasm accessions received and added in the national genebank

Crop name	No. of accessions	
	Received	Stored in base collection
Barley	621	567
Maize	393	321
Oat	6	5
Paddy	2587	2,334
Wheat	1,610	2,980
Amaranth	732	346
Buckwheat	15	14
Chenopod	5	4
Perilla	6	5
Pearlmillet	295	216
Sorghum	11,132	4,350
Fingermillet	168	66
Foxtailmillet	51	19
Japanese millet	0	38
Barnyard millet	64	0
Proso millet	10	2
Kodomillet	19	0
Littlemillet	15	0
Italianmillet	1	0
Cotton	460	51
Rapeseed mustard	1,478	318
Castor	5	105
Groundnut	467	837
Linseed	32	16
Niger	28	50
Safflower	1,664	761
Sesame	58	10
Soybean	19	17
Black gram	60	15
Chickpea	3,151	608
Cowpea	450	3
Greengram	22	16
Horsegram	239	226
Khesari	6	6
Lentil	871	187
Pea	1,028	52
Pigeonpea	1,074	142
Mothbean	4	4
Ricebean	50	50
Vigna	58	45
Flemingia	1	1
Rhynchosia	9	9
Atylosia	7	7
Ashgourd	1	2
Bittergourd	15	25
Bottlegourd	23	24
Cucumber	0	8
Ridgegourd	20	2
Roundgourd	0	9
Snakegourd	4	8
Spongegourd	1	8
Pumpkin	31	4
Phul	0	2

Frenchbean	76	22
Brinjal	141	105
Tomato	6	2
Muskmelon	13	28
Watermelon	18	21
Medicinal & aromatic plants and narcotics	71	90
Tobacco	139	0
Methi	1	0
Onion	1	0
Okra	16	15
Chilli	695	484
Forages	77	31
Genetic stocks	90	7
Released varieties	711	441
Folk varieties	310	0
Total	31,431	16,141

Table 2 : Status of base collections in national genebank at - 20°C (as on 31.12.2001)

Crop	No. of accessions
Cereals	96915
Millets and forages	17448
Pseudo cereals	2546
Grain legumes	33393
Oilseeds	26099
Fibre crops	6755
Vegetables	10324
Fruits	139
Medicinal & aromatic Plants	814
Narcotics	778
Spices & condiments	2126
Genetic stocks	194
Released varieties	1770
Duplicate safety samples	10192
Total	209493

3.2 Restoration of Germplasm

Under a collaborative research project between ICAR and ICRISAT on restoration of germplasm from ICRISAT to NBPGR, a total of 15,301 germplasm accessions were received. These comprised sorghum (11,112), pearl millet (215), groundnut (491), pigeonpea (332) and chickpea (3151). Of these 7,490 accessions have been processed and transferred to LTS which comprised sorghum (4,347), pearl millet (215), groundnut (478), pigeonpea (332) and chickpea (2,118).

3.3 Regeneration of Germplasm

A meeting of the Project Co-ordinators and Project Directors of the concerned crops, was organised at NBPGR Regional Station, Hyderabad to accelerate the process of regeneration. According to the recommendations of this meeting, 304 chickpea, 1000 pigeonpea and 747 groundnut are being regenerated at AICRP centre, whereas, 301 pigeonpea, 500 groundnut, 437 sorghum, 300 pearl millet are being regenerated at ICRISAT. In addition, 1,419

accessions of rapeseed mustard were regenerated at NRC on rapeseed mustard, Bharatpur. Of these, 919 have been received and 341 accessions of groundnut and 449 accessions of cotton are being regenerated at NBPGR, Amravati and CICR, Nagpur respectively.

3.4 Monitoring of Germplasm

During this period the germplasm of following crops (Table 3) stored in the long-term modules was monitored for seed viability and seed quantity to identify the accessions that may be requiring regeneration as per international standards. The accessions which have been under the long-term storage for 10 or more years, have been monitored as per the genebank standards. According to the monitoring results the samples/lots registering viability below the specified genebank standards will be regenerated in collaboration with the concerned NAGS.

3.5 Documentation and database management

A total of 10,058 accessions of various crops have been reviewed for the availability of passport data and 8,924 records updated.

3.6 Germplasm registration

The final guidelines for the registration of

germplasm have been printed and circulated to all concerned in the Indian National Agricultural Research System. Of the 159 proposals considered during the VIIth and VIIIth meeting of plant germplasm registration committee, 50 proposals belonging to 17 crops were approved for registration.

3.7 Physical verification

Physical verification of the sample packets stored in the long-term modules has been completed in chickpea, cotton, mungbean, guar, brinjal and onion.

3.8 Identification of duplicates

Duplicates in conserved germplasm were identified for tomato (100), bottlegourd (7), bittergourd (4), radish (2), chickpea (1128), mungbean (458), khesari (112), horsegram (76), adjukibean (6), cowpea (5), pea (1), lentil (16), ricebean (81) and pigeonpea (61).

3.9 Supportive research

Ultra-desiccated neem seeds of two accessions have been found to retain over 80 per cent viability at different temperatures (ambient, +25, +4 and -20°C) for a period of 48 months. Studies on several crops to identify the optimum seed moisture content (mc) for *ex situ* conservation showed that sesame seeds with 4.5 and 2% mc maintained viability close to original values at

Table 3 : Monitoring viability of germplasm stored in National Genebank

Crop	No. of accs. monitored	Range of initial viability percentage		Acc. with acceptable viability (%)	% accession for regeneration
			Present		
Wheat	100	80-100	80-100	100	Nil
Barley	60	85-100	85-100	100	Nil
Maize	22	92-100	88-100	100	Nil
Chickpea	148	90-100	90-100	100	Nil
Mustard	250	80-100	70-100	25	10
Sesame	72	80-100	70-100	11	15
Onion	220	95-100	95-100	100	Nil
Brinjal	30	85-100	85-100	100	Nil
Total	902				

ambient temperatures even after 39 months of storage. In castor, after 29 months of storage, germination at 2% moisture (76%) was greater than at 5% moisture (52%) under ambient temperature. In groundnut, after 22 months of storage at ambient temperature, germination is greater at 2% seed moisture (92%) than at 4.3% (72%).

Seed storage behaviour of tropical tree species and their short-term conventional storage techniques were investigated. Lac seeds were found to have dormancy, which could be removed by treating with 200 ppm GA₃ for 24 hrs. The seeds were intolerant to low temperature. Rubber seeds, received from Thrissur were highly recalcitrant but could be stored well for a period of 3 months over saturated solution of potassium chloride.

Seed germination studies were conducted on six wild medicinal plants including one tree species. Following treatments were effective for increased germination.

3.10 Special project

An exploratory project on “Zero energy, based seed conservation” has been initiated in collaboration with DRDO, FRL, Leh. A total of 163 accessions belonging to 50 crop groups were processed and were kept at Khardungla temple, Leh, Ladakh at 18,338 ft. It included some sensitive species, such as soybean.

3.11 Human resource development

A specialised training was organised for technical staff involved in the operation and maintenance of medium term modules at various ICAR institutes from 30th April to 11th May 2001 on “Maintenance and Operation of Genebank Facilities”. In addition, two visiting scientists from Chaudhary Charan Singh Haryana Agricultural University, Hisar were associated with Germplasm Conservation Division under NATP, TOE. They carried out studies on conservation of marigold and *Acacia*.

Species	Common name	Germination substrate/ temp.	Dormancy breaking treatment
<i>Achyranthus aspera</i>	Chirchita	TP/25°C	Removal of glume
<i>Costus speciosus</i>	Kemuka	TP/20°C	Overnight soaking in KN03 /GA3
<i>Randia dumetorum</i>	Madan Phal	TP/25°C	Complete removal of seed coat
<i>Mesua ferrea</i>	Nagkesar	20° C/1% Agar	Breaking the seed coat
<i>Mesua nagassaricum</i>			
<i>Argemone mexicana</i>	Satyanashi	15°C/TP	Pre-soaking in water at 40°C overnight or soaking in GA3 overnight

Research Projects (Project Leader; Associate)

- 1 *Ex-situ* conservation of plant genetic resources of agricultural and horticultural crops
 - 1.1 Establishment and maintenance of National Germplasm Conservation Network (A.K. Singh, Sanjeev Saxena, S.K. Jain, Anjali Kak)
 - 1.2 Conservation of legume germplasm using conventional seed storage methods (Neeta Singh)
 - 1.3 Conservation of paddy using conventional seed storage methods (Sanjeev Saxena; A. D. Sharma)
 - 1.4 Conservation of oilseeds crop germplasm using conventional seed storage methods (S. K. Jain)
 - 1.5 Conservation of cereals other than paddy and pseudo-cereals germplasm using conventional seed storage methods (Kalyani Srinivasan, Manju Uprety)

- 1.6 Conservation of medicinal and aromatic plant species germplasm using conventional seed storage methods (Veena Gupta)
- 1.7 Conservation of fruit and agro-forestry species germplasm using conventional seed storage methods (A. K. Singh; J. Radhamani)
- 1.8 Conservation of forage and fibre crop species germplasm using conventional seed storage methods (Anjali Kak)
- 1.9 Conservation of vegetable and spices germplasm using conventional seed storage methods (Chitra Devi; Vivek Mitter)
- 1.10 Conservation of *sorghum*, pearl millet and minor millets using conventional seed storage methods (Chitra Devi; Anshu Chaudhary)
- 1.11 Data documentation, storage and retrieval of information on plant genetic resources conserved in national genebank (N. K. Chowdhary)
- 1.12 Critical evaluation of seed viability and vigour in some agricultural horticultural crops under different storage regimes (Kalyani Srinivasan, Sanjeev Saxena, S. K. Jain, Manju Uprety, A. D. Sharma)
- 1.13 Use of technique of ultra-desiccation for cost-effective germplasm conservation (Neeta Singh, Anjali Kak)
- 1.14 Investigating germination, dormancy and seed storage behaviour in indigenous medicinal and aromatic plants (Veena Gupta)
- 1.15 Investigating seed storage behaviour of unexplored or less explored plant species (A. K. Singh, J. Radhamani)

4. DIVISION OF PLANT QUARANTINE

Summary: During the period under report, 86,224 samples of different crops were received through Germplasm Exchange Unit for quarantine clearance. Out of these 85,892 samples were imported and the rest 332 were meant for export to various countries. These samples included true seeds, rooted plants, cuttings, rhizomes, suckers, bulbs, nuts and tissue culture plantlets. The detailed quarantine examinations revealed that 374 samples were infested with insects/mites including 112 with hidden infestation; 162 samples were infested with nematodes and 213 were infected with plant pathogens. Seventy-seven samples of soybean infected with downy mildew fungus (*Peronospora manshurica*) were rejected and destroyed. Seventy samples of tomato and 32 samples of pepper germplasm were subjected to prophylactic seed treatment with 10% tri-sodium orthophosphate to prevent the introduction of new strains of tobamoviruses through seeds. Six hundred seventy two infested/infested samples were salvaged through fumigation, hot water treatment (HWT), X-ray radiography, pesticidal dip, ethyl alcohol wash and mechanical cleaning. Phytosanitary certificates were issued for sixteen consignments of material meant for export. A total of 11 samples of transgenic crops were received after clearance certificate for import from DBT. Out of these one sample of *Brassica* was infected with pathogenic seed-borne fungi. It was released after salvaging.

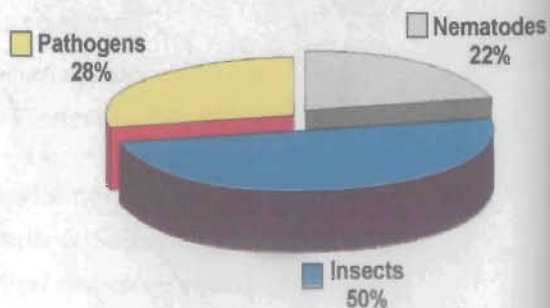
4.1 Quarantine clearance of germplasm under exchange

4.1.1 Import quarantine

4.1.1.1 Quarantine examination: All the planting material (both true seed and vegetative propagules) were inspected for detection of associated pests viz., insects/mites, plant parasitic nematodes, plant pathogens and weed seeds by visual examination followed by specific pest detection techniques. Of the import samples, 703 samples were exposed to X-ray radiography for detection of hidden infestation caused by insects mainly bruchids and chalcids. Seven hundred and forty nine samples were infested/infected/contaminated with various pests (374 with insects/mites; 162 with nematodes and 213 with fungi/bacteria). Major pests intercepted are listed in Table 1 including a number of pests of major quarantine importance which have not yet been reported from India.

4.1.2 Salvaging of infested/infected/contaminated germplasm: Seven hundred and forty nine samples were infested/infected/contaminated with various pests (374 with

insects/mites; 162 with nematodes and 213 with fungi/bacteria). Twenty seven samples were salvaged through fumigation, 139 with hot water treatment (HWT), 112 with X-ray radiography, 117 with pesticide dip, 21 with ethyl alcohol wash and 256 by mechanical cleaning. Five thousand one hundred and fifty nine samples of paddy were given mandatory hot water treatment against seed-borne plant pathogens and nematodes. Seventy seven samples of soybean infected with downy mildew were rejected. In order to avoid introduction of new strains of tomato viruses through seeds of chilli and tomato, all the introduced germplasm samples of these crops [chilli, 32 and tomato, 70] were subjected to 10%



Infected / Infested Samples

Table 1 : Pests intercepted from the germplasm under exchange during 2001

Pests	Host	Source
Insects/ Mites		
<i>Bruchophagus roddi</i>	<i>Medicago sativa</i>	USA
<i>Bruchus lentis</i>	<i>Lens culinaris</i>	Syria
<i>Cryptolestes</i> sp.	<i>Pennisetum typhoides</i>	Nigeria
<i>Lasioderma serricorne</i>	<i>Hordeum vulgare</i>	Syria
<i>Rhizopertha dominica</i>	<i>Hordeum vulgare</i>	Syria
	<i>Triticum aestivum</i>	Azerbaijan
<i>Sitophilus oryzae</i>	<i>Oryza sativa</i>	USA, Thailand
	<i>Triticum aestivum</i>	Nepal
	<i>Zea mays</i>	Thailand, Mexico
<i>Systole coriandri</i>	<i>Coriandrum sativum</i>	Russia
Immature forms	<i>Leucaena leucocephala</i>	USA
	<i>Rhynchosia</i> sp.	USA
Mites	<i>Trifolium</i> sp.	USA
Scales	<i>Vigna</i> sp.	USA
Nematodes		
<i>Aphelenchoides besseyi</i>	<i>Oryza sativa</i>	Philippines
<i>Rhabditids</i> sp.	<i>Panicum maximum</i>	USA
<i>Tylenchorhynchus</i> sp.	<i>Trifolium</i> spp. (soil clods)	USA
Pathogens		
<i>Alternaria brassicae</i>	<i>Brassica</i> spp.	Canada
<i>A. brassicicola</i>	<i>Brassica</i> spp.	Belgium, Canada, Hungary, Netherlands, UK
<i>Botrytis cinerea</i>	<i>Coriandrum sativum</i>	Russia
<i>Catynula</i> sp.	<i>Saccharum officinalis</i> cuttings	Thailand
<i>Claviceps fusiformis</i>	<i>Pennisetum typhoides</i>	Nigeria
<i>C. purpurea</i>	<i>Dactylis glomerata</i>	USA
	<i>Secale cereale</i>	Nigeria, Stuttgart
<i>Colletotrichum dematium</i>	<i>Cyamopsis tetragonoloba</i>	USA
	<i>Glycine max</i>	USA
<i>Diplodia macrospora</i>	<i>Zea mays</i>	USA
<i>Drechslera avenae</i>	<i>Avena sativa</i>	USA
<i>D. oryzae</i>	<i>Avena sativa</i>	Thailand
<i>D. sorghicola</i>	<i>Zea mays</i>	Philippines
<i>D. sorokiniana</i>	<i>Avena sativa</i>	USA
<i>Fusarium poae</i>	<i>Avena sativa</i>	USA
<i>Gloeotinia temulenta</i>	<i>Festuca pratensis</i>	USA
<i>Peronospora manshurica</i>	<i>Glycine max</i>	Japan, Taiwan, USA
<i>Phoma lingam</i>	<i>Brassica</i> sp.	Canada
<i>Phoma</i> sp.	<i>Oryza sativa</i>	Philippines
<i>Phyllosticta panici</i>	<i>Panicum maximum</i>	USA
<i>Puccinia carthemi</i>	<i>Carthamus tinctorius</i>	USA
<i>P. helianthi</i>	<i>Helianthus annuus</i>	France
<i>Rhizoctonia</i> sp.	<i>Glycine max</i>	Taiwan
<i>Tilletia foetida</i>	<i>Triticum vulgare</i>	Azerbaijan
<i>Trichoconis padwickii</i>	<i>Oryza sativa</i>	Philippines, Thailand
<i>Xanthomonas campestris</i> pv.	<i>Brassica</i> spp.	Canada, Hungary, UK

tri-sodium orthophosphate treatment.

4.1.3 Grow-out test in PEQN: International nursery trial material-wheat (3,184 entries), barley (1,416), triticale (49) and *Secale cereale* (4) was grown in PEQN. Loose smut of wheat (*Ustilago segetum* var. *tritici*) was intercepted in 5 entries (i.e. 15th KBSN- 55, -56, -131, WON-D-54 and RWHTON- 43) from CIMMYT, Mexico. Infected plants were uprooted and destroyed.

A total of 353 samples of exotic germplasm of different crops comprising cowpea (52), fababean (36), frenchbean (8), mungbean (22), pea (15), soybean (200) and sunflower (20) were grown in Post Entry Quarantine Greenhouse and Post Entry Quarantine Nursery. Virus-like symptoms were observed in seedlings of four accessions of cowpea (EC 472252, EC 472263, EC 472270 and EC 472295), one accession of mungbean (EC 470098), three accessions of pea (EC 455038, EC 455042 from Syria and EC 454029 from Nepal) and four accessions of sunflower (SFH-03, SFH-10, SFH-14 and SFH-15 from France). Electron microscopy revealed the presence of flexuous particles of potyvirus in pea and sunflower. Virus particles were not found in mungbean and cowpea.

The presence of pea seed-borne mosaic potyvirus (PSbMV) in seeds of above mentioned pea accessions was further confirmed by Double Antibody Sandwich-Enzyme Linked Immunosorbent Assay. Also, local lesions were observed on *Chenopodium amaranticolor* after inoculation with the extracts of leaves showing symptoms of PSbMV.

4.1.4 Export quarantine: Three hundred and thirty two samples intended for export to various countries were also processed to eliminate detection of associated pests and pathogens. Eighteen samples were infested/ infected with pests/ pathogens. Important interceptions were: Insects-*Rhizopertha dominica* on *Oryza sativa*; *Sitophilus oryzae* on *Zea mays*; *Tribolium*

castaneum on *Helianthus annuus*; Nematodes-*Aphelenchoides* spp., *Filenchus* spp., *Trichodorus* spp. on *Camellina sinensis*; *Aphelenchoides besseyi* on *Oryza sativa*; Fungi-*Drechslera oryzae*, *Tricochonis padwickii* and *Ustilaginoidea virens* on *Oryza sativa*; *Colletotrichum gloeosporioides* and *Pestalotia* sp. on *Camellia sinensis*. Sixteen phytosanitary certificates were issued. Infected/ infested material was salvaged and released to the importing countries.

4.2 Seed health testing of germplasm of different agri-horticultural crops for pest-free conservation (NATP Project)

A total of 2,063 samples of different crops collected under NATP (PB) project were received for seed health testing and salvaging for their conservation in a pest-free state. All the samples were examined by using different techniques. Of these, 877 samples were exposed to X-ray radiography that revealed hidden infestation in 716. Of the 1,072 samples infected/ infested, 877 samples were salvaged through suitable disinfestation procedures. The remaining 195 samples could not be salvaged hence rejected. A total of 1868 samples were sent to Conservation Division for storage. The pests/ pathogens detected were as follows:

Fungi: *Botryodiplodia* spp. on *Nelumbo nucifera*; *Colletotrichum dematium* on *Capsicum* spp. and *Vigna mungo*; *Drechslera oryzae* on *Oryza sativa*; *D. sorghicola* on *Oryza sativa* and *Triticum aestivum*; *Fusarium semitectum* on *Vigna radiata*; *Macrophomina* spp. on *Vigna radiata*; *Melanconium* spp. on *Nelumbo nucifera*; *Neovossia horrida* on *Oryza sativa*; *Periconia* spp. on Sem bean; *Phomopsis* spp. on *Lens culinaris*; *Rhizoctonia* spp. on *Vigna radiata*; *Ustilaginoidea virens* on *Oryza sativa*.

Insects: *Bruchidius mimosae* on *Mimosa*

rubicaulis; *Bruchus lentis* on *Lens culinaris*; *B. pisorum* on *Pisum sativum* and *Lathyrus sativus*; *Callosobruchus cajanus* on *Cajanus cajan*; *C. chinensis* on *Macrotyloma uniflorum* and *Vigna unguiculata*; *C. maculatus* on *Vigna mungo*, *Vigna radiata*, *Cicer arietinum*, *Lens culinaris*, *Macrotyloma uniflorum* and *Glycine max*; *C. phaseoli* on *Lablab purpureus*; *Conicobruchus albopubens* on *Cyamopsis tetragonolobus*; *Caryedon acaciae* on *Acacia nilotica*; *Spermophagus albosparsus* on *Hibiscus subdariffa*; *Systole coriandri* on *Coriandrum sativum*; *Rhizopertha dominica* on *Hordeum vulgare*, *Oryza sativa* and *Triticum aestivum*; *Sitophilus oryzae* on *Hordeum vulgare*, *Oryza sativa*, *Triticum aestivum* and *Zea mays*; *Tribolium castaneum* on *Triticum aestivum*; *Sitotroga cerealella* on *Hordeum vulgare*, *Oryza sativa*, *Triticum aestivum* and *Zea mays*

4.3 National containment/ quarantine facility for transgenic planting material (DBT-ICAR project)

During the period under report 11 imported samples of different transgenic crops comprising chickpea (2) from Australia with bean alpha amylase inhibitor; *Brassica juncea* (1) from Belgium with barnase and barstar genes; cotton (3) from USA with Bt gene (cry X/Vip-3); maize (4) from USA-rn (2) with Cry IA(b) and pat and (2) with cry IA(b); rice (1) from Switzerland with plant phytoene synthase (psy), bacterial phytoene desaturase (crt I) and lycopene β -cyclase (lcy) were subjected to quarantine processing.

All the samples of *Brassica* and rice were salvaged by hot water treatment as precautionary measure and released to indentor. Samples of chickpea and cotton were exposed to X-ray radiography to detect the hidden infestation of bruchids.

Appropriate plant protection measures were

undertaken as and when required so as to release disease-free material. Till the time CL-4 facility was not available at NBPGR, planting materials / samples were grown by the indentor and examined from time to time by NBPGR scientists during the appropriate stages of plant growth. The leaf and soil samples were collected and processed for interception of pests.

A unique Containment facility, of the Containment Level-4 (CL-4) was inaugurated on 25th October, 2001 by Sh. Bachhi Singh Rawat, Hon'ble Minister of State for Science and Technology in the presence of Dr. (Mrs.) Manju Sharma, Secretary, DBT and Dr. Panjab Singh, DG, ICAR and Secretary, DARE.

The facility is ready to handle potentially hazardous genetically modified plant material to prevent their direct contact with the environment. It has been built in a way that no viable biological material / pathogen/ pollen can enter or leave the building. The facility comprises of four greenhouse bays, one soil-bay and laboratory facility in one contained unit. The five bays have the facility of controlled atmosphere: air temperature 20-30°C and relative humidity 50-80%. All the air exchange in the facility is through adequate High Efficiency Particulate Air [HEPA] filters. The facility has outer and inner decontamination rooms with airlock system and neutral pressure. A double entry autoclave has been provided for steam sterilization of material entering or leaving the facility and provision has been made for safe effluent treatment. An in-built computerized facility has been provided to monitor bay conditions and recording data without contaminating the bay areas.

A check list of the pests (fungi, bacteria, viruses, insects and nematodes) of *Brassica* spp. has been prepared with respect to their geographical distribution and quarantine significance to serve as a ready reckoner and to facilitate quarantine processing of transgenic seeds of *Brassica* spp.

Second Orientation Course on “Biosafety Considerations for Evaluation of Transgenic Crops” was organised during November 2-9, 2001 at NBPGR, New Delhi. The objective of the orientation course was to develop a critical mass of scientists at national level who can comprehend, appreciate and participate in tackling various issues related to biosafety concerns for evaluation of transgenics. Different aspects of genetic engineering, provisions of International Biosafety Protocol, seed quality law enforcement, impact of Genetic Use Restriction Technologies (GURT), quarantine strategies, regulatory mechanism for import of transgenics and for undertaking limited field trials, impact of transgenics on environment and human health and case study of Bt cotton and transgenic *Brassica* (from lab to fields) were dealt with in detail. A total of 20 participants from ICAR Institutes, State Agricultural Universities, Central Universities, State Government Departments etc. attended the course.

4.4 Diagnostics and development of seed certification protocols for management of seed-transmitted viral diseases of grain legumes (NATP mission mode project)

- **Assessment of prevalence of viral diseases:** The percent incidence of different seed-transmitted viral diseases of mungbean, urdbean and soybean in the fields of different states under survey were:

Mungbean: Urdbean leaf crinkle disease (ULCD) in A.P and Karnataka (0.1-8%).

Urdbean: ULCD in A.P., Gujarat, Karnataka and Rajasthan (0.5-50%).

Soybean: Soybean mosaic potyvirus (SMV) in Gujarat, Haryana and Karnataka (0.1-3%).

The disease incidence varied with location and the crop variety and was experimentally

correlated with the increase in aphid population in cowpea and soybean.

- **Assessment of seed transmission of viruses:** Studies on seed transmission of viruses based on symptoms in growing-on test of the seeds collected from diverse sources revealed a seed transmission rate of 1-6% and 2-27% of black eye cowpea mosaic potyvirus (BICMV) in cowpea and urdbean respectively, 2-6% and 3-19% of ULCD in mungbean and urdbean, respectively and 3-12% of SMV in soybean. The rate of seed transmission of SMV varied with the location even for the same variety.
- **Optimization of virus detection techniques:** The techniques for detection of viruses included variants of enzyme linked immunosorbent assay (ELISA) such as Double Antibody Sandwich-ELISA and Direct Antigen Coating-ELISA that were adopted with certain modifications. The group testing of embryos using above mentioned variants of ELISA was also undertaken to optimize the number of embryos required to be tested per group for authentic batch testing.
- **Identification of potential virus-free areas:** The survey results gave preliminary indication on areas that were found to be free from certain viral diseases. These included villages/sites in:
 - Karnataka (1) from cowpea aphid borne mosaic potyvirus and southern bean mosaic sobemovirus of cowpea
 - A. P (21) and Karnataka (6) from ULCD of mungbean
 - Gujarat (2) and Karnataka (1) from ULCD of urdbean
 - Gujarat (10), Karnataka (8) and Uttaranchal (1) from SMV of soybean.

These areas would be resurveyed for confirmation of their disease-free status.

- The Review Workshop was organized on 7th and 8th June, 2001 at University of

Mysore, Mysore and Group Meeting was organized on 29th November, 2001 at NBPGR, New Delhi to review the progress of work done by all the three centres.

Research Projects (Project Leader; Associates)

1. Quarantine clearance of germplasm under exchange and supportive research (R.K. Khetarpal, Arjun Lal, Shamsher Singh, P.C. Agarwal, *Usha Dev, Manju Lata Kapur, Rajan, Baleshwar Singh, D.B. Parakh, Shashi Bhalla, V.Celia Chalam, Kavita Gupta, Charan Singh).
2. Seed health testing of germplasm of different agri-horticultural crops for pest free conservation of germplasm (NATP) (R.K.Khetarpal; Arjun Lal, Shamsher Singh, P.C. Agarwal, *Usha Dev, B. Lal, Manju Lata Kapur, Rajan, Baleshwar Singh, D.B. Parakh, Shashi Bhalla, V.Celia Chalam, Kavita Gupta, Charan Singh, A.K. Maurya, Dinesh Chand).
3. National containment/ quarantine facility for transgenic planting material (R.K. Khetarpal, R.V. Singh, R.K. Tyagi, Gurinder Jeet Randhawa, Rajan, Baleshwar Singh, Shashi Bhalla, V.Celia Chalam, Rakesh Singh).
4. Diagnostics and development of seed certification protocols for management of seed-transmitted viral diseases of grain legumes (R.K.Khetarpal, D.B.Parakh, V.Celia Chalam).

* On sudy leave.

5. GERMLASM EXCHANGE UNIT

Summary: During the period under report 94,811 samples were imported from 35 countries which included germplasm as well as trial material of different agricultural and horticultural crops. Requirements for germplasm from abroad were met by arranging material from different Indian sources and 100 samples were sent to 11 countries. Based on request received from research workers in the country, 10,608 samples of germplasm of diverse crops were supplied to various users for crop improvement programmes.

5.1 Import of plant genetic resources

The division continued to channelize its efforts for germplasm introduction to meet the specific requirements of scientists working in ICAR research institutes, agricultural universities and non-governmental organizations. Introduction comprised of material introduced at the initiative of the Bureau and material obtained on request from the scientists as well as collaborators for international trials to be conducted in India. Introduction of seed/plant propagules made during the year were as follows:

Samples procured and handled	94,811
(a) germplasm	23,268
(b) trials	71,543
Number of transgenic material imported	40
Consignment received and handled	292
Number of countries involved	35
New import cases registered	298
Number of import permits issued	694

Some promising introductions made in important crops are listed in Table I.

5.1.1 Cereals and millets

Avena sativa (5) from USA; *Hordeum vulgare* (2), *Hordeum vulgare* sub sp. *vulgare* (17) both from USA trials (6,140) ISNBON, ISEBON,IBYT-LRA-M,IBON-MRA,IBRWAGP-

02, BYDY, IBGP-CWANA2, ISBCB, FAREAST 02, BON LRA, IBYDY GP-2002, EMBSN, IBON, IBYT, HBSN, IBYT-MRA all from CIMMYT, Mexico and ICARDA, Syria; *Oryza sativa* (2,722) from Philippines, Thailand and USA; trials (3244) IRHON, IRLON, IIRON, IDRON, IURON, IRFAON, IRTON, IRBBN, IRCTN, IRGMN all from IRRI, Philippines, *Oryza alta* (1), *O. australiensis* (8), *O. brachyantha* (24), *O. eichiengeri* (4), *O. grandiglumis* (4), *O. glaberrims* (5), *O. latifolia* (3), *O. minuta* (20), *O. officinalis* (29), *O. punctata* (7), *O. rhizomatis* (3) all from Philippines; *Pennisetum americanum* (2) from South Africa; *P. glaucum* (91) from Niger, Nigeria, USA, Zimbabwe, Tanzania, Kenya, Mali, Uganda; *P. typhoides* (10) from Nigeria; *Sorghum bicolor* (156) from Niger and USA and 6,681 samples from ICRISAT. *Secale cereale* sub. sp. *cereale* (4) from USA; *Sorghum sudanense* (4) from Canada; *Sorghum* sp. (31) from USA; *Tritosecale* (7) from Canada and Mexico; trials (142) from CIMMYT, Mexico, *Triticum aestivum* (460) from Australia Hungary, Iran, Mexico, Nepal, UK and USA; trails (50,092) EGPSN, EGPYT, F3BWM, F3BW ME4SA, F3BMEY2, HLWSN, F2BASX01, F2DWSXS01, IBWSN, EMSWN, WAWSN, IDSN, SAWSN, IDYN*6, 33RD IDYN*1, EDUYT, 33rd, IDYN*6, 33rd HTWYT*6, ITYN*6, F3BWIME, HTWYT, ITSN, KBSN, GAWYT, WON-D, DON-MD DYT-MTA, WHFGP. 2nd RWYT-MR, RWCP-02 from CIMMYT, Mexico, Nepal and ICARDA.

Syria; *Triticum durum* (20) from Azerbaijan; *Triticum timopheevi* (1) from Mexico; *Triticum* sp (19) from Canada and Germany; *Zea mays* (5802) from Argentina, Australia, Egypt, Brazil, Israel, Mexico, Philippines, Thailand, USA and Zimbabwe; trials (8,940) CHTSEY, CHTSY, CHTTEW, CHTTEY, CHTSEW, EVT 16A, EVT16B, EVT14A, EVT 14B, CHTTWQ, CHTSW, CHTTYQ, CAVTON-1, CAVT01-2 TAMNET-E, TAMNET-L, DR0101, BLSB0102, WL0103, DN0105, IS0106, LET 0107, DR0108 all from CIMMYT, Mexico.

5.1.2 Oilseed crops : *Arachis hypogaea* (175) from Malawi, Niger and USA; *Brassica juncea* (196) from Belgium, Canada and UK; *Brassica napus* (4) from Canada; *Brassica niger* (43) from Canada, Germany and USA; *Carthamus glaucus* (1), *C. lanatus* (9), *C. palestinus* (2), *C. tenuis* (1), *C. tinctorius* (13) *Carthamus* sp. (5) all from USA; *Helianthus annuus* (191) from China, France, USA and Yugoslavia; *Helianthus* sp. (21) from France.

5.1.3 Grain legumes : *Cajanus cajan* (7) from Ghana, Myanmar and USA; *Cicer arietinum* (40) from Australia, Bangladesh, Iran, Scotland and 811 samples from ICRISAT; trials (1566) CIDTN-02 CICTN, C1F3N-SL, CIEN-LA, C1FWN, CIABN, CIEN-SL-1 from ICARDA Syria; *Cyamopsis senegalensis* (1), *C. serrata* (1), *C. tetragonoloba* (18) all from USA; *Glycine max* (1,660) from Australia, Japan, Taiwan and USA; *G. canescens* (2), *G. soja* (19), *G. tabacina*, *G. tomentella* (1) all from Taiwan; *Glycine argyrea* (1), *G. canescens* (2), *G. cyrtoloba* (2), *G. clandestina* (8), *G. centennial* (1), *G. latifolia* (3), *G. tabacina* (44), *G. tomentella* (8), *G. microphylla* (1) all from USA; *Lathyrus sativus* (2) from Bangladesh; trials (90), ILAT-LS-02 from ICARDA, Syria; *Lens culinaris* (4) from Bangladesh; *L. ervoides* (5), *L. nigricans* (5), *L. odemensis* (5), *L. orientalis* (7) all from Syria; trials (1329) LIRN, LIF5N-E, LIF5N-L, LIDTN, LIFWN, LIEN-E, LIEN-5, LINN-L, LIABN-02

all from ICARDA, Syria; *Rhynchosia minima* (9), *R. phaseoloid* (1), *R. phramidalis* (1), *R. reticulata* (1), *R. rapatabunda* (1), *Rhynchosia* sp (1) all from USA; *Vigna aconitifolia* (1), *V. ambacensis* (4), *V. angularis* (2), *V. comosa* (1), *V. frutescens* (2), *V. gracilis* var. *gracilis* (2), *V. glabrescens* (1), *V. heterophylla* (1), *V. hosei* var. *hosei* (2), *V. hosei* var. *pubescens* (1), *V. laurentii* (1), *V. luteola* (1), *V. maruia* (2), *V. membranacea* (1), *V. minima* (1) *Vigna mungo* (7) from Bangladesh and Belgium and *V. nakashimae* (1), *V. oblongifolia* (1), *V. parkeri* (3), *V. racemosa* (4), *V. radiata* (3) from Bangladesh and Belgium; *V. reticulata* (1), *V. trilobata* (1), *V. membranacea* (1), *V. reticulata* (1), *V. riukiuiensis* (1), *V. trilobata* (1) all from Belgium; *V. unguiculata* (121) from Belgium and Nigeria and *V. wittei* (1) from Belgium.

5.1.4 Vegetable crops : *Allium cepa* (3) from Israel and Taiwan; *Brassica rapa* (21) from Canada and Sweden; *Brassica oleracea* var. *botrytis* (28) from Hungary and UK, *B. oleracea* var. *capitata* (130) from Netherlands and UK, *Brassica oleracea* (77) from USA; *Capsicum annum* (35) from Taiwan and USA; *C. chacoense* (3) from Taiwan, *Capsicum* sp (4) from Israel; *Citrullus lanatus* (10) from Taiwan; *Cucurbita pepo* (3) from Israel; *Cucumis melo* (7) from Taiwan and USA; *C. sativus* (1) and *Cucumis* sp (2) from Israel and *Lycopersicon esculentum* (48) from Israel and Taiwan; *L. pimpinellifolium* (10) from Taiwan; *L. hirsutum* (6), *L. pinnellii* (6), *L. peruvianum* (3) all from Taiwan; *Physalis acutifolia* (1), *P. ixocarpa* (19), *P. peruviana* (3), *P. pruinosa* (2), *P. pubescens* (1), *P. nicandroides* (2), all from USA; *Solanum aethiopicum* (10) from Taiwan and ICARDA, Syria and *S. melongena* (34) from Taiwan.

5.1.5 Fruit crops : *Carya illinoensis* (8) from USA; *Hippophae rhamnoides* (3) from Russia; *Juglans* sp (4) from France; *Musa* sp (66) from Belgium; *Pistacea vera* (1) from USA; *Prunus avium* (3) from Canada; *P. persica* (6) from Italy;

Pycnanthemum tenuifolium (1) from USA; *Ribes alpinum* (1), *R. aureum* (1), *R. bracteosum* (1), *R. burejense* (1), *R. formosanum* (1), *R. lobbii* (1), *R. pentalandii* (1), *R. petraceum* (1), *R. roezlii* (1), *R. tristeklatt* (1), *Ribes* sp (1) and *R. wolfii* (1) all from USA; *Rubus bogotensis* (1), *R. briaceus* (1), *R. canascens* (1), *R. chingii* (1), *R. cissooides* (1), *R. columellaris* (1), *R. conothyrsoides* (1), *R. echinatus* (1), *R. erythropros* (1), *R. hagellaris* (1), *R. grabowskii* (1), *R. hillii* (1), *R. ikenoensis* (1), *R. kawakamii* (1), *R. lasiostylus* (1), *R. minusculus* (1), *R. megalococcus* (1), *R. praecox* (2), *R. plicatus* (1), *R. roseus* (1), *R. saxatilis* (1), *Rubus* sp (21) all from USA; *Vaccinium* sp (19) from USA.

5.1.6 Fibre crops: *Crotalaria incana* (1), *C. goreensis* (1), *C. microcarpa* (1), *C. ononoides* (1), *C. plosa* (12), *C. pumila* (3), *C. retusa* (1), *C. sagittalis* (2), *C. zanzibarica* (12) all from Colombia; *Gossypium hirsutum* (14) from USA and 21 samples from ICRISAT.

5.1.7 Spices and condiments: *Coriandrum sativum* (10) from Russia.

5.1.8 Tuber crops : *Ipomoea batatas* (31) from Peru and *Solanum tuberosum* (82) from Canada, Peru and USA.

5.1.9 Plantation crops: *Cocos nucifera* (12) from Comoros and Reunion Islands and Sri Lanka.

5.1.10 Forage and fodder crops: *Dactylis* sp (57) from USA; *Festuca arundinacea* (46) from USA; *F. pratensis* (35) from UK and USA; *Lolium multiflorum* (25) from USA; *L. perenne* (78) from UK and USA, *L. temulentum* (13) from USA; *Medicago sativa* (4) from Slovakia; *Panicum maximum* (256) from USA; *Thinopyron ponticum* (2) from Slovakia; *Trifolium ambiguum* (19) from USA; *T. pratense* (54), *T. repens* (75) both from UK and USA.

5.1.11 Agroforestry tree species: *Eucalyptus camaldulensis* (7), *E. degliipta* (1), *E. grandis*

(6), *E. pellita* (1), *E. tereticornis* (1) all from Australia.

5.1.12 Under utilized and under-exploited crops: *Acacia crassicarpa* (2), *A. mangium* (2), *A. peregrina* (2) all from Australia; *Chloris gayana* (40) from USA ; *Leucaena diversifolia* (2), *L. hybrid* (2), *L. leucocephala* (1) all from USA; *Sesbania cannabina* (1), *S. coerulescens* (1), *S. emerus* (3), *S. exasperata* (2), *S. grandiflora* (1), *S. herbacea* (1), *S. macrophylla* (1), *S. quadrata* (2), *S. rostrata* (1), *S. sesban* (15), *S. virgata* (1) all from Colombia.

5.1.13 Sugar yielding crops: *Saccharum spontaneum* (89) from Thailand.

5.1.14 Narcotics and beverages: *Nicotiana tabacum* (25) from Iran and Zimbabwe; *Theobroma cacao* (52) from UK; *Humulus* sp (1) from USA.

5.1.15 Miscellaneous : *Lotus coribricensis* (5), *L. corniculatus* (30), *L. pedunculatus* (1) *L. uliginosus* (12) all from USA.

Transgenic material routed through NBPGR for quarantine clearance

- *Brassica juncea* var. DBN-322-1106 (EC 477203) – containing **BAR** gene, resistant to glufosinate ammonium and **BARSTAR** gene for restoration of male sterility from Belgium.
- *Cicer arietinum* (EC 469461-90) from Scotland containing polygalactourinase inhibiting protein genes from raspberry or kiwi fruit along with marker genes like **GUS** and **BAR** which express a protein imparting resistance to fungal pathogens (*Botrytis grey mould*); EC 469512-13 from Australia containing Bean alpha amylase inhibitor gene conferring resistance in chickpea against *Callasobruchus chinensis* a serious pest of stored grains.
- *Gossypium hirsutum* var. Cot-102, S-35 Cot

102-BC1, S-9 Cot 102-BC1 (EC 478226-28) containing **CIP-3** gene responsible for imparting resistance to the attack of boll worm and other common insects of cotton from USA.

- *Zea mays* (EC 483037-40) from USA containing gene for imparting insect resistance.

5.2 Export of plant genetic resources

The seed and planting material of agricultural and horticultural crops were exported on the basis of:

- requests received by the Bureau/ICAR headquarters.
- requests received from the scientist working in ICAR Institutes/Agricultural Universities in India under various protocols/workplans/memoranda of understanding with different countries/CGIAR institutes.

The plant material intended for export was procured from known Indian sources through correspondence and the same were forwarded to the indentors in foreign countries along with phytosanitary certificate issued by Plant Quarantine Division of the Bureau and export permit if any. The volume of export of seed/plant material during 2001 is indicated below:

Number of consignments exported	: 18
Number of requests registered	: 58
Number of countries to which material exported	: 11
Number of samples received/handled for export	: 100

The details of samples forwarded to various countries along with phytosanitary certificate are listed below:

- ### 5.2.1 Cereals, pseudo-cereals and millets :
- Oryza sativa* (14) to Ghana, Philippines and U.K., *Zea mays* (26) to Thailand and East Timor,

Triticum aestivum (12) to Australia and Mexico.

5.2.2 Grain legumes : *Vigna radiata*(1) to Sri Lanka.

5.2.3 Oilseed crops : *Arachis hypogaea* (3) to Vietnam., *Brassica* sp (7) to UK and Vietnam, *Helianthus annuus* (4) to Vietnam.

5.2.4 Fruit crops : *Prunus* sp (5) *Prunus domestica* (3), *Prunus persica* (6) all to USA; *Punica granatum*(1) to Sri Lanka, *Pyrus* sp (11), and *Pyrus communis* (3) to USA.

5.2.5 Vegetable crops : *Capsicum annuum* (1) to Taiwan.

5.2.6 Beverages : *Camellia sinensis* (3) to U.K.

5.2.7 Country-wise flow of PGRs from India to other countries : The relevant information on the nature of Indian genetic stocks exported to 11 countries during 2001 is as follows:

Australia (8) *Triticum aestivum*; Ghana (1) *Oryza sativa*; East Timor (23) *Zea mays*; Mexico (4) *Triticum aestivum*; Philippines (9) *Oryza sativa* ; Sri Lanka (2) *Punica granatum*; *Vigna radiata*; Taiwan (1), *Capsicum annuum*; Thailand (3) *Zea mays*; U.K. (9) *Brassica* sp, *Camellia sinensis*, *Oryza sativa*; USA (28) *Prunus* sp. *Prunus domestica*, *Pyrus communis*, *Pyrus* sp; Vietnam (12) *Arachis hypogaea*, *Brassica* sp, *Helianthus annuus*.

5.3 Inland supply of plant genetic resources

The seed and plant material of diverse agricultural and horticultural crops were supplied to ICAR institutes/co-ordinated projects, agricultural universities, farmers and private seed agencies in different states and union territories of India. Based on specific requests received, 10,608 accessions including promising collections/landraces/wild types were supplied under Material Transfer Agreement (MTA) by the division from active/working germplasm holdings. The details of germplasm supplied to various indentors is given in Table-1

Table 1 : Inland (national) supplies of germ plasma during 2001

Crop	No. of samples	State / Union territory
Cereals & millets		
<i>Aegilops</i> sp.	27	Haryana
<i>Hordeum vulgare</i> (Barley)	738	Uttranchal, Haryana, Uttar Pradesh, Rajasthan, Bihar, Delhi
<i>Oryza</i> sp. (Paddy)	296	Andhra Pradesh, Delhi, Kerala, Orissa, Tamil Nadu, Meghalaya
<i>Triticum</i> sp. (Wheat)	7265	Uttranchal, Haryana, Delhi, Madhya Pradesh, Himachal Pradesh, Rajasthan, Uttar Pradesh, Tamil Nadu, Bihar, Jharkhand, Delhi
<i>Tritosecale</i> (Triticale)	25	Madhya Pradesh
<i>Zea mays</i> (Maize)	10	Haryana
Oilseeds		
<i>Brassica campestris</i> var. <i>toria</i> (Toria)	11	Haryana
<i>Brassica juncea</i> (Mustard)	639	Delhi, Rajasthan, Punjab, Madhya Pradesh, Jharkhand, Uttranchal, Haryana, Jammu & Kashmir, Uttar Pradesh
<i>Carthamus tinctorius</i> (Safflower)	3	Haryana
<i>Eruca sativa</i> (Taramira)		
Grain legumes		
<i>Cyamopsis tetragonoloba</i> (Guar)	10	Haryana
<i>Dolichos uniflorus</i> (Kulthi)	15	Himachal Pradesh
<i>Glycine max</i> (Soybean)	20	Tamil Nadu
<i>Lathyrus sativus</i> (Lathyrus)	5	Orissa
<i>Lens esculenta</i> (Lentil)	89	Rajasthan, Uttar Pradesh, Haryana, Bihar, Delhi
<i>Macrotyloma uniflorum</i> (Horsegram)	72	Jharkhand, Rajasthan, Madhya Pradesh, Himachal Pradesh, Maharashtra, Bihar
<i>Pisum sativum</i> (Pea)	228	Uttar Pradesh, Rajasthan, Delhi, Haryana, Madhya Pradesh
<i>Phaseolus vulgaris</i> (Rajmah)	10	Uttranchal
<i>Vicia faba</i> (Broad bean)	21	Madhya Pradesh, Uttar Pradesh, Punjab, Himachal Pradesh, Bihar, Orissa
<i>Vigna aconitifolia</i> (Mothbean)	20	Rajasthan
<i>Vigna mungo</i> (Urd bean)	14	Rajasthan, Tamil Nadu
<i>Vigna radiata</i> (Mungbean)	135	Andhra Pradesh, Delhi, Uttar Pradesh
Vegetables		
<i>Abeimoschus esculentus</i> (Okra)	163	Gujarat, Tamil Nadu, Karnataka
<i>Allium sativum</i> (Garlic)	10	West Bengal
<i>Capsicum annuum</i> (Chilli)	29	Karnataka, Jharkhad, Delhi, Uttar Pradesh, Kerala, Maharashtra
<i>Lagenaria ciceraria</i> (Bottlegourd)	40	Uttar Pradesh, Uttranchal, Rajasthan
<i>Lycopersicon esculentum</i> (Tomato)	87	Uttranchal, Himachal Pradesh, Tamil Nadu, Andhra Pradesh, Jammu & Kashmir, Delhi, Uttar Pradesh, Kerala, Punjab
<i>Momordica charantia</i> (Bittergourd)	43	Gujarat, Haryana
<i>Solanum melongena</i> (Brinjal)	42	Delhi, Gujarat, Tamil Nadu
<i>Trichosanthes anguina</i> (Snakegourd)	15	West Bengal
Fruits		
<i>Musa</i> sp. (Banana)	56	Kerala, Delhi, West Bengal
<i>Ziziphus</i> sp. (Ber)	1	Jharkhand, Delhi
Spices and condiments		
<i>Curcuma domestica</i> (Turmeric)	10	Uttar Pradesh, Orissa
<i>Trigonella foenum graecum</i> (Fenugreek)	58	Maharashtra, West Bengal

<i>Zingiber officinale</i> (Ginger)	116	Orissa, Kerala
Other spices	15	Kerala
Under-utilized and under-exploited crops		
<i>Amaranthus</i> sp. (Amaranth)	123	West Bengal, Karnataka, Rajasthan, Orissa, Maharashtra, Haryana, Punjab, Uttar Pradesh, Tamil Nadu Jharkhand Delhi, Madhya Pradesh, Gujarat
<i>Cassia auriculata</i>	1	Kerala
<i>Fagopyrum esculentum</i> (Buckwheat)	15	West Bengal
<i>Psophocarpus tetragonolobus</i> (Winged bean)	15	Punjab
<i>Sesbania</i> sp. (Dhaincha)	16	Haryana
<i>Simmondsia chinensis</i> (Jjoba)	9	West Bengal, Rajasthan
<i>Terminalia</i> sp	1	Kerala
<i>Vigna umbellata</i> (Rice bean)	1	Uttar Pradesh
Fibre crops		
<i>Crotalaria</i> sp. (Sunn hemp)	12	Kerala
Plantation crops		
<i>Indigofera tinctoria</i> (Indigo)	1	Kerala
Beverages		
<i>Camellia sinensis</i> (Tea)	1	Meghalaya
Medicinal & aromatic plants		
<i>Andrographis paniculata</i>	5	Kerala
<i>Cymbopogon martini</i> (Palmarosa)	1	West Bengal
<i>Melia azadirachta</i> (Neem)	4	Delhi
<i>Ocimum sanctum</i> (Tulsi)	1	Uttar Pradesh
<i>Plantago ovata</i> (Isabgol)	5	West Bengal
<i>Plantago arenaria</i>	1	West Bengal
<i>Vetiveria zizanioides</i> (Vetiver)	2	West Bengal

Table 2 : Promising introductions made during 2001

Crop/Ec no.	Country	Important Traits	Distribution
Cereals and millets			
<i>Avena sativa</i> 469501-03	USA	Combined resistance to Crown rust, high grain yield, thin hulls	NBPGR, New Delhi
473800-801	USA	Variety chapman and florida with high grain and forage yield, early maturing	NBPGR, New Delhi
<i>Hordeum vulgare</i> 473169	USA	Consistent and highly resistant to barley stripe rust	NBPGR, New Delhi
473921	USA	Large grain and high protein, resistant to stripe rust	NBPGR, New Delhi
<i>Oryza sativa</i> 472985-3073	Philippines	CMS and maintainer lines	Advanta India Ltd, Raheja Chambers, Delhi
469595-97	Philippines	Line with wide compatibility gene	NBPGR Regional SLO-17
470264-84	Philippines	Breeding lines from Basmati crosses and new plant types	CARI, Portblair, A&N Islands
477711-725	Philippines	New plant types	NRL Plant Biotechnology, IARI, New Delhi

478048-51	Philippines	Sticky rice (Glutinous types)	PD, DRR, Hyderabad
<i>Pennisetum typhoides</i> 469936-945 470391-397	Nigeria	Early maturing, drought tolerant and dual purpose types	AICRP on Bajra, ARU, Bikaner
<i>Pennisetum typhoides</i> ssp <i>mentana</i> 473259	USA	Potential for increasing growth rate, resistant to rust, smut and leaf spot	NBPGR, Regional Station, Jodhpur
<i>Sorghum bicolor</i> 482670-97	USA	Male sterility and fertility restorer lines. Immediate application for basic research on effect plant colour, pericarp colour, high quality grain for food and fodder	Director, NRC Sorghum, Hyderabad
<i>Triticum durum</i> 478016-17	USA	Varieties AC Pathfinder and AC Navigator resistant to loose smut race T 26	PD, DWR, Karnal
<i>Triticum aestivum</i> 481176-76	USA	Variety Proweres and Prowes 99, Superior baking quality, resistant to soybean cyst nematode	PD, DWR, Karnal
467256-65	Mexico	Improved resistant to <i>Septoria</i> leaf blotchy to leaf rust	PD, DWR, Karnal
467680	USA	Variety harding – red winter with excellent survival and broad disease resistance	NBPGR, New Delhi
467720	USA	Variety scholar, red spring wheat, high protein, good yield, resistant to diseases	NBPGR, New Delhi
468366-68	USA	Varieties with high grain yield, superior and use quality, diseases	NBPGR, New Delhi
477993	USA	Superior bread making quality, high yield potential, resistant to stem rust	PD, DWR, Karnal
<i>Tritosecale</i> 467937	Canada	Variety Bobcat sprouting tolerant and resistant to stem rust and leaf rust	NBPGR, Regional Station, Bhowali
<i>Zea mays</i> 468257-285	Mexico	Early maturing and drought tolerant lines	Tirhut College of Agriculture, Dholi, Muzaffarpur
469504	USA	Sweet corn, insect resistant	NBPGR, New Delhi
466914-15	USA	Sources of resistance to leaf feeding by corn borer and army fall worm	NBPGR, New Delhi
470106-280	Mexico	High sugar content, green cob for roasting, elite lines	PD, DMR, New Delhi
Grain legumes			
<i>Glycine</i> sp 473111-138	Taiwan	Rust resistant and wild perennial lines Soybean, Indore	Director, NRC,
<i>Glycine max</i> 483041-61	USA	Lines resistant to foliar feeding, insect stem canker, high protein, genetic male sterility, low trypsin inhibitor lines, rust resistant, drought tolerant.	Director, NRC Soybean, Indore
<i>Glycine max</i> 468377-629	USA	Lines with rust resistance, root knot nematode resistance, drought and heat resistance. Soybean mosaic virus	Director, NRC Soybean, Indore

478225	USA	resistant, low lipoxygenase, multiple foliar disease resistant, downy mildew resistant Resistant to soybean cyst nematode	Director, NRC Soybean, Indore
473265-3288	Taiwan	Vegetable purpose types and rust resistant lines	Director, NRC Soybean, Indore
<i>Phaseolus vulgaris</i> 467266	Canada	High yielding, early maturing cultivar	NBPGR, New Delhi
Oilseeds			
<i>Arachis hypogaea</i> 470030	Sudan	Bunch variety, bold seeded	ICRISAT
<i>Brassica nigra</i> 472729-2738	Germany	Genotypes resistant to <i>Alternaria blight</i>	Deptt. of Plant Breeding, PAU, Ludhiana
Sugar yielding			
<i>Saccharum</i> sp. 467345-433	Thailand	Wild species <i>Saccharum spontaneum</i>	SBI, Coimbatore
Spices & Condiments			
<i>Coriandrum sativum</i> 467681-7690	USA	Long duration types	NBPGR
Fruits			
<i>Hippophae rhamnoides</i> 468632-33	Russia	High Vitamin C content	Organizing secretary, Directorate of Research, HPAU, HP
<i>Ribes</i> sp. 469984-95	USA	Different species viz. <i>R. formosum</i> , <i>R. lobii</i> , <i>R. bracteatum</i> , <i>R. roezlii</i> , <i>R. wolfii</i> , Golubka open pollinated, <i>R. aireum</i> , <i>R. alpinum</i> , <i>R. pentlandii</i> , <i>R. tristeeklatt</i> , <i>R. burefense</i>	NBPGR, Regional Station, Shimla
<i>Rubus</i> sp. EC-469946-59, 469996-470014	USA	Different varieties with improved characters viz., Columbian, Darrow, Smooth stem, Eldorado IDX, Burbank thornless, Austin thornless. Different <i>Rubus</i> species- <i>R. ikenoensis</i> , <i>R. flageilaris</i> , <i>R. minisculus</i> , <i>R. kawakami</i> , <i>R. lasiostylus</i> , <i>R. precox</i> , <i>R. echinatus</i> , <i>R. erythrops</i> OP selection, <i>R. grabowskii</i> (<i>thrysoideus</i>), <i>R. canascens</i> (<i>tomentosus</i>), <i>R. chingii</i> , <i>R. plicatus</i> , <i>R. hillii</i> , <i>R. bogotensis</i> , <i>R. megalococcus</i> , <i>R. collumellaris</i> , <i>R. briaceus</i>	NBPGR, Regional Station, Shimla
<i>Vaccinium</i> sp. EC-469960-82, 470016-23	USA	Different varieties with improved characters -Grover, Pacific, Rubel, Stanley, Weymouth, Cabot, Blomidon, Olympia, Angola, Bounty, Koralle, Cape fear, Northland, Ornablue and Red Pearl and <i>Vaccinium</i> species- <i>V. hirtum</i> , <i>V. fuscatum</i> (<i>artococcum</i>), <i>V. parvifolium</i> , <i>V. myrtilus</i> , <i>V. macrocarpon</i> , <i>V. neilgherrense</i> , <i>V. amoenum</i> NC 95-6-1	NBPGR, Regional Station, Shimla

Research Projects (Project leader; Associates)

1. Exchange of plant genetic resources with foreign countries (import and export) and inland (national) supplies of the germplasm and related information to scientists/ users in the country (R. V. Singh, Deep Chand, Nidhi Verma, Vandana Tyagi, S. P. Singh)
2. Assembly of literature and preparation of crop inventories on plant genetic resources (R. V. Singh, Deep Chand, Nidhi Verma, Vandana Tyagi, S. P. Singh)
3. Preparation of bibliography on plant genetic resources (R. V. Singh, Deep Chand, Nidhi Verma; Vandana Tyagi, S. P. Singh).
4. Documentation and dissemination of information on imported and collected germplasm in the form of plant introduction reporter (R. V. Singh, Deep Chand, Nidhi Verma, Vandana Tyagi, S. P. Singh).

6. TISSUE CULTURE AND CRYOPRESERVATION UNIT

Summary: During the year, a total of 1,196 accessions of different tuber and bulbous crops, spices, plantation and new industrial crops, fruits, medicinal, aromatic and rare/endangered plants were maintained *in vitro* and sub-cultured at regular intervals and conserved under culture room conditions as well as at low temperature. Attempts continued towards devising suitable plantlet regeneration and conservation protocols in different species. *In vitro* cultures of *Allium* spp., *Piper colubrinum* and *Simmondsia chinensis* were processed for cryopreservation whereas cryopreservation and subsequent plantlet regeneration was achieved in *D. floribunda* and *D. deltoidea*. Regarding studies on genetic stability, comparison of RAPD profiles between *in vivo*- and *in vitro*-conserved germplasm of *Curcuma* was done and no significant variation was observed between the two. A total of 4,043 accessions of orthodox, intermediate and recalcitrant seed species were conserved in the cryobank.

The objectives of TCCU are *in vitro* conservation and cryopreservation of germplasm and monitoring genetic stability of *in vitro* conserved germplasm. Salient achievements during the year are described below:

6.1 *In vitro* conservation and cryopreservation

A total of 1,196 accessions of different crop plants were maintained *in vitro* and sub cultured at periodic intervals as shown in Table 1. The new accessions added in the repository during the year include: *Aegle marmelos* (1), *Allium sativum* (11), *Colocasia esculenta* (33), *Curcuma* (8), *Dioscorea* species (20), *Morus* sp. (1), *Musa* (45), *Zingiber* (20), and medicinal and aromatic plants (8).

6.1.1 Banana and plantains : A total of 360 accessions of *Musa* were conserved as *in vitro* cultures at 25°C and 16/8 hr photoperiod regime. The average subculture period in these conditions varied from 6-12 months, depending on the genotype. An important aspect of the conservation protocol is that the medium for conservation (MS salts + 10µMBAP + 1µM IAA) is common for all the accessions.

Under the IPGRI-ICAR MoU for Workplan on Banana Research and Development, 16 new banana genotypes were procured, as proliferating

cultures, from the International Network for Improvement of Banana and Plantain (INIBAP), Transit Center at Belgium. These accessions comprised improved synthetic hybrids and germplasm. The new synthetic hybrids introduced are CRPB 39, FHIA 02, FHIA 18, FHIA 21, FHIA 25, PV 42-320, TMB x 1378, TMB2 x 9128-3, TMB3 x 15108-6, TMP2 x 2829-62 and SH-3640. New germplasm introduced were Pisang Berlin, Pisang Ceylan, Pisang Jari Buaya, Pisang Lilin and Williams (Bell South Johnstone). All the material was multiplied and conserved as *in vitro* cultures.

Under the National Agriculture Technology Project on Plant Biodiversity [NATP (PB)], 29 new accessions of banana were added to the *in vitro* repository during the year. A total of 62 accessions of banana have been conserved *in vitro* under the NATP project. These comprise landraces and cultivars collected by the NRC on Banana, Trichy from states of Andhra Pradesh, Assam, Bihar, Gujrat, Karnataka, Kerala and Tamil Nadu.

6.1.2 Bulbous crops : In *Allium hookeri*, procured from Bhowali Regional Station, multiple shoots were obtained using bulbed shoot bases as explants on growth regulator - supplemented media. Shoot elongation occurred on the same medium in which shoot multiplication occurred.

Experiments were initiated to induce rooting of micropropagated shoots on basal as well as on growth regulator - supplemented media. In *A. senescens*, multiple shoots obtained on cytokinin-supplemented media, were rooted on hormone-free or on growth regulator- supplemented media and regenerants were transferred to pots for establishment in the soil. In the *Gladiolus* cultivar procured from Bhowali, shoot bud initiation, multiplication and elongation occurred on the same medium i.e. MS semi-solid medium supplemented with BAP. Shoots, though, exhibited rooting on MS basal medium but roots appeared very fragile. Efforts continued in the *Gladiolus* cultivar to obtain healthy roots following implantation of shoots on various media.

To assess the impact of infection on the status of *in vitro* cultures following fumigation of the culture room, efforts were made to salvage the infected germplasm of *Allium* spp. following fungicide treatment. Cultures which were salvaged were multiplied for maintenance under culture room conditions as well as at low temperature.

All the 11 accessions of *A. sativum* received under NATP (PB), were introduced *in vitro*. Of these, 6 accessions were established in culture with the rest exhibiting poor growth. Various accessions produced only one shoot per explant. *In vitro* bulblets were formed with many accessions exhibiting bulblet dormancy upto 50 - 80%. Efforts were made to multiply one shoot each of various accessions (6) as also of those exhibiting poor growth. *In vitro* bulblets were subjected to various treatments to break the dormancy. One accession of *Allium* species obtained from Thrissur, was introduced *in vitro*. Experiments continued on *Allium* spp. regarding effect of various pre-freezing treatments for standardization of encapsulation - dehydration and vitrification techniques.

6.1.3 Medicinal, aromatic and rare /

endangered plants : *In vitro* clonal multiplication and conservation experiments continued in several medicinal and aromatic and rare/endangered plants. A total of 23 accessions of various species- *Aconitum violaceum* (1), *Coleus forskohlii* (10), *Chlorophytum* sp. (1), *Pogostemon patchouli* (2), *Rauwolfia serpentina* (6), *R. canescens* and (1) and *Tylophora indica* (2) were re-established following fungicide and sterilant treatments.

Germplasm of 24 accessions of 17 species received from various sources was processed for initial *in vitro* establishment and 6 accessions were grown in pots for introducing them in culture during the period reported upon. Of these, 18 accessions are in different stages of *in vitro* establishment and multiplication. New accessions added to the repository include: *Digitalis lanata* (1), *Kaempferia rotundata* (2), *Plumbago zeylanica* (2), *Swertia chirayita* (1), *Tylophora indica* (1) and *Valeriana wallichii* (1).

In a new species, *Kaempferia rotundata*, multiple shoots were obtained from shoot base explants on growth regulator-supplemented media. In *Plumbago zeylanica* various combinations of growth regulators are under testing to obtain optimum shoot multiplication. In *Bacopa* and *Aconitum*, multiple shoots were obtained. Efforts continued to improve and standardise shoot multiplication and *in vitro* rooting. Maintenance of existing cultures of various species continued through transfer/subculture (4-24 months) either under culture room conditions and/or at low temperature, after treatment with the fungicide and the sterilant.

6.1.4 Spices, plantation and new industrial crops : A total of 271 accessions comprising 172 of *Zingiber* species, 61 of *Curcuma*, 7 species of *Piper*, 5 each of *Elettaria* and *Vanilla planifolia*, 12 of *Simmondsia chinensis* (6 each of male and female), 8 of *Humulus lupulus* and one of *Fagara schinifolia*, were maintained under short- to medium-term storage.

Table 1. Status of *in vitro* conservation of germplasm in TCCU (as on December 31, 2001)

Crops	Storage temp. (°C)	Optimum subculture interval (months)	Accessions in culture (No.)
Tuber crops			
<i>Alocasia</i> spp.	25	10	1
<i>Colocasia esculenta</i>	25	8-10	63
<i>Dioscorea</i> spp.	25	8-12	43
<i>Ipomoea batatas</i>	25	8-12	230
<i>Xanthosoma sagittifolia</i>	25	10	3
Bulbous crops			
<i>Allium sativum</i>	25,4	6-12	97
<i>Allium</i> spp.	25,4	6-22	14
<i>Gladiolus</i> cultivar	-	-	1
Spices & industrial plants			
<i>Curcuma</i> spp.	25	6-10	61
<i>Elettaria</i> spp.	25	15	5
<i>Fagara schiniifolia</i>	25	6	1
<i>Humulus lupulus</i>	25	-	8
<i>Piper</i> spp.	25	10-22	7
<i>Vanilla planifolia</i>	25	6	5
<i>Simmondsia chinensis</i>	25	6	12
<i>Zingiber</i> spp.	25	8-24	172
Fruits			
<i>Musa</i> spp.	25	8-12	360
<i>Actinidia chinensis</i>	25	8	3
<i>Fragaria</i> spp.	25	8-10	20
<i>Prunus</i> sp.	25	4	2
<i>Rubus</i> spp.	25	8-10	5
<i>Malus</i> spp.	25	3-4	2
<i>Morus</i> sp.	25	8-10	1
Medicinal /aromatic plants			
<i>Aconitum violaceum</i>	-	-	1
<i>Bacopa monnieri</i>	25	6	1
<i>Coleus forskohlii</i>	25	12	10
<i>Cholorophytum</i> sp.	-	-	1
<i>Digitalis</i> spp.	4	11	6
<i>Eremostachys superba</i>	25	6	2
<i>Gentiana kurroo</i>	4	12	1
<i>Kaempferia rotundata</i>	-	-	2
<i>Mentha</i> sp.	25	12	22
<i>Picrothiza kurroa</i>	4	12	4
<i>Plumbago zeylanica</i>	-	-	2
<i>Pogostemon patchouli</i>	25	12	2
<i>Pycnanthemum</i> spp.	25	6	4
<i>Rauvolfia serpentina</i>	25	22	6
<i>Rauvolfia canescens</i>	25	22	1
<i>Rheum moorcroftianum</i>	4	12	1
<i>Saussurea lappa</i>	4	12	2
<i>Swertia chirayita</i>	4	6	3
<i>Tylophora indica</i>	25	12	3
<i>Valeriana wallichii</i>	4	12	5
Others			
<i>Cicer microphyllum</i>	-	-	1
Total			1,196

The average subculture period is 8 and 24 months for *Zingiber* species (for shoots and *in vitro* rhizomes, respectively), 6-10 months for *Curcuma* species, 12-24 months for *Piper* species, 14-15 months for *Elettaria* species, 18-22 months for *Vanilla planifolia*, 8-15 months for *Simmondsia chinensis* and 12 months for *Humulus lupulus*.

Germplasm was added to the *in vitro* repository under the NATP (PB) and these comprised ginger (20 accessions) and *Curcuma* (8 accessions). As a follow-up action of the decision of the Staff Research Council meeting, *in vitro*-conserved germplasm of ginger and turmeric is to be transferred to the newly established *in vitro* repository at NBPGR Regional Station, Thrissur. In this regard a total of 160 accessions of ginger, along with the protocols, were transferred, from Delhi to Thrissur, in a phased manner.

A new protocol for rapid regeneration of *Piper* was developed. Direct shoot regeneration was obtained from leaf segments and internode explants of *Piper colubrinum*, *P. hapnium*, *P. longum* and *P. nigrum*. A total of 6-25 shoots/explant regenerated on MS supplemented with high concentration of BA and low concentration of IAA. Rooting occurred on half-strength MS medium. In *S. chinensis*, rooting was achieved in 30-35% shoots on MS+IBA. Pulse treatment of IBA was better and rooting could be increased to about 40-70%.

Experiments on cryopreservation of *Piper colubrinum* and *Simmondsia chinensis* were continued using vitrification and encapsulation-dehydration techniques. No success was achieved in *P. colubrinum*. In *S. chinensis*, however, using encapsulation-dehydration method, 30-35% survival was achieved after liquid nitrogen treatment. Vitrification method yielded upto 50% survival.

6.1.5 Temperate and minor/ under-utilized

tropical fruit crops : A total of 33 accessions namely *Actinidia* (3), *Fragaria* (20), *Malus* (2), *Morus* (1), *Prunus* (2) and *Rubus* (5) were maintained under short- to medium- term storage. The cultures were maintained at 25°C and subcultured at 4-10 months interval. Accessions of *Fragaria* stored at 4°C resumed normal growth and were successfully multiplied under culture room conditions.

Five new accessions of mulberry collected from Issapur Farm, New Delhi were established under tissue culture conditions. Protocol was developed for conservation of *in vitro* cultures of *Morus*, which were successfully conserved for 10 months at 25°C. One accession of *Aegle marmelos* was established *in vitro*. Experiments are continued to have an efficient multiplication protocol.

6.1.6 Tuber crops : A total of 148 accessions of different tuber crops such as taro (95) and various edible (51) and medicinal (2) species of *Dioscorea* have been procured/ received from various sources such as Central Tuber Crops Research Institute (CTCRI), Trivandrum; Dr. Y.S. Parmar University of Horticulture and Forestry, Solan; Directorate of *Cinchona* and other Medicinal Plants, Calcutta; National Research Centre on Groundnut (NRCG), Junagadh; NBPGR, Regional Station, Thrissur and through Germplasm Handling Unit, NBPGR. Of these, a total of 56 accessions have been established and maintained *in vitro*. These include: *Colocasia esculenta* (33 accessions), *Dioscorea rotundata* (10 accessions), *D. bulbifera* (6 accessions), *D. alata* (3), *D. deltoidea* (1), *D. prazeri* (1) and *Arachis* spp., (2).

Micropropagation protocols for two new medicinally important species of *Dioscorea* namely *D. deltoidea* and *D. prazeri* have been developed using axillary buds. Micropropagation protocol has also been standardized for two wild species of groundnut namely *Arachis duranensis* and *A. kretschmeri*.

Cryopreservation protocol was developed for a new edible yam (*Dioscorea rotundata*), using shoot tips. Application of vitrification and encapsulation-dehydration techniques resulted in high frequency regeneration (65%) from cryopreserved explants. Protocol for cryopreservation of *in vitro* shoot tips of *D. pentaphylla*, an edible wild species was developed. In case of *D. bulbifera*, cryopreservation protocol was standardized using somatic embryos/embryogenic tissues. Encapsulated-dehydrated embryogenic tissues showed 75% survival and 53% regeneration after cryopreservation.

In sweet potato, cryopreservation protocol has been standardized using somatic embryos/embryogenic tissues. Encapsulation-dehydration followed by slow pre-freezing resulted in 65% survival and the regenerated plants were transferred to the field.

Cryopreservation protocols using shoot tips have also been developed for two important medicinal yams such as *D. floribunda* and *D. deltoidea*. Both vitrification and encapsulation-dehydration techniques were equally effective for both the species and plant regeneration from cryopreserved shoot tips recorded were 30% and 80% respectively. As *D. deltoidea* is the most important indigenous, endangered medicinal yam, it is a significant achievement that cryopreservation protocol has been developed and the material has been cryopreserved for more than nine months till date.

6.1.7 Other important crops : In *Cicer microphyllum*, an important cold-tolerant wild species, *in vitro* cultures were maintained under standard culture room conditions as well as at low temperature.

6.2 Monitoring genetic stability of in-vitro conserved germplasm

Isozyme analysis was carried out for 14 species

and 21 morphotypes of *Curcuma* for eight enzymes. The data was analysed through NTSYS PC programme and a dendrogram constructed for the characterization of *Curcuma* germplasm. Three distinct groups were observed based on their similarity index.

Genetic stability was studied for *in vitro*-conserved germplasm of *Curcuma* by comparing it with the *in vivo* conserved material of the same accession using biochemical and molecular methods. Isozyme analyses of acid phosphatase, esterase, peroxidase, superoxide dismutase, malate dehydrogenase, glutamine synthase and glutamate dehydrogenase enzymes showed no variation between *in vitro*- and *in vivo*- conserved germplasm of *Curcuma* (21 morphotypes). Using 30 random primers, RAPD analysis was done in 14 species and 21 morphotypes of *Curcuma*. Of the tested primers, 20 gave 5-8 polymorphic bands. Comparison of RAPD profiles between *in vivo*- and *in vitro*-conserved germplasm of *Curcuma* was done and no significant variation was observed between the two.

6.3 In vitro germplasm supply

A total of 79 accessions of banana were supplied as *in vitro* cultures to various institutes including National Research Centre for Banana, Trichy (60 accessions), Kerala Agriculture University, Kannara (18 accessions) and Tata Energy Research Institute, New Delhi (1 accession). This was primarily for field trials and evaluation of banana germplasm introduced from INIBAP. Eleven accessions of *Fragaria*, two of *Actinidia* and one of *Prunus domestica*, in the form of potted plants, were transferred to NBPGR Regional Station, Bhowali, for field evaluation.

6.4 Seed Cryopreservation

Seed morphological studies have been carried out in *Garcinia indica* and *G. gummi-gutta*. Desiccation and freezing sensitivity studies were carried out to determine the degree of

recalcitrance. Both these species have been found to be highly recalcitrant in nature. *In vitro* establishment of both the species was done through adventitious bud proliferation. Histological studies on regenerated plantlets were conducted. Seeds of 85 accessions of wild species of *Vigna*, *Abelmoschus*, *Cucumis* and *Sesamum* were cryostored. Intermediate seed species of black pepper (21 accessions) and papaya (59 accessions) were processed for cryostorage. A total of 36 varietal materials were also cryostored. Status of cryopreserved germplasm is given in Table 2.

Under the NATP Project on "Cryopreservation of Agrobiodiversity" more than 300 accessions of various species were received and processed for cryostorage. A total of 37 accessions of medicinal and aromatic plant species were also cryostored. A collaborative exploration was conducted with NRC *Citrus*, Nagpur and 23 accessions of 6 *Citrus* species were collected from Bundelkhand area of UP and MP and processed for cryostorage. A total of 13 *Citrus* germplasm procured from NRC *Citrus*, Nagpur were also cryostored using seeds and excised embryonic axes. Regular monitoring of viability was done for several plant species e.g. papaya, *Digitalis*, *Citrus* sp., and various medicinal and aromatic plants.

Under the NOVOD sponsored project on "Storage of diverse neem germplasm using cryopreservation" more than 350 neem

Table 2. Status of cryopreserved germplasm in TCCU (as on December 31, 2001)

Categories	Accessions
Cereals	134
Millets and forages	202
Pseudo-cereals	59
Grain legumes	435
Oilseeds	211
Fibre crops	23
Vegetables	268
Fruits & nuts	567
M&AP	494
Narcotics	23
Spices & condiments	70
Plantation crops	4
Wild species	97
Agroforestry species	1456
Released varieties	160
Total	4,043

accessions were received from 7 National Neem Network Collaborators. Viability and moisture content determination was done and samples with high viability were processed for cryostorage mainly in the form of seed and also as embryonic axes.

Studies seed storage behaviour have been attempted in materials collected from different zones. Several species exhibited intermediate seed storage behaviour. Neem samples stored at -180°C, -20°C and at room temperature have been retested for viability and vigour at six months interval. A total of 75 samples were retested and data compared for various agroclimatic zones.

Research Projects (Project leader; Associates)

1. Conservation of economically important plants and their wild relatives using *in vitro* conservation and cryopreservation (Rekha Chaudhury)
 - 1.1 *In vitro* conservation of tuber crops with special reference to sweet potato, yams and taro (B. B. Mandal; Zakir Hussain)
 - 1.2 *In vitro* conservation of spices, plantation and new industrial crops (R. K. Tyagi)
 - 1.3 *In vitro* conservation of bulbous, vegetable and ornamental crops and their wild relatives (Ruchira Pandey)
 - 1.4 *In vitro* conservation of medicinal, aromatic and rare/endangered plant species (Neelam Sharma)

- 1.5 *In vitro* conservation of tropical fruit crop species and their wild relatives (Anuradha Agrawal; D. B. Parakh (till May, 2001))
- 1.6 *In vitro* conservation of temperate and minor/under-utilized (tropical) fruit crops (Sandhya Gupta; D. B. Parakh (till May, 2001))
- 1.7 Cryopreservation of germplasm in various forms using liquid nitrogen (Rekha Chaudhury)
- 1.8 Investigations on seed storage behaviour and cryopreservation of economically important tree species (S. K. Malik)
- 1.9 Studies on genetic stability of *in vitro* conserved germplasm (R. K. Tyagi; Zakir Hussain)

7. NRC ON DNA FINGERPRINTING

Summary: AFLP analysis of barley, pearl millet, *Sorghum*, pigeonpea, mungbean, soybean, safflower, cotton, chickpea, mango, cashew, citrus, neem, banana and vetiver was carried out. During the year, a total of 494 cultivars were fingerprinted in these crops. RAPD analysis was carried out on 17 pearl millet, 37 *Sorghum*, 31 pigeon pea, 37 chickpea, 34 chillies and 19 cashew cultivars and in selected accessions.

7.1 DNA Fingerprinting

7.1.1 Sorghum: STMS analysis was carried out in 37 sorghum cultivars using six fluorescence labelled primer pairs and amplification products were resolved on automated sequencer. Data analysis was completed for three STMS markers which showed 8, 10 and 9 alleles in the size range of 172-186, 161-177 and 116-132 bp, respectively. Heterozygous allelic condition was observed in most of the hybrids and nearly all the hybrids could be clearly assigned to their respective parents.

AFLP analysis was initiated in *Sorghum*. A total of 64 primer pairs were screened for optimum amplification and good polymorphism and 21 were selected. An analysis of 29 *Sorghum* genotypes was completed with the 21 selected primer pairs. High polymorphism was revealed and Jaccard's similarity coefficient ranged from 0.29 to 0.78. All the male sterile lines were closely placed with the respective maintainer lines and most of the hybrids were grouped with at least one of their parents in the dendrogram.

7.1.2 Pearl millet: RAPD analysis was carried out in 17 pearl millet cultivars using 37 decamer random primers. Out of 226 bands, 126 (55.8%) were polymorphic. Jaccard's similarity coefficient values ranged from 0.74 to 0.95 revealing moderate polymorphism.

Fifteen pearl millet cultivars were analyzed using AFLP markers. Out of 64 primer pairs screened, 21 were selected for analysis. A total

of 2,681 bands were generated of which 2,519 (93.9%) were polymorphic. A higher per cent polymorphism was obtained using AFLP markers as compared to RAPD analysis. However, the clustering pattern in the dendrograms obtained in the two studies was similar as the hybrids were closely placed with at least one of the parents.

7.1.3 Barley: AFLP analysis was initiated in barley cultivars during the year. The AFLP protocol was optimized using automated sequencer. A total of 64 combinations were screened using three barley cultivars for selecting the most useful primer pairs. Thirty primer pairs, which gave optimum amplification and moderate to high polymorphism were selected for subsequent analysis.

7.1.4 Pigeonpea: Protocol for the AFLP analysis in pigeonpea was optimized on automated sequencer. Sixty-four primer-pairs were surveyed for three cultivars and primer pairs that gave optimum amplification, were selected. A total of 27 cultivars of pigeonpea have been analyzed with 15 primer pairs. Low genetic differences were observed among the cultivars. Analysis of data is in progress. RAPD analysis was completed in 31 cultivars of pigeonpea using 23 random primers. High genetic similarity was observed in the cultivars analyzed.

7.1.5 Chickpea: RAPD and AFLP fingerprinting of 37 accessions/cultivars have been completed. STMS fingerprinting technique has been used to further characterize these accessions. Eleven

AFLP primer combinations have been used to fingerprint all the accessions/cultivars. Four combinations were highly informative, as 90% of the total bands generated by these primers were polymorphic. Twelve microsatellite primer combinations were used to further analyze all accessions/cultivars, total 31 alleles were scored, of which 29 were polymorphic, indicating high degree of polymorphism detected by the microsatellites. Chickpea accessions/cultivars were screened with 100 random primers, of which 40 primers revealed polymorphism. Out of 432 products amplified by 40 polymorphic primers, 61 were polymorphic. Genetic similarity was calculated based on Jaccard's coefficients. Among the three techniques used for fingerprinting of chickpea, microsatellite markers detected highest degree of polymorphism, whereas AFLP markers showed highest effective multiplex ratio. The study demonstrates that both AFLP and microsatellites markers are highly efficient in revealing genetic polymorphism.

7.1.6 Soybean: The 64 commercially available AFLP primer pairs were screened using three selected soybean cultivars. Twelve most informative primers were selected and used to analyze 78 released and notified soybean cultivars. The results indicated presence of very low genetic differences among the cultivars. Further detailed statistical analysis of the data is in progress.

7.1.7 Safflower: AFLP protocol was optimized for safflower. A total of 64 primer combinations were screened and 15 primer pairs were selected for the analysis. Fourteen safflower cultivars were analyzed using these 15 primer pairs. Data analysis is in progress.

7.1.8 Cotton: AFLP analysis of diploid cotton cultivars was continued and six primer pairs were used for analysis of 17 cultivars. A total of 751 markers were obtained using these six primer-pairs, generating 70% polymorphism. Primer

combination E-ACT/M-CTT distinguished the maximum number of cultivars (10) by producing cultivar specific markers. All the cultivars except one could be distinguished from one another using this set of six primer-pairs. In another study, 32 cultivars of cotton were analyzed using six AFLP primer-pairs and the study is underway for more primers and data analysis will be carried out subsequently.

7.1.9 Chilli: Amplification of ISSR regions in chilli was completed using five more primers – (GACAC)₄, (AGG)₅, (TCC)₅, (GTG)₄ and (GTG)₆. A comparison of the RAPD, ISSR, and AFLP markers to characterize thirty-four accessions of chilli found the ISSR markers to be most efficient in detecting polymorphism. Whereas each of the AFLP primer pairs could individually distinguish all the 34 accessions, a combination of three ISSR primers, (GATA)₄, (CCTA)₄, (ACTG)₄ and three random primers OPH1, OPP6, OPA12 were sufficient to discriminate all the accessions by the respective techniques.

Species specific polymorphic bands generated by ISSR primers were cloned into vector pGEM T Easy. These would be subsequently sequenced for designing primers for SCAR analysis.

7.1.10 Citrus: DNA fingerprinting of *Citrus* was carried out in thirty-four accessions that included ten species. Following primer screening, AFLP of these accessions was carried out using fifteen primer-pair combinations. While detailed analysis of the data is in progress, initial results indicate that the rough lemon types, the oranges and the pomellos can be differentiated using the AFLP markers.

7.1.11 Mango: Twenty-three commercially important cultivars were analysed for marker diversity using 15 AFLP primer pairs and twelve ISSR primers. AFLP generated 1528 markers ranged from 50-450 bp. All the cultivars were

discriminated efficiently. (GACA)₄ alone could distinguish all but two cultivars Amrapali and Neelam.

7.1.12 Cashew: ISSR analysis of 19 samples was carried out using additional three primers. Altogether, twelve ISSR primers produced 171 bands of sizes ranging from 200 bp to 2800 bp with a mean of 14.3 bands per primer. The number of polymorphic markers per primer ranged between 2 and 24, with a mean of 10.5. In all, 73.7% ISSR markers were polymorphic. Polymorphism was low compared to other techniques since ISSR generated greater number of markers that were common between pairs of accessions. The average JSC was 0.711 and range was from 0.489 to 0.899. UPGMA cluster analysis of pairwise similarity estimates generated dendrogram that separated all the 19 accessions. The consensus trees obtained subsequent to bootstrap analysis clearly positioned *A. pumilum* accession as an outgroup.

A second set of 143 accessions comprising released varieties, obsolete varieties, farmers' cultivars, elite breeding lines and unique genotypes were collected from NRC Cashew, Puttur. Fluorescent AFLP analysis of these samples using three selected primer-pairs was carried out. Conversion of AFLP peak data into binary data and statistical analysis is in progress.

7.1.13 Banana and plantain cultivars: AFLP analysis of 126 accessions of banana and plantains representing 92 distinct cultivars was completed using 12 most informative primer pairs. The results indicated that all the cultivars could be distinguished from each other by the AFLP profiles developed. The primers selected were also suitable for diversity analysis. The efficiency of AFLP technique to distinguish closely related cultivars of *Musa* was demonstrated.

The range of Jaccard's pair-wise similarities between the accessions ranged from 0.150-0.813 and the mean PIC values per primer pair ranged

between 0.270-0.340. The UPGMA dendrogram indicated presence of high genetic diversity among AAB and ABB genome of *Musa* cultivars. Analysis of over 34 accessions of six cultivars collected from different banana growing regions indicated the presence of considerable extent of intra-cultivar variation in banana.

7.1.14 Neem: Eight exotic neem accessions collected from Arid Forest Research Institute, Jodhpur, Rajasthan and 14 indigenous accessions collected from western part of India were analyzed with 15 AFLP primer combinations. Six combinations were highly informative, as more than 90% of the total bands generated by these primers were polymorphic. Jaccard's similarity coefficient based on 15 primer combinations showed a genetic distance of 0.208 to 0.897 existing among the accessions. Dendrogram generated by UPGMA cluster analysis based on Jaccard's coefficient, indicates that exotic lines grouped together and formed separate cluster, which indicates that Indian neem gene pool is different from exotic.

7.1.15 Vetiver: Nineteen accessions of vetiver were also analyzed with 20 AFLP primer combinations. Jaccard's coefficient based on nine primer analysis shows a genetic distance of 0.20 to 0.70 existing among the accessions.

7.2 Genetic diversity in eggplant (*Solanum melongena*) and its related wild and weedy taxa using isozyme analysis-ICAR adhoc project

Isozyme analysis in nine *Solanum* accessions belonging to *S. melongena*, *S. incanum*, *S. insanum* and *S. macrocarpon* was carried out using five enzyme system viz., aspartate aminotransferase (AAT), glutamate dehydrogenase (GDH), shikimate dehydrogenase (SKDH), glucose phosphate isomerase (GPI) and triose phosphate isomerase (TPI). These accessions alongwith 14 others studied earlier for allozyme

variation revealed low polymorphism in the cultivated eggplant varieties. Consequently, it was not possible to differentiate varieties on the basis of enzyme profiles. Hence, PCR-based RAPD and ISSR techniques were used for fingerprinting 40 accessions belonging to seven species. Thirty selected decamer primers generated 456 amplification products of different sizes ranging from 290 bp to 3kb. Each RAPD primer produced on an average 15.2 bands, of which 89.2% were polymorphic. In the ISSR analysis, a total of 157 bands were obtained with 10 microsatellite repeat sequences. These results revealed significant molecular polymorphism among the eggplant varieties and the possibility of their successful discrimination on the basis of molecular profiles.

7.3 Molecular characterisation of promising germplasm of cotton-ICAR Project on Technology Mission on cotton

DNA from 17 advanced lines of cotton (*G. hirsutum*) procured from Division of Genetics, IARI, New Delhi, was isolated following CTAB method. The isolated DNA was purified and quantified. Six AFLP primer-pairs were tested for the purpose of molecular characterizations across these 17 lines and these were E-CTT/M-ACT, E-CTT/M-AAG, E-CTT/M-AGC, E-CTA/M-ACT, E-CTA/M-AAG and E-CTA/M-AGC. More primer-pairs will be tested and the data generated will be analyzed using suitable statistical software.

7.4 Molecular detection of transgenes - DBT* Project

Designing of molecular probes for testing of transgenic material with polymerase chain reaction (PCR), Southern Hybridization and Northern Hybridization has been standardized for *Kanamycin*, *Bar*, *Barnase* and *Barstar* genes. Molecular probe for detection of a component of terminator genes (*cre* sequences) has been designed. Threshold level (minimum copy no.

which can be detected using agarose gel with ethidium bromide stain) for detection of transgenes varies with the size and the complexity of the genome. For example, study carried out in our lab showed that in case of tobacco with genome size (4221-4646Mb), minimum 200 copies can be detected whereas in rice having smaller genome size (565Mb), minimum 20 copies can be detected. The threshold level of marker gene *hyg*, *nptII* and *gus* has been optimized in transgenic soybean, rice, tobacco and mustard.

Detection of *npt II* gene in transgenic *Glycine max* (CP4 EPSPS, *aad* and *npt II*) and *barnase* and *barstar* genes in transgenic *Brassica juncea* (*bar*, *barnase* and *barstar*) has been confirmed. Experiments are under progress with transgenic crops such as rice, maize and chickpea using primers for CaMV 35S promoter.

7.5 Development of molecular markers for the study of genetic diversity in sesame - DST Project

Genetic diversity analysis: Sixty-four AFLP primer combinations were screened. Data was analyzed and nine most informative primers were selected for further analysis. The analysis of 322 accessions of the core set and a random sample of 48 accessions has been completed. The data scoring and analysis is in progress.

7.6 Molecular marker assisted gene tagging in chickpea (*Cicer arietinum* L.) for genetic enhancement-NATP Project

For tagging a gene conferring resistance to soil-borne *Fusarium* wilt disease using molecular markers, 126 recombinant inbred lines (RILs) alongwith their parental lines ICCV 2 (*Fusarium* wilt resistant) and JG 62 (wilt susceptible) were procured from ICRISAT, Hyderabad. All the 126

RILs and their parents were sown in the glasshouse of NBPGR, and DNA was extracted from 3-4 week old seedlings with CTAB method. The resistant ICCV 2 and susceptible JG 62 were screened with 500 Operon random primers to identify putative polymorphic markers specific to the resistant parent as well as the susceptible parent. Six primers generated polymorphic fragments specific to the resistant parent ICCV 2. SSR markers are also being used to tag the gene and so far two SSR markers clearly differentiated the resistant parent from susceptible parent for *Fusarium* wilt.

7.7 Validation of core collection in sesame using molecular markers - NATP Project

A set of 12 most suitable AFLP primer pairs has been identified out of the 64 available. The analysis indicated that information obtained by the use of these 12 primer pairs is comparable to the results from 64 primer pairs. Further analysis led to the identification of a set of four pairs, which were found to classify the representative collection of the seven *Sesamum* species into groups similar to those obtained with the full

data set.

7.8 Development of DNA Fingerprinting Database and its Utility

DNA Fingerprinting experiments generate a large amount of profile data, that needs to be organised for early retrieval and analysis. NRC has developed a database of the fingerprints in different crops developed by the centre. This system is developed in MS Access 2000. Presently this database has data of ten crops, namely: banana, cashew, mango, chilli, tomato, mungbean, barley, non-aromatic rice, cotton, and chickpea. This software has various search options, which helps to retrieve information according to the choice; such as searching by crop, technique, variety, primer, accession number and source. The search option shows complete detail alongwith photographs of DNA Fingerprints and molecular profiles. Statistical analysis is one of the important constituents of the database. This option is introduced to perform various statistical analysis such as Jaccard's coefficients, gene diversity and polymorphic information content.

Research Projects (Project leaders; Associates)

1. Technology development for DNA fingerprinting of cereals and pseudocereals (Suman Lakhanpaul; Lalit Anand, Sandhia G.S.)
2. Technology development for DNA fingerprinting of pulses, oilseeds and fibres - (K.V. Bhat; Suman Lakhanpaul, M.K. Rana, Gurinder Jit Randhawa and Rakesh Singh)
3. Technology development for DNA fingerprinting of horticultural crops - (J.L. Karihaloo; Sunil Archak, Ambika Baldev and K.V. Bhat)
4. Technology development for DNA fingerprinting of medicinal and aromatic plants - (Gurinderjit Randhawa; Rakesh Singh)
5. Genetic diversity in eggplant (*Solanum melongena*) and its related wild and weedy taxa using isozyme analysis (ICAR Ad-hoc project) - J.L. Karihaloo.
6. Development of molecular markers for the study of genetic diversity in sesame (DST) - K.V. Bhat; Suman Lakhanpaul.
7. Validation of core collection in sesame using molecular markers (NATP) - K.V. Bhat; Suman Lakhanpaul.
8. Molecular marker-assisted gene tagging in chickpea (*Cicer arietinum* L.) for genetic enhancement (NATP) - (Gurinder Jit Randhawa; Rakesh Singh)

9. Molecular aspects of interdivisional project National Containment/Quarantine facility for transgenic/planting material (DBT) - (Gurinder Jit Randhawa; Rakesh Singh)
10. Molecular characterisation of promising genetic material of cotton (Technology mission on cotton) - (Mukesh Kumar Rana; K.V. Bhat)

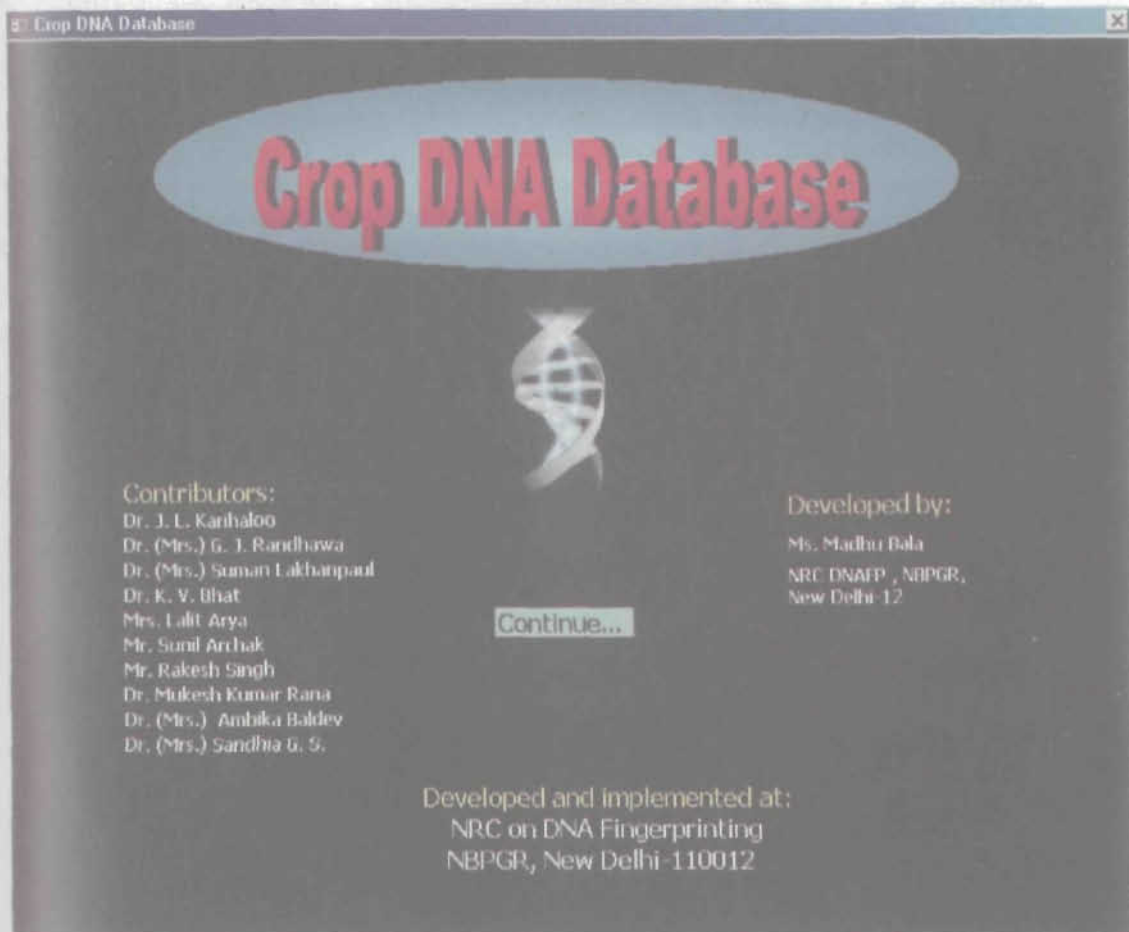


Fig. 1 Startup screen

8. REGIONAL STATION, AKOLA

Summary: Three plant explorations were undertaken covering Sardar Sarovar catchment area in the north-east Chattisgarh, and parts of Konkan and Goa for collection of wild minor fruits and other cultivated crops. A total of 381 accessions were collected from 123 collection sites including farmers fields and natural forests. A total of 1317 accessions were supplied to different research organizations and universities for using them in different crop improvement programmes through headquarters. Twenty seven soybean lines were introduced from Nigeria and added in our existing germplasm. A total of 7536 accessions were grown for regeneration and maintenance while 1921 accessions for evaluation and characterization. A total of 340 accessions were promising for yield and yield-contributing characters. At present, the total germplasm holding of active collection is 31344. A total of 1985 accessions were deposited in NGB. One zonal workshop, one group meeting, one germplasm field day and four grass root trainings were organized for PGR awareness.

8.1 Plant Exploration and Collection

First exploration in this year was undertaken in north-eastern parts of Chattisgarh region for minor fruits collection from 8-22 June. Diversity was collected in Jamun and Chironji. The tribals inhabiting the region are *Kanwar*, *Uraon*, *Korwa*, *Nagahia* and *Nagesia*. Diversity for shape, size, colour and weight of fruit was collected in jamun at an altitudinal range of 350-1300 m.

Second exploration was conducted as a special mission to Nandurbar district of Maharashtra from 29 October to 7 November covering 33 villages in Satpura region of Maharashtra. Out of 33 villages which will be submerged on completion of Sardar Sarovar Dam Narmada valley, only 10 villages were accessible for seed sampling. The ethnic diversity comprised various tribal groups namely the *Bhils* with sub-race *Tudwi*, *Basawe*, *Wodwi* and *Padwi*. The altitude varied from 70-800 m.

The salient features of the collection were:

- Fafda, a local landrace of Chilli, on the verge of extinction was collected. It is highly pungent and bears 15 cm long pods.
- Four races of *Sorghum* namely, Mali jowar

(late), Bajri jowar (early), Mishri jowar, (sweet in taste - for popping) and Red jowar (for papad) were collected.

- Diversity for seed size, seed colour, pod size and pod colour was collected in cowpea and variation in size and colour was also collected in pumpkin.

Third exploration trip to parts of Konkan region was undertaken for minor millets and other available crops from 26 November to 5 December. The altitude ranged from 70-300 m. Ragi was the dominating crop followed by *Panicum sumatrense* and *Panicum miliaceum* is near extinction. Ragi is locally known as Nachani, Nachene while other millet is known as Wari and *Panicum miliaceum* is known as Sava. The crop viz., ragi and *Panicum miliaceum* have got localized in pockets thus which has led to conservation of its diversity. The crops are being replaced by paddy which has an impact on the health of farmers due to nutritional imbalance. The genetic erosion rate is quite fast as Kodo millet is totally extinct and *Panicum miliaceum* is on the verge of extinction. In a few pockets in Kanakwali and Kudal of Sindhudurg district, horsegram, urid and ragi are being planted during rabi season.

Collection of cultivated and wild plants

Cultivated: cowpea (25), uridbean (14), pigeonpea (13), mungbean (9), chickpea (1), soybean (1), horsegram (3), mothbean (2), maize (12), paddy (11), amaranth (2), okra (12), chilli (7), sponge gourd (7), ridge gourd (5), bottle gourd (5), *Hibiscus* spp. (12) *Dolichus lablab* (3), garlic (1), pumpkin (6), pea (1), *Cucumis* (1), radish (1), *Sesame* (8), groundnut (4), mustard (1), niger (11), pearl millet (9), sorghum (18), barnyard millet (8), foxtail millet (13), ragi (30), little millet (21), proso millet (2), yam (2) and others (13).

Wild relatives of crops: wild species of *Cucumis* (3), wild cotton (1), tomato (1), okra (4), brinjal (1), *Cajanus* (1) and *Vigna* (1) were collected.

Wild minor fruits: jamun (37), chironji (33), kosam (3), tendu (2), mahua (1).

8.2 Characterization, Evaluation and Maintenance of Germplasm

Collections grown for characterization/evaluation: A total of 1918 accessions of different crops were grown for (characterisation and evaluation.) The details are as follow:

Pulses	Chickpea (1053), pigeonpea (3), horsegram (43)
Oilseeds	Linseed (497), sesame wild (22), sesame cultivated (17), niger (79), soybean (27)
Vegetables	Okra cultivated (91)
Small millets	Finger millet (6), foxtail millet (3), little millet (36), kodo millet (18), barnyard millet (23)
Pseudocereals	Amaranth (3)

Collections grown for regeneration / maintenance: A total of 7536 accessions of various crops were grown for seed increase or maintenance. Crop-wise details are given below:

Pulses	<i>Lathyrus</i> (117), pigeonpea (122)
Oilseeds	Sesame core material (329), sesame wild (122), sesame cultivated (1820), groundnut (122), segregating F_4 bulks in sesame (21), soybean (1009), safflower (923)
Vegetables	Okra species (7), okra cultivated (1819), wingedbean (244)
Small millets	Finger millet (391), foxtail millet (217), little millet (123), kodo millet (34), barnyard millet (116)

Promising accessions identified in different crops

Early Maturing: IC 120432, 120434, 120435, 120441, 120442.

Promising Accessions: IC 120422, 120423, 120434, 120435, 120436, 120437, 120438, 120439, 120440, 120445, 120488, 120517, 248973, NIC 18847, 18850, 18851, 18868.

Chickpea (ICRISAT)

Early Maturing: IC 268935, 268947, 268959,

268979, 269094, 269097, 260103, 269105, 269116, 269138, 269165, 269182, 269361, 269407, 269414, 269449, 269451, 269453, 269496, 269552, 269591, 269619, 269625, 269630, 269631, 269640, 269643, 269655, 269659, 269677, 269686, 269689, 269697, 269706, 269729, 269731, 269753, 269801, 269820, 269823, 269875.

Good agronomic score: IC 268912, 268918, 268932, 268981, 269030, 269031, 269049, 269097, 269123, 269157, 269159, 269331, 269352.

Total germplasm holding of active collections maintained by Akola

Crop Group	Crop Name	Total
Oilseeds	Sesame	6,616
	Safflower	2,383
	Groundnut	646
	Niger	425
	Castor	254
	Linseed	743
	Soybean	2,593
Pulses	Pigeonpea	2,616
	Chickpea	1,482
	Horsegram	1,066
	Lentil	651
	Winged bean	241
	Lathyrus	146
Millets	Finger millet	4,323
	Foxtail millet	1,365
	Barnyard millet	529
	Little millet	504
	Proso millet	401
Pseudo-cereal	Amaranth	1,146
	Kodo millet	528
Vegetables	Okra cultivated	2,317
	Wild relatives	369
Total		31,344

Good vigour: IC 268856, 268857, 268870, 268873, 268884, 268888, 268909, 268912, 268929, 268931, 268935, 268943, 268944, 268967, 268969, 268984, 268985, 268995, 268999, 269003, 269004, 269020, 269024, 269032, 269038, 269044, 269049, 269061, 269066, 269103, 269118, 269353, 269354.

High yield potential: IC 268979, 268981, 268988, 268995, 269003, 269020, 269038, 269049, 269075, 269103, 269165, 269266, 269449, 269453, 269496, 269552, 269561, 269683, 269706, 269820.

Erect plant habit: IC 268857, 268909, 268963, 269023, 269091, 269188, 269220.

Sesame (cultivated)

High yield potential: IC-205362, 205417, 205419, 205429, 205519, 205546, 205607, 203888, 203931, 203936, 204078, 204091,

204137, 204193, 204195, 204301, 204348, 204356, 204468, 204469, 204472, 204476, 204548, 205582, 205583, 204602, 204770, 205300, 205301, 205309

Sesame (wild): IC-204539, NIC- 848474, NIC-848474-A, NIC- 9824-N, IC-199438-C, T-12

Soybean high yielding: EC- 7033, 10194, 11740, 18126, 18440, 26193, 34137, 34402, EC-36813, 37081, 39088, 39202, 39252, 39361-A, 39780, 75193, 93745, 103889, 109566, 112683, 111334, 117887, 118147-A, 172600, 172645, 172631, 232082, 241898, 242022, 251354, 251359, 251379, 251381-A, 251431, 251457, 2651516, 251520, 274675, JS (SH) -88-139, PK-1187, PK-1186, PK-1173, PK-1175, EC-431377, EC-439307

Soybean early: EC-326-1, 7023, 7362, 9280, 11740-A, 14273, 18107, 18531, EC-18595-A, 24528, 25478, 39040-A, 39121, 85605

Little millet (*Panicum sumatrense*) (old germplasm)

Tall green panicle: IMPR-21539, 21532, NIC-21544, SD3/712.

Purple panicle: NIC-22150, 22154.

Open panicle: (New collections)

Kodo millet (*Paspalum scrobiculatum*)

Promising types : IC-3388, 97015, 97011, 88472.

Barnyard millet (*Echinochloa frumentacea*)

(Old germplasm): IC-97072, 97082, 28430, 28439, 97066, 97043, 52690, 41784, NIC-4849

(New germplasm): 23 accessions were of open inflorescence type. Some of them are LS 21, 39, 70, 82, 110, 125. Compact inflorescence: LS 49,

Promising type: LS 131, 134.

Finger millet (*Eleusine coracana*)

Promising type: IC-43261-A, 45841, 45844, 45858, 49955, 49976-B, 49981, 65698-B, 65922, 65966, 71413-B, 206161.

Tall and late maturing: LS 45

Foxtail millet (*Setaria italica*): IC- 28434, 41898, 97093, 97095, 97108, 97188, N- 915, NKG-9, NKG-157, BDJ-2025, L-228, L4- 214, K-2660, K-2705, K-2775, U5-52, RAP-78, T42/ 83-5, M-77/20, LS-140, LS-147

Okra: IC- 3769A, 6276B, 7856A, 9856C, 10252, 10256A, 12934, 12934A, 12994, 13356, 13917A, 13995, 14096, 14845, 18536, 18540, 18975, 22232, 29136, 33315.

8.3 Distribution of Germplasm

Active germplasm collections supplied to users through GEX unit included soybean (70), pigeonpea (40), okra (32), horsegram (59), *Lathyrus* (57), amaranth (91) and winged bean(21).

8.4 Conservation of Germplasm

Germplasm sent for medium-term conservation : A total of 188 samples including cowpea (23), urdbean (8), pigeonpea (8) mungbean (6), maize (12), paddy (6), okra (11), chilli (6), sponge gourd (5), ridge gourd (5), bottle gourd (5), ambari (11), sesame (6), groundnut (3), pearl millet (9), sorghum (18), barnyard

millet (8) and foxtail millet (11) were conserved in the medium term storage.

Germplasm sent for long-term conservation: 1985 samples including chickpea (1033), pigeonpea (337), amaranth grain (530) and amaranth vegetable (85) were sent to National Genebank for LTS. Total germplasm accessions deposited in National Genebank by this station are given below.

Crop Group	Crop Name	No. of Acc. in NGB
Oilseeds	Sesame	4,092
	Safflower	1,399
	Groundnut	134
	Niger	415
	Castor	289
	Linseed	703
	Soybean	2,366
Pulses	Pigeonpea	2,130
	Chickpea	2,655
	Horsegram	1,050
	Wingedbean	09
	<i>Lathyrus</i>	146
Millets	Finger millet	238
	Foxtail millet	1,011
	Barnyard millet	316
	Little millet	363
	Proso millet	205
	Kodo millet	510
Pseudo-cereals	Amaranth (grain)	609
Vegetables	Okra	762
	Amaranth	85
	Okra Wild	369
Total		19,856



Kosam (*Schleichera oleosa*) a wild fruit collected from Chattisgarh



Jamun (*Syzygium cumini*) fruits collected from forest area of Chattisgarh



An early maturing and high yielding accession of *Eleusine coracana*

Research Projects (Project Leader; Associates)

1. Augmentation, collection, evaluation, documentation and conservation of agri-horticultural crops in Central India (D. P. Patel; T. R. Loknathan).
- 1.1 Building up of germplasm of pulse crops with particular reference to pigeonpea and chickpea, their evaluation, characterization, documentation and conservation (D. P. Patel).
- 1.2 Building up of genetic resources of winged bean, amaranth and okra, their evaluation, characterization, documentation and conservation including the under-utilized co-ordinated trials (D. P. Patel).
- 1.3 Exploration and collection of indigenous genetic resources of various cultivated agri-horticultural crops and their wild relatives from Central Indian plains (T. R. Loknathan; D. P. Patel).
- 1.4 Building up of germplasm of soybean (*Glycine max*) and linseed (*Linum spp.*), their evaluation, characterization, documentation and conservation (T. R. Loknathan).
- 1.5 Building up of germplasm of millets and minor millets, their evaluation, characterization, documentation and conservation (T. R. Loknathan; D. P. Patel).
- 1.6 Building up of various oilseeds germplasm, its evaluation, utilization and conservation (T. R. Loknathan).

9. SATELLITE CENTRE, AMRAWATI

Summary: Preliminary evaluation and conservation of mungbean (264 accs), urdbean (54), sem (83), mothbean (16), citrus (5), ber (14), pomegranate (16), papaya (23), west Indian cherry (11), sweet potato (323) and other species (20) of economic importance were done. Trials for the evaluation and genetic enhancement of mungbean (25 accs), sesame (28), cowpea (238) and maize (104) were conducted. Three hundred and thirty four accessions of groundnut were grown for seed multiplication.

9.1 Conservation and Preliminary Evaluation of Agricultural Crops

Agricultural crops: A total of 264 accessions of mungbean were sown in 3 rows, 4 m long in an augmented block design on 16.6.2001. The control lines were T-1, PS-16, TAP-7, S-8 and Kopergaon. Two accessions (STV 2693 and IC 39502) failed to produce seeds due to mosaic virus. The data on initial flowering, 50% flowering, branching, cluster, height, pod length and width, total pods and 100 seed wt were recorded and harvested seed was deposited in the Genebank for long term storage.

Urdbean: 54 accessions were evaluated during the kharif season.

Mothbean: 16 accessions of mothbean received under NATP programme were evaluated in the kharif season. The flowering period was from 107 to 121 days.

9.2 Conservation and preliminary evaluation of horticultural plants

Citrus: Five accessions of citrus including EC 61353 (orange contanigme) are being maintained. Accession EC 61353 having two plants of Japan orange yielded more than 800 fruits. The average yield of fruit was 270-300 g. The major pests observed were borer and citrus psylla.

Ber: 14 accessions of ber germplasm being maintained at the centre were characterised for the following fruit traits.

Accession name	Planting year	Fruit length (cm)	Fruit width (cm)	100 fruit wt (kg)
Sunhar No. 6	1988	4.06	3.16	2.533
Pewandi sasani	1971	3.58	2.12	1.023
Kadaka	1988	4.72	2.62	1.552
Kaithali	1971	3.46	2.90	1.588
Jogia	Very old	3.52	2.76	2.311
Najuk badam	1988	3.72	2.74	1.742
Nagpur local	1964	5.10	3.38	2.229
Villayachi	1988	1.50	1.60	0.237
Ponda	Very old	3.98	3.22	2.070
Mundia marera	1971	3.92	2.52	0.909
Seb	1971	3.36	3.20	1.261
Umran patiala	1971	3.86	2.34	1.357
Katha	1971	2.96	2.40	1.044
Aligarh	Very old	3.86	2.98	1.593

Nagpur local was identified as a promising ber accession for good quality, high yield, good market value, less susceptibility to fruit borer, bold fruit and yield 2.13 qtls/ plant.

Pomegranate: A total of 16 plants of pomegranate were maintained throughout the year.

West Indian cherry: A total of 11 plants were maintained throughout the year and bumper yield of cherry was obtained (90 kg) from July to September.

Papaya: (*Carica papaya*): 23 accessions of papaya germplasm were sown on 06.06.2000 and transplanted on 14.07.2000 for evaluation. The results are presented below.

Acc. No.	Plant height (m)	Girth (cm)	Fruits/ plant	Wt per fruit (kg)
IC 26495	2.48	39	68	2.00
IC 26496	2.48	30	62	0.40
EC 108917	2.35	31	37	1.12
EC 109080	3.40	37	32	1.37
EC 109082	2.54	30	19	0.60
EC 109083	2.38	30	31	0.70
EC 109084	2.38	32	36	0.50
EC 109086	2.53	31	38	1.00
EC 109087	2.50	29	27	0.55
EC 109089	2.59	33	35	2.10
EC 109090	2.03	28	44	0.60
EC 109091	1.25	20	11	0.47
EC 336567	1.93	24	20	0.46
EC 336569	2.29	29	16	0.70
EC 336571	2.28	26	19	0.82
EC343249	1.96	29	26	0.55
EC343250	2.28	26	29	1.80
EC343256	2.28	28	38	1.33
EC343262	2.65	33	37	1.13
BDS 1207	2.35	34	25	0.85
BDS 1211	2.63	31	26	1.38
Rahatgaon (local)	2.63	31	26	1.38
Malkapur (local)	2.85	38	46	2.20

Following promising accessions were identified:

EC 109089-bold fruit, mosaic resistant (length of fruit 20.5 cm. and diameter 16.5 cm)

Malkapur local-bold fruit, mosaic resistant (length 22 and diameter 16 cm)

IC 26495-bold fruit, mosaic resistant (length 18 cm, diameter 16.3 cm)

New collections of papaya seed received under NATP programme from Ranchi (Bihar) have been planted in the nursery for multiplication of seed. The plants are in flowering stage/ vegetative stage.

Sweet potato: Germplasm comprising 323 accessions has been maintained throughout the year by repeated transplanting of the vines in a double, 1 m long row spaced 1 m apart in an augmented block design using Amravati local, Pusa red and pusa white, as check.

Sem: A total of 83 accessions of sem were sown during kharif 2000 by dibbling method with single replication in an augmented block design. All the accessions germinated properly and growth was normal. For preliminary evaluation, characters like flowering date, no. of branches/ plant, no.

of pods/ cluster, pod length, weight of pods, vegetable/ seed type etc. were recorded.

9.3 Conservation and Preliminary Evaluation of

Other Economic Plants

The other economic plants grown at this satellite centre were maintained throughout the year by adopting various agricultural practices. The crops are as under :

Crop	Acc. No.	No. of plants	
<i>Simarouba glauca</i>	EC 19701	32	plants in fruiting stage
Bursera	Aromatic plant	1	plant maintained
Karonda	EC 35952,	2	plants
	Local	3	plants
Sweet tamarind		1	plant
Ramphal		2	plants
Hybrid sisal	EC 37543	1	plant
<i>Brosimum alicastrum</i>	EC 117858	4	plants
Coconut		2	plants
Turmeric	EC 23864	1	variety
<i>Maclura aurantica</i>	EC 87859	1	plants
<i>Rauvolfia serpentina</i>		5	plants
<i>Rauvolfia canescence</i>		40	plants
<i>Jatropha curcas</i>	IW 3472	2	plants
<i>Achras sapota</i>		2	plants
<i>Bauhinia blackenna</i>		2	plants
Khimi		1	plant
Mulberry		2	plants (fruiting)
Bixa	EC 339375	4	plants (fruiting)
Fig		2	plants
Seedless lemon		1	plant

9.4 Studies on Insect Host Plant Interaction

The important crops grown at this satellite centre were observed for occurrence of pest under natural field conditions. Accessions showing tolerance/ resistance to pests were identified and screened next year.

9.5 Genetic Enhancement in Various Crops

Trials and evaluation of the following crops were conducted at NBPGR, satellite centre, Amravati.

9.5.1 Trial on genetic enhancement in mungbean: Twenty five accessions of mungbean germplasm were sown in 3 rows in a

randomized block design with three replications and second trial of mungbean consisting of 27 accessions in 2 rows each in a single replication. The data on this crop have been recorded and analysed.

9.5.2 Trial on genetic enhancement in *Sesamum*: A total of 28 accessions were sown in 4 rows each on in a single replication. The data on the various parameters were recorded and the analysis was done.

9.5.3 Trial on genetic enhancement of cowpea: 238 accessions of cowpea received from NBPGR, New Delhi (through NBPGR, Akola) were sown on 8.7.2001 in 4 rows each in an augmented block design having 3 checks

namely V-240, V-585 and local check DPP. The data on various parameters were recorded and statistically analysed.

9.5.4 Trial on genetic enhancement of maize:

104 accessions and checks *viz.*, 97, 98, 99 and 100 were grown and the data on various parameters were recorded and subjected to statistical analysis.

9.5.6 Multiplication of groundnut seed: 334 accessions of groundnut seed were received from NBPGR, New Delhi. All the accessions were sown in a row of 4 m having 3 lines each. The sowing was done on 8 and 9 November 2001. The germination was poor in most of the accessions and stunted growth rate was recorded due to severe cold in this region during germination period.

Research Projects (Project Leader)

1. Conservation and preliminary evaluation of agri-horticultural plants (W. L. Barwad).
- 1.1 Conservation and preliminary evaluation of mungbean and other agricultural crops (W. L. Barwad).
- 1.2 Conservation and preliminary evaluation of horticultural plants (W. L. Barwad).
- 1.3 Conservation and preliminary evaluation of other economic plants (W. L. Barwad).
- 1.4 Studies on insect-host plant interaction in mungbean (*Vigna radiata*), sweet potato and papaya (W. L. Barwad).

10. REGIONAL STATION, BHOWALI

Summary: A total of 981 germplasm accessions of various crop plants and their wild relatives were collected during 12 explorations undertaken in parts of Chamoli, Uttarkashi, Tehri, Dehradun, Nainital, Almora, Pauri (in Uttaranchal), Bundelkhand region in UP and Sardar Sarovar Dam area in Gujarat. A total of 400 accessions of temperate and sub-tropical fruits were maintained in field genebank and 1147 accessions of various agricultural crops collected from Uttaranchal were grown for seed increase and characterisation. Besides, several accessions of flowering plants, M&AP and economically important wild relatives of crop plants were grown for maintenance. Rooted plants of kiwi, strawberry, *Cryptomeria japonica* and some M&AP were supplied to indentors/ farmers for their utilisation.

10.1 Exploration and Collection of Germplasm

A total of 981 germplasm accessions (914 under NATP and 67 under UP-DASP) were collected through 12 explorations (11 NATP and 1 UP-DASP)

During the emphasis was given to Garhwal region, particularly in Tehri-dam and other check dam areas. One exploration was conducted in Sardar Sarover Dam Area in Gujarat and two in alpine zones (Sunderdhunga Glacier and Valley of Flowers, District Chamoli). Total collections included cereals (180), pulses (130), millets (30),

vegetables (258), horticultural crops (70), M&AP (154) and others (159). Details are given in Tables 1 and 2.



Harvested fruits of five varieties of Kiwi fruit from field genebank, Bhowali



Citrus jambhiri, well adapted to Central Himalayan region

Table 1. Explorations undertaken during 2001 by Regional Station, Bhowali

Period	Areas explored	Total Sample collected	Cereals	Millet	Pulses	Vegetables	Hort. Crops	M & AP	Others
Jan 31- Feb 8	Dehradun	161	35	2	22	80	1	2	19
Feb 20- Mar 3	U S Nagar & Champawat	155	33	----	6	60	2	12	42
Feb 23-Mar 3	Uttarkashi, Tehri & Chamoli	100	10	5	13	13	2	----	57
Mar 18-23	Eastern Kumaon	25	----	----	----	----	----	25	----
Jun 21-30	Valley of Flowers (Chamoli)	42	----	----	----	----	----	42	----
Jun 9-17	Bundelkhand region of Uttar Pradesh	67	----	----	21	40	----	6	----
Sep 24-30	Valley of Flowers (Chamoli)	28	----	----	----	----	----	28	----
Sep 29-Oct 8	Sunderdhunga Glacier (Bageshwar)	37	1	----	1	----	----	34	1
Oct 11-18	Champawat, US Nagar, Nainital, Almora & Pauri	80	10	13	19	17	----	11	10
Oct 26-Nov 3	Garhwal region	134	25	5	49	48	----	----	7
Nov 4-9	Almora, Bageshwar, Chamoli, Champawat & Pithoragarh	25	----	----	----	----	25	----	----
Dec 22 - 29	Sardar Sarovar Dam areas in Gujarat	127	66	5	20	19	----	----	17
Total		981	180	30	130	258	70	154	159

Table 2. Explorations undertaken by co-operators under NATP in Uttaranchal during 2001

Co-operators	No. of explorations	Diversity collected
NBPGR, New Delhi	2	214
VPKAS, Almora	2	311
DARL, Pithoragarh	4	943
Total		1468

10.2 Germplasm Evaluation

Germplasm Characterisation / Initial Seed Increase Under NATP: A total of 279 accessions comprising *Lolium* spp. (33), *Trifolium*

spp. (34), *Festuca* sp. (1) and pea (210) from NBPGR, New Delhi and *Phaseolus lunatus* (1) from NBPGR Regional Station, Thrissur were received for evaluation at this station.

The germplasm accessions collected from Kumaon and Garhwal regions of Uttaranchal were characterised at Bhowali during kharif and rabi

seasons. The details of germplasm grown for seed increase/ characterisation are given in Table 3.

Table 3. Germplasm Characterisation / Initial Seed Increase

Crop	No. of Accessions	Checks Used	Main Attributes
Spinach	25	-----	Seed increase
Fenugreek	9	-----	Seed increase
Coriander	38	-----	Seed increase
Lentil	642	VL-1, VL-105, VL-108	Variability was observed for qualitative characters viz., growth habit (erect, prostrate), pubescence (grey, brown), leaf colour (green, light green dark green), pigmentation on stem, leaf size (small, medium, large), pod colour (grey, dark grey, brown, light black) seed coat colour (brown, light brown, dark brown, grey, olive green, black, stripped / mottled).
Amaranth	48	-----	Seed increase
Hemp	20	-----	Seed increase
Buckwheat	05	-----	Seed increase
Perilla	07	-----	Seed increase
Groundnut	66	-----	Seed increase
Ginger	103	-----	Seed increase
Colocasia	137	-----	Seed increase
Turmeric	10	-----	Seed increase
French bean	37	-----	Seed increase
Sem bean	15	-----	Seed increase
Total	1147		

Advanced varietal trial of rice bean: All India Co-ordinated Trial (Hills AVT-2001) of rice bean comprising 11 varieties, was conducted. Promising selections viz., PRR 9301, Naini and BRS-1 performed relatively better in yield than other entries and checks. Some of the promising accessions of rice bean viz., BRS-1, Naini, BRS-3 and Chaukhamba were multiplied for seed increase.

Horticultural plants: Field genebank of citrus germplasm was updated as per master plan. Kiwi fruits of five different varieties were harvested from experimental plots and sold. A total of 400 accessions of fruit crops were maintained (Table

4). Chilli accessions (112) were sown and seeds of 95 accessions were sent to Hyderabad for joint evaluation programme under NATP.

Tubers/ rhizomes/ plants of *Dahlia* spp. (18), *Gladiolus* (31), *Tagetes* spp. (36), *Rosa* spp. 6), *Chrysanthemum* sp. (1), *Codonopsis convolvulacea* (1), *Hydrangea paniculata* (1), *Iris* sp. (4), *Jasminum* sp. (3), *Juniperus macropoda* (1), *Lagerstroemia indica* (1), *Michelia* sp. (1), *Pelargonium crispum* (5), *Polyanthes tuberosa* (1), *Spiraea* sp. (2), *Solanum capsiquoides* (1) and *Wisteria sinensis* (1) and seeds of 43 accessions of different flowering annuals were sown for regeneration/

maintenance and seed supply. Walnut (EC-467892, EC-467892, EC-467892, EC-467892), tissue cultured plants of *Fragaria* sp. comprising exotic (8) and indigenous (3) accessions and 2 accessions of kiwi received from NBPGR, New Delhi were established in the field.

10.3 Wild Economically Useful Plants

Enrichment and preliminary evaluation of wild relatives of *Allium* species: A total of 45 accessions of *Allium* (mainly wild) are being

Table 4. Maintenance of germplasm of fruit crops

Name of crop	Botanical name	No. of accessions
Akhrot	<i>Juglans regia</i>	23
Anar	<i>Punica granatum</i>	02
Anola	<i>Emblica officinalis</i>	04
Apple	<i>Malus</i> sp.	22
Badahar	<i>Artocarpus lakoocha</i>	01
Badam	<i>Prunus amygdalus</i>	05
Bael	<i>Aegle marmelos</i>	07
Cherry	<i>Prunus avium</i>	03
Citrus	<i>Citrus</i> spp.	172
Cotoneaster	<i>Cotoneaster</i> sp.	01
Ficus	<i>Ficus</i> sp.	07
Ghiwai	<i>Elaeagnus latifolia</i>	02
Grape	<i>Vitis</i> sp.	05
Hazelnut	<i>Corylus</i> sp.	02
Hisalu	<i>Rubus</i> sp.	21
Kaku	<i>Diospyrus kaki</i>	03
Kamarakh	<i>Averrhoa carambola</i>	01
Karonda	<i>Carissa</i> sp.	06
Kathal	<i>Artocarpus heterophyllus</i>	01
Khubani	<i>Prunus armeniaca</i>	05
Labera	<i>Cordia</i> sp.	04
Loquat	<i>Eriobotrya japonica</i>	01
Mullberry	<i>Morus</i> sp.	02
Naspati	<i>Pyrus</i> sp.	07
Peach	<i>Prunus persica</i>	06
Phalsa	<i>Grewia</i> sp.	01
Plum	<i>Prunus domestica</i>	05
Rasbhari	<i>Physalis</i> sp.	02
Shahajan	<i>Moringa oleifera</i>	02
Strawberry	<i>Fragaria</i> spp.	77
Total		400

maintained in the field genebank. Few of them i.e., *Allium griffithianum*, *A. chinensis*, *A. cernuum* are being multiplied for seed increase.

Maintenance of wild economically useful plants: A total of 100 accessions of wild related species of cucumber, *Hedychium* sp., raspberries, *Abelmoschus*, *Crotolaria*, *Macrotyloma*, *Parthenocissus*, *Phytolacca*, *Solanum*, *Zingiber*, *Ribes* etc. were grown and established in the field genebank. Seeds of new species of wild horse gram (*Macrotyloma var-garhwalensis*), rich in seed protein, were multiplied for increased seed quantity.

Maintenance of arborescent plant material: A total of 180 accessions of arborescent plants comprising 146 species (representing 90 genera of 50 families, both endemic and exotic) were maintained at the Station's Biodiversity Botanical Garden. Some of the new plant materials added include *Betula*, *Ribes*, *Elaeocarpus*, *Mallotus* etc.

Maintenance of bamboosetum: A total of 35 accessions comprising 18 species belonging to six genera i.e. *Arundinaria*, *Dendrocalamus*, *Melocanna*, *Bambusa*, *Phyllostachys* and *Thamnocalamus* are being maintained. The range of variation in the important characters such as: culm length (10.50 -34.60 cm); culm diam (0.35 -8.10 cm); no. of tillers (2-84); height of plants (105-1320 cm) and no. of nodes (7- 51) was recorded.

Maintenance of forage legumes and grasses: In forage legumes, 170 accessions of *Medicago* and 48 accessions of *Trifolium* species were maintained for their preliminary evaluation. A total of 54 accessions of temperate forage grasses were also maintained.

Medicinal and aromatic plants: A total of 290 accessions comprising 200 species belonging to 114 genera in 37 families have been conserved and established in field genebank/ herbal garden of the station. Some of

the promising and high prized aromatic plants such as lemon grass (*Cymbopogon flexuosus*); Indian valerian (*Valeriana jatamansi*); rosemary (*Rosmarinus officinalis*); scented rose-geranium (*Pelargonium graveolens*); garden sage (*Salvia officinalis*); Bulgarian rose (*Rosa* sp.); Lavender cultivars : Carlova and Sher -E- Kashmir, pot-marigold (*Calendula officinalis*); wild marigold/hazari (*Tagetes minuta*); Ban-haldoo/ Kapur-Kachari (*Hedychium spicatum*), Maruvum (*Marjorana hortensis*) were transplanted and

multiplied for seed and vegetative propagules for their supply to indentors. About 50,000 rooted plants of scented rose-geranium cv. Egyptian were distributed in the nine districts of Uttaranchal through farmers' nurseries for its large scale cultivation. Some of the potential aromatic plants were subject ed to steam distillation for analyzing percentage of essential oils and a range of variation (0.02 to 0.20) in the different seasons of the year. Summary of the important herbal species is given in Table 5.

Table 5. Summary of important M & AP maintained in the herbal garden

Important genera	No. of species	Species
<i>Achillea</i>	11	<i>A. asiatica</i> , <i>A. biberstinii</i> , <i>A. borealis</i> , <i>A. conferta</i> , <i>A. falcata</i> , <i>A. filipendulina</i> , <i>A. lanulosa</i> , <i>A. millefolium</i> , <i>A. nobilis</i> , <i>A. santolina</i>
<i>Calendula</i>	5	<i>C. arvensis</i> , <i>C. eckerenii</i> , <i>C. officinalis</i> , <i>C. stellata</i> , <i>C. suffruticosa</i>
<i>Datura</i>	6	<i>D. bernhardii</i> , <i>D. ferox</i> , <i>D. innoxia</i> , <i>D. metel</i> , <i>D. quercifolia</i> , <i>D. stramonium</i>
<i>Hypericum</i>	5	<i>H. canariensis</i> , <i>H. montanum</i> , <i>H. olympicum</i> , <i>H. perforatum</i> , <i>H. pilosum</i>
<i>Matricaria</i>	3	<i>M. aurea</i> , <i>M. chamomilla</i> , <i>M. recutita</i>
<i>Mentha</i>	5	<i>M. citrata</i> , <i>M. cardiaca</i> , <i>M. piperata</i> , <i>M. spicata</i> , <i>M. arvensis</i>
<i>Papaver</i>	4	<i>P. bracteatum</i> , <i>P. leteriticum</i> , <i>P. orientale</i> , <i>P. pseudo-orientalis</i>
<i>Pelargonium</i>	6	<i>P. alchemilloides</i> , <i>P. boehnicum</i> , <i>P. carolinanum</i> , <i>P. columbinum</i> , <i>P. graveolens</i> , <i>P. tomentosum</i>
<i>Plantago</i>	12	<i>P. arborescense</i> , <i>P. arenaria</i> , <i>P. afra</i> , <i>P. aristata</i> , <i>P. atrata</i> , <i>P. camtschatica</i> , <i>P. hookeriana</i> , <i>P. lagopus</i> , <i>P. lanceolata</i> , <i>P. major</i> , <i>P. media</i> , <i>P. semipervirens</i>
<i>Salvia</i>	11	<i>S. deserta</i> , <i>S. horminum</i> , <i>S. lanata</i> , <i>S. nemorosa</i> , <i>S. officinalis</i> , <i>S. sclarea</i> , <i>S. superba</i> , <i>S. tesquicola</i> , <i>S. verbenaea</i> , <i>S. verticillata</i> , <i>S. virgata</i>
<i>Solanum</i>	7	<i>S. aviculare</i> , <i>S. nigrum</i> , <i>S. surratense</i> , <i>S. hispidum</i> , <i>S. pseudo-capsicum</i> , <i>S. seaforthianum</i> , <i>S. jasminoides</i>

Determination of percentage of essential oil:

A total of 52 accessions of aromatic plants comprising 25 genera and 37 species belonging to 15 families were analyzed for percentage of essential oil in different seasons through Clevenger apparatus. Most of the aromatic plant material was maintained in the herbal and botanical gardens of the station. Some of the promising aromatic plants i.e. *Artemisia* sp. (0.06 to 0.63%), scented rose-geranium (0.05 to 0.38%), *Melissa* sp., (0.05 to 0.48%), *Mentha* sp., (0.12 to 0.44%), *Ocimum* sp. (0.17 to 0.20%), *Salvia* sp. (0.09 to 0.53%), *Cymbopogon* sp., (0.24 to 0.46%), *Hedychium*

sp. (0.05 to 1.40 %) were assessed for essential oil content.

ISM&H project: Four plant species have been assigned to Bhowali i.e. Priyangoo, Karchoor, Kakarsingee and Timroo. A good harvest was obtained for Priyangoo, Karchoor and Kakarsingee. Timroo germplasm is being built-up through exploration.

Regeneration of germplasm: Wild relatives of cereals viz. *Aegilops* spp. (43), *Triticum* spp. (459), Barley (70), French bean (121) and *Vicia faba* (21) were sown for seed increase.

10.4 Germplasm conservation

Chilli germplasm (686 accessions) were supplied to national genebank for long-term storage.

10.5 Germplasm supply

Seed samples and live material of M&AP & viz., *Asparagus*, Rosemary, *Maruvum*, scented rose-geranium, *Caraway* and *Chalmomile*, were

distributed among farmers for popularisation. Rooted plants of kiwi (407), strawberry (50) and *Cryptomeria japonica* (26) were supplied to different indentors. Chilli germplasm (686 accessions) were supplied to the Head, Department of Vegetable Sciences, GBPUA&T, Pantnagar, Uttaranchal.



Kaku (*Diospyros kaki*; IC 219062), a promising accession maintained in glasshouse at Bhowali



Women from Uttaranchal participating in one day training programme on cultivation of scented rose-geranium

Research Projects (Project leader; Associates)

1. Exploration for collection of germplasm diversity in agri-horticultural crops and their characterization, evaluation, regeneration and documentation in Uttaranchal (D. C. Bhandari)
2. Exploration for collection of germplasm diversity in agri-horticultural crops of northern hills with emphasis on ethnobotanical aspects (D. C. Bhandari).
3. Evaluation, characterization, regeneration and documentation of genetic resources of temperate horticultural plants (S. K. Verma).
4. Regeneration, maintenance, evaluation and documentation of medicinal and aromatic, wild economically useful, rare and endangered plants with emphasis on their conservation and utilization (K.S.Negi).
5. Evaluation, characterization, regeneration and documentation of crop plant species of hilly areas including exotic wheat, barley and their wild relatives (D.C.Bhandari).

11. EXPLORATION BASE CENTRE, CUTTACK

Summary: Four explorations were conducted under NATP (PB) and a total of 179 accessions comprising 83 accessions of cultivated crops, 21 accessions of wild relatives and 75 accessions of medicinal and aromatic plants were collected from Orissa and Chhattisgarh. A set of 1760 accessions of cultivated rice have been screened for submergence tolerance under natural condition and the same accessions will be further screened under artificial condition. Out of 1760 accession only 16 accessions were identified as promising. Beside a set of 55 accessions of turmeric germplasm and 9 accessions of pigeonpea germplasm were characterized for morpho-agronomic traits. A total of 812 accessions comprising medicinal and aromatic plants, cultivated rice and other crops collected by NBPGR base centre and other CCPs under NATP were deposited for MTS, 745 accessions of cultivated rice were deposited for LTS in NGB and 1516 accessions of cultivated rice were deposited in the active collection site(CRRI). Apart from this a set of 106 accessions comprising 50 accessions of cultivated rice, 4 accessions of M & AP & were sent to NBPGR, New Delhi for research purpose and 52 accessions of jute and allied fibres were deposited with CRIJAF, Barrackpore for regeneration and evaluation.

11.1 Germplasm Exploration and Collection

During the year, a total number of four explorations were undertaken for collection of jute and allied fibres, wild relatives of *Vigna* and sesame, and medicinal and aromatic plants from various districts of Orissa and Chhattisgarh. The exploration programmes were conducted under Jai Vigyan National Science and Technology Mission on conservation of agro-biodiversity (NATP on Plant Biodiversity) in collaboration with CRIJAF, Barrackpore, NBPGR, Head quarter and SARC (NGO), Cuttack. A total of 179 accessions including cereals (18), pulses (6), vegetables (2), oilseeds (2), horticultural crops (3), tuber crops (2), fibre crops (50), M & AP & (75) and other wild relatives (21) were collected during the exploration.

The exploration-wise details with period of collection, region/areas covered, crop diversity and number of accessions collected are given below.

Collection of jute and allied fibre crops from coastal and northern plateau region of Orissa: This crop-specific exploration was undertaken for collection of best fibre crops in

collaboration with CRIJAF, Barrackpore (WB) during 14 - 23 January, 2001 from north-east coastal region of Orissa. The physiography and agro-climatic condition of the area varied from plain, undulating, hot humid, to semi-arid. Soil type was mostly clay, sandy loam and sometimes lateritic. Soil colour varied from yellow, brown, to blackish and reddish and temperature 41^o C (maximum) and 13^o C (minimum). Rainfall varie from 1006.9-1305.0 mm. A total of 52 accessions comprising seven species were collected following both bulk and random sampling strategies. The species-wise collection of jute and allied fibre crops are enumerated below:

<i>Corchorus capsularis</i> (White jute)	24
<i>Corchorus olitorius</i> (Tossa jute)	3
<i>Hibiscus cannabinus</i> (H.C. mesta)	13
<i>Hibiscus sabdariffa</i> (H.S. mesta)	8
<i>Crotalaria juncea</i> (Sunnhemp)	2
<i>Corchorus aestuans</i> (Wild jute)	1
<i>Hibiscus</i> sp (Wild mesta)	1

Extent of diversity and variability patterns: Plant height of mesta (*Hibiscus sabdariffa*) varied from 5 to 10 ft. Leaf shape varied from entire, lobed to deeply lobed. Fruit colour varied from

green to red spotted or entirely red, stems were spiny or glabrous. In jute, plant height ranged from 1 to 9 ft., leaves were oblong, elliptic to oblanceolate. In sunnhemp, no such variation in diversity was observed.

Accessions IC-284424, IC-284427, IC-284428 and IC-284437 are seem to be potential germplasm for higher yield due to plant height and stem diameter. IC-284441 and IC-284449 seem to be good edible oil yielder.

Leaves of both *Corchorus capsularis* and *C. olitorius* and *Hibiscus sabdariffa*, are edible. Seeds and oil extracted from *H. cannabinus* and *H. sabdariffa* are edible. Calyces of *H. sabdariffa* are of medicinal value for curing dysentery and diarrhoea.

Ten districts of Orissa surveyed have enough potential for cultivation of jute in coastal districts and partly semi-arid districts for cultivation of both *H. cannabinus* and *H. sabdariffa* (mesta) or *Crotalaria juncea* (sunhemp).

This germplasm will be grown and evaluated at CRJAF, Barrackpore for fibre yield potential and one part will be stored in the national genebank, NBPGR, New Delhi.

Collection of M&AP from Similipal Biosphere Reserve: Similipal Biosphere Reserve in Mayurbhanj district of Orissa is located between 21° 30' - 28-22° 08' N latitude and 86° 04' - 86° 37' E longitude and covers an area of 2750 sq. km. The area is characterised by innumerable crests and valleys, rich forests, interspersed with countless streams and rivers and contains a confused and broken mountain system ranging from 300 meters to 1166 meters thus exhibiting a great degree of topographic variation. The average rainfall of the area is 173 cm with a maximum of 225 cm and minimum of 110 cm. The rainfall is not well distributed, most of it falling during the rainy months. Relative humidity is generally high throughout the year but more so in the rainy season. The mean temperature

varies from 20° C to 28 ° C. The forests of Similipal are among the most luxuriant and valuable forests of the state. The main forest types found in the area are: northern tropical moist deciduous forests, northern tropical semi-evergreen forests, dry deciduous hill forests, high level sal forests and grassland and savannah. Sal is the predominant type in most areas. There are villages in the core area, 61 villages in the periphery and 1200 villages in the transitional area. Sampling strategies followed included random/bulk and individual plant.

The germplasm collected included M & AP & (37 accs.), cereals (18 accs.), pulses (4 accs.), horticultural plants (3 accs.), vegetable crop (1 acc.), root crops (2 accs.), oil yielding (2 accs.) and wild relatives (23 accs.).

Important medicinal plants such as *Centella asiatica*, *Solanum khasianum*, *Eclipta alba*, *Eupatorium ayapan*, *Hemidesmus indicus* var. *indicus*, *Celastrus paniculatus*, *Entada rheedii*, *Vernonia anthelmintica*, *Mucuna nigricans*, *Scindapsus officinalis*, *Stereospermum chelonoides*, *Operculina turpethum*, and *Cissus quadrangularis* were collected.

Collection of medicinal and aromatic plants from Angul district of Orissa: The district Angul is located between 84° 16' E to 85° 33' E longitudes & 20° 34' N to 21° 44' N latitude and surrounded by the districts viz., Dhenkanal in the East, Boudh and Sonepur in the West, Sundargarh and Keonjhar in the North. The district with its congenial environment is a rich repository of medicinal and aromatic plants. Therefore, the present study was planned for collection, conservation of M & AP and documentation of ethno-botanical information from the district.

The exploration was conducted in collaboration with SARC, Cuttack under NATP on Plant Biodiversity Conservation. A total of 38 samples comprising 30 genera and 34 species

were collected during the tour. Passport data were also recorded at the collection sites. Both live plants of 30 accessions and seeds of 8 accessions were collected from various parts of the district. The live plants were collected in nursery bags and are being maintained in the field gene bank of the centre, whereas, the seeds of 8 accessions. (in 2 sets) have been deposited for MTS and evaluation/regeneration at NBPGR, New Delhi.

During the exploration trip, it was observed that *Pueraria tuberosa*, *Rauwolfia serpentina*, *Geodorum densiflorum*, *Gymnema sylvestre* etc. are either on verge of extinction or in solitary existence because of destructive and mass collection of these important species. Some tribal people informed that during last 2-3 years the tubers of *Pueraria tuberosa* and roots of *Rauwolfia serpentina* were collected on large scale by some outsiders for industrial use. Besides, the team met a traditional herbal healer who engaged himself in the treatment of nervous disorder, specifically facial paralysis by some herbal preparations. The details of preparation, dose and treatment have been recorded during the tour.

Collection of wild relatives of crop plants: An exploration was undertaken for collection of *Vigna* and *Sesame* germplasm from parts of Orissa and Chhattisgarh during 24.10.2001 to 1.11.2001. A total of 20 accessions comprising *Vigna hainiana* (6), *V. trilobata* (3), *V. mungo* (2), *V. radiata* var. *setulosa* (1), *V. dalzelliana* (1), *V. unguiculata* (1), *Sesamum mulayanum* (2), *Cucumis hardwickii* (2), *Cucumis sativus* (1) and *Abelmoschus tetraphyllus* (1) were collected from 16 agro-ecological niches. Local name, location of the area (longitude, latitude and altitude), habitat and pod characteristics were noted right at the collection site. Variability was observed within the *Vigna hainiana* collection in terms of length and width of the pod. Variability was also observed in seed characteristics in the

black gram germplasm. The farmers informed that *V. trilobata* was earlier found in almost all rice field bunds but now it is found in some fields only. It is also known to be salt tolerant. *Vigna dalzelliana* was collected from forest slopes.

11.2 Evaluation and preliminary characterisation

Cultivated rice germplasm (*Oryza sativa*): A total of 1760 accessions of cultivated rice germplasm including 541 collected by rescue exploration mission during June, 2001, were severely damaged due to stagnant flood water during July, 2001. However, the same material was maintained for the observation on submergence tolerance in the left over germplasm. Out of 1760 accessions, a total of 940 accs. could survive and observations on quantitative traits were recorded. On the basis of which 16 accessions were found to be promising against early submergence viz., IC-258990, IC-257701, IC-257644 were found promising against EBT/plant and panicle weight. From the passport information of the varieties survived, it was found that all the 18 accessions were collected during rescue mission from coastal districts of Orissa (Jagatsinghpur-6 accs., Kendrapara-3 accs., Balasore-3 acc., Jajpur-3 accs, Khurda-2 accs. and Ganjam-1 acc.). The range of variability among submergence tolerant rice germplasm was recorded and is presented in Table 1.

Keeping in view the damage caused to the rice germplasm due to flood water another set of 1349 accessions. (remnant seeds) were sown during August, 2001 and transplanted in augmented design with eight standard checks. The standard cultural practices were followed with normal recommended dose of NPK (60:30:30).

Turmeric germplasm (*Curcuma longa*): A set of 55 accessions of turmeric germplasm was grown in the experimental field of the centre for characterization. Observations on morpho-

agronomic parameters were recorded and the spectrum of variability is presented in Table 2.

Table 1. Range of variability among submergence tolerant rice germplasm (kharif, 2001)

Character	Range
Plant height (cm)	115.98 to 169.88
Leaf length (cm)	44.48 to 64.52
Leaf width (cm)	0.8 to 2.8
Ear 1 bearing tillers (EBT)	2.6 to 7.4
Panicle length (cm)	21.7 to 30.94
No. of primary branches	8.2 to 12.0
No. of secondary branches	11.0 to 35.2
Total spikelets/panicle	39.0 to 144.5
No. of chaffs/panicle	5.8 to 52.8
Kernel length (mm)	5.5 to 7.95
Kernel width (mm)	2.4 to 3.14
L/B ratio	1.96 to 3.18
100 grain weight (g)	2.28 to 3.42

Table 2. Morpho-agronomic variability in turmeric germplasm

Character	Range
Plant height (cm.)	24.50 to 150.56
Leaf length (cm.)	16.35 to 71.05
Leaf width (cm.)	4.0 to 19.37
No. of leaves/plant	3.75 to 10.0
No. of primary rhizome/plant	2.0 to 15.66
No. of secondary rhizome/plant	3.0 to 29.0

Pigeon pea (*Cajanus cajan*): A set of nine accessions of pigeonpea germplasm was grown and observation on quantitative traits viz. plant height, pod length, no. of seeds/pod, 100 seed weight were recorded and the range of variability is given in Table-3.

Table 3. Range of variability in quantitative traits of pigeon pea

Character	Range
Plant ht. (cm)	107.6 to 254.4
Pod length (cm.)	4.32 to 8.38
No. of seeds/pod	4.0 to 5.6
100 seed wt.(g.)	5.11 to 22.29

11.3 Germplasm conservation

Medium term storage (MTS): A set of 365 accessions including M&APs, cultivated rice and other agri-horticultural crops collected by NBPGR Base Centre, Cuttack and another set of 447 accession including wild rice, cultivated rice. M&APs and other crops collected by CCPIs of cooperating centres under NATP (PB) were deposited as voucher specimen for MTS at NBPGR, New Delhi.

Long term storage (LTS): A total of 745 accessions of cultivated rice grown during *kharif* 2000 were deposited for LTS in the national genebank at NBPGR, New Delhi.

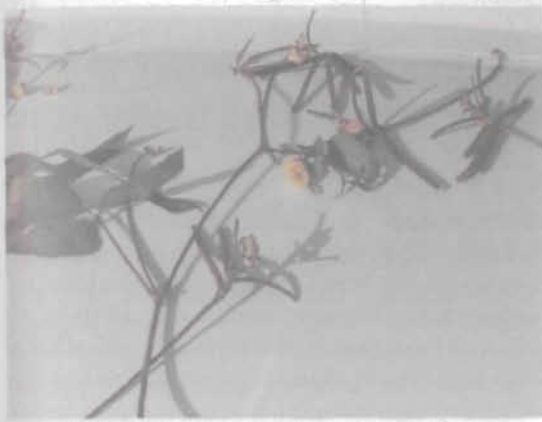
Active collection site: A total of 1516 accessions of cultivated rice were deposited in the national active germplasm site at CRRI, Cuttack.

11.4 Germplasm distribution

During the period under report, a total of 106 accessions comprising 50 of cultivated rice, collected from Koraput district were sent to the Head, Exploration Divison, NBPGR, for research purpose. Three accession of *Bacopa monnieri* (IC-249250, IC-256496, IC-284992) and one of *Gymnema sylvestre* (IC-265872) were sent to NBPGR, New Delhi for *in vitro* multiplication and conservation.

Germplasm maintenance

A total of 1349 accessions of cultivated rice, stubble of 152 accessions of wild rice, 229 of M & APs, 95 of spices, 38 of root/tuber crops, 16 of horticultural crops, 20 of pigeonpea and 17 of other wild relatives of crop plants are being maintained at the centre.



Vigna radiata var. *setulosa* collected from Koraput, Orissa



Vigna bainiana collected from its natural habitat in Koraput, Orissa



Prof. S. K. Sinha addressing the cooperators of Zone - III under NATP-PB

Research Projects (Project leader; Associate)

1. Exploration, collection and evaluation of plant genetic resources of Orissa and adjoining regions (N. Dikshit; D. Pani)
2. Germplasm exploration, collection, evaluation, characterisation and documentation of agri-horticultural crops on sustainable management of Plant Bio-diversity in the mission mode under the National Agricultural Technology Project (NATP on Plant Biodiversity), Zone-III (N. Dikshit; D. Pani).

12. REGIONAL STATION, HYDERABAD

Summary: During the year 2001, a total of 13,647 samples consisting of 4,209 import samples (from 13 countries) and 9,581 export samples were processed for quarantine clearance and a total of 150 phytosanitary certificates were issued. Several pathogens of quarantine importance were intercepted. A total of 655 import samples were infested/infected with pests/pathogens, and 503 samples were salvaged. One hundred and fifty two samples comprising pearl millet (1) and groundnut (151), infected with *Pyricularia oryzae* and *Burkholderia solanacearum* could not be salvaged and hence rejected. In export, 324 samples were rejected due to quarantine pests/pathogens. Quarantine service was extended to 20 organizations in South India. A total of 1,103 accessions of different agri-horticultural crops comprising brinjal, chillies, blackgram, finger millet, maize, sorghum, tomato and other agri-horticultural crops and wild species were sown/maintained for evaluation/rejuvenation/multiplication. A total of nine explorations were conducted to collect germplasm of *Moringa* spp., cowpea and other pulses, minor millets, mango scion material, betelvine, tamarind, *Momordica* spp., medicinal plants and castor. During these explorations, a total of 1,259 accessions of different crops and their wild relatives were collected. The evaluation studies on chillies during 2001 revealed that the earliest accession to mature is EC-399571. One hundred accessions of maize germplasm, received from NBPGR, New Delhi as a part of multilocational trial were evaluated. Two hundred and thirty three accessions of different crops were distributed to the indentors. A total of 30,706 germplasm samples have been conserved in the medium-term storage module upto 31.12.2001.

NBPGR Regional Station, Hyderabad was established in 1985, with a major responsibility of quarantine processing and clearance of ICRISAT mandate crops, rice and other crops meant for the research institutes /universities located in southern region of India. It also serves as an exploration base centre for the collection of agri-horticultural crops in Andhra Pradesh and adjoining areas.

12.1 Plant Quarantine Service

During the year 2001, a total of 13,647 samples of different crops were received and processed for quarantine clearance. Out of these, 4066 samples (paddy-2516; maize-604; sunflower-143; sorghum-162; groundnut-176; pearl millet-393; cowpea-50; tomato-5; *Eucalyptus* species-

13 and *Rhynchosia* species-4) were imported from 13 countries and the rest, 9581 (sorghum-2609; pearl millet-2371; chickpea-3381; pigeonpea-1411; groundnut-1243 and minor millets-63) were exported to 62 countries.

12.1.1 Import Quarantine: All the import samples were subjected to various seed health tests like visual examination, blotter test, X-ray radiography, Enzyme-Linked Immuno Sorbent Assay (ELISA), centrifugation and microscopic examination. Four thousand nine hundred and two import samples (including last year's consignments) were released to the consignees after processing. The following pathogens were intercepted from the import germplasm during the period under report.

Pest	Crop	Country
Unidentified bacteria	Pearlmillet	USA
<i>Pyricularia penniseti</i>	Pearlmillet	Niger
<i>Verticillium</i> sp.	Pearlmillet	Niger
<i>Fusarium solani</i>	Pearlmillet, Maize	Niger, Thailand
<i>Rhizoctonia bataticola</i>	Maize, Groundnut	Thailand, Malawi, Niger
<i>Sclerotium rolfsii</i>	Groundnut	Malawi
<i>Burkholderia solanacearum</i>	Groundnut	Malawi, Niger
<i>Phoma sorghina</i>	Sorghum	USA

Salvaging of infested/infected germplasm: A total of 655 import samples were infected/infested (pathogens-552; insects-58 and nematodes-74) and 503 samples were salvaged by various methods while one sample of pearl millet was rejected due to the infection of *Pyricularia penniseti* and 151 groundnut samples were unfit for release due to bacterial wilt infection.

Post entry quarantine observations: A total of 81 accessions of pearl millet imported from USA (45), Nigeria (20) and Niger (16) were sown at Post Entry Quarantine Isolation Area (PEQIA) of ICRISAT and observations were taken at weekly intervals. Albinism was noticed in two accessions (EC 459626 & EC 459634). Incidence of zonate leaf spot (*Gloeocercospora* species) was noticed in some lines for which two sprays of Dithane M-45 were given. Rust (*Puccinia penniseti*) was recorded in some lines.

Sowing of 995 accessions of finger millet and 24 accessions of pearl millet imported from Zimbabwe and Niger, respectively was inspected at PEQIA of ICRISAT. Observations were recorded at weekly intervals and majority of pearl millet accessions were severely infected with smut (*Tolyposporium penicillariae*). Healthy seeds were released after salvaging the samples.

The groundnut accessions grown in the glasshouse of ICRISAT were inspected at weekly intervals and one accession imported from Malawi was infected with bacterial wilt (*Burkholderia solanacearum*), and hence detained.

Pearl millet (366 accessions) imported from Niger have been grown at PEQIA of ICRISAT and inspected at weekly intervals.

Two sunflower consignments of 16 and 117 samples imported from Netherlands and France, respectively were sown in the greenhouse for post entry quarantine inspection. Observations were recorded at regular intervals and only healthy

seed was released.

Post entry quarantine inspections of private organizations: Post Entry Quarantine inspection of 20 lines of maize, imported from Thailand, at Amareshwara Agritech Limited, Hyderabad revealed that only one line was infected with rust.

Post entry quarantine inspection was carried out for 20 treated maize germplasm accessions at Hindustan Lever's farm located at Hyderabad and the healthy germplasm was released.

Post Entry Quarantine inspection at the time of sowing and crop growth of 124 treated sorghum samples (imported from USA) was done in an isolated field at the farm of Monsanto Technologies Ltd., Aurangabad, Maharashtra.

Post Entry Quarantine inspection of 117 accessions of sunflower (imported from France), being grown at Monsanto Technologies India Ltd. Bellary, was done. Accessions were infected with sunflower necrosis virus and it was advised to clean up the crop area by removing all the weeds including *Parthenium* as they are the sources of survival for the virus.

Post Entry Quarantine inspection of 27 accessions of sorghum (imported from USA) being grown at Pioneer Overseas Corporation, Hyderabad, was done and all accessions were healthy.

Three hundred accessions of maize, imported from Thailand and grown in the field of Monsanto Technologies Ltd., Bangalore were inspected and found healthy. Infected leaf samples brought from the farm revealed the presence of *Drechslera maydis* and *Helminthosporium turcicum*.

Two consignments of maize, meant for PHS Agritech Pvt. Ltd. (80 samples) and Advanta India Ltd. (2 samples) were heavily treated with chemicals. A part of these accessions was sown in the field for Post Entry Quarantine growing at NBPGR Regional Station, Hyderabad. Observations are being recorded at regular intervals.

Imported germplasm released after quarantine inspection

Crop	Country	No. of samples	Organisation
Paddy	Philippines	895	TNAU, Coimbatore
		30	RGCBT, Trivandrum, Kerala
		846	Directorate of Rice Research, Hyderabad
		221	ICRISAT, Hyderabad
		140	Kerala Agricultural University, Palghat, Kerala
		413	ANGRAU, Hyderabad
		84	RRS, Mandya, Karnataka
		8	MAHYCO Ltd., Medak, Andhra Pradesh
		3	Advanta India Ltd., Kurnool, Andhra Pradesh
		21	BASF India Ltd, Mumbai
Maize	China	14	Monsanto Tech. India Limited, Bangalore
	Mexico	207	Vibha Agrotech Pvt. Ltd., Hyderabad
		9	PHS Agritech Pvt. Ltd., Hyderabad
	Thailand	300	Monsanto Tech. India Limited, Bellary, Karnataka
Sorghum	USA	27	Pioneer Overseas Corporation, Hyderabad.
		124	Monsanto Tech. India Limited, Aurangabad, Maharashtra
		48	ICRISAT, Hyderabad
		4	Vibha Agrotech Pvt. Ltd., Hyderabad
Pearlmillet	USA	100	Pioneer Overseas Corporation, Hyderabad
	Niger	388	ICRISAT, Hyderabad
Sunflower	South Africa	3	Advanta India Ltd., Gogilapur, Andhra Pradesh
	Netherlands	16	Advanta India Limited, Bangalore
	Yugoslavia	117	Directorate of Oilseeds Research, Hyderabad
	Australia	3	Advanta india Ltd., Bangalore.
	USA	26	Monsanto Tech. India Limited, Bellary, Karnataka
	France	117	Monsanto Tech. India Limited, Bellary, Karnataka
Cowpea	Niger	50	TNAU, Coimbatore
Groundnut	USA & Malawi	5	ICRISAT, Hyderabad
<i>Eucalyptus</i> sp.	Australia	13	Kerala Forest Department, Kottayam
Tomato	Taiwan	5	IIHR, Bangalore
Total		4209	

12.1.2 Export quarantine: Out of 9,581 export samples comprising nine crops, 324 samples (sorghum-98, pearlmillet-48, chickpea-103, minor millets-2, pigeonpea-41 and groundnut-32) were rejected due to the association of various pests and pathogens. One hundred and fifty phytosanitary certificates were issued during the period, under report.

Interceptions on material meant for export: Majority of the rejections were based on germination failure and bacterial infection in all the crops. The important fungi intercepted in

the export germplasm were *Rhizoctonia solani*, *Cercospora* sp., *Pyricularia oryzae*, *Botrytis* sp., *Fusarium oxysporum*, *F. poae*, *F. solani*, *Botryodiplodia theobromae* etc. on various crops.

12.2 PGR Activities

12.2.1. Germplasm explorations under NATP: Nine plant explorations were undertaken. The details of areas explored and crop diversity collected are given below.

Crop	Region	No. of accessions	Collaboration with
Medicinal & aromatic plants	Papikonda hills of eastern ghats	150	-
<i>Moringa</i> sp., <i>Cucumis</i> sp. and <i>Brassica</i> sp.	Coastal region of Andhra Pradesh	204	-
Betelvine and tamarind	Rayalaseema region of Andhra Pradesh	32-tamarind 5-betelvine 9-others	-
Mango scion material	North coastal region of Andhra Pradesh	36 cuttings	FRS, Ranga reddy (ANGRAU)
<i>Momordica</i> , brinjal and melons	Rayalseema region of Andhra Pradesh	137	-
Medicinal plants	Eastern Ghats of Chittoor district in Andhra Pradesh	172	-
Minor millets	Southern Telangana and Rayalaseema regions of Andhra Pradesh	212	-
Cowpea & other pulses	North coastal region of Andhra Pradesh	167	ANGRAU
Castor	Warangal, Khammam, West Godavari and Guntur	135	DOR & ANGRAU

Visual examination of 178 accessions of pulses and niger, 404 accessions of mesta, 250 accessions of pearl millet and other millets, 1,600 accessions of sunflower and 30 accessions of multicrop germplasm was carried out from seed health angle.

12.2.2 Evaluation of germplasm

A total of 174 accessions of paprika chilli germplasm were evaluated for agro-morphological descriptors in the field. The days to flowering ranged between 58-110 days and the earliest accession to mature was EC-399571.

Preliminary characterisation and evaluation of 180 accessions of finger millet germplasm (105-NATP collections and 75-received from ICRISAT) was completed.

Characterization and evaluation of 93 green gram accessions done under NATP, revealed good variability in plant growth habit (erect-spreading type), days to 50% flowering (40-60 days), number of clusters per plant (2-10), number of pods per cluster (2-23) and seed colour (light green/yellow/brownish green).

These accessions were also analyzed for total protein content.

Three hundred accessions of blackgram received from NBPGR, New Delhi were evaluated for characterization in an augmented complete block design.

The three *Sorghum* lines viz., EC-434430, EC-434431 and EC-434432, which were earlier highly resistant to sugarcane aphid, *Melanaphis sacchari*, were grown for further characterization and multiplication.

Recording of data on 19 descriptors was completed in 100 accessions of maize germplasm received from NBPGR, New Delhi, as a part of multilocal trial. Maize pollination by sib mating was completed in 100 accessions. Harvesting of all the accessions was done. The days to 50% tasseling ranged between 38-75 days. The days to 50% silking ranged between 42-78 days. The days to 50% maturity ranged between 73-106 days. Ganga-11, M-21, M-01, IC-203934 (H-3717) and M-07 are late maturing with 106 days to maturity.

Out of 65 tomato accessions screened for root knot nematode, 8 accessions were tolerant.

12.2.3 Conservation

A total of 30,706 accessions of different agri-horticultural crops including the quarantine import voucher samples have been conserved in the medium term module and the details are given as under :

Crop / Category	Samples*
Brinjal	2506
Blackgram	495
Chilli	2645
Tomato	299
Import voucher samples	7503
Export voucher samples	3192
NBPGR collection	1814
NATP collection	3471
NPTC collection	710
Released & Research Material	
<i>Sorghum</i>	244
Chickpea	1250
Collaborating Institutes	
ANGRAU – Paddy	9
ANGRAU – Vegetables	11
DOR – Sunflower	73
DRR – Paddy	6484
Total	30,706

* (Does not indicate number of accessions)

The particulars of germplasm accessions collected under NATP and NPTC programmes and sent to NGB for long term conservation are given as under :

Crop	No. of accessions	Collected by
Medicinal plants	207	Andhra University
Sunflower	329	DOR, Hyderabad
Minor millets	252	ANGRAU
Castor	76	DOR, Hyderabad
Sesame	120	DOR, Hyderabad
Niger	103	DOR, Hyderabad
Multi crop	233	RARS, Chintapalle, ANGRAU
Pearlmillet & small millets	250	NBPGR RS, Hyderabad
Mesta	404	NBPGR RS, Hyderabad
Pulses & Niger	178	NBPGR RS, Hyderabad
Medicinal plants	59	NBPGR RS, Hyderabad
<i>Sorghum</i>	216	NRCS, Hyderabad
Safflower, castor & pigeonpea	13	DRR, Hyderabad
Paddy	165	DRR, Hyderabad
Multicrop	360	RARS, Chintapalle under NPTC
Total	2965	

Three hundred and thirty two accessions of pigeonpea germplasm, received from ICRISAT were sent to national gene bank (NGB) for long term conservation.

12.2.4 Germplasm distribution

Thirteen accessions consisting of brinjal (three accessions-IC-136104, IC-136026 and IC-305065) and chilli (10 accessions- IC-119549, 119556, 119696, 321433, 339047, NIC-19959, 23829, 23830, 23912 and 23927) were supplied to the Project Coordinator, AICRP on nematodes, for screening the germplasm.

Fourteen chilli accessions consisting of exotic introductions/ released varieties were distributed to different universities viz., Kerala Agricultural University, Birsra Agricultural University and Allahabad University.

Twenty five accessions of spice germplasm (including ginger, turmeric and *Dioscorea*), collected by ANGRAU were sent to NBPGR regional station, Thrissur.

Under the NPTC (Network Project on Tribal area crops of MP, AP, and Orissa, 21 accessions of turmeric and six accessions of ginger were sent to NBPGR, regional station, Thrissur and Indian Institute of Spices Research (IISR), Calicut for field conservation. All the NPTC

accessions were supplied by RARS, Chintapalle.

A set of 19 samples of turmeric germplasm supplied by RARS, Chintapalle as part of 2001-2002 collections has been supplied to Tissue Culture and Cryopreservation Unit of NBPGR, New Delhi for conservation *in vitro*.

Ten accessions of banana supplied by RARS, Chintapalle have been sent to NRC, Banana (NAGS) for conservation and maintenance. One set of the same is being maintained at this station. Passport data with a request for allotment of IC numbers has been sent to HQ.

Out of 54 accessions of cashew seed germplasm supplied by RARS, Chintapalle, 20 accessions were sent to CPU and Tissue Culture and Cryopreservation Unit of NBPGR, New Delhi for cryopreservation. All 54 accessions were sown at our station and another set of the same is being maintained under medium term storage.

One hundred and five seed accessions of finger millet, collected under NATP were supplied to Dr.K.E.Prasada Rao, Chairman, Zonal Technical Coordination Committee for multilocational trial at RARS, Chintapalle.

12.3 Supportive Research

Nematology: Moderately resistant collections in castor against *Rotylenchulus reniformis* were identified. Cultures of *Rotylenchulus reniformis* on castor, cowpea and blackgram; *Meloidogyne javanica* on tomato and brinjal and *Heterodera cajani* on pigeonpea, cowpea and blackgram are being maintained in the glass house.

Plant pathology

Sunflower Necrosis Virus: Sunflower necrosis disease occurring in Karnataka, Andhra Pradesh, Tamilnadu and Maharashtra has been identified as tobacco streak ilar virus, based on serological relationships, molecular weight of coat proteins, nucleic acid species and host range studies.

The experiment on insecticides vs virus incidence indicated that the insecticides have no effect on the incidence of PBNV, which occurred to a reasonable level. However, the effect of insecticides on the incidence of MYMV and ULCV could not be assessed, as their incidence was very low.

Integrated management of viral disease problems in mungbean and uradbean: A survey for the virus disease incidence was undertaken in the districts of Prakasham, Guntur and Krishna covering fields in 3 mandals and 15 villages in each district. MYMV was observed in 62 out of 140 fields surveyed with an incidence upto 70% in Guntur and Krishna districts. PBNV was observed in 129 out of 140 fields surveyed with an incidence not exceeding 14%. The information gathered indicated that majority of the farmers applied plant protection chemicals indiscriminately due to high market price for urdbean, but they were unable to control *Helicoverpa*, *Spodoptera*, PBNV and MYMV effectively. In eighty three cultivars of mungbean and urdbean, virus incidence was recorded. Urdbean leaf crinkle was successfully transmitted by *Aphis craccivora*.

Based on experiments conducted over two seasons at Hyderabad centre, integrated management package for peanut bud necrosis virus (PBNV) in mungbean and urdbean has been formulated and being currently tested in the research farm as well as at one of the selected farmers' field in Venkataramanagudem, Tadepalligudem of East Godavari district. The package consists of resistant cultivars to PBNV and MYMV, seed treatment with Gaucho, border cropping with 7 rows of sorghum and intercropping with sorghum at 1:3 ratio and spray with imidachloprid after 30 days of sowing.

Bacterial wilt of groundnut: Bacterial wilt caused by *Burkholderia solanacearum* (*Pseudomonas solanacearum*) was intercepted

in six out of 93 groundnut accessions received from Australia during Post Entry Quarantine inspections at ICRISAT. The per cent infection varied from 10 to 33.33. Presence of bacterium was noticed even on the seed, which was harvested from the healthy looking plants of each infected accession. Based on the results of physiological and biochemical tests, the bacterium was identified as *B. solanacearum* biovar '3'. Pathogenicity was proved on groundnut and tomato. When the harvested seed of the infected accessions was sown in the glass house, bacterial wilt appeared after five weeks of sowing. The bacterium was present throughout the seed when different parts of the infected seed were tested and the differences observed in various parts were statistically non-significant. When the original seed of the infected accessions was tested after a period of one-year, all seeds showed the presence of the same bacterium indicating its survival in the seed.

Due to frequent interception of *Burkholderia solanacearum* (*Pseudomonas solanacearum*) in the recent past, from groundnut seed imported from Brazil, Australia and Malawi, all 171 accessions of groundnut from different countries were tested using specific medium (Tetrazolium chloride-agar medium). Those seed accessions (34) which were found free from bacterial infection were retested by plating the twig bits (from ELISA- tested seedlings) on specific medium.

12.4 Germplasm restoration from ICRISAT

Sorghum: In all, 11,112 indigenous accessions of sorghum were sent to the national gene bank

at NBPGR, New Delhi for long term conservation. A total of 700 accessions have been sent to NRC sorghum for regeneration.

Groundnut: A total of 341 accessions of groundnut received by NBPGR regional station, Hyderabad from ICRISAT along with passport data under direct transfer of germplasm have been sent for conservation in the medium term storage facility at NBPGR, New Delhi.

Pigeonpea: One thousand accessions of pigeonpea received from ICRISAT, were sent to four co-ordinating centres of pigeonpea for regeneration. Three hundred and thirty two (332) accessions of pigeonpea were sent to NGB for long term conservation.

Chickpea: A set of 209 accessions of chickpea received from ICRISAT have been sent to NBPGR Headquarters for medium term storage whereas 1909 accessions were sent to the national gene bank for long term conservation. A total of 1,944 accessions of chickpea germplasm received from ICRISAT have been conserved under medium term storage at this regional station. A total of 2,991 accessions of chickpea have been sent to the project co-ordinator (chickpea) of seven different co-ordinating centres for regeneration. (One thousand five hundred and twenty chickpea accessions were sent to NGB for long term conservation).

Pearlmillet: Two hundred and fifteen accessions of pearlmillet were sent to NGB for long-term conservation and 163 accessions were sent to project co-ordinator, pearlmillet, for regeneration at Jodhpur.

Number of accessions sent for National Gene bank during January-December 2001

Crop	No. of accessions sent
Chickpea	1909
Groundnut	491
Pearlmillet	215
Sorghum	11,112
Pigeonpea	332

Number of accessions sent for regeneration during January-December 2001

Crop	No. of accessions sent
Chickpea	2991
Groundnut	747
Pearlmillet	163
Sorghum	700
Pigeonpea	1000

Research Projects (Project Leader; Associates)

1. Quarantine processing of plant germplasm under exchange and supportive research (K. S. Varaprasad; R. D. V. J. Prasadara; S. K. Chakraborty; B. Sarat Babu; K. Anitha).
- 1.1. Detection, identification and control of pests associated with import and export of seed/ plant material (K. S. Varaprasad; R. D. V. J. Prasadara; S. K. Chakraborty; B. Sarat Babu; K. Anitha).
- 1.2. Developing a web database on pests and pathogens of quarantine significance (K. S. Varaprasad; R. D. V. J. Prasadara; S. K. Chakraborty; B. Sarat Babu; K. Anitha).
- 1.3. Developing techniques and treatment schedules for seed-borne pathogens (K. S. Varaprasad; R. D. V. J. Prasadara; S. K. Chakraborty; B. Sarat Babu; K. Anitha).
2. Germplasm collection, augmentation, evaluation, conservation, documentation of agri-horticultural crops and their wild relatives from Andhra Pradesh and adjoining areas in the South East coastal zone (K. S. Varaprasad; K. Venkateshwaran; S. Pandrawada; N. Sivraj).
- 2.1. Exploration and collection of germplasm of agri-horticultural crops and their wild relatives from Andhra Pradesh and adjoining areas in the South East coastal zone (K. S. Varaprasad).
- 2.2. Characterization, evaluation, multiplication and rejuvenation of agri-horticultural crops with particular reference to pulses, vegetables and grape germplasm (N. Sivraj).
- 2.3. *Ex situ* conservation, field maintenance and distribution of germplasm of active collections of station's mandate crops and other agri-horticultural crops (K. Venkateshwaran).
- 2.4. Screening of biotic stresses with particular reference to pests and selected agri-horticultural crops (R. D. V. J. Prasadara).
- 2.5. Documentation of PGR data on collections, evaluation and conservation in the SEC zone (K. S. Varaprasad).
3. Germplasm exploration, collection, characterization, evaluation, documentation and quarantine clearance of crop germplasm under NATP-PB project (K. S. Varaprasad).
4. Integrated management of viral disease problem of mungbean (*Vigna radiata*) and urdbean (*Vigna mungo*) (R. D. V. J. Prasadara).
5. Modelling gene flow to assess the risk to biodiversity in traditional cropping systems: a case study with pigeonpea (K. S. Varaprasad).
6. Maintenance and strengthening of quarantine facilities of NBPGR Regional Station, Hyderabad (K. S. Varaprasad).

13. REGIONAL STATION, JODHPUR

Summary: During the period under report eight explorations were conducted in different parts of Rajasthan and Madhya Pradesh. Out of these four were crop specific, three region specific and one was a local collection trip. In all, 525 samples were collected. The collections comprised taramira (31), cucumber and melons (76), plants of saline areas in Kharchiya village (150), mulberry (15), various crops from Barwani and Dhar districts of Madhya Pradesh (177), fibre crops (61) and local collections (15). In the kharif season, 3895 accessions of crops comprising of castor (75), cowpea (369), *Cucumis* spp. (606), guar (1353), mothbean (513), mungbean (613), pearl millet (89), til (395) and tumba (82) were sown for characterisation, multiplication and rejuvenation. In addition, NATP material received was also sown for characterisation. In rabi, 521 accessions of *Triticum* spp. were sown for characterisation and multiplication. All the crops sown were screened for disease tolerance. Germplasm of 15,206 accessions of agricultural, horticultural and plants of economic importance were maintained. A total of 2577 accessions were kept under medium term storage. Seed samples (58) were supplied to various indentors.

13.1 Exploration and collection

During the period under report 4 crop specific, 3 region specific and 1 local exploration trips were undertaken in parts of Rajasthan (under NATP programme) for different agri-horticultural crops, medicinal and aromatic plants and plants of economic importance and their wild species. A total of 525 samples were collected (Table 1).

13.1.1 Exploration and collection of taramira (*Eruca sativa*) germplasm from parts of Rajasthan : A total of 31 collections of taramira were made from areas of Ajmer (1), Alwar (3), Bharatpur (7), Dausa (2), Jaipur (5), Jhunjhunu (1), Jodhpur (1), Nagour (2), Sikar (6) and Tonk (3) districts of Rajasthan during March 14–21, 2001. Local primitive cultivars of taramira were collected. Variability was noticed in seed colour and shape, pod shape, beak on pod, hardness of pod, branching of plant, plant height, bearing of pods on plant, hairiness of stem and pods.

13.1.2 Exploration and collection of cucumber and melon germplasm : A total of 56 samples comprising *Citrullus lanatus* (11), *Citrullus vulgaris* var. *fistulosus* (6), *Cucumis melo* (17), *Cucumis melo* var. *momordica* (6), *Cucumis melo*

var. *utilissimus* (12) and *Cucumis sativus* (4) were collected from 54 diverse sites in Ajmer, Banswara, Baran, Bhilwara, Bundi, Chittaurgarh, Dungarpur, Kota, Pali, Sawai Madhopur, Sirohi, Tonk and Udaipur districts of Rajasthan during May 23 – 30, 2001 (Fig. 2). A wide range of variability was noticed in fruit shape, size and colour, seed colour, pulp colour and size and colour of stripes present on fruits in *Citrullus lanatus*, hairiness and colour of fruits, types of leaves, seed colour and types of stem in *Citrullus vulgaris* var. *fistulosus*, shape, size, colour, taste and hairiness of fruits, seed size in *Cucumis melo*, fruit shape, size and colour, spots on fruits in *Cucumis melo* var. *momordica*, fruit shape, size and colour, shape of ridges and furrow on fruits in *Cucumis melo* var. *utilissimus* and fruit shape, size and colour, spots on fruits in *Cucumis sativus*. Associated indigenous knowledge, role of women in conservation and utilization, and local names of these plants were recorded.

13.1.3 Exploration and collection of cucumber and melon germplasm from North-east Rajasthan : In all 20 collections comprising *Citrullus lanatus* (2), *C. vulgaris* var. *fistulosus* (8), *Cucumis melo* (4), *C. melo* var. *utilissimus*

(3), *C. sativus* (2) and *Luffa acutangula* (1) were collected from 16 different sites of Ajmer (2), Alwar (6), Dausa (1), Jaipur (4), Jodhpur (1) and Nagour (6) districts during May 25–29, 2001. Variability was recorded in number of wines and fruits per plant, size, shape and colour of fruits and seeds.

13.1.4 Exploration and collection of crop germplasm from parts of Rajasthan : A total of 150 collections comprising *Abelmoschus esculantus* (7), *Amaranthus gageiticus* (2), *Annona squamosa* (2), *Capsicum annuum* (4), *Citrullus lanatus* (5), *C. vulgaris* var. *fistulosus* (1) (Fig. 4), *Crotalaria juncea* (4), *Cucumis callosus* (6), *Cucumis melo* var. *utilissimus* (2), *C. melo* var. *momordica* (1), *C. sativus* (1), *Cucurbita moschata* (1), *Cyamopsis tetragonoloba* (11), *Dioscorea alata* (1), *D. deltoidea* (1), *Lagenaria siceraria* (2), *Luffa acutangula* (1), *L. cylindrica* (2), *Lycopersicon esculentum* (2), *Macrotyloma biflorus* (2), *Ocimum* sp. (1), *Pennisetum typhoides* (18), *Punica granatum* (1), *Sesamum indicum* (12), *Sorghum vulgare* (14), *Triticum aestivum* (4), *Vigna aconitifolia* (5), *V. mungo* (1), *V. radiata* (16), *V. unguiculata* (3), *Zea mays* (8) and *Zingiber officinale* (9) were collected from Kharchiya village, Pali, Rajasamand and Udaipur districts. Local uses, indigenous knowledge and role of women in germplasm conservation were also recorded.

13.1.5 Exploration and collection of mulberry germplasm from parts of Rajasthan : In all, 15 collections comprising *Morus alba* (2), *M. indica* (11) and *M. laevigata* (1) were collected from Ajmer (5), Jaipur (4), Jodhpur (1), Pali (3) and Sikar (2) districts during October 18–20, 2001. Variability was recorded in plant height, stem bark colour, number of branches, internodal distance, size, shape, thickness, smoothness, lobbing and colour of leaves and appearance of male and female flowers on the plant. Associated indigenous knowledge and role of

women in conservation and utilization of mulberry were also recorded.

13.1.6 Exploration and collection of various plant genetic resources from parts of Barwani and Dhar districts of Madhya Pradesh : A total of 177 collections comprising cereals (22), pseudo cereals (4), millets (14), minor millets (3), legumes (34), oilseed crops (12), fruits and vegetables (35), spices (5), fibre (13), fodder (2), medicinal and aromatic plants (24), and wild species or wild relatives (8), were collected from different sites viz. Barwani (143) and Dhar (34) districts of Madhya Pradesh during October 31 to November 14 under a special mission to collect plant genetic resources from the area which are going to be submerged after completion of Sardar Sarovar Dam.

13.1.7 Exploration and collection of germplasm of jute, mesta (kenaf) and allied fibre plants from West, South-west and Southern Rajasthan : In all, 61 collections comprising *Corchorus aestuans* (4), *C. depressus* (4), *C. olitorius* (8), *C. tridens* (18), *C. trilocularis* (4), *Crotalaria juncea* (9), *C. medicaginea* (1), *Hibiscus cannabinus* (10) and *Agave angustifolia* (1) from 52 sites of Barmer (9), Dungarpur (6), Jaisalmer (17), Jalore (9), Jodhpur (4), Pali (2), Sirohi (6) and Udaipur (8) districts of Rajasthan were collected during November 20–29. Variability was noticed in plant height, number of branches per plant, stem colour, size, shape texture and colour of capsule and seeds. Indigenous knowledge and role of women in their conservation and utilization were also recorded.

13.1.8 Local collection : A total of 15 collections comprising *Achyranthus aspera* (1), *Cenchrus biflorus* (2), *C. ciliaris* (1), *Indigofera cordifolia* (1), *I. oblongifolia* (1) (famine food plants), *Morus laevigata* (1), *Pithecellobium dulce* (1), *Psidium guajava* (1) (fruit plants) and *Leucas aspera* (1), *Moringa concanensis* (1), *Ocimum americanum* (3), *Tinospora cordiflora* (1)

(medicinal and aromatic plants) were collected.

13.2 Characterization and evaluation

In the kharif season of the year 2001, germplasm of different crops (3,895 accessions) comprising castor (75), cowpea (369), *Cucumis* spp., (606), guar (1353), mothbean (513), mungbean (613), pearl millet (89), til (395) and tumba (82) were sown for characterization, multiplication and rejuvenation. It included 234 accessions of cowpea received from NBPGR, New Delhi for evaluation (Table 2). A total of 230 accessions of guar were observed for various characters. In all 27, 8, 8 and 45 accessions of castor, guar, mothbean and tumba, respectively received under NATP (PB) programme were characterised. This year though rainfall was good but erratic and life saving irrigation was given. Due to cloudy days and rains for one week, incidence of diseases was observed in til crop. Promising and disease free accessions were identified (Table 3).

In the rabi season, seeds of 521 accessions of wheat comprising *Triticum aestivum* (518), *T. dicoccum* (1), *T. durum* (1) and *T. sphaerococcum* (1) were sown for characterisation and multiplication. Out of 518 different accessions of *T. aestivum*, 494 were received from NBPGR, New Delhi and 4 collections from this station were sown on November 5–6 for characterisation. Seeds of 18 accessions of *T. aestivum* (15), *T. dicoccum* (1), *T. durum* (1) and *T. sphaerococcum* (1) were collected under NATP (PB) programme. Nine accessions of *T. aestivum* obtained from Rajasthan Agricultural University, ARS, Jobner were sown on November 28, 2001 for characterisation and multiplication.

Seeds of *Cyamopsis senegalensis* and *C. serrata* obtained from NBPGR, New Delhi were sown in pots and multiplied.

13.3 Maintenance and conservation

Germplasm (15, 206) of crop plants (13915) viz., pearl millet (249), cowpea (396), guar (4869), mothbean (1980), mungbean (1247), castor (370), til (4804); horticultural plants (303) viz., ber (146), *Carissa* spp. 12, *Cordia* spp. (59), Ker (36) pomegranate (11) and others (39) and plants of economic importance (987) viz., *Acacia* spp. (47), *Atriplex* spp. (131), Jojoba (103), *Jatropha* spp. (22), Khejri (*Prosopis cineraria*-404), tumba (197) and others (83) are being maintained at this station.

In addition 2,577 accessions comprising cowpea (238), guar (335), horticultural plants (120), mothbean (167), mung (335), released varieties (48) and til (438) collected during different exploration and collection trips were kept under medium term storage.

13.4 Seed supply

During the year a total of 58 seed samples of *Acacia albida* (ex Senegal; EC 123793; 1), *A. holosericea* (ex Australia; EC 170441; 1), *A. trachycarpa* (ex Australia; 1), *A. victoreae* (ex Australia; 1), *Carissa carandas* (1), *C. grandiflora* (2), *Datura alba* (1), *D. metel* (1), guar (10), jojoba (11), mothbean (24) and *Ziziphus nummularia* cv. tikadi (1) and 8 saplings of *Carissa grandiflora* (3), *Calotropis gigantea* (1), *Murraya koenigii* (1), *Prosopis cineraria* (1), *Salvadora oleoides* (1) and *Tecomela undulata* (1) were supplied to different indentors.

Table 1: Plant exporation and collections undertaken during 2001

Areas explored	Crops/ plants collected	Sample collected
Ajmer, Alwar, Bharatpur, Dausa, Jaipur, Jhunjhunu, Jodhpur, Nagour, Sikar and Tonk (March 14 - 21, 2001)	<i>Eruca sativa</i> (31)	31
Ajmer, Banswara, Baran,	<i>Citrullus lanatus</i> (11), <i>Citrullus vulgaris</i> var. <i>fistulosus</i> (6),	56
Bhilwara, Bundi, Chittaurgarh, Dungarpur, Kota, Pali, Sawai Madhopur, Sirohi, Tonk and Udaipur (May 23-30, 2001)	<i>Cucumis melo</i> (17), <i>Cucumis melo</i> var. <i>momordica</i> (6), <i>Cucumis melo</i> var. <i>utilissimus</i> (12) and <i>Cucumis sativus</i> (4)	
Ajmer, Alwar, Dausa, Jaipur, Jodhpur and Nagour (May 25-29, 2001)	<i>Citrullus lanatus</i> (2), <i>C. vulgaris</i> var. <i>fistulosus</i> (8), <i>Cucumis melo</i> (4), <i>C. melo</i> var. <i>utilissimus</i> (3), <i>C. sativus</i> (2) and <i>Luffa acutangula</i> (1)	20
Saline areas of Kharchiya village, Pali, Rajasamand and Udaipur (October 11-5, 20001).	<i>Abelmoschus esculentus</i> (7), <i>Amaranthus gangeticus</i> (2), <i>Annona squamosa</i> (2), <i>Capsicum annuum</i> (4), <i>Citrullus lanatus</i> (5), <i>C. vulgaris</i> var. <i>fistulosus</i> (1), <i>Crotalaria juncea</i> (4), <i>Cucumis callosus</i> (6), <i>Cucumis melo</i> var. <i>utilissimus</i> (2), <i>C. melo</i> var. <i>momordica</i> (1), <i>C. sativus</i> (1), <i>Cucurbita moschata</i> (1), <i>Cyamopsis tetragonoloba</i> (11), <i>Dioscorea alata</i> (1), <i>D. deltooides</i> (1), <i>Lagenaria siceraria</i> (2), <i>Luffa acutangula</i> (1), <i>L. cylindrica</i> (2), <i>Lycopersicum esculentum</i> (2), <i>Macrotyloma iniflomm</i> (2), <i>Ocimum</i> sp. (1), <i>Pennisetum typhoides</i> (18), <i>Punica granatum</i> (1), <i>Sesamum indicum</i> (12), <i>Sorghum vulgare</i> (14), <i>Triticum aestivum</i> (4), <i>Vigna aconitifolia</i> (5), <i>V. mungo</i> (1), <i>V. radiata</i> (16), <i>V. unguiculata</i> (3), <i>Zea mays</i> (8) and <i>Zingiber officinale</i> (9)	150
Ajmer, Jaipur, Jodhpur, Pali and Sikar (October 18 - 20, 2001)	<i>Morus alba</i> (2), <i>M. indica</i> (11) and <i>M. laevigata</i> (2)	15
Barwani and Dhar districts of Madhya Pradesh (Oct. 31-Nov. 14, 2001)	<i>Abelmoschus esculentus</i> (5), <i>A. manihot</i> (1), <i>A. moschatus</i> (2), <i>Achyranthus aspera</i> (1), <i>Albizia lebbek</i> (1), <i>Allium cepa</i> (3), <i>A. sativum</i> (3), <i>Aloe barbadensis</i> (1), <i>Amaranthus amara</i> (4), <i>Andrographis paniculata</i> (2), <i>A. caudatus</i> (1), <i>Arachis hypogoea</i> (2), <i>Brassica campestris</i> (2), <i>Cajanus cajan</i> (3), <i>Calotropis gigantia</i> (1), <i>Capparis decidua</i> (1), <i>Capsicum annuum</i> (11), <i>Cicer arietinum</i> (2), <i>Cissus quadrangula</i> (1), <i>Citrullus colocynthis</i> (1), <i>Coccinia indica</i> (1), <i>Colocasia esculenta</i> (1), <i>Corchorus fascicularis</i> (1), <i>C. olitorius</i> (2), <i>C. tridens</i> (1), <i>Coriandrum sativum</i> (1), <i>Crotalaria juncea</i> (3), <i>C. medicagenea</i> (1), <i>Cucumis callosus</i> (1), <i>C. melo</i> (1), <i>Curcuma longa</i> (1), <i>Cyamopsis tetragonoloba</i> (3), <i>Datura alba</i> (1), <i>Foeniculum vulgare</i> (1), <i>Glycine max</i> (2), <i>Hibiscus cannabinus</i> (2), <i>H. sabdariffa</i> (1), <i>Lamprachaenium microcephalum</i> (1), <i>Lawsonia inermis</i> (1), <i>Leucas cephalotus</i> (1), <i>Luffa acutangula</i> (4), <i>L. acutangula</i> var. <i>amara</i> (1), <i>L. cylindrical</i> (2), <i>Lycopersicum esculentus</i> (1), <i>Macrotyloma biflorus</i> (2), <i>Medicago sativa</i> (1), <i>Melisa parviflora</i> (1), <i>Ocimum americanum</i> (4), <i>O. sanctum</i> (1), <i>Oryza sativa</i> (2), <i>Pennisetum glaucum</i> (5), <i>Ricinus communis</i> (1), <i>Sesamum indicum</i> (5), <i>Sesamum mulayanum</i> (2), <i>Setaria italica</i> (3), <i>Solanum surattense</i> (1), <i>Sorghum bicolor</i> (9), <i>Spinacia oleracea</i> (1), <i>Tephrosia purpurea</i> (1), <i>Tribullus terrestris</i> (1), <i>Trigonella foenum-graecum</i> (2), <i>Triticum aestivum</i> (7), <i>T. durum</i> (1), <i>Vigna aconitifolia</i> (7), <i>V. mungo</i> (6), <i>V. radiata</i> (7), <i>V. unguiculata</i> (4), <i>Xanthium strumarium</i> (1), <i>Zea mays</i> (12) and unknown (1).	177

Barmer, Dungarpur, Jaisalmer, Jalore, Jodhpur, Pali, Sirohi and Udaipur (November 20-29, 2001)	<i>Corchorus aestuans</i> (4), <i>C. depressus</i> (4), <i>C. oiliorius</i> (8), <i>C. tridens</i> (18), <i>C. trilocularis</i> (4), <i>Crotalaria juncea</i> (9), <i>C. medicaginea</i> (1), <i>Hibiscus cannabinus</i> (10) and <i>Agave angustistifolia</i> (1)	61
Local areas of Jodhpur : (on different months of year 2001)	<i>Achyranthus aspera</i> (1), <i>Cenchrus biflorus</i> (2), <i>C. ciliaris</i> (1), <i>Indigofera cordifolia</i> (1), <i>I. oblongifolia</i> (1), <i>Leucas aspera</i> (10), <i>Moringa concanensis</i> (1), <i>Morus laevigata</i> (1), <i>Ocimum americanum</i> (3), <i>Pithecellobium dulce</i> (1), <i>Psidium guajava</i> (1) and <i>Tinospora cordifolia</i> (1).	15
Total		525

Table 2 : Characterisation of cowpea (234 accessions)

Character	Range	promising accessions
Days to 50% flowering	43.00-78.00	EC- 232352, IC- 68768
Days to 80% flowering	58.00-85.00	EC- 341722, EC- 390212, IC-202821, IC-20278, -202791, 202849, -202881, -208863
Plant height (cm)	25.60-167.4	EC - 232352, IC - 202770
Pods per plant	1-24	IC-202785, EC-341722
Pod length (cm)	7.3-37.66	IC-202800, EC-390256
No. seeds per pod	4.6-19.2	IC-253424, EC-390220
Green biomass per plant	37.13-376.18	IC-202825, IC-5969
Green pod yield per plant	1.85-65.51	IC-202800, IC-219489
Seed yield per plant	1.03-20.79	IC-15667, EC-367682, GC-3
100 seed weight	4.28-19.05	IC-202825, EC-367682

Table 3: Promising accessions identified in various crops evaluated during kharif, 2001

Crop	Accessions identified for specific/ desired traits	Main attributes
Cowpea (234)	EC-202821, -202825, - 219607, - 232352, - 367703, -367705 EC - 18321, - 57449, - 61395, - 232352, - 390204, - 390213 IC - 58905, - 243501, -259069, -259104	High yielding Tolerant to <i>Cercospora</i> leaf spot, powdery mildew, cowpea mosaic virus and charcoal rot
Guar (1153)	IC -742, - 3118A, - 9.38, - 33520, - 445, - 40050, HG - 32, - 72, - 206, - 206, - 207, - 466, - 719 IC - 3118, - 3215, - 8453, - 8919, - 39997, - 9049, - 11506, - 28276, - 33564, - 40076, - 40103, - 40248, - 4028	High yielding Tolerant to bacterial blight, mosaic virus, leaf spot and charcoal rot
Mungbean (607)	IC - 103196, - 103207, - 103785, PLM - 14, -33, 87, - 87, - 99, - 194, - 449, -231, - 609, - 387. IC - 103207, - 39527, - 39528, - 39574, - 39578, PLM- 336, - 601, Diakara, Khiri, CH 26 - 1, CH 132 - 1, CHA 2-3, V 13 - 405, 445/1	High yielding Tolerant to bacterial blight <i>Cercospora</i> leaf spot, stem blight, leaf curl virus and yellow mosaic
Mothbean (500)	IC-39763, -52138, -251877, 251878, -251891, PLMO-204,-219,-232.	Tolerant to bacterial blight, leaf spot and yellow mosaic & mosaic virus
Pearlmillet (89)	NIC-17781,-17800,-17782,-17834	Tolerant to downy mildew and mosaic streak
Til (395)	NIC-8341,-8435, -8402,-8403, EC-377165, -377228, -358022,- 377325.	Tolerant to bacterial blight, <i>Alternaria</i> blight, phyllody, charcoal rot and leaf curl virus



Coccinia indica fruits collected from Barwani, MP



Achyranthus aspera - a medicinal plant collected from Jodhpur



Indigofera cordifolia, collected from Jodhpur



Amaranthus amara collected from Barwani, MP



Dr. B. S. Dhillon, Director, NBPGR in discussion with staff under a Khejri tree at Jodhpur

Research Projects (Project leader; associate)

1. Plant genetic resources activities in arid and semi arid regions.
- 1.1: Exploration and collection of germplasm of agricultural, horticultural crops and plants of economic importance from Gujarat, Haryana and Rajasthan (N.K. Dwivedi; K.C. Muneem).
- 1.2: Evaluation, documentation and maintenance of germplasm of pearl millet and minor millets (K.C. Muneem).
- 1.3: Evaluation, documentation and maintenance of germplasm of legumes (cowpea, guar, moth and mung) (N K Dwivedi; Neelam Bhatnagar).
- 1.4: Evaluation, documentation and maintenance of germplasm of oilseeds mainly castor and til (Neelam Bhatnagar).
- 1.5: Evaluation, documentation and maintenance of germplasm of horticultural plants (vegetables, fruits, ornamentals) (N K Dwivedi; K C Muneem).
- 1.6: Evaluation, documentation and maintenance of germplasm of fodder, fuel, fibre and other plants suitable under arid condition (Neelam Bhatnagar; N.K. Dwivedi).
- 1.7: Evaluation, documentation and maintenance of germplasm of jojoba and tumba (N K Dwivedi).
- 1.8: Conservation of germplasm in medium term storage Facility (Neelam Bhatnagar; N K Dwivedi and K C Muneem).

14. EXPLORATION BASE CENTRE, RANCHI

Summary: Five germplasm explorations were undertaken in east and west Singhbhum, Bokaro, Ranchi, Koderma, Chatra, Hazaribagh, Patna, Samastipur, Nalanda, Lakhisarai, Jamui, Deoghar, Dhumka, Jamatra, Sarguja and Chhattisgarh and 619 collections of various crops and their wild relatives were made. Alongwith important characters of material, indigenous traditional knowledge was also recorded at the site of collection as revealed by the tribals/ farmers.

14.1 Germplasm collection

Five explorations were undertaken during 2001 and 619 germplasm samples of different agri-

horticultural species were collected. The explored areas and details of collection are given below in Table 1.

Table 1: Areas explored and crop diversity collected during 2001

Areas explored (period)	Details of collections	Collections
East and West Singhbhum (19.7.01 to 27.7.01)	Paddy (23), Chilli (3), Maize (4), Pumpkin (3), Jack fruit (15), Sawa (2), Mung (3), Kulthi (2), Urid (4), Ricebean (w), Linseed (5), Sarson (4), <i>Lathyrus</i> (2), Cowpea (2), Brahmi (2), Sorghum (1), Lentil (1), Niger (1), Ridge gourd (1), Okra (1)	99
Singhbhum, Jharkhand (31.10.01 to 7.11.01)	Paddy (45), Maize (2), Pumpkin (2), Ragi (13), Bittergourd (2), Urid (13), Spongegourd (2), Jamun (8), Amaranth (2), Cowpea (4), Til (3), <i>Colocasia</i> (5), Tomato (2), Sweet potato (3), one each of Chilli, Mung, Kulthi, <i>Dioscorea</i> , Brinjal, Gokhuru, Kheksa, Bael, Niger, Groundnut, Khira, Turmeric	118
Bokaro, Ranchi, Giridih, Koderma, Chatra, Hazaribag, Patna, Baishali, Samastipur (28.11.01 to 8.12.01)	Paddy (73), Maize (13), Ragi (5), Sorghum (11), Arhar (2), Urid (3), Mung (3), Cowpea (2), Kerao (2), Lentil (5), Gram (3), Sarson (6), Bottle gourd (2), Sponge gourd (3), Kudrum (4), <i>Colocasia</i> (2), one each of Pumpkin, Sem, Garlic, <i>Ber</i> , Kulthi, <i>Lathyrus</i> , Bakla, Niger, Cotton, Coriander and Linseed	150
Nalanda, Lakhisarai, Jamui, Deoghar, Dumka, Jamtara, Dhanbad, Bokaro and Purulia. In collaboration with CICR Nagpur (20.12.01 to 30.12.01)	Paddy (42), Maize (19), Cotton (8), Sorghum (3), Arhar (8), lentil (2), <i>Lathyrus</i> (2), Mung (3), Urid (2), Kulthi (10), <i>Mucuna</i> (1), Cowpea (8), Sarson (5), Niger (2), Kudrum (3), Chillies (2), Ridge gourd (2), Brinjal (4), <i>Colocasia</i> (2), <i>Dioscorea</i> (2), Sweet potato (2), Garlic (3), Sem (1), Wheat (1), Castor (1), Amaranth (1), Sunflower (1), Bhelwa (1), Aonla (1), Pumpkin (1), Coriander (1), Linseed (1), Ragi (1)	150
Surguja district of Chhattishgarh (24.11.1 to 4.12.01)	Paddy (29), Bottlegourd (2), Maize (3), Sorghum (3), Sawa (3), <i>Hibiscus</i> sp. (6), Little millet (3), Niger (6), <i>Brassica</i> sp. (4), Amaranth (2), Aonla (2), <i>Luffa</i> sp. (4), One each of Tomato, Okra, Cotton, Kodo, Wild Kulthi, Urid, Ground nut, Til, <i>Dioscorea</i> and Wild Jamun	102
Total		619

The nature and extent of variability patterns observed in some major crops germplasm is briefly described here.

East and West Singhbhum districts of Jharkhand are plateau region and most of the area is covered with forest. The forest of both the districts is very rich with *Smilax Cholorophytum*, *Asparagus*, *Curcuma* (wild), anantmul, *Shorea robusta*, *Terminalia belerica*, *Terminalia arjuna*, *Madhuca latifolia*, *Oroxylum indicum*, *Semecarpus anacardium* (Bhelwa), Palas, Asan etc. Agriculture is mostly rainfed and monocropped. The land remains mostly fallow during *rabi* season due to little irrigation facilities. Wherever there are irrigation facilities, vegetables are mainly cultivated as cash crops. Mostly livelihood of the people depends on the forest and its products.

Variability in rice: Variability for hull colour, grain size, shape and test weight, kernel colour was observed. Two types of rice cultivation was observed. The important land races of upland rice viz., **Chorailuki, Gora, Tiker, Relia baba, Safed gora, Kala gora, Chotka gora, Sathi and Lalgora** were collected. The water requirement of these land races is very less.

Second type of rice is cultivated in medium land where there is water stagnation. The duration of such rice is longer and mostly matures in more than 120 days. The important land races collected from the medium land were **Sarno, Manjiharu, Shorma, Ashu bhojna, Kardi kunji, Niya, Lalat, Parmal, Raycee, Anpurna, Singlebaba, Chawra, Garma, Sorya, Tilasari**. The observations on the grain size, width, hull colour, grain colour were recorded and are given in Table 2.

A good variability in Sarguja district of Chhattishgarh for hull colour, grain size, shape and test weight and kernel colour was observed. The important landraces cultivated for upland paddy were: **Hardiguri, Bhaiyagora, Nango, Karahni, Hathuakoda, Sihar, Gurmatia** etc.

These landraces mature within 90 days and are intermediate to tall type. They have the ability to escape the drought. The landraces of upland paddy have been replaced by Kalinga-III, a high yielding variety released by CRRRI, Cuttack.

The important landraces collected in lowland paddy were: **Sonapak, Jhingi, Sihar, Gangai Sharna, Jaldubi, Jeeraphool, Hathwakoda, Bhartaphool, Sukhraphool**. They have been replaced by the modern varieties IR36 and Swarna. The land races **Jeeraphool, Hathwakoda, Bhartaphool, Sukhraphool** are aromatic and preferred by the affluent society.

Variability in urdbean germplasm: Urdbean is widely cultivated as a mixed crop with sorghum, arhar, maize and til. The cultivation of urad was also seen with upland gora rice as a mixed crop. A total of 13 samples of urad were collected. A significant variation in the test weight of 100 grains was observed which ranged from 4.28 to 7.80g. The seed colour varied from light black to deep black.

Variability in cowpea: The cowpea is cultivated by the farmers as a mixed crop with upland rice and maize. It is also cultivated in backyards as well as courtyard by the tribals. Only two samples were collected

Variability in spongegourd: The collection number JBT 27/15 had fruit length 39 cm, girth 23.60 cm and single fruit weight 86.02 g on dry basis whereas JBT 27/55 had fruit length 17.20 cm, girth 22 cm and single fruit weight 60.20 g on dry basis.

Variability in ragi: Ragi is cultivated by the farmers as sole crop as well as mixed crop with sunhemp and arhar. The head was six fingered in JBT 27/58 whereas it was four fingered in JBT 27/64 and JBT 27/66.

Indigenous knowledge (ethno-botanical information): At the site of collection, indigenous knowledge about the uses of various plants was recorded as revealed by the tribals.

Table 2: Grain size, width, shape, hull colour, grain colour in the different landraces collected from East and West Singhbhum

Collector No.	Length (mm)	Width (mm)	Test weight 100-grain(g)	L:W Ratio	Hull Colour	Grain Colour
JBT 27/13	7.00	2.00	2.73	3.50	Straw	White
JBT 27/14	5.00	2.00	2.43	2.50	Gold furrows	White
JBT 27/16	6.00	2.50	2.51	2.40	Brown	Red
JBT 27/19	6.00	2.50	2.48	2.40	Brown	White
JBT 27/20	6.60	2.60	2.32	2.54	Brown	Red
JBT 27/21	7.00	2.50	2.36	2.80	Brown	Red
JBT 27/22	6.20	2.02	2.29	3.07	Gold furrows	White
JBT 27/27	6.66	2.00	2.18	3.33	Brown	Red
JBT 27/28	6.00	2.42	2.38	2.48	Straw	White
JBT 27/31	8.00	2.00	2.39	4.00	Straw	Light red
JBT 27/32	7.33	2.33	2.48	3.15	Straw	White
JBT 27/33	4.40	2.40	2.58	1.83	Brown	Light Brown
JBT 27/34	6.70	2.10	2.52	3.19	Brown	White
JBT 27/35	6.25	2.67	2.41	2.34	Straw	White
JBT 27/36	6.55	2.80	2.54	2.34	Black	White
JBT 27/37	7.00	2.20	2.56	3.18	Straw	White
JBT 27/38	6.00	2.50	2.52	2.40	Straw	White
JBT 27/39	6.80	2.60	2.61	2.62	Reddish	White
JBT 27/42	6.33	2.33	2.41	2.72	Straw	White
JBT 27/43	7.21	1.80	2.42	4.01	Straw	White
JBT 27/44	6.33	2.50	2.46	2.53	Brown	White
JBT 27/45	6.22	2.00	2.39	3.11	Straw	Red
JBT 27/46	6.00	2.33	2.72	2.58	Brown	Brown
JBT 27/47	7.25	2.10	2.29	3.45	Straw	White
JBT 27/48	5.00	2.02	2.46	2.48	Straw	White
JBT 27/49	6.25	2.25	2.37	2.78	Straw	Brown
JBT 27/50	5.62	2.40	2.58	2.34	Reddish purple	White
JBT 27/51	6.70	2.30	2.56	2.91	Brown	Red
JBT 27/52	7.00	2.22	2.48	3.15	Golden	White
JBT 27/59	6.00	2.50	2.63	2.40	Red	White
JBT 27/61	6.25	2.00	2.36	2.13	Straw	White
JBT 27/63	6.67	2.20	2.38	3.03	Straw	Light brown
JBT 27/65	6.00	2.66	2.59	2.26	Black	Purple
JBT 27/75	6.33	2.66	2.60	2.38	Brown	Red
JBT 27/84	6.00	2.50	2.43	2.40	Straw	Red
JBT 27/87	6.00	2.33	2.41	2.58	Brown	Red
JBT 27/93	6.33	2.66	2.49	2.38	Brown	Red
JBT 27/99	6.00	2.70	2.53	2.22	Brown	Red
JBT 27/100	6.10	2.80	2.59	2.18	Golden	White
JBT 27/101	6.00	2.62	2.49	2.29	Brown	Red
JBT 27/106	5.80	2.60	2.42	2.23	Brown	Red
JBT 27/112	6.00	2.66	2.46	2.26	Brown	Red
JBT 27/113	6.04	2.70	2.53	2.24	Straw	White
JBT 27/116	5.33	2.00	2.31	2.67	Straw	White
Mean	6.28	2.36	2.48	2.62		

Botanical Name	Local name	Uses
<i>Psoralea coryiolia</i>	Baguchi	leucoderma – powder of seeds/roots is boiled in sesamum oil and used
<i>Tribulus terrestris</i>	Gokhuru	For vigor and impotency along with ashwagandha, satawari and Baghpanger (<i>Mucuna</i>).
<i>Dioscorea</i> sp.	Khappu	Root or fruit is used after boiling in Dispersia
<i>Trichosanthes palmata</i>	Kawatamar	Cold and cough- after boiling the seeds in mustard oil it is applied on chest. Also used in arthritis
<i>Curcuma</i> sp.	Kali haldi	Stomach pain and antidote to snake bite and pesticide (if consumed)-its tuber is fed
<i>Cassia</i> sp.	Chakod	Fever
<i>Cassia fistula</i>	Banderlohadi	Antidote to dog, rat, jackal bite
<i>Achyranthes aspera</i>	Chirchiri	Antidote to scorpion
<i>Gloriosa superba</i>	Kalahari	Contraceptive
<i>Vitex peduncularis</i>	Charaigodwa	Bark is used in anemia
<i>Urginea indica</i>	Kandrai /Jangli payaj	Arthritis
<i>Smilax macrophylla</i>	Atkir	Gonorrhoeal disease
<i>Pueraria tuberosa</i>	Patal kohada	For tumour treatment, providing vigor and strength
<i>Asparagus racemoses</i>	Kargi	Stomach problem along with bankandi and mayurjhuti

Variability in *Brassica* sp.: Sarson is cultivated by the farmers in upland with no source of irrigation. The crop mainly depended on rainfall for moisture. A good crop of *Brassica* sp. was observed when sown after the harvest of upland rice and was ready within two months of sowing. Variability was observed for seed colour. JBT 28/18 (light to dark maroon and small seeded), JBT 28/41 (yellow and very small seeded), JBT 28/82 (redish to greyish colour), JBT 28/120 (yellowish orange) were collected.

Variability in maize: Due to excessive rain during the current year, maize, mung, urid, sorghum etc. could not be sown widely. However, in some pockets, farmers could broadcast the seeds on the deep sloppy land where water could not stagnate. Some farmer sowed the seeds but could not harvest the crops. Three samples were collected and variation in the kernel colour JBT 28/16 (whitish), JBT 28/89 (cream) and JBT 28/90 (orange) was observed.

Important collections

- *Gossypium arboreum* (cotton) of perennial

nature.

- Tau- a pink coloured crop being cultivated in Sitapur block of Sarguja district (Manhunt area) as a cash crop. It is Tibetan dominated area.
- Samples of *Brassica* sp, from rainfed area.
- Kudrum (*Hibiscus sabdariffa*) of red colour was collected which is used by tribals for chutney.
- *Cucumis hardwickii*- a wild species of *Cucumis sativa* resistant to powdery mildew.
- *Lycopersicon pimpnellifolium* trailing habit with cherry type fruit from Sitapur and itapur blocks of Sarguja district.
- Three species *Chlorophytum arundinaceum*, *C. tuberosum* and *C. borivillium* were collected.
- *Pueraria tuberosa* (Patalkohada), *Rauwolfia tetraphylla*, Karaunda (*Carrisa* sp.), *Smilax procera*, *S. macrophylla*, *Terminalia tomentosa*, *T. bellerica*, *T. chebulla*, *T. arjuna*, *Pongamia pinnata*, *Abelmoschus* sp, Lataru (*Dioscorea* sp.), *Amaranthus* sp. and *Wild tulasi* were collected from forest areas.

NBPGR Base Centre, Ranchi also joined litchi exploration alongwith HARP, Ranchi in areas of Samastipur, Darbhanga, Motihari, Muzafarpur of Bihar from 29.7.01 to 8.8.01. Out of 50 genotypes identified, 25 were from Bawan Bigha Orchard belonging to Maharaja of Darbhanga. 15-20 Gooties (layering) of litchi were prepared in each 34 genotypes to get sufficient layered saplings. These layered materials were collected and transplanted at Crop Research Programme – A center of ICAR Research Complex of Eastern Zone- at RAU Campus PUSA, Samastipur.

Diversity in jack fruit: Good variability was

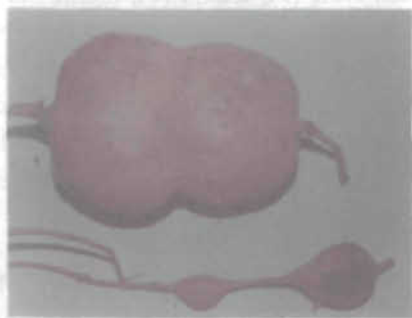
observed and collected in jack fruit with respect to fruit maturity, size, shape, fresh colour, taste and seed size.

14.2 Characterisation and maintenance

A total of 255 collections of various agri-horticultural crops viz. Jackfruit (53), barhal (10), bael (26), jamun (24), tamarind (43), custard apple (24), medicinal plants (38), mango (23), amla (14) were established in field genebank for characterisation.



Leea macrophylla collected from forest of east Singhbhum



Pueraria tuberosum - a rare medicinal plant collected from Sarguja district



Solanum torvum collected from Ranchi

Research Projects (Project leader; associate)

1. Augmentation, characterisation, maintenance, conservation and documentation of germplasm of agri-horticultural crops in Bihar, Jharkhand and adjoining areas.
- 1.1 Exploration and collection of germplasm of various agri-horticultural crops plants of economic importance and their wild relatives from Bihar, Jharkhand and adjoining areas (J.B.Tomar; V.K.Gupta)
- 1.2 Characterisation, maintenance, conservation and documentation of germplasm of agri-horticultural crops and medicinal plants (V.K.Gupta; J.B.Tomar)

15. REGIONAL STATION, SHILLONG

Summary: A total of 1527 accessions of various agri-horticultural crops were collected from ten exploration trips conducted in the Jaintia Hills of Meghalaya, parts of Arunachal Pradesh, Lohit & Dibang Valley, Arunachal Pradesh, Garo Hills of Meghalaya, Blue Mountain of Mizoram, Mikir and Jaintia Hills of North Eastern Region, West Kameng and Tawang of Arunachal Pradesh, parts of Manipur, Upper Assam and Siang district of Arunachal Pradesh. The collected germplasm was evaluated at Barapani farm and promising accessions were identified in maize, paddy, ricebean, ginger, *colocasia*, turmeric and chilli. 166 germplasm accessions of different crops were supplied to various indentors in the country for crop improvement programmes and 154 accessions of different crops were received for regeneration/maintenance. 155 accessions of paddy, ricebean and maize were sent for long term storage at NBPGR, New Delhi

15.1 Exploration and collection of germplasm

Of the ten exploration trips, the first trip was executed in Jaintia Hills of Meghalaya for the collection of indigenous germplasm observing the extent of diversity in various crops. A total of 36 crop accessions were collected during this trip. These are as follow: paddy (4), sesame (1), turmeric (4), chilli (4), garlic (3), ginger (4), black pepper (1), *Perilla* (1), frenchbean (3), pea (2), sponge gourd (1), pumpkin (1), *Colocasia* (2), orange (4) and *Rhus*.

The second tour was conducted in parts of Arunachal Pradesh for the collection of different crop germplasm. A total of 181 accessions were assembled comprising paddy (20), maize (18), soybean (4), adzuki bean (2), cowpea (6), frenchbean (6), amaranth (4), finger millet (7), sorghum (1), sesame (6), sunflower (3), *Perilla* (9), garlic (3), ginger (6), *Luffa* (5), sembean (2), pumpkin (8), radish (2), brinjal (2), muskmelon (1), cucumber (4), bottle gourd (7), leafy brassicae (4), water melon (2), *Colocasia* (6), *Dioscorea* (5), banana (6), orange (1), member of Lamiaceae (1), *Elaeocarpus* (1), *Hedychium* (2), *Alpinia/ Amomum* (1).

During third exploration, a total of 327 samples of different crops were collected from various parts of Lohit & Dibang Valley in

Arunachal Pradesh. Paddy (53), maize (15), chenopod (2), buckwheat (4), foxtail millet (4), kodomillet (4), amaranth (4), cowpea (5), pigeonpea (1), lentil (1), *Vigna* sp. (1), ricebean (2), soybean (4), sem bean (1), frenchbean (1), urdbean (1), pea (1), pumpkin (6), tomato (2), smooth gourd (1), water melon (1), ash gourd (1), radish (2), *Linum* (1), *Niger* (1), sesame (3), *Perilla* (2), *Brassica* (2), chilli (11), turmeric (8), black pepper (2), onion (1), ginger (9), garlic (2), *Coriander* (1), long pepper (1), *Polygonum* (1), Jack fruit (1), lemon (1), orchids & other bulbous plants (105), ornamental flower (1), *Coptis* (1), *Rheum* (1), *Tupistra* (1), *Zanthoxylum* (1), sunhemp (1), jute (1), unidentified (3), *Canna* spp. (1), sugarcane (2), opium (2), tobacco (1), *Jatropha* (1), member of Acanthaceae family (1) were collected.

The fourth exploration and collection trip was made in the month of November 2001 from Garo Hills of Meghalaya. Mango (21), banana (15), jack fruit (27), papaya (1), agmok (1), millets (4), pumpkin (4), muskmelon (7), chilli (1), cucurbit (1), garlic (1) and tomato (1) were collected.

During the fifth exploration, a total of 196 samples of different crop were collected from Blue Mountain areas of Mizoram. Rice (15), maize (18), soybean (2), cowpea (3), ricebean

(10), lablab bean (1), French bean (4), pigeonpea (1), *Coix* (1), foxtail millet (2), sorghum (1), sesame (1), *Perilla* (3), mustard (6), turmeric (1), zinger (6), cardamom (1), tomato (1), brinjal (9), onion (1), radish (2), okra (2), muskmelon (1), watermelon (1), wild okra (1), wild *Solanum* (1), *Momordica* (10), bottle gourd (1), chinese cabbage (1), *Canna* (1) and *Coccinia indica* (1), *Colocasia* (1), *Dioscorea* (1), papaya (2), *Citrus* (3), fig (1), passion fruit (1), *Phyllanthus* (1), *Quercus* (1), *Clerodendrum* (1), *Alpinia* (1), *Kaemferia* (1), others (14), orchids (40), *Hibiscus* (1), tobacco (1), *Hibiscus cannabinus* (1), Coffee (1) and miscellaneous plants (14) were collected.

The sixth exploration was undertaken to collect the germplasm from Mikir hills of Assam and Jaintia hills of Meghalaya. During this trip, a total of 215 germplasm of different crops were collected which included rice (86), maize (10), bajra (1), *Coix* (1), mustard (8), sunflower (1), *Perilla* (4), sesame (6), ricebean (1), french bean (8), cowpea (6), pea (4), blackgram (1), taros (13), sweet potato (4), cassava (3), *Mahonia* (2), ginger (9), turmeric (8), chilli (14), *Cinnamomum* (1), Karbi masala (3), *Zanthoxylum* (1), black pepper (2), *Nigella* (2), methi (2), onion (2), garlic (6), radish (3), chenopod (1), ladies finger (3), tomato (1), *Solanum gillo* (9), brinjal (10), *Hibiscus* (1), *Cyphomandra* (2), pumpkin (6), *Cucumis* (9), bottle gourd (5), *Luffa* (3), *Benincasa* (7), bitter gourd (3), *Coccinia* (1), *Citrus* (12), jack fruit (1), papaya (2), *Phyllanthus* (2), *Saccharum* (1), *Pinus* (1), *Quercus* (1), Orchid (1) and unidentified (1).

The seventh trip for collection of germplasm was conducted in West Kameng and Tawant districts of Arunachal Pradesh. A total of 37 collections were made during this programme which included apple (3), walnut (2), chestnut (1), french bean (5), chilli (5), *Cucumis* (1), radish (1), garlic (1), tomato (1), pumpkin (2), bottle

gourd (1), cabbage (1), *Solanum* sp. (2), millets (1), maize (1) and other crops (9).

The eighth exploration was undertaken from Senapati, Mao and Ukhrul districts of Manipur. During this trip a total of 192 accessions of different crop germplasm were collected including rice (15), maize (14), fox-tail millet (5), buckwheat (1), *Coix* (3), mustard (1), *Perilla* (5), rice bean (6), french bean (22), lima bean (4), winged bean (2), jackbean (1), soybean (1), sembean (5), cowpea (7), pea (4), *Dioscorea* (2), sweet potato (1), potato (2), *Colocasia* (7), ginger (5), turmeric (2), chilli (2), *Celosia* (1), onion (5), garlic (1), coriander (1), ajmud (1), radish (1), spinach (1), ladies finger (2), tomato (5), *S. gillo* (11), brinjal (1), *Cyphomandra* (1), pumpkin (7), *Cucumis* (4), carrot (1), *Amaranthus* (1), *Benincasa* (2), Chow-chow (1), *Citrus* (12), passion fruit (3), *Phyllanthus* (2), guava (1), tea (1), coffee (1), *Taxus baccata* (1), *Aleurites* sp. (1), orchids (3) and chenopod (1).

The ninth exploration trip was meant for the collection of crop germplasm from the districts of Upper Assam. During this collection programme, 174 accessions comprising rice (145), maize (2), ricebean (1), blackgram (3), cowpea (1), mung (1), arhar (1), brinjal (1), mallow (1), bottle gourd (1), *Colocasia* (4), snake gourd (1), ridge gourd (1), *Luffa cylindrica* (1), *Cyclanthera* (2), ash gourd (1), sesame (1), mustard (1), *Coriander* (1), chilli (2), turmeric (1) and ginger (1), were collected.

Tenth exploration and collection trip was undertaken in Siang district of Arunachal Pradesh. A total of 93 germplasm of different crops were collected. These were paddy (25), maize (7), bajra (2), *Coix* (3), millets (8), sesame (3), *Perilla* (1), rice bean (2), beans (2), cowpea (6), soybean (2), *Colocasia* (1), *Dioscorea* (1), ginger (3), chilli (10), cucumber (3), pumpkin (3), leafy brassicae (2) and *Citrus* (7).

15.2 Evaluation and maintenance of germplasm

The germplasm of different agri-horticultural crops collected from this region was grown for preliminary evaluation.¹ After screening of germplasm continuously for three successive years, the material was sent to the National Genebank for conservation. The collected

germplasm was grown under rainfed conditions. Based on yield and resistance against stress parameters, the promising genotypes were identified. The following crops with their respective number of accessions were characterized during the year 2001. The promising genotypes were identified in each crop based on the yield parameter (Table-1).

Table 1. Germplasm evaluation at NBPGR Regional Station, Umiam, Meghalaya

Crop	No. of Accessions	Promising Genotypes
Upland Paddy	73+6 (local)	NIC-22724; IC-211553
Lowland Paddy	72+5 (local)	IC-253546; IC-253543 and IC-253550
Maize	88+5 (local)	M-14; M-23; RKU-114
<i>Perilla</i>	30	EC-216268, RS-12
Adzuki bean	17	EC-120460, HPAB-3
Coix	35	IC-203985, NH6/22
Buckwheat	20	VL-7-A, EC-13376
Ginger	147	RS-14, IC-82209, IC-3064
Turmeric	94	IC-212578, RS-53
Chilli	85	DMRK-56, NIC-204203, RS-27
<i>Colocasia</i>	202	IC-89564, RS-91, FDI-RS-59
Ricebean	368	RBL-130, Vum-90 and LRB-168

15.3 Maintenance of fruit germplasm

Banana (80), *Citrus* (74), Passion fruit (4) and Kiwi fruit (2) were maintained in field genebank at Barapani. Besides above mentioned crops, the under utilized crops such as *Perilla*, adzuki bean were also characterized and the relevant report sent to the Project Co-ordinator, AICRP on under utilized crop plants. Leaf spot disease in *Coix* accessions caused an extensive damage and reduced the grain yield drastically.

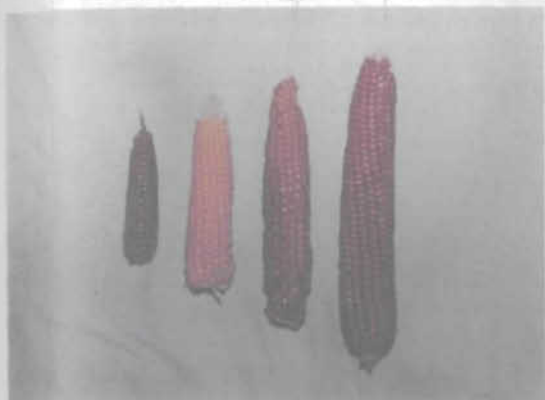
15.4 Germplasm distribution

Coix (85), ricebean (30) and *Colocasia* (1) were

supplied to various indentors in the country for crop improvement programs. 154 accessions comprising ricebean (52), paddy (101) and local tea (1) were received for regeneration/maintenance at this station.

15.5 Germplasm conservation

Upland paddy (27), lowland paddy (6), maize (22) and ricebean (30) were sent to NBPGR, New Delhi for long-term storage in the National Genebank.



Variability in maize cobs collected from south Siang, Arunachal Pradesh



Citrus orchard in west Siang, Arunachal Pradesh



A view of terrace cultivation in a village of Arunachal Pradesh

Research Projects (Project Leader; Associate)

1. Exploration and collection of germplasm of agri-horticultural crops in North-eastern India, (D. K. Hore; R. Srivastava).
2. Maintenance and evaluation of germplasm of different agri-horticultural crops (D. K. Hore; R. Srivastava).
 - 2.1 Characterization, evaluation and maintenance of hill rice, maize and ricebean (D. K. Hore).
 - 2.2 Characterization and evaluation trial on ricebean, adzukibean, buckwheat, *Perilla* and *Coix*, under the AICRP on UU crops (D. K. Hore)
 - 2.3 Maintenance and characterization of both indigenous and exotic lines of chillies, ginger, turmeric, yams, taros, *Citrus*, banana and passion fruit germplasm (R. Srivastava)
3. Development of agro-techniques on four allotted species of medicinal plants (K. Hore).

16. REGIONAL STATION, SHIMLA

Summary: A total of 691 germplasm accessions of 102 crop species including paddy, wheat, maize, walnut, pulses, vegetables, and many others were collected. Some important landraces of paddy viz. **Kalon, Jiri, Begumi, Ukhyal, Gyassu, Laldhan, Ruthadhan, Kishan Mangora, Sundaru, Kalan, Kathuzala** were also collected from Sirmour district. 1757 germplasm accessions of maize, amaranth, buckwheat, chenopod, french bean, adzukibean, ricebean, finger millet and 257 germplasm accessions of apple, peach, pear and apricot were evaluated for various agro-botanical characters. The overall promising germplasm accessions in different crops were IC 278918, IC 278919, IC 310049, IC 42319-5, IC 258249 in amaranth; IC 274440, IC 274442, IC 274441, IC 274444, IC 278972 in buckwheat; IC 108090, NIC 22449, NIC 22500, NIC 50229, IC 108087, IC 107734 in chenopod; IC 311665, IC 311085, IC 313319, IC 280009, IC 274530 in frenchbean; EC 43639, EC 100218, Tropical beauty, Orange Red, Gala, Lalla Delicious, Ambri in apple; Flemish Beauty, Manning Elizabeth, Maxred Bartlet, Leconte in pear; Nugget, Viva Gold and Royal in apricot; Florabella, Nemagaurd, Duke, Kanto 5, Okubo in peach and Methley, Settler and EC 115719 in plum. Germplasm of amaranth (99), buckwheat (31), chenopod (21), frenchbean (93), adzukibean (10), ricebean (46) were kept in the MTS. Germplasm accessions of french bean (290), amaranth (475), buckwheat (38), adzuki bean (183), ricebean (180), horsegram (8); rooted plants apple (20), peach (13), pear (10), plum (2), apricot (11), strawberry (42), *Feijoa sellowiana* (2) hazelnut (6), pecan nut (2), walnut (4), *Ascedra butrecea* (2), chinese ber (4), persimmon (12), and kiwi (104) and bud sticks of walnut (30), persimmon (100), kiwi (600), pecan nut (120) were supplied to various indentors.

16.1 Germplasm collection

16.1.1 Indigenous collections: A total of eight explorations were conducted to different parts of Himachal Pradesh. The important sites visited during the explorations were Thalli, Chamara, Pritmass, Teesa, Manjhu, Rahala, Holi, Garola, Bharmour, Bhrinti, Tooh in Chamba district; Gohar Neri, Basai, Bada, Longani, Bagga, Harhali, Bandli, Panarsha, Bhatwari, Majhwad in Mandi; Darlaghat, Arki, Danoghat, Khajjalghati, Seri forest, Shalaghat, Platokloth, Karadaghat, Ghanagughat, Narag forest, Deothal, Vasani, Sheel, Bagthan in Solan; Goa Dhandarwadi, Punjarli, Jakha, Gumma in Shimla; Chhogtali, Bhatnaul, Bamong, Nari (Niharagarh), Rukhdi, Koti, Bhujjal, Dochi, Kyar, Koti Padhog, Bagol, Kyartu, Kotali, Shaya, Didag, Shamoga, Chauras in Sirmour and Gadsa, Bhogan, Badirapa, Khundan, Bathad, Banjar, Jaan, Sainj Valley, Parvati Valley in Kullu district. The areas explored during the explorations are given in fig. 1. The details of the crop diversity collected (species wise) during the explorations are given in table 1.



During the explorations some interesting landraces were also collected. Their characteristic features were also recorded and are given in table 2.

16.1.2 Introductions: 84 germplasm accessions comprising of *Prunus persica* (6), *Rubus* (34), *Vaccinium* (31), *Ribes* (12) and *Sorbus* (1) were introduced from USA through germplasm exchange unit after quarantine clearance.

Table 1. The crop diversity collected in agri-horticultural crops

Crop group	Crop	Botanical name	Accs. collected
Cereals	Wheat	<i>Triticum aestivum</i>	50
	Rice	<i>Oryza sativa</i>	47
	Barley	<i>Hordeum vulgare</i>	32
	Maize	<i>Zea mays</i>	108
Pseudo-cereals	Amaranth	<i>Amaranth</i> sp.	41
	Chenopod	<i>Chenopodium album</i>	6
	Buckwheat	<i>Fagopyrum esculentum</i> <i>Fagopyrum tataricum</i>	11 11
Millets	Finger millet	<i>Eleusine coracana</i>	22
	Foxtail millet	<i>Setaria italica</i>	12
	Little millet	<i>Panicum sumatrense</i>	2
	Proso millet	<i>Panicum miliaceum</i>	10
	Bajra	<i>Pennisetum americanum</i>	1
Pulses	Frenchbean	<i>Phaseolus vulgaris</i>	138
	Kulthi	<i>Macrotyloma uniflorum</i>	9
	Blackgram	<i>Vigna mungo</i>	18
	Greengram	<i>Vigna radiata</i>	1
	Cowpea	<i>Vigna unguiculata</i>	15
	Rice bean	<i>V. umbellata</i>	3
	Lentil	<i>Lens culinaris</i>	2
Oilseed	Indian mustard	<i>Brassica juncea</i>	13
	Sesame	<i>Sesamum indicum</i>	9
	Sunflower	<i>Helianthus annuus</i>	3
	Soybean	<i>Glycine max</i>	5
	Linseed	<i>Linum perene</i>	1
Vegetables	Okra	<i>Abelmoschus esculentus</i>	4
	Cucumber	<i>Cucumis sativus</i>	6
	Bitter gourd	<i>Momordica charantia</i>	7
	Tomato	<i>Lycopersicon esculentus</i>	3
	Chilli	<i>Capsicum annuum</i>	13
	Brinjal	<i>Solanum melongena</i>	4
	Bottle gourd	<i>Lagenaria siceraria</i>	4
	Pumpkin	<i>Cucurbita maxima</i>	8
	Allium	<i>Allium</i> sp.	9
	Colocasia	<i>Colocasia</i> sp.	7
Fruits	Walnut	<i>Juglans regia</i>	11
	Pomegranate	<i>Punica granatum</i>	14
Spices		10	
M&AP		50	
Wild relatives		12	
Miscellaneous		26	
Total			691
Total number of crop/plant species collected			102

16.2 Germplasm evaluation

16.2.1 Agricultural crops: A total of 1757 accessions of various crops viz. maize (414), amaranth (327), buckwheat (121), chenopod

(76), frenchbean (620), kulthi (58), prosomillet (49), fingermillet (35) and chilli (57) were planted during Kharif 2001. Besides, 291 germplasm accession of pea (162), lentil (48)

Table 2. Important landraces of paddy, wheat and maize and their important characters**a. Paddy landraces**

Landrace	Important characters
Kalon	Up-land type, tall plants, brownish black seeds
Jiri	Irrigated, tall, requires more temperature, late maturity
Begumi	Scented and fine-grained rice
Ukhyl	Early maturing, swells more on cooking, grain colour is pinkish red; husk is pale yellow
Gyassu	Irrigated, tall, prone to lodging, pink grained, long & bold seeded
Laldhan	Red husk, white rice
Laldhan	Yellow husk, pink red rice, good cooking quality
Laldhan	Pink husk, light pink grain
Ruthadhan	Pinkish husk, white grain, good taste, upland type
Kishan Mangora	White seeds, tasty, upland, heat-tolerant
Sundaru	Tall, husk red, rice pinkish, scented, lowland
Kalan	Very tall, husk black, grain bluish white, awnless, panicle 6-7 inches, up land type
Kathuzala	Tall, normal color, light pinkish rice, upland

b. Wheat landraces

Rundal / Rundan	Awnless, tall, thin stem, good yield, good bread
Jhuldi	Awned, ears and grains large
Sirohun	Awned, gives good yield in rotation with paddy but less with maize
Kathuan	Pinkish ear
Kishal	Awned, rainfed, good yielder

c. Maize landraces

Safed makki	Tall, prone to lodging, good taste, big cobs
Pinjouri	Less yield, good taste
Kheel ki makki	Cobs and seeds small
Pahari makki	7-8 ft tall, less yield, good taste

and buckwheat (81) were also planted in rabi 2001-2002. The entries received under AICRP on under-utilised crops viz. amaranth (12), buckwheat (11), ricebean (11), adzukibean (15) were also grown in the kharif season. The details of germplasm grown for preliminary evaluation and multiplication are given in table 3.

Table 3. Germplasm grown for preliminary evaluation and multiplication

Crop	Ist Year	IInd year	Multiplication	Total
Amaranth	143	34	150	327
Buckwheat	89	32	—	121
Chenopod	05	04	67	76
Frenchbean	317	151	152	620
Horsegram	21	09	28	58
Maize	314	100	—	414
Proso millet	29	20	—	49
Finger millet	15	20	—	35
Chilli	38	19	—	57
Total	971	389		

The above data were recorded as per the standard descriptors developed by NBPGR for different crops. The range of variation and

promising germplasm were noted in each crop. The overall best performing germplasm accession in different crops were IC 278918,

IC 278919, IC 310049, IC 42319-5, IC 258249 in amaranth; IC 274440, IC 274442, IC 274441, IC 274444, IC 278972 in buckwheat; IC 108090, NIC 22449, NIC 22500, NIC 50229, IC 108087, IC 107734 in chenopod; IC 311665,

IC 311085, IC 313319, IC 280009, IC 274530 IC 311085, IC 274526, IC 313279, IC 280000 in frenchbean. The germplasm accessions which were noted as promising for important characters in different crops are given in table 4.

Table 4. Range of variation and promising germplasm along with value for different characters in various crops

Crop	Characters	Range	Promising accessions	Value
Amaranth	Plant height (cm)	46.4-331.9	IC 38370, NIC 22560, IC 260347, IC 313258, IC 278914	>256.0
	Leaf length (cm)	2.95-25.75	IC 278923, IC 313272, IC 279971, IC 274462, IC 279957, IC 279966	>22.8
	Petiole length (cm)	1.85-23.45	IC 35407, IC 359440, IC 313265, IC 278914, IC 274449, IC 274451	>14.7
	Inflorescence length (cm)	10.90-95.15	IC 42319-5, IC 258249, IC 313269, IC 278922, IC 278914	>73.7
	Stem thickness (cm)	0.80-3.28	EC 354949, IC 279959, IC 258251, IC 258249, NIC 22550, EC 359437	>2.66
	Days to flower	41.00-134.00	IC 311100, IC 311101, IC 311102, IC 311103, IC 274474, IC 274466, IC 274467	<61.0
	Days to maturity	137.00-176.00	IC 35407, IC 274473, IC 274467, EC 359419, IC 311102, IC 279967, IC 279974	<143.0
	1000-seed wt. (g)	0.30-0.80	IC 278914, IC 25407, IC 278917, IC 279956, IC 274456, IC 274461	>0.8
	Yield/plant (g)	6.27-197.37	IC 278918, IC 278919, IC 310049, IC 260313, IC 258251	>109.1
Buckwheat	Plant height (cm)	38.9-157.9	IC 274444, IC 274432, IC 310104, IC 358241, IC 274437	>148.9
	No. of branches	1.1-7.0	IC 310045, IC 274440, IC 318859, IC 310046	>4.5
	No. of leaves/plant	20.0-102.0	IC 274426, IC 274439, IC 274436, IC 280394, IC 274440	>70.0
	Leaf length (cm)	4.1-11.7	IC 274444, IC 310046, IC 280349, IC 310104, IC 313469	>10.3
	Leaf width (cm)	4.7-12.8	IC 310104, IC 274437, IC 274444, IC 310046	>9.6
	Petiole length (cm)	2.9-11.3	IC 310046, IC 274427, IC 274435	>9.9
	Days to flower	33.0-61.0	IC 258242, IC 258238, IC 258239, IC 274432, IC 274444, IC 258242	<34.0
	Days to maturity	98.0-119.0	IC 258237, IC 258231, IC 258245, IC 274424, IC 274423	<103.0
	1000-seed wt (g)	10.7-37.0	IC 258232, IC 274444, IC 278972, IC 278957, IC 274433	>27.4
	Seed yield/plant (g)	1.6-116.8	IC 274440, IC 274442, IC 274441	>37.9
Chenopod	Plant height (cm)	97.8-302.8	NIC 22449, EC 359447, EC 359445, EC 338953, IC 201618, IC 108808	>235.7
	Leaf length (cm)	3.9-10.2	EC 359445, EC 359451, NIC 22500, EC 338953, IC 109263, IC 107185	>8.2

	Leaf width (cm)	1.3-6.7	EC 359447, IC 108817, NIC 22500, EC 359451	>5.8
	Inflorescence length (cm)	7.2-33.4	IC 108090, NIC 22449, NIC 22500, EC359451, EC 338952	>28.7
	Days to flower	56.0-146.0	IC 258253, IC 258254, IC 258331, IC 258332	<62.0
	Days to maturity	108.0-177.0	IC 258253, IC 258254, IC 258331, IC 258332	<124.0
	1000-Seed wt.(g)	0.2-0.8	IC 243192, IC 109249, EC 359447, NIC 38231, IC 107185	>0.6
	Yield/plant (g)	2.1-61.3	NIC 50229, IC 108087, IC 107734, EC 201618	>31.3
Adzuki bean	Plant height (cm)	20.0-85.0	EC 340255, EC 387896, EC 34625, IC 87897	>75.0
	Days to flowering	55.0-70.0	EC 18959, EC 340280, EC 340278, EC 241041	>60.0
	No. of pods/cluster	2.0-7.0	EC 340285, EC 348258, EC 30256, EC 720460	>6.0
	No. of pods/plant	20.0-65.0	EC 87896, EC 340285, EC 36070, EC 290251, EC 340260	>60.0
	Days to maturity	85.0-105.0	EC 108080, EC 120460, EC 30256, EC 276	>98.0
	Seeds/pod	5.0-10.0	HPAB 38, EC 264, EC 340263, EC 24523, EC 120480	>7.0
	100-Seed wt. (g)	10.0-17.0	EC 340264, EC 390296, EC 87896, HPAB 38, EC 34027, EC 57169	>12.0
	Seed yield/plant	15.0-40.0	EC 340280, EC 34625, EC 108080, EC 15257	>235.5
French bean (Bush type)	Plant height (cm)	27.3 - 65.5	IC 313279, IC 279998, IC 274525, IC 311083	<31.5
	Leaf length (cm)	9.0 - 12.0	IC 311664, IC 313284, IC 274525, IC 274530	>13.0
	Leaf width (cm)	6.2 - 12.5	IC 311664, IC 313284, IC 279999, IC 280001	>10.4
	Branches/plant	2.0 - 8.0	IC 313295, IC 279998, IC 274525, IC 311085	>6.8
	Leaves/plant	21.0 - 75.0	IC 313295, IC 311085, IC 274526, IC 311081	>50.0
	Pods/plant	8.0 - 21.0	IC 311665, IC 311085, IC 274526, IC 313279	>20.0
	Pod length (cm)	9.5 - 12.8	IC 313281, IC 280000, IC 311083, IC 311090	>14.30
	Seeds/pod	3.65 - 8.60	IC 313287, IC 280002, IC 311083, IC 311665	>6.6
	Days to maturity	55.0 - 100.0	IC 274524, IC 279999, IC 311086, IC 313294	<70.00
Seed yield/plant (g)	10.4 - 28.0	IC 311085, IC 274526, IC 313279, IC 280000	>21.0	
French bean (pole type)	Plant height (cm)	90.0 - 200.5	IC 313319, IC 280009, IC 274530, IC 311090	>182.5
	Branches/plant	5.0 - 14.2	IC 311091, IC 313319, IC 274529, IC 274530	>9.8
	Leaves/plant	50.8 - 160.0	IC 311090, IC 311091, IC 274529, IC 274530	>152.0
	Leaf length (cm)	7.4 - 17.5	IC 274529, IC 313300, IC 313318, IC 313309	>13.5
	Leaf width (cm)	6.1 - 14.5	IC 274529, IC 313318, IC 313311, IC 311092	>12.00
	Pods/plant	20.0 - 48.0	IC 311091, IC 313319, IC 274529, IC 274530	>42.5
	Pod length (cm)	9.5 - 14.0	IC 313310, IC 311700, IC 311707, IC 274531	>12.0
	Seeds/pod	3.6 - 9.0	IC 311706, IC 311707, IC 274529, IC 274530	>7.00
	Days to maturity	85.0-140.0	IC 313320, IC 311689, IC 311094, IC 280010	<90.0
	Seed yield/plant (g)	18.0 - 56.0	IC 311091, IC 313319, IC 274529, IC 313319	>51.0
Horse gram	Pod length (cm)	3.0 - 5.5	IC 313361, IC 310086, IC 280030, IC 280032	>5.0
	Pods/plant (no.)	15.0 - 55.0	IC 313370, IC 313369, IC 280030, IC 313362	>52.0
	Seeds/ pod (no.)	4.0-7.0	IC 313369, IC 310086, IC 313368, IC 280032	>6.5

	Earliness	80.0 – 156.0	IC 280030, IC 280031, IC 313368, IC 310086	<90.0
<i>Eleusine</i>	Plant height (cm)	75.0-110.0	IC 274507, IC 274524	>90.5
	Leaf length (cm)	40.0-70.0	IC 274463, IC 274505, IC 274515	>62.5
	Finger length (cm)	6.0-12.0	IC 274505, IC 274518, IC 274520	>10.5
	1000-seed weight (g)		11.80 -13.50 IC 274505, IC 274507, IC 274463	>11.0

16.2.2 Horticultural crops: Under horticultural crops 219 accession of various fruit plants comprising apple (76), pear (20), peach (28), apricot (22), walnut (59) and strawberry (14) were evaluated. The data were recorded for different characters as per standard descriptors. The best performing varieties/ germplasm were EC 43639, EC 100218, Tropical Beauty, Orange

Red, Gala, Lalla Delicious, Ambri, in apple; Flemish Beauty, Manning Elizabeth, Maxred Bartlett, Leconte in pear; Nugget, Viva Gold and Royal in apricot and Florabella, Nemagaurd, Duke, Kanto 5, Okubo in peach and Methley, Settler and EC 115719 in plum. The data for important fruit characters of important varieties/ accessions evaluated are given in table 5.

Table 5. Evaluation data of important varieties for fruit characters in apple, pear, apricot and peach

Variety	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	TSS (%)
Apple				
EC 32221	5.25	6.45	92.11	14.50
Tropical Beauty	5.78	7.46	130.23	13.75
Lalla Delicious	4.88	5.63	142.50	12.50
Jono	5.46	6.81	94.41	15.00
Alkemene	4.27	5.86	77.80	12.60
Yellow Transparent	4.96	5.84	52.70	13.50
Mayan	5.34	6.78	100.30	13.00
Michal	4.95	6.00	88.20	13.00
Ambri	5.30	5.74	74.80	12.00
Laxtunes Fortune	4.23	5.54	62.00	12.70
Gala	4.94	6.03	95.17	11.00
Pear				
Flemish Beauty	7.25	6.65	155.72	12.50
Manning Elizabeth	6.05	5.75	83.75	11.80
Magnes	6.56	5.55	90.18	11.50
Maxred Bartlett	6.31	5.23	134.0	12.70
Keiffer	5.26	6.73	109.83	13.80
Leconte	6.97	5.89	82.19	14.90
Severyanka	8.77	7.28	150.66	13.00
Apricot				
Nugget	4.37	4.40	43.06	16.00
Viva Gold	3.98	4.14	37.50	13.50
St. Ambroise	5.28	4.86	52.13	13.00
EC 252328	4.28	4.43	36.83	12.30
Vittle	3.46	3.51	29.13	14.60

Kalole	4.55	4.31	39.57	17.80
EC 198240	4.21	4.30	41.87	14.00
Peach				
Stanford	4.56	4.70	52.73	11.20
Florabella	5.27	5.48	93.22	11.70
Nishiki4.	72	5.33	74.05	10.00
Kanto 5	6.04	6.15	115.82	12.75
Fire Prince	4.88	5.15	85.70	09.50
Sun Red	5.21	5.36	62.70	12.50

16.3 Germplasm conservation

The major crops, their germplasm and

species being maintained in the station are given below:

Crops	Accs.	Crop species
Amaranth	2574	<i>A. hypochondriacus</i> , <i>A. caudatus</i> , <i>A. cruentus</i> , <i>A. hybridus</i> , <i>A. retroflusus</i> , <i>A. lividus</i> , <i>A. viridis</i> , <i>A. graecizans</i> , <i>A. dubious</i> , <i>A. spinosus</i> , <i>A. tricolor</i> , <i>A. blitum</i> , and <i>A. cannabinus</i>
Buckwheat	568	<i>Fagopyrum tataricum</i> , <i>F. esculentum</i> , <i>F. emerginatum</i> , <i>F. gignatium</i>
Chenopod	76	<i>Chenopodium album</i> , <i>C. quinoa</i> , <i>C. amaranticolor</i> , <i>C. botryas</i> , <i>C. murale</i> , <i>C. ambrisoides</i> .
French bean	2080	<i>Phaseolus vulgaris</i> , <i>P. lunatus</i> , <i>P. coccineus</i> , <i>P. microcarpus</i> , <i>P. micranthus</i> , <i>P. acutifolius</i>
Rice bean	186	<i>Vigna umbellata</i>
Adzuki bean	142	<i>Vigna angularis</i>
Kulthi	20	<i>Macrotyloma uniflorus</i>
Pea	85	<i>Pisum sativum</i> , <i>P. sativum</i> var. <i>arvens</i>
Lentil	54	<i>Lens culinaris</i>
Faba bean	15	<i>Vicia faba</i> , <i>V. hirsuae</i> , <i>V. tetrasperm</i>
Meetha karela	22	<i>Cyclanthra pedata</i>
Apple	144	<i>Malus pumila</i> , <i>Malus baccata</i> , <i>M. sikkimensis</i> , <i>M. dirangensis</i>
Pear	60	<i>Pyrus jacumontiana</i> , <i>P. polycarpa</i> , <i>P. pyrifolia</i> , <i>P. pashia</i> , <i>P. communis</i>
Apricot	28	<i>Prunus nepaulensis</i> , <i>P. armeniaca</i> , <i>P. ceresoides</i>
Almond	15	<i>Prunus dulcis</i> Syn. <i>P. amygdalus</i>
Peach	41	<i>P. persica</i> , <i>P. cornuta</i> , <i>Prunus</i> sp. (bhemi)
Pecan	11	<i>Carya illinoensis</i>
Walnut	83	<i>Juglans regia</i> , <i>J. nigra</i>
Hazelnut	9	<i>Corylus avellana</i> , <i>C. colurna</i> , <i>Corylus ferox</i>
Kiwi	8	<i>Actinidia deliciosa</i> , <i>A. purpurea</i> , <i>A. arguta</i>
Grapes	9	<i>Vitis himalayana</i>
<i>Rubus</i> sp.	24	<i>Rubus ellipticus</i> , <i>R. nivus</i> , <i>R. biflorus</i> , <i>R. fruitcosus</i> , <i>R. lasiocarpus</i>
<i>Ribes</i> sp.	06	<i>Ribes nigrus</i> , <i>R. rubrum</i>
Plum	32	<i>Prunus domestica</i> , <i>P. salicina</i> , <i>P. cerasifera</i> , <i>P. americana</i>
Persimmon	5	<i>Diospyrus kaki</i>
Pomegranate	155	<i>Punica granatum</i>

Miscellaneous	39	<i>Sorbus lanata</i> , <i>Cotoneaster accuminata</i> , <i>C. frigida</i> , <i>Crataegus crenulata</i> , <i>C. oxycantha</i> , <i>Feijoa sellowiana</i> , <i>Cydonia oblonga</i> ; <i>Doycinia hookeriana</i> , <i>Viburnum contifolium</i> , <i>V. lanata</i> , <i>Cornus capitata</i> , <i>Elaeagnus umbellata</i> , <i>Casteria sativa</i> , <i>Olea</i> spp., <i>Ziziphus jujuba</i> , <i>Aesandra butrecea</i> , <i>Avocado</i> , <i>Pistacia</i> , <i>Hippophae rhamnoides</i> , <i>Pinus gerardiana</i> , <i>Ficus</i> spp.
Medicinal Plants	92	<i>Callicarpa macrophylla</i> , <i>Piper longum</i> , <i>Spilanthes acmella</i> , <i>Ocimum</i> sp., <i>Tinospora cordifolia</i> , <i>Salvia moorcroftiana</i> , <i>Dodonaea viscosa</i> , <i>Centratherum anthelminticum</i> , <i>Cymbopogon citratus</i> , <i>Matricaria chamomilla</i> , <i>Mentha</i> sp., <i>Vitex negundo</i> , <i>Datura metel</i> , <i>Datura stramonium</i> , <i>Adhatoda vasica</i> , <i>Woodfordia fruticosa</i> , <i>Sida</i> spp., <i>Abutilon indicum</i> , <i>Aloe vera</i> , <i>Boerhavia diffusa</i> , <i>Cassia tora</i> , <i>Cassia occidentalis</i> , <i>Celastrus paniculatus</i> , <i>Cissampelos pareira</i> , <i>Cryptolepis buchmanii</i> , <i>Withania somnifera</i> , <i>Melia azadirachta</i> , <i>Eclipta alba</i> , <i>Gloriosa superba</i> , <i>Mucuna prurita</i> , <i>Plumbago zeylanica</i> , <i>Solanum indicum</i> , <i>S. lacinatedum</i> , <i>S. nigrum</i> , <i>Bacopa monnieri</i> , <i>Centella asiatica</i> , <i>Roylea elegans</i> , <i>Acorus calamus</i> , <i>Asparagus adscendens</i> , <i>Habenaria intermedia</i> , <i>Hebenaria edgeworthii</i> , <i>Potentilla nepalensis</i> , <i>Potentilla fulgens</i> , <i>Viola serpens</i> , <i>Viola odorata</i> , <i>Curculigo orchoides</i> , <i>Berberis lycium</i> , <i>B. asiatica</i> , <i>Hedychium spicatum</i> , <i>Taxus baccata</i> , <i>Heracleum candicans</i> , <i>Thymus serpyllum</i> , <i>Dioscorea deltoidea</i> , <i>Angelica glauca</i> , <i>Podophyllum hexandrum</i> , <i>Polygonatum cirrifolium</i> , <i>P. verticillatum</i> , <i>Valeriana wallichii</i> , <i>Picrorhiza kurroa</i> , <i>Asparagus filicinus</i> , <i>Berginia ligulata</i> , <i>Roscoea procera</i> , <i>R. alpina</i> , <i>Selinum tenuifolium</i> , <i>Achillea millefolium</i> , <i>Aconitium heterophyllum</i> , <i>Bunium persicum</i> , <i>Betula utilis</i> , <i>Ephedra gerardiana</i> , <i>Juniperus communis</i> and <i>Jurinea dolominea</i> .

16.3.1 Germplasm conserved in the medium term storage: Germplasm of amaranth (99), buck wheat (31), chenopod (21), frenchbean (93), adzuki bean (10), rice bean (46) were conserved in this facility.

16.3.2 Germplasm supply: Following germplasm accessions were supplied to various indentors.

Seeds: Frenchbean (290), amaranth (475),

buckwheat (38), adzukibean (183), ricebean (180), horsegram (8).

Rooted plants: Apple (20), peach (13), pear (10), plum (02), apricot (11), strawberry (42), *Feijoa sellowiana* (2), hazelnut (6), pecan nut (2), walnut (4), *Ascedra butrecea* (2), Chinese ber (04), persimmon (12), and kiwi (104).

Bud sticks: Walnut (30), persimmon (100), kiwi (600) and pecan nut (120).



Spodias pinnata - a potential minor fruit in bearing



Crocus sativus - an endangered plant species of alpine region, HP



High yielding landrace of buckwheat collected from Kullu, HP

Research Projects (Project Leader; Associates)

- 1 Collection, evaluation, conservation and documentation of genetic resources of under-utilized hill crops (JC Rana; BD Sharma, SK Yadav, VD Verma (from May 2001)).
- 2 Collection, propagation, conservation, preliminary evaluation and documentation of genetic resources of temperate fruits (VD Verma; SK Yadav, BD Sharma, JC Rana).
- 3 Survey, collection, evaluation, conservation and documentation of medicinal and aromatic plants of Himachal Pradesh (BD Sharma; JC Rana).
- 4 Central scheme for development of agro-techniques and utilization of medicinal plants used in Ayurveda, Siddha, Unani, Homoeopathy. (Ministry of Health, Govt. of India) (BD Sharma; JC Rana).
- 5 Germplasm exploration, collection, characterization, evaluation and documentation of agri-horticultural crops of Himachal Pradesh and Jammu & Kashmir. (BD Sharma; JC Rana, SK Yadav and VD Verma (from May 2001)).
- 6 *Ex-situ* conservation of rare and endangered plant species of N-W Indian Himalayas in the Botanic Garden. (Ministry of Environment and Forests, Govt. of India) (BD Sharma; JC Rana, SK Yadav).
- 7 Collection of elite germplasm of walnut and almond from Himachal Pradesh (SK Yadav).

17. REGIONAL STATION, SRINAGAR

Summary: A total of 41 collections comprising different agri-horticultural crops was made from different parts of Jammu and Kashmir. A total of 985 accessions of wheat, barley, oat, mustard, gram, pea and lentil were maintained for evaluation/ rejuvenation/ multiplication. Special efforts were made to evaluate local germplasm of saffron during this year.

NBPGR regional station, Srinagar was established in 1989 with major responsibility of germplasm exploration and collection in the region. This station was temporarily closed in 1990 and once again reopened in July 1999. Since then alongwith its major activity of plant germplasm exploration, evaluation of different agri-horticultural crops were also carried out, despite unfavourable sociopolitical environment. NBPGR regional station, Srinagar office is located at Sanatnagar (8 km away from Lal Chowk of Srinagar towards south direction). Experimental Farm of this station is situated at KD Research Farm, Old airfield, Rangreth, about 14 km from Srinagar city.

17.1 Germplasm exploration

One exploration was undertaken during 20-22 December and a total of 41 collections comprising different agri-horticultural crops was made. This exploration was undertaken in the Udgam district and surrounding area of Srinagar.

17.2 Germplasm evaluation

During *Kharif*, a total 975 accessions comprising *uc.chenopodium*, *Sesbania*, amaranth,

buckwheat, frenchbean and maize were sown for evaluation, but crops failed to attain maturity due to lack of irrigation facility at this farm. Also 400 accessions of precious germplasm of wheat, barley, oat and gram were raised in rabi 2001.

17.3 Evaluation of saffron

Local germplasm collected from Pomporer and Khannabal areas of Kashmir were planted in September 2001 for preliminary evaluation. In first year only vegetative growth occurred except few which came to flowering stage. This is a perennial crop and in the next season evaluation would be undertaken.



Saffron in flowering at Srinagar

Research Project (Project leader; associate)

1. Exploration for collection of germplasm of agri-horticultural crops of Jammu and Kashmir and adjoining areas and their evaluation (A. K. Singh; R. S. Kumar).

18. REGIONAL STATION, THRISSUR

Summary: Under NATP-PB, 704 accessions of germplasm were collected by the station in 12 exploration and collection missions to various parts of Kerala, Tamil Nadu and Karnataka. Sixteen co-operating centres of the NATP-PB under Zone-II collected 1220 accessions in 61 exploration and collection missions. In all 6858 accessions belonging to 26 crops, their wild relatives, medicinal and aromatic crops, minor fruits, miscellaneous vegetables, tropical fruits and exotic introductions were maintained in field genebank. A total of 2426 accessions of NATP-PB and pre-existing materials were characterised. Rambutan, Kokam and Indian gooseberry have been identified to have potential for diversification of horticulture in this part of the country. Two accessions of Malabar tamarind and one accession of jackfruit were identified as promising for registration. A total of 393 accessions of crop plants / their wild relatives was sent to National Genebank for long-term storage and 157 accessions to TC & CP unit, New Delhi. With regard to germplasm supply, 1054 accessions were given to NBPGR and 548 to other user agencies.

18.1 Exploration and collection of germplasm

In twelve exploration and collection missions under NATP-PB, 704 accessions of germplasm were collected as detailed below:

Area(s) explored	Period	Diversity collected	No. of accns.	Collaborating institute(s)
Palakkad, Thrissur (Kerala); Coimbatore (Tamil Nadu)	Jan	Cereals, spices and <i>M & A</i> plants	23	CTCRI, Trivandrum
Ernakulam, Palakkad, Thrissur (Kerala); Coimbatore (Tamil Nadu)	Jan	Tubers, fruits, spices & wild relatives of crop plants	103	CTCRI, Trivandrum, IISR, Kozhikkode, NRC (B), Trichy
Kollam, Trivandrum, Thrissur (Kerala); Tirunelveli (Tamil Nadu)	Feb	Spices and tubers	92	CTCRI, Trivandrum
Nelliampathy, Palakkad dt. (Kerala)	Jun	Wild relatives of crops	11	MSSRF, Chennai
Palakkad, Kottayam, Chinnar Wild Life Sanctuary, Idukki dt. (Kerala)	Jul	Wild relatives of crop plants	115	NBPGR, New Delhi IIVR, Varanasi
Walayar & Muthikulam forests of Palakkad dt. and Nilambur forest of Malappuram dt. (Kerala)	Jul	Spices, tubers, minor millets & wild relatives of crop plants	70	IISR, Kozhikkode CTCRI, Trivandrum
NRC (B), Trichy Indira Gandhi Wild Life Sanctuary, Coimbatore dt. (Tamil Nadu)	Aug	Tubers, <i>M & A</i> Plants, spices and wild relatives	104	IHR, Bangalore
Trivandrum & Aleppey dt. (Kerala); Kanyakumari dt., (Tamil Nadu)	Aug	Wild relatives of crop plants	8	NBPGR, New Delhi
Thrissur dt. (Kerala)	Sep	Cereals, pulses, <i>M&A</i> plants and wild relatives	15	-

Indira Gandhi Wild Life Sanctuary, Coimbatore dt., (Tamil Nadu); Thrissur & Palakkad dt. (Kerala)	Sep	Wild relatives of crop plants	50	-
Kudremukh National Park, Chickmangalur, Shimoga, South Canara (Karnataka)	Oct	Tubers, spices, fruits	77	IISR, Kozhikkode CTCRI, Trivandrum
Parambikulam Wild Life Sanctuary, Palakkad dt. (Kerala)	Dec	Tubers, spices and wild relatives of crop plants	36	-
TOTAL			704	

Herbarium: A total of 215 voucher herbarium specimens comprising 173 of this station and 42 of other co-operating centres of Zone-II under NATP-PB, were provided.

18.2 Germplasm maintenance

A total of 1265 accessions of crop plants/ wild relatives were maintained in the field genebank as follows:

Crop / species	Accessions maintained		Total
	Pre NATP	NATP-PB	
Lesser yam	63	4	67
Chinese potato	57	—	57
Cassava	175	12	187
Coco yam	25	17	42
<i>Alocasia</i>	1	2	3
<i>Maranta</i>	4	1	5
<i>Canna</i>	3	5	8
Wild rice	227	—	227
<i>Garcinia</i> spp.	4	1	5
<i>Cinnamomum</i> spp.	3	8	11
<i>Vanilla</i> spp.	10	—	10
Indian gooseberry	51	—	51
<i>Phyllanthus fischeri</i>	2	—	2
Bitter gourd	—	9	9
Ivy gourd	15	—	15
Brinjal	0	2	2
<i>Solanum</i> spp.	17	18	35
Misc. vegetables	10	—	10
M & A plants	288	217	505
Exotic introductions	13	1	14
Total	968	297	1265

18.3 Germplasm characterisation and evaluation

A total of 4982 accessions of pre-NATP-PB and 611 of NATP-PB were maintained in the following

crops/ species out of which 1998 accessions of pre-NATP-PB and 428 of NATP-PB were characterised for quantitative and qualitative traits as shown below:

Crop/ species	Accs. maintained		Total
	Pre NATP	NATP-PB	
Taro	470	18	488
Greater yam	182	13	195
<i>Dioscorea</i> spp.	107	60	167
Elephant yam	47	8	55
<i>Amorphophallus</i> spp.	75	17	92
Rice	870	—	870
Ginger	42	33	75
<i>Zingiber</i> spp.	36	5	41
Turmeric	585	80	665
<i>Curcuma</i> spp.	248	48	296
Black pepper	174	39	213
<i>Piper</i> spp.	42	28	70
Malabar tamarind	61	1	62
Kokam	6	1	7
Banana	301	2	303
Jack fruit	72	—	72
Mango	128	—	128
Minor fruits	62	—	62
Horsegram	966	68	1034
<i>Vigna</i> spp.	27	74	101
<i>Momordica</i> spp.	9	14	23
<i>Trichosanthes</i> spp.	11	—	11
Okra	341	23	364
Wild okra	10	14	24
Drumstick	21	—	21
Field bean	—	23	23
Sesame	35	9	44
<i>Sesamum</i> spp.	54	33	87
Total	4982	611	5593

Turmeric: Out of 70 accessions under NATP-PB, characterisation was done in 67 accessions

for 8 quantitative vegetative characters and range obtained is furnished below.

Characters	Minimum	Maximum
Plant height (cm)	52.0	103.5
Number of suckers	1.0	6.0
Plant basal diameter (cm)	1.75	10.13
Leaf sheath length (cm)	3.0	35.0
Leaf petiole length (cm)	4.5	33.0
Leaf length (cm)	16.0	61.3
Leaf width (cm)	5.0	19.0
Number of leaves	4.0	7.5

Wild turmeric (*Curcuma* spp.): Out of 248 finger bearing accessions of *Curcuma* species maintained in the field, 18 belong to NATP-PB. A total of 26 accessions belonging to 5 species have flowered during

April- May. Detailed observations on the 40 floral characters could be made in 26 accessions and mean of 3 important quantitative characters is furnished in the table below.

Species	Peduncle length (cm)			Spike length (cm)			Spike width (cm)		
	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
<i>Curcuma amada</i>	10.0-17.5	13.67	2.84	10.5-15	13.5	1.61	5-8	6.27	1.02
<i>C. zedoaria</i>	11.5-28.0	17.7	6.29	13-19	16.2	2.41	6.5-11.5	9.34	2.2
<i>C. malabarica</i>	22-26.5	24.83	2.47	14.5-18	16.5	1.8	6.5-9	8.1	1.39
<i>C. raktakanta</i>	24.5-28	26.25	2.47	13-14.5	13.75	1.06	6-7	6.5	0.71
<i>C. sylvatica</i>		15.0			13.4			6.0	
<i>C. aromatica</i>		8.5			18			9.5	
<i>Curcuma</i> spp.	11-21	15.13	4.77	11.5-14.5	12.63	1.31	5.5-1	7.25	2.02

Black pepper (*Piper nigrum*): Thirty-two accessions maintained under NATP-PB were characterised for 8 quantitative and 14 qualitative juvenile leaf characters. However,

only 22 accessions could be characterised for mature leaf quantitative characters. Range, mean, SD and CV observed for quantitative traits are as follows:

Character	Range	Mean	SD	CV
Juvenile leaf petiole length (cm)	2.5 - 10.3	5	1.95	38.95
Juvenile leaf length (cm)	6.8 - 16.0	10.6	2.62	24.79
Juvenile leaf width (cm)	4.5 - 10.6	7.2	1.64	22.70
Juvenile leaf thickness (mm)	0.18 - 0.52	0.3	0.08	24.23
Mature leaf petiole length (cm)	2.5 - 6.5	4.2	1.04	24.92
Mature leaf length (cm)	5.5 - 15.7	10.4	2.32	22.33
Mature leaf width (cm)	5.0 - 12.2	7.2	1.56	21.85
Mature leaf thickness (mm)	0.21 - 0.69	0.4	0.12	31.47

Wild pepper (*Piper* spp.): Out of 28 accessions of *Piper* species collected under NATP-PB, characterisation was done in 25 accessions for 12 quantitative traits. The

data computed for 3 quantitative characters, each for juvenile and mature leaves, respectively, are furnished for 3 species in the table below.

Species	Characters	Range	Mean	SD
<i>Piper galeatum</i>	Juvenile leaf petiole length (cm)	2.0-7.1	3.7	1.8
	Juvenile leaf length (cm)	9.7-14.2	11.9	1.7
	Juvenile leaf width (cm)	5.0-10.8	7.2	2.1
	Mature leaf petiole length (cm)	2.5-6.0	3.7	1.5
	Mature leaf length (cm)	10.5-15.0	12.2	1.6
	Mature leaf width (cm)	5.0-12	7.2	2.5
<i>Piper attenuatum</i>	Juvenile leaf petiole length (cm)	2.5-2.9	2.7	0.3
	Juvenile leaf length (cm)	13.4-14.7	14.1	0.9
	Juvenile leaf width (cm)	9.2-10.3	9.8	0.8
	Mature leaf petiole length (cm)	2.4-2.6	3.4	0.1
	Mature leaf length (cm)	13.5-14.2	13.9	0.5
	Mature leaf width (cm)	7.7-8.1	7.9	0.3
<i>Piper argyrophyllum</i>	Juvenile leaf petiole length (cm)	3.6-6.0	4.7	1.2
	Juvenile leaf length (cm)	8.3-11.0	9.7	1.4

Juvenile leaf width (cm)	5.5-7.3	6.6	1.0
Mature leaf petiole length (cm)	2.2-3.5	2.9	0.7
Mature leaf length (cm)	10.5-11.4	11.0	0.5
Mature leaf width (cm)	6.5-8.1	7.2	0.8

Ginger (*Zingiber officinale*): A total of 75 accessions were maintained, out of which 15 accessions were evaluated for 12 quantitative and 3 qualitative characters. The range and mean recorded for 12 quantitative characters are given below:

Traits	Range
Number of tillers	9-16
Tiller height (cm)	48-72
Number of leaves per tiller	9-16
Length of largest leaf (cm)	22.0-28.3
Width of largest leaf (cm)	2.0-3.1
Basal pseudostem thickness	0.40-0.73
Fresh weight of rhizome (g)	14.0-80.0
Rhizome length (cm)	9.9-18.0
Rhizome width (cm)	5.0-9.5
Primary rhizome thickness (cm)	1.35-2.03
Secondary rhizome thickness (cm)	1.15-1.66
Tertiary rhizome thickness (cm)	0.95-1.29

Malabar tamarind (*Garcinia gummi-gutta*): In Malabar tamarind 97 trees in 62 accessions including one accession collected under NATP-PB were maintained. Out of the pre-NATP-PB germplasm, 16 trees in 13 accessions flowered and fruited so far and were characterised for 18 characters.

Four accessions namely IC 244100-2, 244077-1, 244111-1 and 244083-1 were promising for yield (> 35 kg). Four accessions viz., IC 244100-2, 244077-1, 136681 and 244083-1 were promising for number of fruits (> 500). IC 244111-1 was promising for single fruit weight (> 100g). IC 244100-2 was promising for prolonged bearing including both season and off-season (> 5 months) and early bearing.

Multiplication through grafting was attempted for supply of promising lines to crop based ICAR institutes as per their indents and

the following success rate was obtained: IC 244100-2 (100%), IC 244077-1 (83%), IC 244083-1 (100%) and IC 244081-2 (100%).

Kokam (*Garcinia indica*): A total of 7 accessions (6 of pre-NATP-PB and 1 of NATP-PB) was maintained and out of the pre-NATP-PB germplasm, 5 trees in 3 accessions were characterised for fruiting season and yield attributes during this year:

Wild okra (*Abelmoschus spp.*): Twenty-four accessions of wild okra belonging to five species viz. *Abelmoschus manihot* (11), *A. moschatus* (1), *A. angulosus* (8), *A. tuberosus* (1) and *A. tuberculatus* (3) were multiplied for LTS. Seven accessions of *A. angulosus* and two of *A. manihot* were evaluated for plant height and number of fruits per plant. In *A. angulosus*, the plant height ranged from 177.50–269.80 cm (IC 273833), whereas in *A. manihot* it was from 217.40–239.40 cm (IC 27706). In *A. angulosus*, the average number of fruits per plant ranged from 5.90–24.70 (IC 203863), whereas in *A. manihot*, it ranged from 13.55–29.35 cm.

Wild bitter gourd (*Momordica spp.*): Twenty-three accessions of *Momordica* species comprising *Momordica charantia* var. *muricata* (15), wild *M. charantia* var. *charantia* (5), *M. dioica* (2) and *M. denudata* (1) were evaluated for 7 qualitative and 14 quantitative traits. The number of fruits per plant ranged from 10 (collector's No. VB/99-05) to 362 (IC 256226) in *M. charantia* var. *muricata*, 8 (IC 248256) to 64 (IC 248292) in wild *M. charantia* var. *charantia*, 5 (IC 203836) to 7 (IC 255378) in *M. dioica* and 30 (IC 256228) in *M. denudata*. Average single fruit weight ranged from 7.67 (collector's No. JN/95-01) to 18.90g (IC 256110) in *M. charantia* var. *muricata*, 6.17 (IC 248246)

to 14.00g (IC 248292) in wild *M.charantia* var. *charantia*, 13.10 (IC 255378) to 14.67g (IC 203836) in *M. dioica* and 7.9g in *M. denudata*.

Wild Snake gourd (*Trichosanthes* spp.): Eleven accessions of wild snake gourd comprising *Trichosanthes cuspidata* (1), *T. cucumerina* (4) and *T. lobata* (6) were evaluated for 4 qualitative and 13 quantitative traits. Average fruit length ranged from 8.60 (IC 255388) to 20.80 cm (IC 255382) in *T. lobata*, 4.43 (IC 248205) to 6.88 cm (IC 248207) in *T. cucumerina* and 10.46 (IC 248259) in *T. cuspidata*. Average single fruit weight ranged from 23.00 (IC 255381) to 138.25g

(IC 255384) in *T. lobata*, 5.33 (IC 248205) to 18.70g (IC 248217) in *T. cucumerina* and 22.10g (IC 248259) in *T. cuspidata*. Total number of fruits per plant ranged from 5 (IC 255381) to 65 (IC 255386) in *T. lobata*, 40 (IC 255384) to 60 (IC 248217) in *T. cucumerina* and 37 (IC 248259) in *T. cuspidata*.

Wild vigna (*Vigna* spp): In wild *Vigna*, a total of 101 accessions were maintained and all were characterised for 23 quantitative and 51 qualitative characters (fig. 3). Range of variation in 7 quantitative traits in 13 species is given below:

<i>Vigna</i> spp.	No. of accns	Days to flowering	Pods per raceme	Pod length (cm)	Seeds per pod	Seed size L x B (sq. mm)	100 seed weight (g)
<i>Vigna umbellata</i>	27	55-164	2-5	3.07 - 4.63	5-10	2.74-10.46	0.7 - 1.15
<i>Vigna vexillata</i>	4	48-106	1-3	9.10 - 10.73	12-18	1.73-16.30	1.809-2.543
<i>Vigna radiata</i> var. <i>sublobata</i>	4	48-83	1-4	3.60 - 5.80	6-15	4.76-8.40	0.714-1.593
<i>Vigna pilosa</i>	6	68-179	1-2	3.87-8.6	7-12	4.76-21.66	0.677-0.755
<i>Vigna bournea</i>	4	125-151	1-2	5.33 to 6.10	8-13	7.34-9.74	1.34-1.786
<i>Vigna mungo</i> var. <i>sylvestris</i>	17	48-98	2-4	2.40 to 3.67	3-10	6.17-14.40	1.20-1.573
<i>Vigna trilobata</i>	5	48-84	2-4	2.50 to 4.50	8-13	3.87-10.22	0.373-1.112
<i>Vigna radiata</i> var. <i>setulosa</i>	5	48-79	1-3	4.50 to 6.07	7-13	1.83-9.85	0.749-1.516
<i>Vigna mungo</i>	9	48-53	2-5	3.63 to 9	7-15	11.44-16.68	2.94-4.697
<i>Vigna hainiana</i>	9	48-74	2-6	2.87 to 5.30	7-13	0.96-6.12	0.425-0.77
<i>Vigna dalzelliana</i>	1	76	2-3		9-10	3.79	1.02
<i>Vigna unguiculata</i>	2	61-104	1-2	13.50 to 15.40	10-16	28.52-28.68	7.97-8.02
<i>Vigna khandalensis</i>	1	106	2-4	5.53	8-9	13.56	2.35

Miscellaneous fruits: A total of 62 accessions in 39 species of various minor fruits were maintained. Out of the six-year-old 7 rambutan (*Nephelium lappaceum*) trees maintained, one fruited and another one turned out to be male. The fruited accession (IC 202107) yielded 62 fruits with an average fruit weight of 20g. This

particular collection with its attractive fruits holds good promise for diversification of horticulture in Kerala.

Sesame (*Sesamum indicum*): Forty-four accessions were maintained and characterised for 3 quantitative and 9 qualitative traits. Range of variation observed is as follows:

Trait	Minimum	Mean	Maximum
Internode length (cm)	2.76	4.17	6.42
Plant height (cm)	47.25	82.72	128.50
Days to 50% flowering	42.0	53.16	68.0

Wild sesame (*Sesamum* spp.): Out of 33 accessions maintained, a total of 23 accessions in 3 species were evaluated and characterised. Observations on plant vigour, stem pubescence, internode length, branching habit, plant height, days to 50% flowering, flower colour, corolla pubescence, capsule pubescence, capsule shape, locules per capsule and capsules per leaf axil were recorded for each accession. Range of variation observed in each of the following 3 quantitative traits of each species is as follows:

Genetic enhancement in sesame and mung:

In the twenty-two crosses attempted last year involving four different species of *Sesamum*, namely, *S.indicum*, *S.radiatum*, *S.malabaricum* and *S.laciniatum*, F₁s of eight successful crosses were studied. Among the five crosses which germinated F₁s were characterised for 12 quantitative and 29 qualitative characters.

18.4 Regeneration of rice germplasm (under USIF project)

During the period under report, 870 germplasm

accessions were taken up for characterization and evaluation in three separate trials.

In rabi (2000), 198 accessions collected from Tamil Nadu, Karnataka, Madhya Pradesh and Uttar Pradesh, were characterised and evaluated for 39 qualitative and 20 quantitative characters following IRRI descriptors (IRRI, 1980). High proportion of accessions were characterized by presence of non-pigmented (73.73%) seedlings, highly pubescent leaf (54.04%), green ligule (93.94%), green auricle (96.46%), green collar (96.96%), white stigma (67.17%) well exerted (57.07%), awnless (77.78%), bearing heavy secondary branches (69.70%), erect panicle (95.45%). Similarly high proportion of genotypes had straw-coloured (55.56%) grains possessing hairs on upper portion (98.48%) of the lemma and palea and with small sterile glumes (97.98%). 132 out of 198 accessions had red pericarp/bran and 164 accessions had non-chalky kernel.

Germplasm lines representing the specific characteristic types are listed below

IC Number	Local name	Special Feature
85713	Kottaram samba	Long ligule; long bold grains
85715	Moolaikarappu	Highly pubescent leaf
85717	Kuruvai	Lax panicle
85727	Sanbathane	Curved (beak) apiculus
85739	Basadathi	Well exerted, lax panicle, excess tillers but weak
85742	Basadathi	Distinct plant types: Reddish culm; long droopy leaves, early, few tillers, broad grains
67604	Malakarivadakkan	Prominent purple auricle
70685	Para veluthan	Black, compact panicle
145238	Semba	Long panicle
65561	Chittirakkaran	Variable purple spikelet, purple glumes
65905	Karunellu	Wider culm angle
65945	Manavaran	Black grain; white pericarp
66295	Matta samba	Purple grain white pericarp
74637	Bilaspuri	Light brown pericarp
74650	Kashnipuri	Fine grains
74658	Matmuri	Rough leaves, strong culm, suitable for "THOS" system
74733	Rati	Whole plant is purple, pubescent grains
74736	Karginiloi	High density grains, semi dwarf
74747	Bhadehi	Early, high yield
74766	Kanga	Long pink awn
74795	Bagri	Photosensitive
74794	Kanahausa	Reddish purple leaf sheath, purple blotched leaves
74900	No. 2022	Good tillering, fine grain

In kharif (2001), 186 accessions of basmati rice were characterised for 16 quantitative and 39 qualitative traits, following IRRI descriptors (IRRI, 1980). This was a repetition of the experiment conducted during kharif (1999). In kharif (2001), 12 basmati rice germplasm accessions were characterised for 16 quantitative traits. This trial was a repetition of the experiments conducted during kharif (1999) and rabi (2000) in order to study the performance of these accessions under humid tropical climate of Kerala. Stability analysis was carried out for yield/plant as per Eberhart and Russel (1966). Also during kharif (2001), 382 indigenous rice germplasm accessions of Malabar region of Kerala were evaluated for nine quantitative traits.

Taro (*Colocasia esculenta*): In 470 accessions, corm yield / plant varied from 15 (IC 87033 of M 18) to 800g (IC 87055 of M23). Promising accessions based on tuber yield per plant (>700g) are listed below:

Accessions	Morphotype	Yield (g)
IC 87204	1	700
IC 87152	51	700
IC 87174	55	703
IC 87188	58	733
IC 87179-B	60	750
IC 70307	51	756
IC 87151	50	783
IC 87254	50	776
IC 86855	1	783
IC 87055	23	800

Banana (*Musa hybrids*): A total of 72 accessions were harvested and characterised for 12 kg. quantitative and nine qualitative bunch and fruit characters. Bunch weight varied from 1.2 (IC 127938) in 'Namrai' belonging to AA to 17.75 kg (IC 84827) in 'Ottunadan' belonging to ABB genomic groups. Pseudostem weevil incidence in 99 varieties of banana with 2 plants in each was scored on 0-9 scale. Out of 99 varieties observed three cultivars showed high level of borer incidence. Based on bunch yield, IC

84827, 127965, 127991 and 127992 were found to be promising with a bunch weight of 15 kg.

Artocarpus heterophyllus two hundred and nine trees in 72 accessions were maintained in the field genebank. During the period under report, 49 trees in 47 accessions came to bearing and they were characterised for 39 fruit characters, based on three randomly selected fruits from each tree in each accession.

Based on fruit yield and fruit quality, 19 trees were identified as promising for further multiplication. These trees were grafted with local type (root stock) to establish an "elite clonal repository". The promising collections are; IC 97641-3-A, IC 96152-3-A, IC 97641-1A, IC 97624-1-A, IC 96152-1-A, IC 97641-2-A, IC 94742-1-A, IC 97627-2-A, IC 91737-2-A, IC 97634-2-A, IC 91808-3-B, IC 91836, IC 95550-2-A, IC 91808-3-A, IC 97627-1-A, IC 91736-3-A, IC 91736-2-A, IC 97633-1-A, IC 96152-2-A.

Okra (*Abelmoschus esculentus*): A total of 188 accessions comprising 146 indigenous and 42 exotic germplasm were characterised and evaluated.

Wild sesame (*Sesamum spp.*): Fifty-four accessions in 4 wild species were maintained and 53, except an accession of *S. laciniatum*, which is perennial, were regenerated for evaluation and characterisation. Observations on plant vigour, stem pubescence, internode length, branching habit, plant height, days to 50% flowering, flower colour, corolla pubescence, capsule pubescence, capsule shape, locules per capsule and capsules per leaf axil were recorded for each accession.

Greater Yam (*Dioscorea alata*): A total of 182 accessions were maintained in the field. Out of these, 5 accessions were characterised for 14 quantitative and 29 qualitative vegetative and bulbil characters. Thirty-four accessions in 19 morphotypes were analysed at CTCRI, Thiruvananthapuram, for protein and sugar

Promising genotypes identified for some economic traits are given below.

Characters	Preference	Top ranking genotypes
Days to first flowering	Earliness (< 50 days)	IC 140902, 128127, EC 305741, EC 306741 A6, EC 306741 B1
Crop duration	Perennial nature (> 175 days)	EC 305749, 305749 A1, 305749 C1, 305771, 306722 A2, 306722 A3, 305725, 306741 A2, 306741 A4, 305676, IC Nos. 264697, 264736, and 260039
First fruiting node	Basal setting (< 5 th node)	IC 128127, EC 305741 A, 305745, 305749 A
Plant height	Tallness (> 150cm)	EC 305736 CG, 306706 B2, 306722 A4
No. of fruits/plant	High yield (> 10 fruits)	TCR 899, EC 305749 C, 306722 A, 306722 A4.
Pod quality	Score 5	IC 218878, 264749, EC 305771, 306741 A2, 306741 B3, & 306742.

content in tubers. Sugar and protein contents were highest in IC 87358 (36.7 mg/g) and IC 136849 (105.4 mg/g) respectively.

***In vitro* propagation and conservation**

Tissue culture work was initiated in the following crops/ species and the following number of accessions are in culture:

18.5 *In vitro* propagation and conservation (USIF-IN-ARS-863)

Black pepper, ginger and cassava were also taken up for *in vitro* propagation and conservation under this project. A total of 146 accessions of three-mandate crops/ wild relative are in culture now.

Species	Explant	Medium used (for multiplication)	No. of accns. in culture
<i>Zingiber officinale</i> (Ginger)	—	MS+BAP 2.5 mg/l	134 *
<i>Curcuma sylvatica</i> , <i>C. raktakanta</i> , <i>C. amada</i> , <i>C. caesia</i> , <i>C. aeruginosa</i>	Rhizome buds	MS+BAP 2.5 mg/l	5
<i>Dioscorea oppositifolia</i> , <i>D. pubera</i> , <i>D. floribunda</i> , <i>D. pentaphylla</i> , <i>D. belophylla</i> , <i>D. hamiltonii</i> , <i>D. intermedia</i>	Nodal cuttings, axillary buds & shoot tip	MS	8
<i>Garcinia gummi-gutta</i> (Malabar tamarind)	Shoot tip, node & seed	MS+BAP 0.5 mg/l MS+BAP 6 mg/l+NAA 2 mg/l	10
<i>Garcinia indica</i> (Kokam)	Shoot tip & node	MS+BAP 1 mg/l+Kinetin 0.5 mg/l MS+BAP 2 mg/l + NAA 1 mg/l WPM+BAP 1mg/l	4

* Cultures transferred from TC & CP Unit, NBPGR, New Delhi

Crop	Explant	Medium used (for multiplication)	No. accns. in culture
Ginger	Rhizome buds	MS+BAP 2.5 mg/l +Gentamycin 50 mg/l	40
<i>Zingiber zerumbet</i>	Rhizome buds	MS+BAP 2.5 mg/l +Gentamycin 250 mg/l	5
Black pepper	Node, shoot tip	½ MS+BAP 1 mg/l + IAA 1 mg/l ½ WPM+BA (3 mg/l) + Kn (1mg/l)	52
Cassava	Shoot meristem	MS + Sucrose 3% + Agar (6g/l)	49

18.6 Germplasm conservation

A total of 6828 accessions of various crops including NATP-PB exploration materials kept in the MTS facility (at 7°C) were as follows:

Crop	Number of accns.
Rice	3536
Rice (KAU)	427
Okra	869
Horsegram	527
Bittergourd	240
<i>Vigna</i> spp.	149
Wild okra	132
Sword bean	65
Wild cucurbits	35
Snake gourd	20
NATP-PB exploration material	828
	6828

Two chiller cabinets were used to store tubers/rhizomes of vegetatively propagated crops during summer (from January to May) and the following crops were stored:

Crop	No. of accns.	Condition
Taro	488	13°C & 68% RH
Turmeric	502	— do —
<i>Curcuma</i> spp. (tuberising)	21	— do —
Ginger	50	— do —
Lesser yam	63	16°C & 73% RH
Wild yams	149	— do —
Elephant foot yam	56	— do —

In order to study the effect of storage of corms in chiller cabinet (16°C & 78% RH), an

Released varieties sent to NGB, New Delhi for LTS

ICAR Institute/ SAU	Crop	No. of varieties	Varieties
AC&RI, TNAU, Madurai	Rice	4	MDU 2, MDU 3, MDU 4 & MDU 5
AC&RI, TNAU, KILLIKULAM	SENNA	1	KKM 1
ARS, Mugad, UAS, Dharwad	Rice	5	Amruth, Avinash, Abhilash, Intan & Mugad Sugandh
RRS, TNAU, Vridhachalam	Groundnut	4	VRI-2, VRI-3, VRI-4 & VRI Gn-5
AICRP on Groundnut, Dharwad	Groundnut	6	JL-24, Dh-3-30, Dh-40, P-8808, R-9251 & GPBD-4

experiment was conducted in which 33 accessions of elephant foot yam stored in the chiller cabinet for two years were compared with the same accessions stored in room temperature. No significant difference was observed in the total yield of corms in both the treatments, which indicated that the corms could be safely stored in the chiller cabinet for two years without any considerable reduction in the yield thereby skipping one year of cropping season. This can reduce the cost of field maintenance of germplasm of this crop.

18.7 Germplasm distribution

Germplasm supplied to regeneration sites:

Four hundred and seventy-four accessions collected by the station were sent to different regeneration sites for regeneration/ establishment of germplasm for subsequent supply of material in required quantity to National Genebank.

Supply: A total of 1602 accessions were supplied to 15 user agencies (548) and NBPGR, New Delhi and Hyderabad (1054).

In total, 240 accessions of various germplasm materials were received from the cooperators of Zone II for medium term storage.

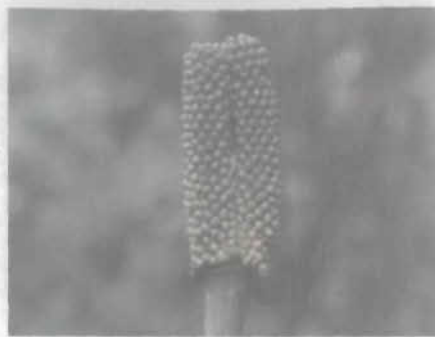
Germplasm deposited in National Genebank:

A total of 393 accessions were sent to the National Genebank for long term storage.

154 accessions of various plants were sent to Tissue Culture and Cryopreservation Unit, New Delhi for *in vitro*/ cryopreservation



Variability in fruits of *Garcinia gummigatta*



Close-up of fruiting body of elephant foot yam



Collection of elephant footyam with its fruiting body at the top



Jackfruit collection with high yielding potential

Research Projects (Project Leader; Associates)

- 1 Exploration, collection, characterisation, evaluation and conservation of plant genetic resources in Southern India (P. K. Jayan; K. C. Velayudhan, K. Joseph John, M. Abdul Nizar, K. I. Asha, M. Latha, C. Rajlakshmy, R. Ashokan Nair).
- 1.1 Exploration, collection and augmentation of plant genetic resources (P. K. Jayan; K. C. Velayudhan, Z. Abraham, M. Abdul Nizar, K. I. Asha, M. Latha, R. Ashokan nair).
- 1.2 Characterisation, evaluation and documentation of plant genetic resources (P. K. Jayan; Z. Abraham, K. Joseph John, M. Abdul Nizar, K. I. Asha, M. Latha, C. Rajlakshmy, R. Ashokan Nair).
- 1.3 Use of *in vitro* technology for mass propagation and conservation of clonally/ vegetatively propagated crops and their wild relatives (Z. Abraham; K. I. Asha, M. Latha, C. Rajlakshmy, R. Ashokan Nair).
- 1.4 Medium term storage of germplasm (K. C. Velayudhan; P. K. Jayan, Z. Abraham, K. Joseph John, K. I. Asha, M. Latha, R. Ashokan Nair).

Externally funded projects

- 2 USIF Project IN-ARS-862 – Regeneration of agro-biodiversity comprising agri-horticultural crops, their wild and weedy relatives and other economically useful plants of South India (K. C. Velayudhan; P. K. Jayan, Z. Abraham, K. Joseph John, K. I. Asha, M. Latha, R. Ashokan Nair).
3. USIF Project IN-ARS-863: Use of *in vitro* technology for mass propagation and conservation of clonally/ vegetatively propagated crops and their relatives (Z. Abraham; K. I. Asha).

19. GENERAL INFORMATION

This chapter includes information on various committees constituted for efficient management of PGR activities, personnel, budget estimates and expenditure, organization of training programmes, participation of staff in seminars, symposia, workshops, other extra curricular activities and publications.

19.1 Institute Management Committee (IMC)

Chairman: Dr. B.S. Dhillon, Director, NBPGR, New Delhi.

Members: Asstt. Director General (Seeds), ICAR, Krishi Bhawan, New Delhi; Dr. J. L. Karihaloo, Project Director, NRC on DNA Fingerprinting, NBPGR, New Delhi; Dr. S. S. Malik, Head, Exploration Division, NBPGR, New Delhi; Dr. R.K. Khetarpal, Head, Plant Quarantine Division, NBPGR, New Delhi; Dr. (Mrs.) Saroj Sardana, Principal Scientist, Germplasm Evaluation Division, NBPGR, New Delhi; Sh. Rahul Khullar, Development Commissioner (Rural), Govt. of Delhi; Sh. Rajiv Arora, Director (Agriculture), Directorate of Agriculture, Govt. of Haryana, Chandigarh; Dr. P.S. Sirohi, Head, Vegetable Crops Division, IARI, Pusa Campus, New Delhi; Sh. Roshan Lal, F&AO, NATP, Pusa Campus, New Delhi; Sh. Santokh Singh, Sr. Admn. Officer, NBPGR, New Delhi.

A meeting of IMC was held on 22 March 2001 under the chairmanship of Dr. B. S. Dhillon, the Director of NBPGR.

19.2 Research Advisory Committee (RAC)

Chairman: Dr. H. K. Jain (Ex. Director, IARI), 40, Surya Niketan, I. P. Extension – II, Delhi.

Member Secretary: Dr. S. S. Malik, Head, Division of Plant Exploration & Collection, NBPGR, New Delhi.

Members: Dr. V. P. Gupta, (Retd. Prof.), Punjab Agril. University, Ludhiana; Dr. K. P. S. Chandel, (Retd. Director), NBPGR, New Delhi; Dr. C. D. Mayee, Vice Chancellor, MPAU, Parbhani, Maharashtra; Dr. Brahma Singh, Director, Food & Agril. Sciences, DRDO Hq., 75, L Block, Church Road, New Delhi; Dr. Suman Sahai, Gene Campaign, F-31, Green Park Extn., New Delhi; Sh. S.K. Chaudhry, Education Trust, Basaith Chanpura, Madhubani, Bihar; Sh. Chasham Pal Singh Nain, 108 – Model Town, Karnal (Haryana); Director, NBPGR, New Delhi (Ex Officio Member); ADG (Seeds), ICAR (Ex Officio Member).

A meeting of the RAC was held under the Chairmanship of Dr. H. K. Jain on 22 May 2001 at NBPGR, New Delhi.

19.3 Staff Research Council (SRC)

Since the guidelines from ICAR demanded two SRC meetings in a year, the first SRC meeting of the Bureau was conducted on 10-11 May 2001 and the second meeting was held on 11-13 December. Dr. B. S. Dhillon, Director, NBPGR chaired the meetings. Dr. S. Bala Ravi (ADG Seeds), ICAR and Dr. C. P. Singh (ADG, IPR and Seeds), ICAR were the invited members for the 1st and 2nd meeting respectively. The secretary SRC presented the action taken report based on the recommendations of previous SRC and the proceedings of the same were approved by the house. Progress in all the projects both from

Headquarters and regional stations was reviewed and emphasis was laid on fostering inter-institutional linkages especially for germplasm evaluation activities.

19.4 Institute Joint Staff Council (IJSC)

Chairman: Dr. B. S. Dhillon, Director, NBPGR, New Delhi.

Secretary (Official side): Dr. Arjun Lal, Principal Scientist, Plant Quarantine Division.

Members (Official side): Sh. Santokh Singh, Sr. A. O., NBPGR, New Delhi; Dr. B. B. Mandal,

Head, TC&CP Unit; Dr. (Ms.) Anjula Pandey, Scientist (Sr. Sc.); Sh. B. K. Bansal, F&AO.

Secretary (Staff side): Sh. Rakesh Singh, T-5 (Tech. Officer), NATP Cell.

Members (Staff side): Sh. Anang Pal Singh, T-II-3; Sh. Yogesh Kr. Gupta, Sr. Clerk; Smt. Vijay Laxmi Sharma, Sr. Clerk; Sh. Mahabir Mahto, S. S. Gr.-IV; Sh. Yatish Chander, S. S. Gr.-I.

A meeting of the IJSC was held on 18 July 2001 under the chairmanship of Dr. B. S. Dhillon to discuss and improve the conditions of work and welfare of employees.

19.5 Personnel

1. Scientific Staff

Name	Designation	Discipline
Dr. B. S. Dhillon	Director	RMP
Division of Germplasm Evaluation		
Dr. Mahendra Singh	Head	Genetics
Dr. V. K. Srivastava	Principal Scientist	Agril. Chemistry
Dr. R. K. Mahajan	Principal Scientist	Agril. Statistics
Sh. B. M. Singh	Principal Scientist	Economic Botany
Dr. S. Mandal	Principal Scientist	Biochemistry
Sh. Ranbir Singh	Principal Scientist	Economic Botany
Dr. R. L. Sapra	Principal Scientist	Agril. Statistics
Dr. (Ms.) Saroj Sardana	Principal Scientist	Plant Breeding
Dr. I. P. Singh	Principal Scientist	Plant Breeding
Sh. N. K. Gautam	Senior Scientist	Economic Botany
Dr. B. S. Phogat	Senior Scientist	Agronomy
Dr. P. L. Premi	Senior Scientist	Agril. Entomology
Dr. V. K. Dhobal	Senior Scientist	Plant Breeding
Dr. Dinesh Kumar	Scientist (Sr. Scale)	Plant Breeding
Dr. Ambrish Sharma	Scientist (Sr. Scale)	Plant Breeding
Dr. K. K. Gangopadhyay	Scientist (Sr. Scale)	Horticulture
Sh. Gunjeet Kumar	Scientist	Horticulture
Mrs. Sangeeta Yadav	Scientist	Bio-Chemistry
Division of Plant Exploration and Collection		
Dr. S. S. Malik	Head & Principal Scientist	Plant Breeding
Dr. Umesh Chandra	Principal Scientist	Economic Botany
Dr. (Ms.) E. Roshni Nayyar	Principal Scientist	Economic Botany

Dr. (Ms.) Anjula Pandey	Scientist (Sr. Scale)	Economic Botany
Division of Germplasm Conservation		
Dr. A. K. Singh	Head	Plant Breeding
Ms. N. K. Chaudhary	Principal Scientist	Agril. Statistics
Dr. Sidheshwar Prasad	Senior Scientist	Agril. Engineering
Dr. Sanjeev Saxena	Senior Scientist	Plant Physiology
Dr. (Ms.) Neeta Singh	Senior Scientist	Plant Physiology
Dr. S. K. Jain	Senior Scientist	Seed Technology
Dr. (Ms.) K. Srinivasan	Scientist (Sr. Scale)	Plant Physiology
Dr. (Ms.) Veena Gupta	Scientist (Sr. Scale)	Economic Botany
Dr. Vivek Mitter	Scientist (Sr. Scale)	Seed Technology
Ms. J. Radhamani	Scientist (Sr. Scale)	Plant Physiology
Dr. Chitra Devi	Scientist	Seed Technology
Ms. Anjali Kak	Scientist	Economic Botany

Division of Plant Quarantine

Dr. R. K. Khetarpal	Head & Principal Scientist	Plant Pathology
Dr. Arjun Lal	Principal Scientist	Nematology
Dr. Shamsher Singh	Principal Scientist	Plant Pathology
Dr. P. C. Agrawal	Principal Scientist	Plant Pathology
Dr. Beche Lal	Principal Scientist	Agril. Entomology
Ms. Usha Dev	Principal Scientist	Plant Pathology
Ms. Manju Lata Kapoor	Principal Scientist	Agril. Entomology
Dr. Rajan	Senior Scientist	Nematology
Dr. D. B. Parakh	Senior Scientist	Plant Pathology
Dr. Baleshwar Singh	Senior Scientist	Plant Pathology
Dr. (Ms.) Shashi Bhalla	Senior Scientist	Agril. Entomology
Ms. Kavita Gupta	Scientist	Agril. Entomology
Ms. Celia Chalam	Scientist	Plant Pathology

Germplasm Exchange Unit

Dr. Ranvir Singh	Head & Principal Scientist	Economic Botany
Sh. Deep Chand	Scientist (Sr. Scale)	Economic Botany
Ms. Pratibha Brahma	Scientist (Sr. Scale)	Economic Botany
Ms. Nidhi Verma	Scientist	Economic Botany
Ms. Vandana Tyagi	Scientist	Economic Botany

Under Utilised and Under Exploited Plants Project

Dr. G. D. Sharma	Project Coordinator	Plant Breeding
Mrs. Vandana Joshi	Scientist (Sr. Scale)	Economic Botany
Shri H. L. Raigar	Scientist	Agril. Statistics

Tissue Culture & Cryopreservation Unit

Dr. B. B. Mandal	Principal Scientist	Genetics & Cytogenetics
Dr. (Ms.) Rekha Chaudhary	Senior Scientist	Economic Botany
Dr. R. K. Tyagi	Senior Scientist	Economic Botany
Dr. (Ms.) Ruchira Pandey	Scientist (Sr. Scale)	Economic Botany

Dr. (Ms.) Neelam Sharma	Scientist (Sr. Scale)	Economic Botany
Dr. (Ms.) Anuradha Agrawal	Scientist (Sr. Scale)	Economic Botany
Ms. Sandhya Gupta	Scientist	Economic Botany
Dr. S. K. Malik	Scientist	Economic Botany
Dr. Rakesh Singh	Scientist	Biotechnology
Ms. Ambika Baldev	Scientist	Biotechnology
Dr. Zakir Hussain	Scientist	Genetics
PGR Policy Unit		
Dr. Sudhir Kochhar	Principal Scientist	Plant Breeding
Technical Cell		
Dr. I. S. Bisht	Senior Scientist	Plant Pathology
ARIS Cell		
Dr. R. C. Agrawal	Scientist (Sr. Scale)	Agril. Statistics
NATP Cell		
Dr. S. K. Pareek	Principal Scientist	Agronomy
Dr. Ashok Kumar	Senior Scientist	Plant Breeding
Dr. K. C. Bhatt	Scientist (Sr. Scale)	Economy Botany
National Research Center on DNA Fingerprinting		
Dr. J. L. Karihaloo	Principal Scientist & Project Coordinator	Genetics & Cytogenetics
Dr. (Ms.) G. Randhawa	Senior Scientist	Genetics
Dr. (Ms.) S. Lakhanpaul	Scientist (Sr. Scale)	Genetics & Cytogenetics
Dr. K. V. Bhat	Scientist (Sr. Scale)	Plant Breeding
Ms. Lalit Anand	Scientist	Bio-Chemistry
Sh. Sunil Archak	Scientist	Bio-Technology
Dr. Mukesh Kumar Rana	Scientist	Plant Breeding
Ms. G. S. Sandhia	Scientist	Genetics
Ms. Madhu Bala	Scientist	Computer Application
Regional Station, Akola		
Dr. D. P. Patel	Principal Scientist & I/C	Economic Botany
Dr. T. R. Lokanathan	Senior Scientist	Plant Breeding
Satellite Center, Amravati		
Dr. W. L. Barwad	Senior Scientist	Agril. Entomology
Regional Station, Bhowali		
Sh. K. C. Muneem	Principal Scientist	Plant Pathology
Dr. V. D. Verma	Senior Scientist	Economic Botany
Dr. K. S. Negi	Senior Scientist	Economic Botany
Dr. S. K. Verma	Senior Scientist	Horticulture
Base Center, Cuttack		
Sh. Nilamani Dikshit	Scientist (Sr. Scale)	Economic Botany
Sh. Diptiranjani Pani	Scientist	Economic Botany
Regional Station, Hyderabad		
Dr. K. S. Varaprasad	Principal Scientist & I/C	Nematology

Dr. R. D. V. J. Prasada Rao	Principal Scientist	Plant Pathology
Dr. S. K. Chakraborty	Senior Scientist	Plant Pathology
Dr. B. Sarath Babu	Senior Scientist	Agril. Entomology
Sh. S. R. Pandrawada	Scientist (Sr. Scale)	Economic Botany
Ms. Kamla Venkateswaran	Scientist	Economic Botany
Dr. Natrajan Sivaraj	Scientist (Sr. Scale)	Economic Botany
Ms. T. Rama Srinivas	Scientist	Horticulture
Ms. Anitha Kodaru	Scientist (Sr. Scale)	Plant Pathology

Regional Station, Jodhpur

Dr. D. C. Bhandari	Principal Scientist & I/C	Economic Botany
Dr. N. K. Dwivedi	Principal Scientist	Economic Botany
Ms. Neelam Bhatnagar	Senior Scientist	Economic Botany

Base Center, Ranchi

Dr. J. B. Tomar	Principal Scientist & I/C	Economic Botany
Dr. V. K. Gupta	Scientist (Sr. Scale)	Plant Breeding

Regional Station, Srinagar

Dr. Anil Kumar Singh	Scientist	Economic Botany
Dr. R. Senthil Kumar	Scientist	Horticulture

Regional Station, Shimla

Dr. B. D. Sharma	Principal Scientist & Incharge	Plant Breeding
Dr. J. C. Rana	Scientist (Sr. Scale)	Plant Breeding
Dr. S. K. Yadav	Scientist	Horticulture

Regional Station, Shillong

Dr. D. K. Hore	Principal Scientist & Incharge	Economic Botany
Sh. Rakesh Srivastava	Scientist (Sr. Scale)	Horticulture

Regional Station, Thrissur

Dr. P. K. Jayan	Principal Scientist & I/C	Economic Botany
Sh. K. C. Velayudhan	Principal Scientist	Economic Botany
Dr. Z. Abraham	Principal Scientist	Economic Botany
Dr. Joseph John K.	Scientist (Sr. Scale)	Economic Botany
Sh. Mohd. Abdul Nizar	Scientist (Sr. Scale)	Economic Botany
Ms. Asha K. I.	Scientist (Sr. Scale)	Economic Botany
Ms. M. Lata	Scientist	Plant Breeding

ii. Administrative Staff (above the assistants)

Name	Designation	Posted at
Sh. Santokh Singh	Sr. Administrative Officer	New Delhi
Sh. R.P. Dhasmana	Asstt. Admin. Officer	New Delhi
Sh. Kapil Dev Manjhi	Asstt. Admn. Officer	New Delhi
Mrs. R.K. Dua	Superintendent	New Delhi
Sh. M.K. Ahuja	Jr. Acc. Officer	New Delhi
Mrs. Archana Raghav	Asstt. Dir. (OL)	New Delhi
Sh. U.C. Sati	Security Officer	New Delhi

iii. Technical Staff (T-5 and above)

Name of the Employee	Designation	Posted at
Sh. Suresh Chandra Sharma	T-8	New Delhi
Sh. B.P. Dahiya	T-7	-do-
Sh. O.M. Prakash	T-6	-do-
Sh. Jitender Mohan	T-6	-do-
Smt. Indra Rani	T-6	-do-
Sh. Bankey Lal	T-5	-do-
Sh. Abhay Sharma	T-5	-do-
Smt. Rita Rani	T-5	-do-
Sh. Charan Singh	T-6	-do-
Sh. Rajiv Mathur	T-6	-do-
Dr. C.S. Raghav	T-6	-do-
Dr.(Mrs.) Manju Upreti	T-6	-do-
Sh. Ranbir Singh Rathi	T-6	-do-
Miss Sheela Kumari	T-6	-do-
Sh. Rakesh Singh	T-6	-do-
Sh. Mahabir Singh Rathore	T-5	-do-
Sh. Ram Prasad Yadav	T-5	-do-
Sh. Harinder Singh	T-5	-do-
Sh. Ram Singh	T-5	-do-
Miss Poonam Suneja	T-5	-do-
Miss Anshu	T-5	-do-
Sh. Satya Pal Singh	T-5	-do-
Sh. K.D. Joshi	T-5	-do-
Sh. Daya Shankar	T-5	-do-
Sh. P.S. Mehta	T-5	-do-
Sh. R.K. Kale	T-5	Akola
Sh. J.K. Ingle	T-5	Akola
Sh. V.K. Pant	T-5	Bhowali
Sh. G.L. Arya	T-5	Bhowali
Sh. A.S. Rana	T-5	Bhowali
Sh. Babu Abraham	T-5	Hyderabad
Sh. B.C. Bachhawan dia	T-5	Jodhpur
Sh. Brij Pal Singh	T-5	Shimla
Sh. R. Ashokan Nair	T-5	Thrissur
Sh. C. Rajlakshmy	T-5	Thrissur

19.6 Staff Reservations

Total number of employees in position and number of scheduled castes and scheduled tribes among them as on 31.12. 2001.

Class	Total Number of Employees	Total Number of Scheduled Caste Employees	Number of Scheduled Tribe Employees	Number of OBC Employees
Class I	149	11	—	2
Class II	23	04	01	—
Class III	137	40	10	5
Class IV	156	59	08	19

19.7 Staff joined NBPGR on transfer

Administrative Staff : Shri B. K. Bansal joined as Finance & Accounts officer on May 21.

Scientific Staff : Mrs. Archana Peshin, Scientist (Biochemistry) joined GED on transfer from CPRI, Shimla on June 1.

Technical Staff : Dr. A. K. Singh, T-6, joined after transfer from CICR Regional Station, Sirsa on September 26.

19.8 Staff left NBPGR on promotions/ transfer

- Dr.R.L. Sapra, Sr. Scientist, GED transferred to Genetics Division, IARI, New Delhi w.e.f. 20 April, 2001.
- Sh. D.P. Verma, F&AO transferred to CS&WR Institute, Avikanagar (Raj.) w.e.f. 21 May, 2001.
- Dr. Sudhir Kochhar, Principal Scientist transferred to ICAR, Krishi Bhawan, New Delhi, w.e.f. 8 June, 2001.

19.9 New appointments

Mrs. Sharda Devi joined as SS grade I on compensatory grounds on June 2.

19.10 Promotions

Scientific Staff: The following scientists were promoted to the next higher scale on the basis of the recommendations of the Departmental Promotion Committee (DPC).

Senior Scientist: Dr. Ruchira Pandey, Dr. Neelam Sharma, Dr. Veena Gupta, Dr. Vandana Joshi, Dr. Anjula Pandey, Dr. R. K. Tyagi, Dr. V. K. Dhoval, Dr. Dinesh Kumar, Dr. K. V. Bhat, Dr. Ashok Kumar, Dr. Ambrish Sharma, Dr. S. K. Jain, Dr. I. S. Bisht, Dr. D. B. Parakh, Dr.

Shashi Bhalla, Dr. P. L. Premi, Dr. R. C. Agrawal, Dr. Gurinderjit Randhawa, Dr. Kalyani Srinivasan and Dr. Suman Lakhanpaul at Headquarters.

Drs. K. S. Negi, S. K. Verma, Shri K. C. Muneem at Regional Station Bhowali; Drs. B. Sarath Babu, RD.V.J. Prasada Rao at Regional Station, Hyderabad; Dr. N. K. Dwivedi at Regional Station, Jodhpur; Dr. Rakesh Srivastava at Regional Station, Shillong; and Dr. J. C. Rana at NBPGR Regional Station, Shimla.

Scientist (Selection Grade/ Senior Scale): Shri Deep Chand, Dr. Pratibha Brahmi, Ms. Anjali Kak, Dr. Anuradha Agrawal, Dr. Sandhya Gupta, Dr. Vandana Tyagi, Dr. Celia Chalam V, Dr. Kavita Gupta and Ms. J. Radhamani at Headquarters.

Shri Nilamani Dikshit at Regional Station, Cuttack; Shri S. R. Pandrawada, Shri M. Abdul Nizar, Ms. T. Rama Srinivasa at Regional Station, Hyderabad; Dr. V. K. Gupta at Base Centre, Ranchi; and Shri Joseph John K, Ms. K. I. Asha at Regional Station, Thrissur.

Technical Staff: The following staff/ members were given merit promotions on the basis of the recommendations of the Assessment Committee.

Category II

T-5: Shri N. S. Panwar, Headquarters; Shri G. L. Arya and Shri A. S. Rana, Regional Station, Bhowali.

T-4: Shri Y. S. Rathi, Shri O. S. Ahlawat, Shri Anang Pal, Shri Narender Pal at Headquarters; Shri S. Mani and Shri R. Guna Sekharan NBPGR Regional Station, Thrissur.

T-3: Shri R. C. Yadav, Shri R. K. Sharma, Shri Mangal Das, Shri S. N. Rai, Headquarters, Shri N. T. Atram, Shri R. A. Awale at Regional Station, Akola; Shri Ramit Joshi, Regional Station Jodhpur, Shri T. T. Velayudhan, Regional Station, Thrissur.

Category I

T-2: Shri Dev Sunder, Shri Wazir Singh, Shri Balwant Singh, Shri Ranjit Singh, Shri Balak Ram, Shri Dayal Singh, Shri Ravinder Kumar, Shri Braham Prakash, Shri Brij Mohan at Headquarters; Shri L. T. Debekar, Regional Station, Akola, Shri Narendra Ram, Regional Station, Ranchi, Shri Joginder Singh, Regional Station, Shimla, Shri E. N. Prabhakaran, Regional Station, Thrissur.

Administrative Staff: The following staff was

placed in the next higher cadre on the basis of DPC recommendations:

Ms. R. K. Dua, Asstt. Administrative Officer, Shri Girish Chand, Assistant, Shri Joginder Prasad, Upper Division Clerk at Headquarters, Shri Srikant Wange, Assistant, Regional Station, Akola; Shri M. Srinivasa Rao, Upper Division Clerk, Regional Station, Hyderabad.

Supporting Staff: Mr. E. Satyanarayana, Mr. P. Suleman and Mr. M.B.C.K. Raju have been promoted to SSG-2 w.e.f. July 11.

19.11 Staff Members Retired

Sl. No.	Name of the employee	Designation and place	Date of retirement
1.	Sh. Jagdish Jha	T-2, (Fieldman), PQD retired from service	31.1.2001
2.	Sh. G. V. Madhavan	S.S. Gr.-I, Thrissur	28.2.2001
3.	Dr. P. K. Jayan	Sr. Scientist, Thrissur	31.3.2001
4.	Sh. N. T. Atram	T-I-3, Akola	31.3.2001
5.	Sh. V. Rama Chandaran	T-I-3 (Driver), Thrissur	31.3.2001
6.	Sh. Ram Phal (Majri)	S.S. Gr.-II, Issapur Farm	30.4.2001
7.	Sh. Prithi Singh	S.S. Gr.-II, Jodhpur	31.5.2001
8.	Sh. Jasaundi Ram	S.S. Gr.-IV, Shimla	30.6.2001

19.12 Field Days Organised

A field day was organised at Jodhpur on 28 September 2001 for Kharif Crops.

A field day on Okra and Banana was organised at NBPGR, Thrissur on August 3.

A field day on Rabi crops was organised on February 27 at NBPGR experimental station, Issapur, New Delhi.

Field day on Wheat, Barley and Triticale was organised at NBPGR, New Delhi on March 27.

A Chickpea germplasm field day was organised on 20 February 2001 at ICRISAT, Hyderabad.

19.13 Deputation Abroad

1. Dr. R. K. Khetrapal was on study tour under UNDP project on "Development &

Strengthening Plant Quarantine Facilities" to Chile, Uruguay and Canada from February 2-18.

2. Dr. (Ms.) Anuradha Agrawal was deputed for 6 months to Belgium from March 20 – September 19 to avail BOYSCAST fellowship.
3. Dr. B. S. Dhillon, Director, went to FAO, Rome, Italy for attending 6th extraordinary session on the commission on Genetic Resources for Food and Agriculture from 26-30 June.
4. Dr. A. K. Singh, Head, Germplasm Conservation Division participated in the international workshop on Seed conservation; "turning science into practice" at Wakehurst place, Kew, U. K. from July 26-31.

19.14 Participation in ICAR Staff Sports Meet

NBPGR sports contingent comprising (men and women players) participated in Inter-institutional

sports meet held at CIRB, Karnal from 3-7 November 2001. NBPGR table tennis team (men) stood winners and brought laurels to the institute. Badminton and volleyball shooting team were runners-up.



NBPGR sports contingent with the prizes won during sports meet at CIRB, Hisar

19.15 Participation of Staff in Seminars/Symposia/Workshops/ Trainings

Seminar/ Symposium/ Workshop/ Others	Period	Name
Vegetable workers group meet, Varanasi	Jan14 – 17	Dr. K. K. Pandey
Training programme on awareness generation in relation to PGR management, Ranchi	Jan 18 – 19	Dr. K. K. Pandey
Uttranchal herbal plant growers workshop, GBPHED, Almora	Jan 19 – 21	Dr. K. S. Negi
Orientation course on integrated pest management in rabi crops, NCIPM, New Delhi	Jan 15 – 23	Drs. R. K. Khetrpal, G. J. Randhawa, Shashi Bhalla
Workshop on nematode taxonomy, MANUU, Hyderabad	Jan 27 – 28	Dr. K. S. Varaprasad
Annual group meet on network project on genetic evaluation & improvement of sesbania & crotolacea for green manuring, Modipuram.	Jan 30 – 31	Drs. S. Sardana, I. P. Singh, Vandana Joshi
Golden jubilee symposium on biotechnological innovations in conservation & analysis of plant diversity, Delhi	Feb 7 – 9	Drs. J. L. Karihaloo, Veena Gupta, S. K. Jain
Symposium on impact of human on Thar desert environment, Rajasthan	Feb 15 – 17	Dr. A. K. Singh

Workshop on conservation assessment & management plan, EPTRI, Hyderabad	Mar 9 – 11	Dr. N. Sivaraj
Annual workshop of AICPON, Soybean, MAU, Parbani	Mar 12–14	Dr. R. K. Khetrapal
Training on genomic library construction and screening, IARI, New Delhi	Mar 30 – Apr 19	Mr. Rakesh Singh
National symposium on biodiversity vis a vis resource exploration: an introspection CARI Port Blair	Apr 23 – 24	Dr. K. S. Varaprasad
Annual group meet of pigeonpea and MULLaRP crops TNAU, Coimbatore	Apr 27 – 30	Dr. M. Singh, Dr. S. Sardana
Symposium on plant sciences-unfinished frontiers, Agra	Apr 29	Dr. J. L. Kariahloo
Workshop on human and social issues in soil nutrient management in semi arid India, Bangalore, Karnataka	Apr 30	Dr. K. S. Varaprasad
National biodiversity storage action plan, EPTRI, Hyderabad	May 5	Dr. N. Sivaraj, Mr. Sunil Neelam
Brain storming session on development of analytical methods for testing the GM foods & products derived therefrom, CDFD, Hyderabad	May 28	Dr. G. J. Rañdhawa
Brainstorming session on research prioritisation for management of alien invasive species, NBPGR	Jun 2	Dr. R. K. Khetrapal
Workshop on diagnostics and development of seed certification protocols for management of seed transmitted viral diseases of grain legumes in India.	Jun:7-8	Drs. D. B. Parakh and R. K. Khetrapal
Training programme on positive attitude, trust and interpersonal skills for efficient secretarial work. MANAGE, Hyderabad	Jun 11–15	Ms. Radha Rani, M. Srinivas Rao
Technical programme formulation of micro mission research activities on oilseeds & pulses under TMOP	Jun 12–13	Dr. S. Sardana
Training programme on diversity assessment, principles & procedures. ICRISAT	Jun 26 – 28	Drs. Varaprasad, N. Sivaraj, Someshwara Rao, Pandravada, Mrs. T. Rama Srinivas & Mr. Sunil Neelam
ICAR-CABI meeting of ICWC at ICAR	Jul 5	Dr. R. K. Khetrapal
Steering committee meeting on national biodiversity strategy action plan EPTRI, Hyderabad.	Jul 7	Dr. N. Sivaraj
International conference on tropical ecosystems: structure, diversity & human welfare, Bangalore.	Jul 15 – 18	Dr. D. K. Hore
Summer institute, NEHU, Meghalaya	Jul 24	Dr. D. K. Hore
Annual workshop of AICRIP on chickpea & Mulla RP, Jaipur	Sep 3 - 6	Dr. S. Sardana
National level training on command area development programme with emphasis on warabandi, plandu, Ranchi	Sep 13 – 19	Dr. J. B. Tomar & Dr. V. K. Gupta
Training on plant genetic resources information management with special reference to passport data, Hyderabad	Sep 6 – 15	Dr. Gunjeet Kumar, Ms. Rita Gupta and Mr. O. P. Dhariwal

UGC refresher course NEHU, Shillong	Oct 5	Dr. D. K. Hore
Rice production training programme, Barapani, Meghalaya	Oct 11	Dr. D. K. Hore
National seminar on orchid diversity in India: Science and Commerce IHBT, Palampur, H P	Oct 11-13	Dr. Veena Gupta
Training programme on computers in Hindi, CMC Ltd., Bangalore	Oct 15-19	Ms. C. Rajalaxmi
National seminar on approaches for increasing agricultural productivity in hill and mountain ecosystem, ICAR Res. Complex, Barapani, Meghalaya	Oct 18	Dr. D. K. Hore
Training programme on cultivation of rose-geranium under drought prone areas, Ranikhet, Bhowali	Nov 1	Dr. S. K. Verma & K. S. Negi
Workshop under AICRIP on spices KAU, Vellänikara, Kerala	Nov 1-3	Dr. Z. Abraham
Workshop on carbon sequestration and biodiversity conservation using integrated approach to develop an optimal village agro system in Uttaranchal. GBPIHED, Almora	Nov 7	Dr. K. S. Negi
Swadeshi science congress. KFRI, Kerala	Nov 7-9	Dr. M. Abdul Nizar
Training programme on molecular markers: tools for fish population genetic analysis, NBFGR, Lucknow	Nov 9	Dr. J. L. Karihaloo
Thematic working group for domesticated biodiversity – public hearing, KFRI, Thrissur	Nov 11	Drs. Z. Abraham, M. Abdul Nizar
Advanced in storage and seed entomology at CCSHAU, Hisar	Nov 20	Dr. Baleshwar Singh
International conference on pesticide environment and organised by society of pesticide science of India, Div. of Entomology, IARI	Nov 19-23	Drs. Shashi security food Bhalia, Manjulata Kapur, B. Lal and Charan Singh
Policy makers workshop on farmers right: from legislation to action and kerela's bioresources conservation kalepetta, Wayanad, Kerala	Nov 24	Dr. Z. Abraham
Grass root level training under NATP, GBPIHED, Joshimath	Nov 30	Dr. K. S. Negi
Training organised by division of plant pathology GBPUA&T, Pantnagar	Nov 19 – Dec 9	Dr. B. Singh
Training on biometrical methods for agricultural research at IASRI, New Delhi	Dec 4	Dr. J. L. Karihaloo
Symposium on plant pathogens/ microbes in human welfare, IARI, New Delhi	Dec 6	Drs. R. K. Khetrpal, Celia, Chalam V., Kavita Gupta, Anju Jain
XVIII meeting of ICAR reg. Committee no. VIII, CTCRI, Thiruvananthapuram, Kerala	Dec 14 – 15	Dr. Z. Abraham
5 th executive development programme in agricultural research management, NAARM, Hyderabad	Dec 21 – 24	Dr. J. L. Karihaloo

19.16 Training Programmes Organized by the Bureau

Training programme and venue	Period
Grassroot level training	
• Two grassroot level trainings on crop genetic resources awareness programme at Sipajhar & Khoirabari of Assam	8 & 15 July
• Grassroot level training for Zone IX at KKV, Dapoli, MS	7 – 8 November
• Grassroot level training for Zone IV at FDI Guwahati by Basar, Arunachal Pradesh	10 – 14 November
• Grassroot level training at Pasighat, Arunachal Pradesh	1 December
• Grassroot level training at Basar, Arunachal Pradesh	5 December
• Grassroot training by Zone VIII at NBPGR Regional Station, Ranchi	January
• Grassroot training by Zone IX at JNKVV, Tikamgarh, M. P.	29-30 January
• Grassroot training by Zone IX at CHES, Ranchi	8 October
• Grassroot training by Zone III at CTRI, Trivandrum	8 February
• Grassroot training by Zone VII at PRDF, Gorakhpur	8 February
• Grassroot training by Zone X at NRAU, R. S., Chintapalli	24 February
• Grassroot training by Zone X at Chintalapalli, A. P.	9 March
• Grassroot training by Zone V at Chaddha, Nainital	12 March
• Grassroot training by Zone III at R. K. Mission, Narendrapur	22-23 March
• Grassroot training by South east coastal zone at NBPGR, Hyderabad	5 September
Orientation training cum workshop NBPGR, N. Delhi	27 Feb-1 March
Trainer's training programme under NATP (PB) at NBPGR, N. Delhi	2 - 21 March
Orientation course on biosafety consideration for evaluation of transgenic crops at NBPGR, New Delhi	2 – 9 November
A 10 day training programme on PCR based techniques for plant DNA fingerprinting, NBPGR, New Delhi	19 – 28 November
Farmers training on the cultivation of kiwi & scented rose – geranium at NBPGR Regional Station, Bhowali	1 October
Training on plant genetic resources information management with spl. reference to passport data at NBPGR, New Delhi	6 – 15 September
Maintenance & management of seed bank facilities at NBPGR, New Delhi	30 April – 11 May
Training on <i>in vitro</i> conservation at NBPGR, New Delhi, Cooperators training (Zone III) at NBPGR Regional Station, Orissa, Cuttack.	17 – 20 October

19.17 Publications

Research papers published

Agrawal P.C., Singh Baleshwar, Rani Indra, Joshi K.D., Maurya A. K. and Khetarpal R. K. 2001. Pathogenic fungi intercepted in introduced germplasm during the year 2000. *Indian J. Plant Genet. Resour.* 14: 142-143.

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Bhalla Shashi, Gupta Kavita, Lal B., Kapur Manju Lata, Singh Charan, Kumar Naresh, Meenakshi and Baloda R.S. 2001. Interception of insect and mite pests in germplasm under exchange during the year 2000. *Indian J. Plant Genet. Resour.* 14: 116-118.

Chakrabarty S. K., Rao RDVJ Prasada and Anitha K. 2000. Eradication of *Colletotrichum graminicola* (Ces.) Wills from sorghum seeds. *Indian Journal of Plant Protection* 28 (1): 109-110.

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Gupta S. 2001. ABA induced growth retardation of kiwifruit (*Actinidia chinensis*) *in vitro*. *Indian J Plant Genet Resour* 14: 312-313.

Gupta V, Srinivasan K. and Saxena S. 2001. Effect of various physico-chemical treatments on hardseededness in *Mucuna pruriens*. *Ind. J. Pl. Genet. Res.* 14:323-324.

Gupta V, Srinivasan K., Singh, S Saxena, S K Jain, A Kak, C Devi, M Uprety, A D Sharma, RS Yadav, Toshi, A Sharma and A K Singh (2001) Germplasm monitoring at National Gene Bank *Indian. J. Pl. Genet. Resour* 14:306-307.

Gupta Veena 2001. Structural changes in seed coat morphology during dormancy breaking in some medicinal plants. *Journal of Medicinal and*

Gupta Veena, Kak Anjali, Mitter Vivek and Singh B. B. 2001. Techniques to remove hard seedness in wild medicinal plant-*Abutilon indicum*. *Journal of Medicinal and Aromatic Plant Sciences*. 23:369-371.

Jain SK, Kak A., Singh N., Saxena S., Srinivasan K., Gupta V., Radhamani J., Uprety M., Sharma A. D., Toshi, Sharma A. and Singh A. K. 2001 Augmentation of Plant Genetic resources through assembly of Indian released varieties and registered germplasm. *Ind. J. Pl. Genet. Resour.* 14:260-261.

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Khetarpal, R. K., Singh Shamsher, Parakh D. B., Chalam Celia V. 2001. Viruses intercepted in exotic germplasm during 1991-2000 in Quarantine. *Indian J. Plant Genet. Resour.* 14: 127-129.

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19.18 Library and documentation services

NBPGR Library maintained its designated activities of acquisition of books and journals, exchange of literature, cataloguing and documentation. During the year, 331 new books related to various aspects of PGR management were added to main library at Headquarters and regional stations' libraries through purchase and exchange basis. The library also procured 125

scientific journals including 65 foreign and 60 Indian through subscription/ gift and exchanges for the readers at Headquarters and different regional stations. News and clipping services related to PGR and its related subjects were provided to the readers regularly. The library provided reprography services to its internal as well as external users. Bureau's publications were supplied to over 250 different organisations in India and abroad. In return Bureau received 315 publications as gratis from various organisations.

Scientists, technicals, M.Sc. students,

trainees are users of NBPGR Library. About 400 reference and queries were attended from internal as well as external users. Nine reprints were provided to scientists in India and abroad. A fortnightly current content service named 'Mirror' was provided to all regional stations. Under current content service 25 articles were provided on demand to regional stations' scientists. NBPGR Annual Report, Research Highlights, Newsletters, Crop Catalogues, NBPGR Brochures and other publications were also distributed to various trainees and visitors from India and abroad.

19.19 Budget estimates and expenditure incurred (Rs. In lakhs) during 2001-2002

Item Sub-head	Budget		Revised		Expenditure		NRC on DNAFP	M & AP (G-15)
	Non-plan	plan	Non-plan	plan	Non-plan	Plan		
Establishment Charges	749.30	3.00	678.00	0.00	676.23	0.00	37.32	3.91
Travelling Charges	5.50	4.00	6.00	11.00	5.80	11.00	1.00	0.28
Overtime allowance	0.20	0.25	0.20	0.20	0.20	0.20	32.92	3.42
Contingencies	100.00	100.00	100.00	71.29	167.6	60.38	6.65	0.22
Equipments	0.00	0.00	0.00	0.00	36.76	10.91	0.00	0.00
Works	15.00	134.75	165.00	104.51	164.72	104.51	0.00	0.00
Wages	20.00	0.00	20.00	0.00	19.97	0.00	0.00	0.00
Matching grant	0.00	0.00	97.30	0.00	0.00	0.00	0.00	0.00
Revenue generation	0.00	0.00	7.00	0.00	0.00	0.00	0.00	0.00
TOTAL	890.00	242.00	1073.50	187.00	1071.28	187.00	77.89	7.83

Annexure I. Meteorological data (temperature in degree celsius and rainfall in mm)

Station	Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Akola	Max. temp.	29.4	34.5	36.3	39.9	42.3	34.5	31.1	29.8	34.0	32.2	32.4	30.4
	Min. temp.	12.8	14.0	19.6	22.3	28.2	24.6	23.7	22.9	22.5	19.2	17.6	12.6
	Rainfall	38.2	00.0	48.0	13.1	12.8	204.5	89.2	112.4	76.4	136.6	00.0	00.0
Bhowali	Max. temp.	12.4	18.3	21.1	21.3	27.2	24.0	25.0	25.7	25.2	23.2	19.4	15.2
	Min. temp.	-1.00	0.00	3.5	4.3	18.3	16.1	13.4	18.0	14.7	11.9	5.7	1.7
	Rainfall	26.8	43.0	14.0	125.1	100.6	292.0	267.0	126.0	0.0	12.0	0.0	0.0
Hyderabad	Max. temp.	29.8	34.6	35.8	36.8	40.0	33.3	32.2	29.6	30.8	30.1	30.5	29.3
	Min. temp.	12.9	13.6	19.9	23.0	26.7	23.9	23.2	22.4	22.2	19.9	17.5	11.3
	Rainfall	1.0	0.0	8.4	89.2	0.0	175.4	32.0	188.2	147.7	198.1	0.0	0.0
Jodhpur	Max. temp.	25.4	29.4	34.4	38.3	41.0	38.5	32.7	33.5	37.1	38.1	32.9	28.8
	Min. temp.	9.3	12.8	17.8	22.6	27.8	28.0	25.7	24.9	23.2	21.0	15.5	12.3
	Rainfall	0.0	0.0	0.0	7.3	33.9	5.35	203.6	113.7	10.6	14.6	0.0	0.0
Shillong	Max. temp.	18.8	21.7	25.6	27.7	26.1	26.7	28.2	28.0	26.7	25.6	22.6	20.6
	Min. temp.	6.4	9.7	13.8	15.8	17.7	20.1	20.9	20.5	19.1	16.8	13.1	7.1
	Rainfall	6.8	45.2	24.2	137.6	355.3	417.2	508.7	425.1	428.7	286.7	90.8	2.3
Thrissur	Max. temp.	32.6	34.5	34.9	38.4	34.5	32.8	31.0	30.6	33.0	30.7	31.6	31.4
	Min. temp.	23.2	22.9	24.0	22.5	22.0	21.6	21.4	22.0	20.3	21.6	22.3	22.2
	Rainfall	—	12.2	4.4	243.1	192.6	676.2	477.7	253.2	200.9	215.8	115.8	—