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वार्षिक प्रतिवेदन

ANNUAL REPORT

2011-2012

राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो

NATIONAL BUREAU OF PLANT GENETIC RESOURCES

(भारतीय कृषि अनुसंधान परिषद)

(Indian Council of Agricultural Research)

पूसा परिसर, नई दिल्ली-110012

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PREFACE

It gives me immense pleasure to place before you the Annual Report (2011-12) of the National Bureau of Plant Genetic Resources (NBPGR), a nodal organization of the country mandated with planning, execution and coordination of all activities concerned with germplasm collection, introduction, quarantine, evaluation, conservation and documentation at national level. Since its establishment in 1976 by the Indian Council of Agricultural Research (ICAR), NBPGR has played a pivotal role in the management and sustainable utilization of plant genetic resources for crop improvement.

Taking into account the suggestions of the Germplasm Advisory Committees (GACs) and Group Meetings of All India Coordinated Projects on various crop groups, plant explorations were undertaken to collect the trait-specific germplasm and wild relatives of crop plants, which constituted >50% of the total collections made during the period under report. Similarly, trait specific germplasm for improving nutritional quality, resistance to biotic and abiotic stresses, and transgenic material for research was introduced from abroad and made available to indentors/ researchers after quarantine clearance.

NBPGR was awarded a research project on 'Acquisition, evaluation and identification of climate resilient wheat and rice genetic resources for tolerance to heat, drought, and salt stresses' under the ICAR network mega-project on 'National Initiative on Climate Resilient Agriculture' (NICRA) in February, 2011. Under this, >20,000 accessions of wheat (*Triticum aestivum, T. dicoccum* and *T. durum*) were sown in augmented block design at CCS Haryana Agriculture University (CCSHAU), Hisar, Haryana in *rabi* 2011-12, to characterize for agro-morphological traits and develop core sets of wheat germplasm conserved in the National Genebank. Simultaneously, another set of the same material was sown at Issapur Farm, New Delhi, for evaluating the wheat germplasm for heat and drought tolerance. A third set was sown at farm of IARI, Regional Station, Wellington, Nilgiris, Tamil Nadu (hot spot for rust diseases) for screening against rust and other foliar diseases. Simultaneous evaluation and screening of such a large number of germplasm is being carried out for the first time in the history of NBPGR. The identified disease resistant germplasm of wheat would be available to the breeders for wheat crop improvement programme of NARS. On similar lines, >18,000 chickpea germplasm is being evaluated during *Rabi* 2011-12 at Mahatma Phule Krishi Vidyapeeth, Rahuri for agro-morphological, resistance to biotic and abiotic stresses and quality parameters.

A total of 5,131 accessions of orthodox seeds were added to the base collection raising the total germplasm holding to 3,88,985 accessions in the National Genebank. In addition, 2,075 accessions of fruit crops, bulb and tuber crops, medicinal, aromatic and rare/ endangered plants, spices, plantation and industrial crops were conserved as *in vitro* cultures. Significant progress was made in the development of protocols for cultivar identification in crops of national importance using molecular techniques like STMS, AFLP and ISSR markers. Varieties of different crops were fingerprinted and included in the database on DNA fingerprinting. Two M.Sc and two Ph.D students were awarded degrees in PGR from Post Graduate School, IARI, New Delhi during the year.

I take this opportunity to place on record my sincere thanks and gratitude to Dr S Ayyappan, Hon'ble Director General, ICAR and Secretary, DARE, Govt. of India, Prof. S K Datta, DDG (Crop Sciences), Dr. H.P. Singh, DPG (Hort.), Dr Arvind Kumar, DDG (Education) and Dr J S Sandhu, ADG (Seed), ICAR for their continued guidance, encouragement and support in executing the mandate of NBPGR.

I thank the HoDs, Officers-in-charge, all the scientists, technical, administrative and audit, and supporting staff of NBPGR for their teamwork, efficiency and dedication.

Sincere efforts of Drs Arjun Lal, Kavita Gupta, Vandana Tyagi and Sangita Yadav in compilation and editing the report are highly appreciated.

29 May 2012
New Delhi

K C Bansal
Director

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EXECUTIVE SUMMARY

National Bureau of Plant Genetic Resources (NBPGR) continued its role of leadership for the management of plant genetic resources in the country. Several significant achievements were made during the year 2011 in plant exploration and collection of germplasm; germplasm introduction, plant quarantine inspection, treatment and release of germplasm; characterization, evaluation, identification of promising accessions and maintenance; *ex situ* conservation of accessions in National Genebank and DNA Fingerprinting of crop cultivars and are summarized hereunder.

PLANT EXPLORATION AND COLLECTION OF GERMPLASM

A total of 47 explorations were undertaken across the country and 3,235 accessions of various agri-horticultural crops, their wild relatives and other economic plants were collected. Of these, 582 accessions were collected by NBPGR Headquarters, New Delhi through ten explorations from parts of Arunachal Pradesh, Assam, Chhattisgarh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland and Odisha. A total of 283 herbarium specimens, 26 seed samples and 19 economic products were processed and added to the National Herbarium of Cultivated Plants (NHCP). Major emphasis was given for collection of wild species including wild relatives of crops. Germplasm collected by NBPGR Regional stations during various explorations is summarized hereunder.

Akola: Two exploration and collection missions undertaken under NEH programme during the reporting period. A total of 101 accessions of germplasm comprising *Oryza nivara* (17), *O. rufipogon* (16) and *O. sativa* (68) were collected from Chattisgarh and adjoining Uttar Pradesh under NICRA and Western and Southern Tripura district in Tripura.

Bhowali: Two crop-specific explorations and one survey cum identification (26 acc. tagged) tour were undertaken and 58 accessions were collected which include landraces and primitive cultivars of cereals (32) and fruits (26) from remote areas of Uttarakhand hills under National Exploration Programme.

Cuttack: Five explorations were undertaken and a total of 261 accessions comprising cultivated rice, cotton (29), *Crotalaria* (10) M&AP (49), chilli (01), sesame (01) and wild relatives of crop plants (06) were collected from 193 collection sites covering Odisha, Mizoram, Arunachal Pradesh and West Bengal (Sundarban). Wide range of variability was observed for various morphological and agronomical traits among cultivated rice and other collected germplasm. The significant collections among rice germplasm include drought tolerant land races (*Kusuma, Chingerdhan, Kuliha, Kumarmani, Dasaramatia, Muridanra, Kundadhan*), cold tolerant land races (*Lahi, K. Botha, Sikota lahi* and *Dal boradhan*) and salt tolerant land races (*Getu, Nonabokra, Talmugur, Kalonunia, Darsal, Marisal* and *Dudheswar*). The significant collection of medicinal and aromatic plants, wild relatives of crops and wild economic plants viz. *Mucuna nigricans, Solanum erianthum, S. violaceum, Adenanthera pavonina, Rubus ellipticus, Argyreia nervosa, Crotalaria micans, Gossypium barbadense, Ocimum americanum* were made during the exploration. Ethno-botanical survey was carried out and indigenous knowledge on less known/ unreported uses/ practices of plant species for tribal healthcare and livelihood support was recorded.

Hyderabad: Fourteen explorations (including 8 explorations in Adilabad district under the NAIP) were undertaken and 1461 collections made in various crops.

Jodhpur: An exploration trip was undertaken for the collection of landraces of major crops, minor fruits, M&AP and economic potential species from Rana Chowki, Jhakham Dam, Balmikhi Ashram, Dhulia Khem and Sari Pipli collection sites around Sitamata forest area Sanctuary (Pratapgarh, Chittaurgarh Districts of Rajasthan). A total of 90 accessions, including rare and endangered species, were collected, namely, cereals (07), minor millets (01), pulses (06), oil seeds (07), minor fruits (06), fiber yielding (01), vegetables (12), medicinal and aromatic plants (30), and economically potential tree plants (20). One biodiversity survey and germplasm collection trip was undertaken under NAIP (Harmonizing Biodiversity) project in Udaipur. Twenty four landraces were collected, *viz*., bhindi (02), bottle guard (03), cow pea (01), gram (02), long melon (01), maize (05), mung (01), muskmelon (01), pumpkin (01), rice (01), sesame (01), sponge guard (03) and urd (02) from Block Salumber, District Udaipur (Rajasthan).

Ranchi: Three explorations were undertaken in the areas of Dumka, Jamtara, Pakur and Deoghar districts of Jharkhand during 2011 and 113 samples of different plant species were collected.

Shillong: Three explorations were conducted in Manipur, Mizoram and Sikkim during 2011. A total of 41 aromatic rice (chakhao rice) germplasm were collected from Manipur. Collection of multi-crop germplasm comprising vegetables (14), rhizomatous crops (6), fruits (4), cereals (4) and 10 other crops were made from Mamit, Aizawl and Champhai districts of Mizoram. From the exploration trip in the Eastern, Western and Southern districts of Sikkim, maize (46), rice (17), buckwheat (22), *Vigna* spp. (37) were collected. The station also collaborated in two other explorations to Arunachal Pradesh under NEH exploration plan.

Shimla: Three explorations were conducted and diversity collected represent maize (51), kidney bean (27), rice (14), wheat (17), buckwheat (25), barley (11), mustard (15), amaranth (32) and others (26). Significant collections include landraces of red rice, traditional maize, kidney bean and grain amaranth.

Thrissur: Four exploration/ collection missions were conducted in 2 districts of Goa, 4 districts of Mizoram, 3 districts of Tripura and 6 districts of Assam and a total of 365 samples of germplasm were collected from Goa (54), Mizoram (150), Tripura (96) and Assam (65). Out of the collected germplasm, 2 samples of unique chillies landraces and 61 of landraces of deep-water rice from Assam were sent for long-term storage at Germplasm Conservation Division, NBPGR, New Delhi.

EXCHANGE OF GERMPLASM

Introduction of germplasm: During the period under report 1, 16,980 samples were imported which included 31,548 accessions (31,877 samples) of germplasm and 7,044 entries (90,165 samples) of CGIAR nurseries for trials.

Promising trait specific germplasm introduced: ***Triticum aestivum*** **(Wheat)** PHS tolerant white wheat (EC693905) from Canada; Variety Vijay (BL 3063) having good resistance against variants of Ug99, and impressive agronomic performance under both normal and late sown conditions in the Tarai region of Nepal, is believed to have terminal heat tolerance, bold seeded amber colored grains, high protein content (12.5%), and good quality for baking industries (EC721736) from Nepal; coloured germplasm (EC699417-418) from USA.

Oryza sativa **(Paddy)** lines for heat tolerance screening (EC695984); Submergence tolerant lines (EC699258); salinity and submergence tolerant lines (EC714174-176); mapping populations (EC715643- EC716353); blast monogenic lines (EC716881- EC716911); bacterial leaf blight resistant lines (EC717928-937); thermogenic male sterile lines (EC720903-904); high yielding hybrid variety H512 (EC720905); salinity tolerant lines (EC699098-9257); drought tolerant pyramiding lines, salinity tolerant, and low input tolerant (EC725224- EC725249); submergence tolerant line (EC725250- EC725252) from Philippines.

Hordeum vulgare **(Barley)** cv Sidney a Russian wheat aphid (RWA) resistant spring, two rowed feed barley (EC698842); germplasm STARS 0637B to 0643B, resistance to RWA (*Diuraphis noxia* (Mordvilko), They are comparable to their recurrent parents in yield, test weight, plant height, and heading date in the absence of RWA and superior in grain yield to their recurrent parents in the presence of RWA (EC698889-95) from USA.

Zea mays **(Maize)** Tolerant to downy mildew (EC707957- EC708021) from Indonesia; High yielding lines (EC697044-7131) from Mexico.

Helianthus annuus **(Sunflower)** Rust resistant line (EC699721); High oil content (EC699730- 31, 738, 740, 742, 762, 770-71, EC699816); Downy mildew resistant (EC699748-50, 753-758); High oleic acid content (EC699735-36, 756); CMS lines (EC699765,67,69), Orobanche resistant (EC699746-47) and Dwarf types (EC699732,760-761 EC699764, 774) from USA.

Vigna radiata **(Mung bean)** Early maturing lines resistant to *Mungbean yellow mosaic virus*, *Pea yellow mosaic virus* and bold seeded (EC718740- EC718745) from Taiwan.

Capsicum annuum **(Chilli)** Anthracnose resistant lines (EC695166- EC695175) from Taiwan.

Lycopersicon esculentum (Tomato) homozygous for resistance to *Fusarium* wilt race 1, 2 & 3 (EC698821-836); resistant to *Tomato mosaic virus*, *Fusarium* wilt race 1, 2 & 3 (EC699710-718, EC700929-939); high

beta carotene lines (EC721238- EC721241) from Taiwan; segregating lines of tomato with resistance to bacterial wilt (EC698844-698875) from USA.

***Colocasia esculenta* (Taro)** taro leaf blight tolerant and susceptible lines, very good taste (EC714177- EC714201, EC719534-541) from Fiji.

Export of Germplasm: Requirements for germplasm from abroad were met by arranging material from different Indian sources and 1,303 samples of different crops were exported to ten countries under SMTA/ MTA after the approval of DARE.

National Supply: A total of 4,043 samples of different crops were supplied to national users for utilization in various crop improvement programmes in the country based on requests received from research workers under material transfer agreement (MTA)

QUARANTINE OF GERMPLASM

At New Delhi, A total of 1,16,980 samples of imported germplasm accessions as well as trial material entries of various crops and their wild relatives were processed for quarantine clearance. These samples included true seeds, rooted plants, cuttings, rhizomes, suckers, bulbs, nuts and tissue culture plantlets. The infested/ infected samples (1,346)- comprised due to insects (487), nematodes (119), fungi/ bacteria (644), viruses (27), weeds (69) and several exotic pests. Of the 1,346 infested/ infected/ contaminated samples, 1,314 were salvaged through fumigation, hot water treatment (HWT), X-ray radiography, pesticidal dip, mechanical cleaning and growing-on test. Thirty two samples of *Oryza sativa* from China and USA were rejected due to infection by *Neovossia horrida*, a quarantine pest for India. The remaining infested samples were salvaged through physico-chemical methods. A total of 2144 samples were processed for export of which 14 infested/ infected samples were salvaged and 15 Phytosanitary Certificates were issued. Fifty six samples of exotic germplasm of different legume crops imported from different countries/ sources were grown in post-entry quarantine (PEQ) greenhouses and the harvest of the plants free from viral symptoms only was released to the indenters. Quarantine processing of 946 samples of imported transgenic planting material revealed, fungi and insect infestation in maize and rice; absence of terminator gene was ensured and all samples were salvaged prior to release. A total of 14759 samples were received from Germplasm Conservation Division for seed health testing of which 944 samples were subjected to X-ray radiography. A total of 1,060 samples were rejected as they could not be salvaged.

At Hyderabad, a total of 43,232 samples consisting of 14, 901 import samples and 28, 331 export samples were processed for quarantine clearance and a total of 106 phytosanitary certificates were issued. Several pathogens of quarantine importance were intercepted, of these, downy mildew (*Peronospora manshurica*) of soybean and bacterial speck of tomato (*Pseudomonas syringae* pv *tomato*) are quarantine pests for India. The import samples (2625) that were found infested/infected with pests/pathogens could be salvaged and released to the consignees except thirteen detained/rejected samples (sunflower-1; tomato-2 & soybean-10). In exports, 103 samples were rejected due to the association of quarantine pests/pathogens. Quarantine service was extended to 46 organizations in South India. Post-entry quarantine inspection was conducted on 2,103 samples of different crops meant for ICRISAT (1002), and private industry (1101), which include transgenics also.

GERMPLASM CHARACTERIZATION, AND EVALUATION

During the year a total of 7,825 accessions of various agri-horticultural crops comprising cereals (2,097), millets (235), pulses (2,387), oilseeds (542), vegetables (1936), underutilized crops (493), and medicinal and aromatic plants (135) were grown for characterization, evaluation, regeneration, multiplication and species identification. In addition, 4503 accessions of international nurseries comprising of wheat, barley and *Triticale* were also evaluated under Post Entry Quarantine Nursery (PEQN). A total of 2,376 accessions of various crops namely, pearl millet (223), rapeseed-mustard (713), black gram (344), chickpea (90), lentil (30), okra (192), tomato (582), brinjal (200) were also screened for important biotic stresses (insects/pests and diseases). Under abiotic stresses, 224 accessions of wheat were evaluated for terminal heat tolerance. Under biochemical evaluation a total of 945 accessions of different crops were analyzed for oil content and fatty acid profile, protein, sugar, minerals etc. Under phyto-chemical evaluation 465 samples of different medicinal and aromatic plants were analyzed for their active compounds. Under multi-location evaluation (MLE), 1100 accessions of wheat,

900 accessions of rice, 200 accessions of maize, 240 accessions of mustard, 200 accessions of brinjal, 200 accessions of okra, 320 accessions of chickpea, 340 accessions of pigeonpea, 300 accessions of lentil and 14 accessions of *Tinospora* were multiplied and evaluated for agronomic traits, biotic and abiotic stresses and quality parameters in collaboration with NAGS, AICRPs and SAUs. The details of germplasm characterized and evaluated at the various regional stations are as follows:

Akola: A total of 2,465 accessions were characterized, out of which a total of 1,361 accessions of germplasm comprising of grain amaranth (1,170), of vegetable amaranth (85), linseed (52) and safflower (55) accessions were characterized during *rabi* 2010- 2011 and 1,104 accessions of germplasm comprising finger millet (273), niger (443), castor (288) and winged bean (100) were characterized during *kharif* 2011. Sesame (1,662), pigeon pea (793), green gram (641) and *Abelmoschus* spp. (237) during the *kharif* 2011 were regenerated and multiplied. In all 330 accessions of germplasm comprising sesame (307) and grain amaranth (23) accessions were multiplied and sent for conservation in the National Genebank.

Bhowali: A total of 942 accessions were received from for regeneration, characterization and maintenance. Some of the elite seed samples and live rooted plant material *viz.* M. & AP and WEUPS (Wild Economically Useful Plant Species): *Hedychium spicatum* (300 nos.), *Pelargonium graveolens* (4576 nos.), *Origanum vulgare* (335 nos.), *Rosmarinus officinalis* (49156 nos.), *Valeriana jatamansi* (300 nos.), Horticultural Plants: Kiwi (1174 nos.), Kiwi seedlings (200 nos.), Kiwi fruits: 265 kg. (Grade – A: 136 kg. + Grade – B: 126 kg. + Grade – C: 03 kg.), Strawberry (5.250 Kg + 540 nos.), Kagazi nimbu (788 nos. + 06 kg.); Agricultural Crops: Green pod peas (56 kg), Horsegram (17 kg.), Paddy mix (70 Kg), Rice bean mix (17 Kg), Soybean (38 kg.) were supplied to different farmers / indentors.

Cuttack: A total of 1927 acc comprising cultivated rice (1500), green gram (57), black gram (41), *Ocimum* species (30), *Mucuna pruriens* (12), wild *Oryza* species (254) and other wild relatives of crops (33) were characterized for various agro-morphological traits. A set of 1149 accessions of cultivated rice was evaluated and screened against bacterial leaf blight in collaboration with CRRI, Cuttack out of which, 18 accessions have been identified as tolerant against BLB. In addition, 254 acc of wild rice germplasm and 33 acc of wild relatives of vegetable crops were grown for characterization and a total 2516 acc comprising cultivated rice, sesame, *Trichosanthes*, tubers, *Ocimum* spp., *Andrographis paniculata*, *Mucuna pruriens* and other medicinal plants were multiplied for conservation in LTS.

Hyderabad: A total of 1231 accessions of different crops were characterized/ evaluated and multiplied in Rabi 2010-11 and 1715 accessions in Kharif 2011 and Rabi 2011-12. A total of 329 accessions of different crops were supplied to researchers in India under MTA; a promising accession of Dolichos lablab having resistance to anthracnose and aphids was registered (INGR 110311)

Jodhpur: Also, 81 germplasm collections of different crops, maize landraces (68) [Malan (28) and Sathi (40)], Urd (04), Sorghum (08) and Horse gram (01) were raised in *kharif* 2011 under NAIP (Harmonizing Biodiversity) project. In all 4,596 germplasm accessions were grown for characterization, evaluation and multiplication. Twenty-one genetic stocks are identified in the five mandate crops of the station, suited for the arid and semi-arid climate like Jodhpur and its adjoining areas, most suited for 250-350 mm rainfall and also can resist 48 -50°C temperature. A total of 33,856 germplasm accessions were conserved in the MTS facility. A total of 751 germplasm accessions of different taxa are maintained in the field gene bank. Seed samples of 6,134 accessions were received from different sources and 386 germplasm accessions were supplied to various inventors.

Ranchi: A total of 411 accessions comprising kulthi (362), *Mucuna* (39) and *Cajanus cajan* (10) were multiplied and evaluated. A total of 669 accessions of mandate crops, namely, jack fruit tamarind, jamun, bael, barhal, aonla, mango, *Lawsonia indica*, moringa and several medicinal and aromatic plant species were maintained in the Field Gene Bank. Accessions of *Jatropha* spp. were maintained in National Jatropha Germplasm Garden.

Shillong: A total of 1,082 accessions of different agri-horticultural crops comprising maize (151), upland paddy (273), lowland paddy (229), rice bean (155), *Coix* (54), *Perilla* (40), buckwheat (85) and chilli (95) were characterized for agro-morphological traits. Lowland paddy germplasm were evaluated for leaf blast incidence and considerable variation was observed for per cent

disease incidence (4.4-77.8%). In field gene bank, 610 accessions of various horticultural crops and M&APs were maintained.

Shimla: A total of 2,013 germplasm accessions were grown for characterization, evaluation and multiplication. Genetic variability for seed and pod colour, shape and size was recorded in pea germplasm and also for other traits in different crops. Sixty-four accessions of field pea were screened against 4 isolates, *viz*., *Rangway*, *Trilokinath*, *Stingri*, *Kangra* of powdery mildew (*Erysiphe pisi*)**.** Among fruits**,** 202 accessions of apple (41), pear (24), plum (41), apricot (22), peach (33), and walnut (41) were characterized and evaluated. Wide range of variability was recorded for traits like fruit colour, shape and size. In peach EC038736, EC312408, EC552643, EC552644 and EC387511were found superior for multiple traits while 'Silver King' of nectarine was found promising for fruit size and colour**.**

Srinagar: The 478 accessions of wheat (240), barley (114) and mustard (124) were evaluated for their morphological characters during *rabi* 2010-11 under rainfed conditions. The 723 accessions of wheat (335), barley (280) and sarson (108) were sown in *rabi* 2011-12 for characterization and evaluation under rainfed condition of Himalayan. The 39 accessions comprising *Dioscorea deltoidea* (23) strawberry (5), pran (onion) (5), mint (3) and *Iris* spp. were maintained as live plants in the field.

Thrissur: During *rabi* 2010-11, 170 accessions of rice (*Oryza sativa*), 3 of wild bittergourd (*Momordica charantia* var. *muricata*), 22 of pumpkin (*Cucurbita moschata*), 5 of cushaw (*C. argyrosperma*), 5 of *Solanum insanum*, 17 of *Kaempferia galanga* and 380 of horsegram (*Macrotyloma uniflorum*) were evaluated. During *Kharif* 2011, 34 accessions of upland landraces and 85 of lowland rice, 43 of *Sesamum* species and 36 of Malabar tamarind (*Garcinia cambogia*) were characterised/ evaluated. Seeds of 67 accessions mostly of forage crops and pumpkin were multiplied and sent for long-term storage.

GERMPLASM CONSERVATION

A total of 13,620 accessions of germplasm including varieties to be notified and released and trait-specific registered germplasm of various crops were received for long-term conservation in the National Genebank. These were processed following the genebank standards, adding another 5,131 accessions to the base collection raising the total germplasm holding to 3,88,985. Monitoring of seed germination and quantity in stored germplasm (5,044 accessions) and distribution (1,05,760) for evaluation/regeneration/research/restoration of active collections were the other priority activities. Dormancy breaking methods were standardized for *Andrographis paniculata*, (GA_3 500 ppm for 48 and 72 h) *Capsicum* spp. (GA_3 500 ppm co-applied at 15^0C) and *Morinda citrifolia* (clipping treatment + GA_3 1000 ppm for 24 h). Assessment of longevity of ultra-dry seeds of safflower, sesame, chickpea, niger, and groundnut indicate significantly higher germination (64-96%) in seeds with low moisture content (mc) (1.7-3.0 %) than the germination (0-40%) recorded in seeds with next higher level of mc (3.8-5.0%) after 13-15 years of storage at ambient temperature. Agronomic and yield parameters during field evaluation of cotton seeds stored for 15 years at different moistures corroborate the benefit of ultra low seed moisture ($\leq$ 3%) and low temperature storage. Studies on onset and loss of desiccation tolerance during wheat embryogenesis were initiated in *Triticum aestivum, T. durum* and *T. dicoccum*. A total of 88 accessions with unique traits were approved for registration and processed for long- term conservation.

Long-term storage (LTS) of seeds of various agricultural and horticultural crops in the National Genebank (-18^0C), and medium-term storage (MTS at $+8^0$C) of reference samples of introduced and collected accessions was carried out. In addition, the registration of potentially valuable germplasm and conservation of released varieties and genetic stocks identified under the National Agricultural Research System has been the other important activity to facilitate their use in crop improvement programmes. Efforts were made to update and correct the information on conserved germplasm and port the data for incorporation in the national database. Supportive research directed towards understanding the storage behaviour of hitherto under-explored species, identification and manipulation of factors that prolong the storage life of seeds in a cost-effective manner and overcoming seed germination problems continued.

***In vitro/* Tissue Culture Conservation:** During the year, a total of 2,075 accessions belonging to fruit crops, bulb and tuber crops, medicinal, aromatic and rare/ endangered plants, spices, plantation and industrial crops, and others were conserved as *in vitro* cultures, under culture room conditions and/or at low temperature. The

average subculture duration ranged from 4-24 months, depending on the species. In *Allium tuberosum* and *Picrorrhiza scrophuliflora,* cultures were conserved for 21 and 8 months, respectively at low temperature in dark. In *Kaempferia galanga,* encapsulated shoot bases were stored in cryovials without nutrient medium, up to 4 weeks. Cryopreservation experiments using droplet-vitrification, encapsulation-dehydration or vitrification techniques, led to varying degree of pre- and post-freezing success in *Allium* spp*., Malus domestica and Prunus armeniaca.* The genetic stability assessment was carried out in *in vitro*-conserved plantlets of *A. tuberosum* and *Colocasia esculenta* and, cryopreserved plantlets of *A. tuberosum* and *Morus* sp. using SSR markers. There were no significant differences between the *in vitro*–conserved regenerants and/or post-thaw regenerated plants, and their controls.

Cryopreservation: A total of 91 accessions comprising *Allium sativum* (3), *Dioscorea* spp. (3), *Malus domestica* (35) and *Musa* sp. (50) were cryostored as shoot tips or dormant buds. A total of 59 accessions comprising *Bacopa monnieri* (1)*, Fragaria* x *ananasa* (18), *Musa* spp. (34), *Picrorrhiza scrophuliflora* (1) and *Vaccinium ovatum* (5) were supplied as *in vitro* cultures to various indentors. A total of 381 accessions were cryostored as seeds, embryonic axes and dormant buds during the year, totalling 9,869 accessions in the cryogenebank. Successful cryopreservation was achieved in seeds, embryos and embryonic axes of *Citrus karna*, *C. pseudolimon, C. megaloxycarpa, C. pati-jora (citron), C. jhambiri, C. sinensis* and *Manilkara hexandra.*

DNA FINGERPRINTING

For genetic variability and characterization of germplasm in *Jatropha curcas,* 285 selected accessions were analyzed using AFLP and SSR markers. In addition 18 RAPD and 24 SRAP primers were used to analyze 37 Pongamia accessions. SSR genotyping information was generated in *Cucumis*, mothbean and *Lathyrus*. Eleven polymorphic functional markers (EST-SSRs) were used for genetic diversity analysis in 12 germplasm lines of finger millet of Indian and African origin for genetic variability studies. Genetic characterization of *Morinda tomentosa* accessions were analyzed using 21 ISSR primers. Seventy ISSR markers used for characterization of collected accessions of *Luffa* species. Molecular diversity among 24 released varieties and germplasm lines of wheat have been demonstrated with 32 identified SSR markers having high PIC value. A total of 391 cotton samples were fingerprinted using 25 genome-wide microsatellite loci. In 94 accessions of *Linum* microsatellite fingerprinting was carried out.

For molecular mapping and QTL analysis in sesame germplasm, large-scale DNA sequence information was generated using next generation sequencing approach. The contigs generated were mined for SSR markers. The RILs comprising 210 lines in F8 generation in sesame were evaluated for 20 morphological traits at Delhi conditions for two seasons. In wheat, a 237 promising germplasm lines showed near immunity for leaf rust resistance in nine different locations across the climatic zones in India. A new program was initiated to develop mapping populations for heat and drought tolerance in wheat during 2010 summer at IARI, RS, Wellington, Tamil Nadu and NBPGR, New Delhi.

Over 200 candidate gene sequences were screened in the contrasting accessions of *Cucumis, Lathyrus* and mothbean for development of SNP markers. Novel promoter region targeted marker CBDP (CAAT box derived polymorphism) and Start Codon Targeted (SCoT) polymorphism markers were developed and demonstrated their utilization in cultivars of *Corchorus capsularis* and *Corchorus olitorius*. SRAP (Sequence-Related Amplified Polymorphic) marker was also standardized in jute. Genomic SSR markers have been developed in finger millet. Ten Resistance gene analogue polymorphism (RGAP) markers were demonstrated in finger millet to produce polymorphic profiles in 32 finger millet accessions. Sixty SSR markers have been demonstrated for transferability from cucumber to characterize 40 bottle gourd germplasm lines. Eight SSR enriched library has been developed each for Giloe and Andrographis using different combination of biotin labeled repeat sequences. Ninety eight microsatellite primers in jute were custom synthesized and screened for amplification in a representative panel of eight genotypes. Twenty nine new microsatellite loci have been identified through genomic library enrichment and sequencing for identification of microsatellite markers in bittergourd.

Under the genomic resources development from plant genetic resources activities Transcriptome profiling in *Cucumis, Lathyrus* and mothbean has been carried out and stress response genes has been classified. Cloning of a novel cold tolerance gene *COR14* from white clover (*Trifolium repens*) has been carried out. A carotenoid

pathway gene, phytoene synthase 1, was amplified (750bp amplicons) and sequenced from red pulp black seeded watermelon line DRB-669 using degenerate primers from conserved region of *psy*1 gene. Sixteen Resistance gene candidates (RGCs) has been isolated and characterized from ToLCND Virus tolerant sponge gourd genotype and submitted to GeneBank. A Carbonic anahydrase gene has been amplified and characterized from the young leaves of cowpea cv. PUSA Kamal. Allelic variations of the CA gene have been demonstrated in cowpea genotypes. In mothbean SSH library has been developed for moisture stress.

For biosystematics and species evolution survey of different eco-geographical regions has been conducted for occurrence of *Vigna, Cucumis* and *Abelmoschus*. Molecular taxonomic studies have been carried out for species delineation and differentiation of *Cucumis* and *Abelmoschus* species based on cpDNA, mtDNA and rDNA sequences. Separately species relationship studies have been conducted in *Luffa* spp.

Multiplex-PCR based diagnostic tools have been developed for GM-maize events. Event-specific Real-time PCR protocols have also been developed in Bt Brinjal and Bt cabbage. A real time PCR-based diagnostics of GM event in imported transgenic planting materials has been conducted. DNA fingerprinting services has been provided to agencies and resources were generated through the service.

OTHER ACTIVITIES

- Meetings of the Institute Management Committee, Research Advisory Committee and Institute Research Council were held timely to review the progress of work related to PGR management and planning strategies for strengthening various activities and infrastructure / facilities to achieve the targets.

- The scientists, research associates, technical and administrative staff from the headquarters and its regional stations/ centres participated in a number of seminars, symposia, conferences, workshops, trainings and summer institutes to exchange ideas and upgrade their skills. Ten scientists were sent abroad to participate in foreign meetings. Details of these participations are given in Chapter 20 on General Information.

- Several distinguished scientists, administrators, policy makers, farmers and students visited the National genebank, DNA Fingerprinting labs, plant quarantine glasshouses, National Containment facility (C4 level) and tissue culture labs at the headquarters and field genebanks at Issapur, Akola, Bhowali, Cuttack, Hyderabad, Jodhpur, Ranchi, Shillong, Shimla and Thrissur.

- **Symposia/ Workshops/ Trainings/ Brainstorming sessions Organized by NBPGR**:

- A Farm Innovators' Meet was organized on February, 2011 at Issapur Farm in which 28 innovative farmers were honoured for their contribution in PGR conservation.

- Training on Crop Gene Expression Data Analysis and Structural Bioinformatics from 1-11 March, 2011

- Training Course on Diagnostic Methods for Detection and Identification of Pests of Seed and Other Planting Material and their Management from 18-28 May, 2011

- Training on Forest Biotechnology from 11 to 20 July, 2011

- Training on Molecular Diagnostics for Risk Assessment and Management of Genetically Modified Crops from 8 to 21 November, 2011

- International training course on '*In Vitro* and Cryopreservation Techniques for Conservation of Plant Genetic Resources' from 14- 26 November 2011

- One day training programme on Kiwi production was organized at village Bairangna, Block Dasauli, Dist. Chamoli, UK under HTM MM-I at NBPGR, R/S Bhowali on 15 December, 2011

- **Field days organized**: At Issapur Experimental Farm and IARI, New Delhi, Five Germplasm Field Days on *rabi* oilseeds, *rabi* pulses, wheat, barley and *Triticale*, maize and okra were organized to promote germplasm utilization by the plant breeders/ research workers. Field days on various

crops were also conducted at Regional Stations *viz.,* Akola, Hyderabad, Jodhpur and Thrissur for the benefit of breeders. Four Germplasm Advisory Committee meetings of various crop groups were organized under the expert guidance of crop specialists.

- **Publications:** NBPGR Annual Report and quarterly Newsletter were published and distributed to all concerned with PGR management. Besides, research papers (121) on various subjects were published in national and international journals; book chapters/ review articles (44) in various edited books/ manuals/ annual review/ teaching aids (8); plant germplasm reporter (1); crop catalogues (2); souvenir and abstracts book (6) and popular technical articles/ technical bulletins in Hindi/ English (25) were published by the scientists of the NBPGR (details are given in chapter 20).

- **Germplasm Registered:** Out of 209 proposals received for germplasm registration, 88 were approved for registration by the Plant Germplasm Registration Committee..

Funds allocated and expenditure incurred during the financial year 2011-12 (Rs. in lakhs)

A: NON PLAN			
Head	**Allocation**	**Revised Allocation**	**Expenditure**
Estt. Charges	2520.20	2727.00	2727.00
Wages	43.00	36.00	35.98
OTA	0.00	0.00	0.00
TA	7.00	7.00	7.00
Contingency	132.80	503.00	502.95
Works	103.00	289.00	288.96
Total	**2806.00**	**3562.00**	**3561.89**
B: PLAN			
TA	27.00	20.00	20.00
Contingency	698.00	720.26	720.27
Works	150.00	122.56	122.56
HRD	5.00	1.20	1.19
Total	**880.00**	**864.02**	**864.02**
C: AICRP			
TA	2	1.29	1.29
Contingency	5	1.33	1.33
Funds Released to Centers	381	300.38	300.38
Total	**388**	**303.00**	**303.00**

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 been given the national mandate to plan, conduct, promote and coordinate all activities concerning plant exploration and collection 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 purpose.

Besides having a 40 ha experimental farm at Issapur village (about 45 km west of Delhi), the Bureau also has a network of 10 regional stations/ base centre's 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/ work plans 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.

Mandate

To act as nodal institute at national level for acquisition and management of indigenous and exotic plant genetic resources (PGR) for food and agriculture, and to carry out related research and human resource development for sustainable growth of agriculture.

Objectives

- To plan, organize, conduct and coordinate exploration and collection of desired indigenous and exotic PGR.
- To undertake introduction, exchange and quarantine for augmenting PGR.
- To characterize, evaluate, document and conserve crop genetic resources and promote their use in collaboration with other national organizations.
- To develop genomic resources and tools, to discover and validate the function of genes of importance to agriculture and to develop bioinformatics tools for enhanced utilization of genomic resources.
- To develop information network for effective utilization of PGR.
- To conduct research, undertake teaching and training, develop policy guidelines and create public awareness on PGR.
- To promote use of PGR for sustainable agriculture at international level.

Organizational Set-up

The Director, NBPGR is overall in-charge of administration, research management and coordination. The Institute Management Committee, Research Advisory Committee, Crop Advisory Committees and the Institute Research Council play important roles. The Bureau functions through its four main Divisions, namely i) Plant Exploration and Germplasm Collection, ii) Plant Quarantine, iii) Germplasm Evaluation, and iv) Germplasm Conservation. The Bureau has units of Germplasm Exchange, Tissue Culture and Cryopreservation (TC&CP), PGR and Policy Planning (PPU). A principal scientist/ senior scientist heads each Division/ Unit.

Other centralized services include units of Administration and Management, Purchase, Stores, Maintenance, Audit and Accounts, Security and Library. Regional Stations/ Base Centres, headed by a Principal scientist/senior scientist, are located at Akola, Shimla, Bhowali, Shillong, Jodhpur, Hyderabad, Thrissur, Srinagar, Ranchi and Cuttack. It also houses NRC on DNA Fingerprinting, and an All India Coordinated Network Research Project on Under-utilized Plants. The total sanctioned staff strength is 354 comprising 117 scientific, 94 technical,

57 administrative and 86 supporting staff.

National Genebank

The Indian National Genebank was established by the council at 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 vault obtained from UK in 1983, four modules (two units of 100 m^3 and two of 176 m^3 capacity) were installed for long-term storage of seeds of orthodox species kept in laminated aluminium foils at -20^{0}C after drying them to 5-7% moisture content. Stand-by diesel generator backs up the electricity supply. Vegetatively propagated clonal materials and recalcitrant seeds 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 National Genebank facility commissioned in 1997 has 13 modules, each with a storage capacity of 50,000 to 76,000 samples depending upon the size of seeds. One of these modules is used for medium term storage of active germplasm collections and the rest for base collections for 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 National Genebank has a total capacity to store 0.85 to 1.25 million samples. This is one of the most modern Genebank 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 57 National Active Germplasm Sites responsible for different crops where germplasm collections are evaluated and multiplied under field conditions, backed by medium-term storage facilities. The Research Advisory Committee and Germplasm Advisory Committees for different crops advise the Bureau regarding improving the capability, efficiency and effectiveness of its services.

International Collaboration

NBPGR implements work plans developed under MoU between ICAR and IPGRI (now called as Bioversity International). 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 advanced training programmes focusing on scientific procedures for collection, exchange, quarantine/ biosecurity, biosafety, DNA Fingerprinting, evaluation, documentation and conservation linked to use of plant genetic resources. Major accomplishments of its staff are published in Annual Reports. NBPGR Newsletter is brought out quarterly. Crop Catalogues based on computerized data are also developed and published. Bureau's library at Headquarters specialized in information dealing with plant genetic resources and also subscribes to foreign and national journals.

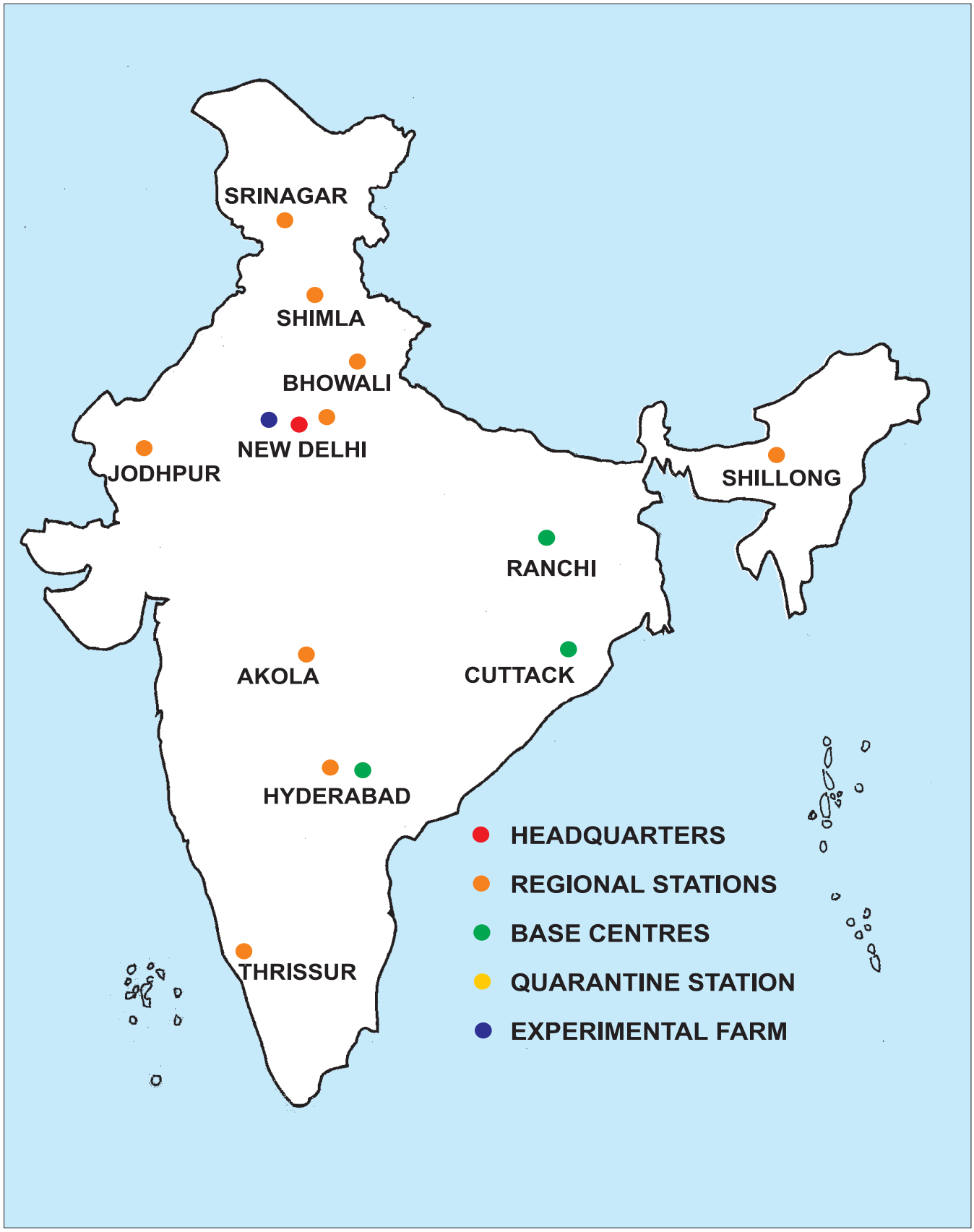
Post-graduate Teaching Programme

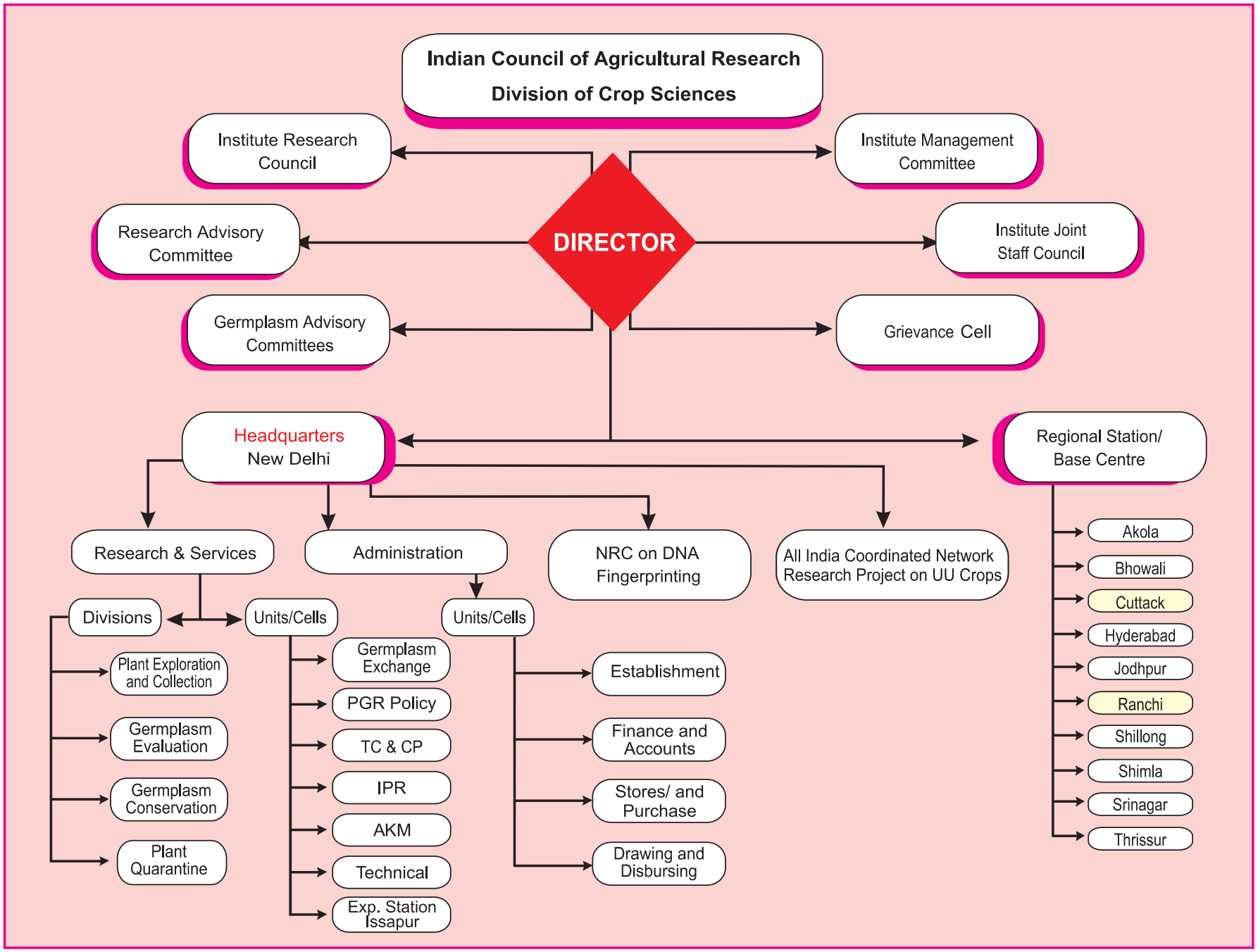
Since academic session 1997, Bureau is undertaking teaching in plant genetic resources leading to M.Sc. degree linked with Post Graduate School, IARI, New Delhi. From the academic session 2004-2005, a Ph.D. degree programme in plant genetic resources has also started in collaboration with the Post Graduate School, IARI, New Delhi.

Extension Services for PGR Awareness

Bureau organizes Kisan Diwas/ field days for *rabi* and *kharif* crops and distributes seeds/planting material along with relevant literature on technical know-how for raising crops and management of PGR. Special emphasis is 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 the National Genebank, DNA Fingerprinting, tissue culture and quarantine labs, Plant quarantine glass houses/containment facilities at New Delhi.

NBPGR's National Presence




Indian Council of Agricultural Research
Division of Crop Sciences
Institute Research Council
Institute Management Committee
Research Advisory Committee
DIRECTOR
Institute Joint Staff Council
Germplasm Advisory Committees
Grievance Cell
Headquarters New Delhi
Regional Station/ Base Centre
Research & Services
Administration
NRC on DNA Fingerprinting
All India Coordinated Network Research Project on UU Crops
Divisions
Units/Cells
Units/Cells
Plant Exploration and Collection
Germplasm Evaluation
Germplasm Conservation
Plant Quarantine
Germplasm Exchange
PGR Policy
TC & CP
IPR
AKM
Technical
Exp. Station Issapur
Establishment
Finance and Accounts
Stores/ and Purchase
Drawing and Disbursing
Akola
Bhowali
Cuttack
Hyderabad
Jodhpur
Ranchi
Shillong
Shimla
Srinagar
Thrissur

1. PLANT EXPLORATION AND GERMPLASM COLLECTION

Summary: A total of 47 explorations were undertaken across the country and 3,235 accessions of various agri-horticultural crops, their wild relatives and other economic plants were collected. Of these, 582 accessions were collected by NBPGR Headquarters, New Delhi through ten explorations from parts of Arunachal Pradesh, Assam, Chhattisgarh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland and Odisha. A total of 283 herbarium specimens, 26 seed samples and 19 economic products were processed and added to the National Herbarium of Cultivated Plants (NHCP).

1.1 Plant Exploration and Germplasm Collection

During the period under report a total of 47 explorations were undertaken and 3,235 accessions of different agri-horticultural crops comprising 2,735 accessions of cultivated and 500 of wild species including wild relatives of crop plants were collected from parts of Andhra Pradesh, Assam, Arunachal Pradesh, Chhattisgarh, Goa, Gujarat, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Rajasthan, Sikkim, Tripura, Tamil Nadu and Uttarakhand. Emphasis was mainly laid on collection of crop diversity from North eastern region involving the Krishi Vigyan Kendras (KVKs) located in respective states as facilitators. Details of explorations undertaken and germplasm collected are given below (Tables 1 and 2).

Table 1: Explorations undertaken and germplasm collected during 2011

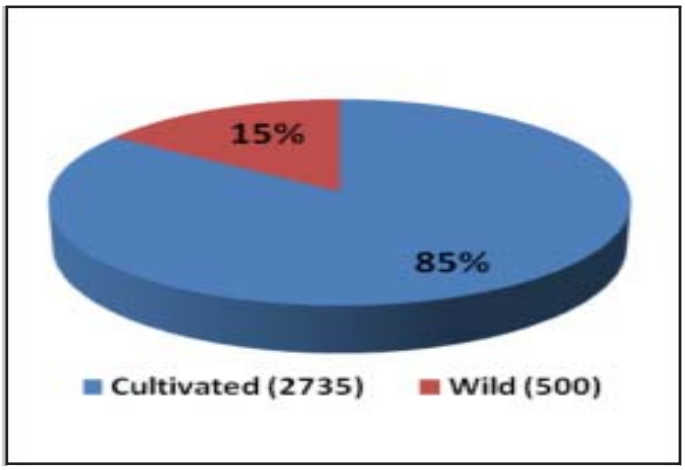
Headquarters/ Regional Stations/ Base Centres	Explorations undertaken	Accessions collected
Jodhpur (Arid region)	1	90
Thrissur (Southwest coastal region)	4	363
Cuttack (Humid/ moist tropical east coastal region)	5	261
Shillong (Northeast Hill region)	3	201
Bhowali (Central Himalayan region)	2	58
Shimla (Northwest Himalayas and high altitude region)	-	-
Srinagar (Northwest Himalayas and high altitude region)	-	-
New Delhi (Northwest plains)	10	585
Ranchi (Sub-tropical humid region)	3	113
Akola (Central Indian region)	2	101
Hyderabad (Southeast coastal region)	17	1463
Total	**47**	**3,235**

Table 2: Details of crop diversity collected during 2011

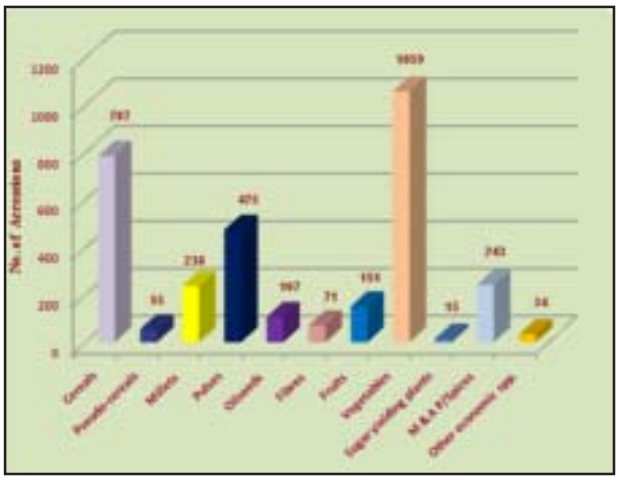
Crop group(s)	Crop(s)	Accs.
Cereals	*Coix lacryma-jobi* (13), *Hordeum vulgare* (14), *Oryza rufipogon* (18), *O. sativa* (524), *Triticum aestivum* (30), *T. durum* (21), *Zea mays* (167)	**787**
Pseudocereals	*Amaranthus cruentus* (3), *Chenopodium album* (4), *Fagopyrum esculentum* (23), *F. tataricum* (25)	**55**
Millets and minor millets	*Echinochloa frumentacea* (9), *Eleusine coracana* (61), *E. indica* (1), *Panicum miliaceum* (5), *P. sumatrense* (25), *Paspalum scrobiculatum* (2), *Pennisetum glaucum* (5), *Setaria italica* (34), *S. viridis* (2), *Sorghum bicolor* (94)	**238**
Pulses	*Cajanus cajan* (69), *Cicer arietinum* (23), *Glycine max* (3), *Lathyrus sativus* (1), *Macrotyloma uniflorum* (17), *Phaseolus lunatus* (9), *P. vulgaris* (85), *Vigna aconitifolia* (1), *V. angularis* (1), *V. dalzelliana* (2), *V. hainiana* (14), *V. mungo* (44), *V. radiata* (70), *V. radiata* var. *sublobata* (5), *V. stipulacea* (9), *V. trinervia* (1), *V. umbellata* (55), *V. unguiculata* (66)	**475**
Oilseeds	*Arachis hypogaea* (1), *Brassica juncea* (6), *Carthamus tinctorius* (2), *Guizotia abyssinica* (10), *Jatropha curcas* (2), *Linum usitatissimum* (3), *Perilla frutescens* (19), *Pongamia pinnata* (2), *Ricinus communis* (17), *Sesamum malabaricum* (1), *S. indicum* (44)	**107**
Fibres and allied species	*Cannabis sativa* (1), *Crotalaria verrucosa* (1), *C. juncea* (2), *C. micans* (5), *C. pallida* (5), *Gossypium arboreum* (18), *G. barbadense* (13), *Hibiscus cannabinus* (1), *H. sabdariffa* (25)	**71**

Fruits	*Aegle marmelos* (7), *Annona reticulata* (3), *Carissa carandas* (4), *Citrus aurantifolia* (1), *C. grandis* (3), *C. ichangensis* (2), *C. jambhiri* (15), *C. karna* (2), *C. latipes* (2), *C. limetta* (1), *C. limettioides* (2), *C. limon* (3), *C. limonia* (3), *C. medica* (14), *C. megaloxycarpa* (2), *C. nobilis* (2), *C. paradisi* (4), *C. pseudolimon* (1), *C. reshni* (2), *C. reticulata* (3), *C. sinensis* (5), *C. volkamerina* (1), *Cordia rothii* (1), *Diospyros melanoxylon* (4), *Emblica officinalis* (2), *Garcinia cambogia* (1), *G. cowa* (1), *G. indica* (1), *Garuga pinnata* (2), *Grewia asiatica* (1), *Manilkara hexandra* (14), *Musa acuminata* (1), *Passiflora incarnata* (1), *Phyllanthus acidus* (2), *Pithecellobium dulce* (3), *Poncirus trifoliata* (2), *P. trifoliata* x *Citrus sinensis* (1), *Prunus persica* (2), *Pyrus communis* (24), *Rubus ellipticus* (1), *Salvadora persica* (4), *Ziziphus mauritiana* (1)	**151**
Vegetables	*Abelmoschus crinitus* (4), *A. esculentus* (8), *A. ficulneus* (3), *A. manihot* (7), *A. manihot* ssp. *tetraphyllus* var. *pungens* (2), *A. moschatus* (1), *Abelmoschus* sp. (3), *A. tetraphyllus* (4), *A. tuberculatus* (3), *Allium cepa* (116), *A. cepa* var. *aggregatum* (1), *A. sativum* (9), *Amaranthus dubius* (2), *A. tricolor* (33), *A. viridis* (16), *Amorphophallus campanulatus* (1), *Amorphophallus* sp. (1), *Basella alba* (2), *Benincasa hispida* (33), *B. juncea* subsp. *rugosa* (1), *Canavalia ensiformis* (5), *Capsicum annuum* (74), *C. chinense* (1), *C. frutescens* (4), *Citrullus vulgaris* (2), *Coccinia indica* (2), *Colocasia esculenta* (4), *Cucumis melo* var. *conomon* (4), *C. sativus* var. *hardwickii* (9), *C. hystrix* (7), *C. melo* (8), *C. melo* var. *agrestis* (4), *C. melo* var. *momordica* (3), *C. pubescens* (1), *C. sativus* (56), *C. sativus* var. *sikkimensis* (1), *Cucurbita ficifolia* (1), *C. maxima* (5), *C. moschata* (51), *C. pepo* (8), *Cyclanthera pedata* (1), *Dioscorea alata* (4), *D. bulbifera* (1), *D. esculenta* (1), *Gymnopetalum chinense* (2), *Ipomoea batatas* (4), *Lablab purpureus* var. *lignosus* (32), *L. purpureus* var. *purpureus* (64), *Lagenaria siceraria* (27), *Luffa acutangula* (25), *L. acutangula* var. *amara* (1), *L. aegyptiaca* (29), *L. hermaphrodita* (9), *Lycopersicon esculentum* (2), *L. pimpinellifolium* (2), *Momordica charantia* (27), *M. charantia* var. *muricata* (12), *M. cochinchinensis* (3), *M. dioica* (34), *M. subangulata* subsp. *renigera* (67), *Moringa oleifera* (6), *Oxalis corniculata* (1), *Pisum sativum* (4), *Portulaca oleracea* (2), *Psophocarpus tetragonolobus* (3), *Rumex vesicarius* (11), *Sechium edule* (1), *Solanum erianthum* (1), *S. gilo* (5), *S. incanum* (4), *S. khasianum* (3), *S. lasiocarpum* (1), *S. melongena* (26), *S. virginianum* (4), *S. torvum* (1), *S. viarum* (3), *S. violaceum* (2), *Spinacia oleracea* (12), *Trichosanthes cucumerina* (2), *T. anguina* (12), *T. dioica* (5), *T. lepiniana* (7), *Trichosanthes* sp. (1), *T. tricuspidata* (22), *T. truncata* (1), *T. wallichiana* (14), *Trigonella foenum-graecum* (6), *Vicia faba* (6), *Xanthosoma sagittifolium* (1), *Zehneria angulata* (45)	**1059**
Sugar yielding plants	*Borassus flabellifer* (15)	**15**
Medicinal and aromatic plants, spices and condiments	*Abrus precatorius* (5), *Acorus calamus* (7), *Adenanthera pavonina* (1), *Aloe barbadensis* (1), *Alpinia galanga* (1), *Alpinia* sp. (2), *Andrographis paniculata* (14), *Argyreia nervosa* (1), *Aristolochia indica* (1), *Asparagus racemosus* (15), *Asphodelus tenuifolius* (1), *Bacopa monnieri* (2), *Balanites aegyptiaca* (1), *Barleria longiflora* (1), *Barleria* sp. (1), *Berberis darwinii* (2), *Boswellia serrata* (3), *Butea monosperma* (1), *Caesalpinia bonduc* (1), *C. crista* (1), *C. decapetala* (1), *Cassia angustifolia* (1), *Cassia fistula* (1), *C. tora* (2), *Cedrus deodara* (1), *Chlorophytum arundinaceum* (5), *C. borivilianum* (1), *Cissus quadrangularis* (1), *Clerodendron serratum* (1), *Clitoria ternatea* (6), *Coriandrum sativum* (9), *Costus speciosus* (2), *Cryptolepis reticulata* (1), *Cuminum cyminum* (1), *Curculigo orchioides* (2), *Curcuma amada* (1), *C. angustifolia* (1), *C. caesia* (1), *C. longa* (2), *C. zedoaria* (1), *Diplocyclos palmatus* (2), *Elaeocarpus ganitrus* (2), *Eryngium foetidum* (1), *Hedychium spicatum* (1), *Hedysarum alpinum* (1), *Helicteres isora* (2), *Hodgsonia heteroclita* (3), *Holarrhena antidysenterica* (1), *Ipomoea* sp. (1), *Jasminum sambac* (3), *Lawsonia inermis* (1), *Mallotus philippensis* (2), *Mimosa pudica* (1), *Mucuna nigricans* (1), *M. pruriens* (16), *Ocimum americanum* (10), *O. basilicum* (7), *O. gratissimum* (6), *Ocimum* sp. (1), *O. tenuiflorum* (12), *Onosma echioides* (1), *Pandanus* sp. (1), *Pimpinella anisum* (8), *Piper betle* (1), *Psoralea corylifolia* (1), *Rauvolfia serpentina* (3), *Salvia sclarea* (1), *Sapindus mukorossi* (1), *S. trifoliatus* (1), *Semecarpus anacardium* (1), *Smilax* sp. (1), *Sterculia* sp. (1), *Sterculia urens* (1), *Symplocos racemosa* (3), *Tagetes erecta* (2), *Tephrosia purpurea* (1), *Terminalia arjuna* (1), *Tinospora cordifolia* (9), *T. rumphii* (1), *Urginea indica* (5), *Vitex peduncularis* (1), *Withania somnifera* (1), *Zingiber cassumunar* (2), *Z. officinale* (4), *Z. zerumbet* (1), others (12)	**244**

Other economic species	*Abelia triflora* (1), *Alliaria petiolata* (1), *Acacia catechu* (1), *Bambusa* sp. (1), *Byttneria herbacea* (1), *Cassia auriculata* (1), *C. floribunda* (1), *C. hirsuta* (1), *C. obtusa* (2), *C. senna* (3), *Celosia cristata* (1), *Crossandra infundibuliformis* (3), *Lasia heterophylla* (1), *Leucaena leucocephala* (1), *Parkia timoriana* (1), *Pentapetes phoenicea* (2), *Sesbania aculeata* (2), *S. grandiflora* (1), *Soymida febrifuga* (2), *Tectona grandis* (2), *Teramnus labialis* (1), *Typhonium* sp. (1), *T. trilobatum* (1), *Voacanga globosa* (1)	**33**
	Total	**3,235**



Germplasm collected in cultivated and wild species



Germplasm collected in different crop groups

1.2 Explorations undertaken by Headquarters

Ten explorations were undertaken in parts of Arunachal Pradesh, Assam, Chhattisgarh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland and Odisha. A total of 585 accessions of different agri-horticultural crops were collected (Table 3). The details of areas explored and germplasm collected during explorations are given below:

Table 3: Explorations undertaken by the headquarters during 2011

Areas explored/ diversity collected	Collaborator(s)/ Facilitator(s)	Duration	No. of accessions		
			Cult.	Wild	Total
Minor fruits from parts of Gujarat	-	April 19 to 29	2	34	36
Stem borer tolerant maize from parts of Nagaland	DMR , New Delhi; ARI (ANGRAU) Centre; Hyderabad/ KVK, Jharnapani	October 11 to 22	71	5	76
Cucurbitaceous vegetables (cult. & wild) from parts of Arunachal Pradesh	IIVR, Varanasi; KVKs, Lower Dibang Valley, East Siang & Lohit	October 15 to 29	44	16	60
Fruit borer tolerant brinjal and chilli from parts of Meghalaya	IIVR, Varanasi; IARI, New Delhi; KVK, West Garo Hills	October 28 to November 9	73	11	84
Prevalent indigenous diversity in paddy and maize from parts of Manipur	KVK, Bishnupur	October 31 to November 7	46	-	46
Cucurbitaceous vegetables (cult. & wild) from parts of Meghalaya	IIVR, Varanasi; KVKs, Ri-Bhoi and West Khasi Hills	November 14 to 26	54	26	80

Pseudocereals and perilla from parts of Nagaland	KVKs, Kohima, Wokha, Mokokchung, Zunheboto, Tuensang	November 15 to 26	62	-	62
Citrus from parts of Assam and Nagaland	Citrus Res. Stn., Tinsukia, Assam; KVKs, Kohima, Wokha, Mokokchung	December 7 to 20	54	13	67
Exploration undertaken under externally funded projects					
Terminal heat tolerant wheat (under NICRA Project)	-	March 3 to 10	22	-	22
Abelmoschus, Cucumis and *Vigna* (under NAIP Project)	Shivaji University, Kolhapur, Maharashtra	December 12 to 22	4	48	52
Total			**432**	**153**	**585**

1.2.1 Minor fruit collection from parts of Gujarat and Maharashtra: Sub-tropical underutilized minor fruits (36) comprising *Aegle marmelos* (5), *Carissa carandas* (4), *Cordia rothii* (1), *Diospyros melanoxylon* (1), *Garuga pinnata* (2), *Manilkara hexandra* (14), *Pithecellobium dulce* (3), *Phyllanthus acidus* (2) and *Salvadora persica* (4) were collected from parts of Vadodara, Bharuch, Navsari, Surat, Tapi, Narmada, Panchmahal and Kheda districts of Gujarat and Nandurbar district of Maharashtra. Good variability was collected in khirni for fruit size, taste and TSS value.

Garuga *(Garuga pinnata)* - a potential minor fruit from Gujarat

Sale of minor fruits in local market of Gujarat

1.2.2 Maize germplasm collection from parts of Nagaland: A total of 76 accessions comprising of maize (58), paddy (8), Job's tears (3), *Trichosanthes lepiniana* (1), *T. wallichiana* (1), *T. tricuspidata* (3), foxtail millet (1) and *Hodgsonia heteroclita* (1) were collected from parts of Phek, Longleng, Tuensang, Mokokchung, Zunheboto, Wokha and Kohima districts of Nagaland in collaboration with Directorate of Maize Research, ARI (ANGRAU), Hyderabad and KVK, Jharnapani, Nagaland. In maize, remarkable variability was observed in kernel size in sweet corn type (small: 8-10 cm, medium: 15-20 cm and long: 20-25 cm), grain colour (white, red, orange, yellow, orange-yellow, maroon, violet, black), shank colour (white, pink, violet), kernel shape (short/ bold, thin/ long, conical), kernel type (flint, dent and semi-flint types), rows per cob (10-12), cob filled up to tip, number of cobs (1-2 cobs/ plant) and sticky and non-sticky types. Popcorn type is not grown on a large scale in Nagaland. The collected germplasm showed variability in cob size (short and bold), shape (thin cylindrical, conical), grain colour (red, orange, yellowish-white), shank colour (white and pink), number of cobs (2-3 cobs/ plant), kernel type and quality (flint, sticky/ non sticky).

Collection of maize with KVK officials in Nagaland

Variability in maize from Nagaland

1.2.3 Collection of cucurbitaceous vegetables from parts of Arunachal Pradesh: An exploration was undertaken for collection of diversity in cucurbits (60) from parts of East Siang, Lower Dibang Valley and Lohit districts in Arunachal Pradesh in collaboration with Indian Institute of Vegetable Research (IIVR), Seed Production Centre (SPC), Kushinagar, Uttar Pradesh. The taxa collected were *Abelmoschus manihot* var. *pungens* (1), *Benincasa hispida* (6), *Cucumis melo* var. *momordica* (3), *Cucumis sativus* (1), *Cucurbita moschata* (7), *Hodgsonia heteroclita* (1), *Luffa acutangula* (5), *L. aegyptiaca* (5), *L. hermaphrodita* (3), *Lagenaria siceraria* (4), *Momordica charantia* (3), *M. charantia* var. *muricata* (1), *M. subangulata* subsp. *renigera* (4), *Solanum lasiocarpum* (1), *Trichosanthes anguina* (2), *T. dioica* (4), *T. tricuspidata* (8) and *T. truncata* (1). Variability was observed in shape, size and colour in leaves and fruit in *Trichosanthes* spp. In *Momordica* spp. flower colour and fruit size were variable.

Big fruit size in ash gourd from Arunachal Pradesh

1.2.4 Germplasm collection of chilli and brinjal from parts of Meghalaya: Eighty-four accessions comprising of chilli (54), brinjal (19), *Solanum gilo* (5), *S. khasianum* (3), *S. incanum* (2) and *S. torvum* (1) were collected from parts of East, West and South Garo

***Momordica subangulata* subsp. *renigera*- a wild vegetable**

Hills districts of Meghalaya in collaboration with IIVR, Varanasi and Indian Agricultural Research Institute, New Delhi. Variability was observed for fruit size, colour and pungency in chilli and for fruit shape, size and colour in brinjal.

1.2.5 Collection of cucurbitaceous vegetables from parts of Meghalaya: A total of 88 accessions in 17 taxa of cucurbitaceous vegetables were collected from parts of Khasi and Jaintia Hills, Meghalaya covering the districts of Ri-Bhoi, East Khasi Hills, West Khasi Hills and Jaintia Hills in collaboration of IIVR, SPC, Kushinagar, Uttar Pradesh. Significant diversity was represented in *Benincasa hispida* (3), *Cucurbita ficifolia* (1), *C. maxima* (5), *C. moschata* (15), *C. pepo* (3), *Cucumis sativus* var. *hardwickii* (3), *C. sativus* var. *sikkimensis* (1), *C. sativus* (10), *Cyclanthera pedata* (1), *Gymnopetalum chinense* (2), *Lagenaria siceraria* (5), *Luffa aegyptiaca* (3), *Momordica charantia* (6), *M. subangulata* subsp. *renigera* (1), *Trichosanthes lepiniana* (4), *T. wallichiana* (10) and *T. tricuspidata* (7). Collected germplasm showed good variability with respect to fruit traits (shape, colour, prominence of ridges, weight). Variability was also observed for leaf shape and size and fruit shape, size and colour in *Trichosanthes* spp.

Variability in *Cucumis* spp. from Meghalaya

Variability in *Cucurbita* spp. under cultivation in Meghalaya

1.2.6 Paddy and maize germplasm collection from parts of Manipur: Forty-six accessions comprising of paddy (20), maize (17), cowpea (4), faba bean (3) and pea (2) were collected from parts of Bishnupur, Thoubal, Churachandpur, East Imphal, West Imphal, Senapati, Chandel districts of Manipur in collaboration with KVK, Bishnupur, Manipur. Variability in paddy for grain husk colour, grain colour, awned/ awnless types and aroma was observed.

Variability in paddy from Manipur

1.2.7 Collection of pseudocereals, rice bean and oilseed Perilla germplasm from parts of Nagaland: A total of 62 accessions of various crops comprising of *Coix lacryma-jobi* (10), rice bean (16), *Perilla frutescens* (16), winged bean (2), sesame (2), paddy (1), foxtail millet (1), french bean (11), ash gourd (1), sponge gourd (1) and cowpea (1) were collected from parts of Kohima, Wokha, Mokokchung, Zunheboto, Tuensang districts of Nagaland in collaboration with KVKs (located in Kohima, Wokha, Mokokchung, Zunheboto, Tuensang), Nagaland. Variability was recorded in seed colour and size of coix, rice bean and perilla.

Variability in rice bean from Nagaland

Variability *in Coix lacryma-jobi* from Nagaland

1.2.8 *Citrus* spp. collection from Nagaland: Sixty-seven diverse collections representing 20 species of *Citrus* were made from parts of Kohima, Wokha, Mokokchung districts in Nagaland and Tinsukia district in Assam in collaboration with Citrus Research Station, Tinsukia and Krishi Vigyan Kendras, Nagland. *C. medica* (locally known as *jora tenga*) occurring in natural wild populations was collected from Dibru-Saikhowa National Park. Sizable diversity of *C. jambhiri* and *C. medica* was collected from Nagaland. Rare and endangered wild species of citrus were also collected from Nagaland.

***Citrus jambhiri* with heavy bearing collected from Nagaland**

1.2.9 Explorations undertaken under NICRA project: A total of 22 accessions of wheat comprising of *Triticum durum* (21) and *T. aestivum* (1) were collected from parts of Dharwad, Gadag, Koppal, Bagalkot, Bijapur and Yadgir districts, Karnataka for terminal heat tolerance testing.

1.2.10 Explorations undertaken under NAIP: An exploration was undertaken for collection of wild relatives from parts of Cuttack, Sambalpur, Berhampur, Rayagada, Ganjam, Kalahandi and Koraput districts of Odisha; Mandla, Raipur districts of Chhattisgarh; and Jabalpur, Damoh, Sagar, Katni, Pachmarhi, Hoshangabad and Raisen districts of Madhya Pradesh in collaboration with Shivaji University, Kolhapur, Maharashtra. Fifty-two accessions comprising of *Abelmoschus crinitus* (2), *A. ficulneus* (1), *A. moschatus* (1), *A. manihot* subsp. *tetraphyllus* (4), *A. tuberculatus* (3), *Cucumis sativus* var. *hardwickii* (5), *C. melo* var. *agrestis* (4), *Vigna dalzelliana* (2), *V. hainiana* (14), *V. mungo* (1), *V. radiata* var. *sublobata* (5), *V. stipulacea* (9) and *V. trinervia* (1) were collected.

1.3 National Herbarium of Cultivated Plants (NHCP)

A total of 283 herbarium specimens, 26 seed samples and 19 economic products were processed and added to the NHCP; the total collection amounts to 20,703 herbarium specimens, representative of 3,908 species, 1,451 genera and 264 families, and 2,934 seed samples and 604 economic products. During the period 32 taxa, not earlier represented, were added to the NHCP (Table 4).

Herbarium specimens/ samples (123) were added through explorations (7) from Arunachal Pradesh, Gujarat, Manipur, Odisha, Uttar Pradesh (UP) and Western Ghats (Karnataka, Goa Maharashtra). Material received from Regional Stations included specimens of *Vigna, Crotalaria* and *Canavalia* from Hyderabad (40), *Ocimum* spp. (31) from Bhowali and *Mucuna monosperma* from Cuttack. Specimens collected and added to NHCP (88) included *Artocarpus hirsutus* from Kerala, and along with seeds procured from Thrissur station, from the Botanical Garden of Indian Republic, Noida, Uttar Pradesh and vouchers from experimental fields of *Vigna aconitifolia*, *Allium*, *Cucumis* and *Luffa*.

Identification services of specimens/ samples (75) were provided and authentication certificates (67) were issued to students and researchers. Three groups of students (54) were given technical know-how on herbarium preparation and processing.

Table 4: Some important taxa added to NHCP

Plant name (Family)	HS no.	Locality	Parts used
Enydra fluctuans Lour. (Asteraceae)	20588	Simlipal, Odisha	Domesticated as leafy vegetable by local tribals
Diospyros ferrea (Willd.) Bakh. (Ebenaceae)	20606	Cuttack, Odisha	Fruit edible; grown as ornamental
Maranta arundinacea L. (Marantaceae)	20617	Cuttack, Odisha	Cultivated for edible rhizomes; source of arrowroot starch
Cananga odorata (Lam.) Hk. f. & Thoms. (Annonaceae)	20628	Punjabi Bagh, New Delhi	Source of essential oil, used in perfumery
Luffa tuberosa Roxb. (Cucurbitaceae)	20630	Virudhunagar, Tamil Nadu	Fruits as minor vegetable and medicine
Artemisia capillaris Thunb. (Asteraceae)	20615	Cuttack, Odisha	Medicinal and aromatic value
Hodgsonia heteroclita Hook. f.	20701	Lohit, Arunachal Pradesh; South Senapati, Manipur	Fruits Thoms. (Cucurbitaceae) edible; seeds yield edible oil
Zanthoxylum rhetsa (Roxb.) DC (Rutaceae)	20674	East Siang, Arunachal Pradesh	Fruits medicinal; leaves used as condiment
Pueraria montana (Lour.) Merr. var. *thomsonii* (Benth.) M.R. Almeida (Fabaceae)	20676	East Siang, Arunachal Pradesh	Forage and as soil binder
Piper peepuloides Roxb. (Piperaceae)	20706	East Siang, Arunachal Pradesh	Semi-domesticated leafy vegetable

Dipterocarpus turbinatus Gaertn. f. (Dipterocarpaceae)	20686	East Siang, Arunachal Pradesh	Source of oleoresin and medicinal use; promoted locally for timber value
Pauldopia ghorta (Buch.-Ham.) Steenis (Bignoniaceae)	20695	Lohit, Arunachal Pradesh	Cultivated for medicinal use
Garcinia pedunculata Roxb. (Clusiaceae)	20702	Lohit, Arunachal Pradesh	Fruits eaten raw or cooked
Cajanus crassus (Prain ex King) Maesen* (Fabaceae)	20475	Experimental field, NBPGR, New Delhi	Pigeonpea relative
Ziziphus spina-christi Willd. (Rhamnaceae)	20478	Field Genebank, Central Institute of Arid Horticulture, Bikaner, Rajasthan	Introduced for edible fruits
Artocarpus hirsutus Lam.* (Moraceae)	20480	Thrissur, Kerala	Minor fruit crop; wood best substitute for teak wood
Plectranthus amboinicus (Lour.) Spreng.* (Lamiaceae)	20536	Botanical Garden of Indian Republic, Greater Noida, UP	Leaves and flowers for medicinal and aromatic use
Gmelina asiatica L.* (Verbenaceae)	20560	Qutab Heritage site, Mehrauli, New Delhi	Fruits and roots for medicinal use

* Vouchers for experimental cultures

1.4 Biosystematic Studies

***Allium* spp.:** Studies continued in cultivated and wild taxa of *Allium* namely, *A. cepa* var. *cepa*, *A cepa* var. *aggregatum*, *A. chinense*, *A. ascalonicum*, *A. ampeloprasum* (Eastern and Western Himalaya), *A roylei*, *A. clarkei* (Western Himalaya) and *A. cepa* var. *aggregatum* (southern region) using live material and observations on various identified characters were recorded. Variants of *A. chinense* from Nagaland and Arunachal Pradesh showed differences in bulbs size (smaller, narrow, and bold), shape, colour of membrane (pale yellow/ white), leaves size and thickness, flowers, aroma, etc. Germplasm of locally cultivated *Allium* species called *doona* (identified as *Allium cepa* var. *aggregatum*) from Uttarakhand and North-eastern region showed variation in morphology of bulb shape, size, colour of the membrane and odour.

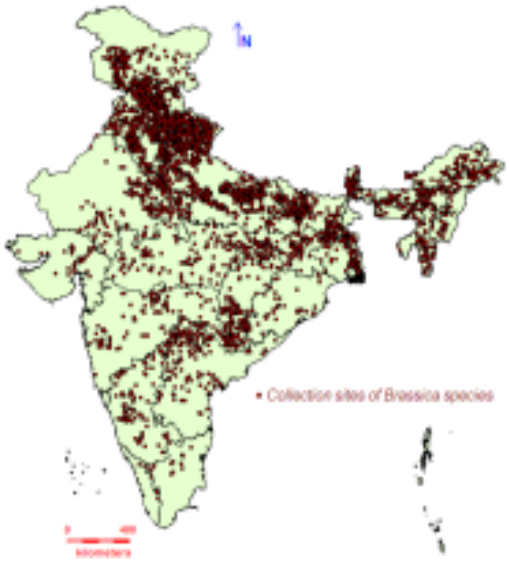
***Trichosanthes* spp.**: Thirtysix samples representing six taxa, *viz*., *Trichosanthes anguina, T. dioica, T. tricuspidata, T. lepiniana, T. wallichiana* and *T. truncata* were collected from Arunachal Pradesh and Meghalaya, the last species being collected first time. Twenty diverse shortlisted accessions of *T. cucumerina* complex (based on previous year's study) were studied for 13 key characters and significant variants were identified. Twentyfour samples of *T. cucumerina* complex, collected from Odisha during last year, were studied at NBPGR Base Centre Cuttack. Few intermediary forms between *T. cucumerina* and *T. anguina* were evident in these collections. Detailed observations on seedling and morphological parameters were recorded for 32 samples of *T. tricuspidata/ bracteata* (20), *T. dioica* (6), *T. lepiniana* (4) and *T. anaimalaiensis* (2). One hundred herbarium specimens/ seed material of 80 accessions belonging to *T. tricuspidata* complex (*anaimalaiensis*, *bracteata*, *lepiniana*, *tricuspidata*, *wallichiana*) were studied. Seven different forms/ morphotypes of *T. tricuspidata/ bracteata* adapted to different habitats/ locations in the country were identified.

1.5 Documentation of Diversity Collected in different Agri-horticultural Crops of India

Mapping of diversity (5,000 acc.) of cultivated and wild species of *Brassica* collected through crop-specific and multi-crop explorations from different regions of India during last three decades was done. Rich diversity was assembled from north, north-western parts and eastern regions. Priority areas were identified for collection of germplasm, *viz*., tribal belts of Bihar, Chhattisgarh and Madhya Pradesh; Western Himalaya and parts of Andhra Pradesh for *B. nigra*; Uttarakhand adjoining Nepal and North-eastern Hill region for leafy mustard (*B. juncea* var. *rugosa*); and drier parts of J & K, Haryana, Punjab and Rajasthan for *B. tournefortii*.

1.6 Documentation of Information on Local Uses

During explorations information related to local use of plant genetic resources was recorded from parts of North Eastern Hill region (NEH).



Collection sites of *Brassica* spp.

- *Rhus semialata* (Vern. Athum/ Tumgo): Tender leaves and fruits are edible. Dried fruit powder is used in vegetable curry as a substitute for tomato. Fruit is traditionally used to cure diarrhea, dysentery, headache, fever, indigestion, stomach ache, vomiting and food poisoning. Most of the people of Nagaland use fruit powder for various purposes.

- *Neptunia oleracea* (Vern. Ikatabee): The green stem of this aquatic plant is used as vegetable. Fresh leaves are cooked as vegetable and soup is taken with rice in Nagaland.

- *Eryngium foetidum* (Vern. Dhunia): Leaves are aromatic like coriander leaf and used for making chutney or as garnish and making curry in NEH region.

- *Hodgsonia heteroclita* (Vern. Thithi): In most parts of NEH region, roasted seeds/ endosperm is mixed with food items and given to the women after delivery and for children as energy food. Seeds are consumed after boiling with other vegetables.

Research Programme (Programme Code: Title, Leader)

PGR/PGC-BUR-01.00: Exploration for collection of germplasm of agri-horticultural crops, maintenance of herbarium and biosystematic and ethno-botanical studies (**DC Bhandari**)

Research Projects (Project Code: Title, PI, Co-PIs and Associates)

PGR/PGC-BUR-01.01: Exploration for collection of genetic resources of agricultural crops and their wild relatives (**DC Bhandari,** KC Bhatt, Anjula Pandey, DP Semwal and NS Panwar)

PGR/PGC-BUR-01.02: Exploration for collection of genetic resources of horticultural crops and their wild relatives (**Rakesh Srivastava,** SK Malik, E Roshini Nayar and Rakesh Singh)

PGR/PGC-BUR-01.03: Exploration for collection of medicinal and aromatic plants diversity from different phyto-geographical regions (**KC Bhatt,** RC Misra, DP Semwal, CS Raghav, Rakesh Singh and NS Panwar).

PGR/PGC-BUR-01.04: National Herbarium of Cultivated Plants (NHCP), establishment, maintenance, build-up and taxonomic studies on crop plants (**E Roshini Nayar,** Anjula Pandey, K Pradheep and Rita Gupta)

PGR/PGC-BUR-01.05: Genetic resources and systematic studies of Alliaceae in India: *Allium* (**Anjula Pandey,** KS Negi, K Pradheep and Rita Gupta)

PGR/PGC-BUR-01.06: Genetic resources and systematic studies of Cucurbitaceae in India: *Trichosanthes* (**K Pradheep**, KC Bhatt, DR Pani and Rakesh Singh)

Externally funded projects

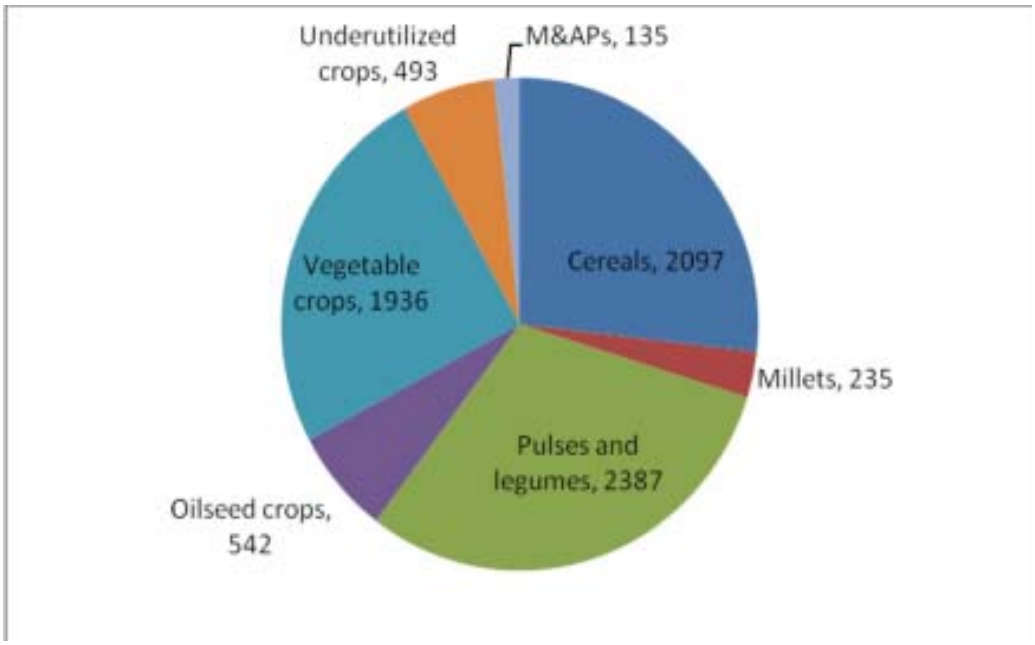
- New Millennium Indian Technology Leadership Initiative (NMITLI) Project on Genetic improvement of *Jatropha curcas* for adaptability and oil yield (Code: 014-CSIR-PECD-KCB-05)
- Digitisation of National Herbarium of Cultivated Plants (Code: 076-DST-PECD-ERN-011)

2. GERMPLASM EVALUATION

Summary: During the year, a total of 7,825 accessions of various agri-horticultural crops comprising cereals (2,097), millets (235), pulses (2,387), oilseeds (542), vegetables (1,936), underutilized crops (493) and medicinal and aromatic plants (135) were grown for characterization, evaluation, regeneration, multiplication and species identification. In addition, 4,503 accessions of international nurseries comprising of wheat, barley and *Triticale* were also evaluated under Post Entry Quarantine Nursery (PEQN). A total of 2,376 accessions of various crops namely, pearl millet (223), rapeseed-mustard (713), black gram (344), chickpea (90), lentil (30), okra (192), tomato (582), brinjal (200) were also screened for important biotic stresses (insects/ pests and diseases). Under abiotic stresses, 224 accessions of wheat were evaluated for terminal heat tolerance. Under biochemical evaluation a total of 945 accessions of different crops were analyzed for oil content and fatty acid profile, protein, sugar, minerals etc. Under phyto-chemical evaluation 465 samples of different medicinal and aromatic plants were analyzed for their active compounds. Under multi-location evaluation (MLE), wheat (1,100), rice (1,000), maize (200), mustard (240), brinjal (200), okra, (200), chickpea (320), pigeonpea (340), lentil (300) and *Tinospora* (14), were multiplied and evaluated for agronomic traits, biotic and abiotic stresses and quality parameters in collaboration with NAGS, AICRPs and SAUs. Five Germplasm Field Days on *Rabi* oilseeds, *Rabi* pulses, wheat, barley and *Triticale*, maize and okra were organized to promote germplasm utilization by the plant breeders/ research workers. A Farm Innovators' Meet was organized in which innovative farmers were honoured for their contribution in PGR conservation. A total of 3,694 accessions, including PEQN entries were supplied to 70 indenters belonging to different ICAR institutes, SAUs and other national organizations to facilitate their use in crop improvement programmes. Four Germplasm Advisory Committee meetings of various crop groups were organized under the expert guidance of crop specialists.

2.1 Germplasm Evaluation

2.1.1 Characterization and preliminary evaluation for agro-morphological traits: A total of 5,888 accessions of various agri-horticultural crops comprising cereals (1,504): wheat (1,219) and maize (285); millets (235): pearl millet (235); pulses (2,123): black gram (483), lentil (1,096) and cowpea (544); oilseeds (112): crambe (112); vegetables (1,286): okra (270), brinjal (380), cucumber (50) and tomato (586); underutilized crops (493): fababean (393) and grain amaranth (100); and medicinal and aromatic plants (135): calmegh (42), holy basil (43) and sweet basil (50) were characterized and evaluated for major agro-morphological traits. In addition, 1,937 accessions of various crops were also grown for regeneration, multiplication and species identification. A total of 323 accessions of medicinal and aromatic plants (M&APs) comprising vetiver (131), palmarosa (55), giloe (25), aloe (50), asparagus (22) and



Accessions characterized and evaluated in various crop groups

other M&APs (40) were also maintained in the field gene bank.

In addition, 4,503 germplasm lines/ breeding entries were grown in the Post Entry Quarantine Nursery (PEQN) for screening against major diseases and pests, seed multiplication, on the spot assessment and seed supply to indenters. A brief detail of various activities undertaken along with the number of accessions included has been given in Table 1.

Table 1: Status of characterization, evaluation, multiplication/ regeneration and species identification (2011) .

Crop group	Species identification	Regeneration and multiplication	Characterization and evaluation	Total
Cereals	-	593	1504	2097
Millets	-	-	235	235
Pulses and legumes	-	264	2123	2387
Oilseed crops	277	153	112	542
Vegetable crops	-	650	1286	1936
Underutilized crops	-	-	493	493
M & APs	-	-	135	135
Total	**277**	**1660**	**5888**	**7825**

Based on characterization and preliminary evaluation, promising accessions for various agro-morphological traits have been identified in different crops. The details of important traits and promising accessions have been presented in table 2

Table 2: Promising accessions in different crops for various important traits

Crop	Traits	Promising accession
Cereals		
Wheat	Tall plant height (>145 cm)	EC660859, EC660603, EC660815
	Dwarf plant height (<55 cm)	EC634378, EC634422, EC634392
	Early maturity (<125 days)	EC660874, EC636208, EC660703
	Flag leaf length (>43 cm)	EC660679, EC660793, EC661248, EC661264
	Spike length (>16 cm)	EC664482, EC660767, EC661270, EC661251
	Grains per spike (>80)	EC613065, EC635588, EC663997, EC613049
Maize	Days to tasseling (<55)	IC309233, IC396852, IC637995, EC639471
	Early maturity (<80 days)	IC075040, IC075043, IC075048, IC075049
	Late maturity (>100 days)	IC396842, IC396843, IC396845
Pearl millet	Early flowering (<40 days)	IC343696, IC343692
	Early maturity (<70 days)	IC343696, IC343692
	100seed weight (>1.5 g)	IC330574
	Spike length (>50 cm)	IC309921, IP3517
	Spike girth (>3 cm)	IC343739
Pulses and legumes		
Lentil	Early flowering (<68 days)	IC559809, IC334282, IC311161
	Pods/ plant (>80)	IC267669, IC361419, IC345628
	Biomass (>60)	IC559744, IC559767, IC559769
	Branches per plant (>4)	IC559870, IC123501, IC559777
Black gram	Primary branches (>7)	IC250208, IC485568, IC485573
	Clusters per plant (>34)	IC485473, IC485474, IC485553
	Pods per plant (>60)	IC530635, IC106194, IC485474
	Seeds per pod (>7)	IC140822, IC530632, IC140825
Oilseed crops		
Toria	Dwarf habit (<80 cm)	IC341459
	Early flowering (29 days)	IC398556
	Siliqua length (>5 cm)	IC342989, IC343127
Yellow sarson	Dwarf habit (<100 cm)	IC212116

	Siliqua length (>5 cm)	IC241678
Mustard	Dwarf habit (<90 cm)	IC579321
	Early flowering (<40 days)	IC331819, IC361511, IC398659
	Non-waxy plant type	IC491214
	Bold seeded (7.5 g/ 1000seed wt.)	IC264133
	Siliqua length (>5 cm)	IC264133
Gobhi sarson	Early flowering (<50 days)	IC399682, IC399684
Black mustard	Dwarf habit (<165 cm)	IC572790
	Siliqua length (>1.5 cm)	IC412899
	Oil content (>30%)	IC570282
Vegetable crops		
Tomato	Flower clusters per plant (>45)	EC608408, EC638518, EC654725
	Flowers per cluster (>9.5)	EC654720, EC000232, EC677097
	Fruit weight (>80 g)	EC608381, EC677068, EC677079
	Pericarp thickness (mm) (>7)	EC608307, EC654683, EC654722
	Total soluble solid (>6%)	EC686534, EC569995, EC608358
	Number of fruits/ plant (>100)	EC686542, EC686540, EC686545
	Fruit wt. per plant (>2.0 kg)	EC608439, EC654714, EC608320
	Per cent infestation per plant (number basis) (<2.0)	EC686543, EC686545, EC686544
	Per cent infestation per plant (weight basis) (<4.0)	EC686543, EC686545, EC686544
Cucumber	Node at which first female flower appears (<7)	IC527397, IC527403, IC527426
	Fruit length (>15 cm)	IC527403, IC410658, IC538155
	Fruit weight (>300 g)	IC538155, IC410658, IC527426
	Fruit storage life (>5 days)	IC527420, IC527397, IC527427
Fenugreek	Primary branches per plant (>4.5)	UM265, UM273, UM274, UM277, AM276, AM271, IC144247, IC5487, IC143867, IC143889
	Pods per plant (>140)	UM256, IC148882, IC143816, UM258, AM194, AM271, IC5487, IC143878, UM274, AM291, AM1, IC144245
	Seeds per pod (>18)	UM274, AM316, IC143821, AM194, AM288, UM258
	Oil content (>6.5%)	IC57192, IC143841, UM284, AM3, UM261, UM-260, UM277, IC143893
	1000seed weight (>15 g)	AM194, UM267, IC143907, IC143821, AM190, IC144247, UM271, AM277, AM193, IC005487
Underutilized crops		
Faba bean	Plant height (>140 cm)	IC329692, EC117842
	Pods per plant (>60)	EC628949, EC591733, ET129650, ET122805
	Seeds per pod (>7)	EC628949
	100 seed weight (>125 g)	EC628939, EC591765, ET003121
	Early maturity (<135 days)	EC628964, EC628965, EC628966
Grain amaranth	Days to 50% flowering (< 80)	SKGPA15, SKGPA17, SKGPA47
	Plant height (>140.00 cm)	SKGPA41, SKGPA44, SKGPA22
	Inflorescence length (>75.00 cm)	SKGPA22, SKGPA44, SKGPA6
	Seed weight per 10 ml (>7.0 g)	SKGPA10, SKGPA22, SKGPA41, SKGPA8, BGA27
Medicinal and aromatic plants		
Kalmegh	Primary branches/ plant (>25)	IC399612, IC471895
	Secondary branches/ plant (>15)	IC342139, IC415019
	Plant height (>40 cm)	IC111287, IC342138
	Leaf length (>4 cm)	IC210635, IC471891
	Leaf width (>1.5 cm)	IC111288, IC111290
Holy Basil	Plant height (>50 cm)	IC583299, IC583313
	Primary branches/ plant (>20)	IC583299, IC583307
	Leaf length (>5 cm)	IC583299, IC583307

	Leaf width (>2 cm)	IC583306, IC583310
	Herbage yield (>400 g)	IC583293, IC583302
Sweet Basil	Plant height (>100)	EC388893, IC328582
	Primary branches per plant (>20)	IC326732, IC328582
	Leaf length (>6 cm)	IC75730, EC338785
	Leaf width (>3 cm)	IC326732, EC388893
	Herbage yield (>800 g)	EC112548, IC378846

Variability in pearl millet ear head and cucumber fruits

2.1.2 Evaluation for biotic and abiotic stresses: In biotic stresses, the germplasm of agri-horticultural crops were screened for the major diseases and insects pests. Under abiotic stress, wheat accessions were screened for terminal heat tolerance. The details of progress under various heads are given below:

2.1.2.1 Screening of germplasm of various crops for resistance against biotic stresses

2.1.2.1.1 Evaluation of okra germplasm for resistance to yellow vein mosaic disease and leaf hopper: A total of 192 germplasm accessions of okra with 8 checks were screened for resistance to yellow vein mosaic disease (YVMD) and leaf hoppers. Incidence of YVMD was observed to vary from 11.3-100% and infestation of leafhopper ranged from 8.33 to 89.47%. The disease reaction in the accessions was assessed based on co-efficient of infection (CI) which is the product of per cent disease incidence and the corresponding response value based on percent disease severity. Altogether 14 accessions showed resistant reaction, of which only 5 accessions were resistant (CI range from 4.41 – 8.82) and nine accessions were found moderately resistant (CI 10.0 – 16.7) (Table 3). Seventeen accessions were found promising to leaf hopper infestation as the infestation was less than 20%. The superior accessions are presented in Table 5.

Table 3: Reaction of okra germplasm against yellow vein mosaic disease

Disease Reaction	Accs	PDI range	PDS range	CI range	AUDPC
Resistant (R)	5	11.76-33.33	22.22-46.84	4.41-8.82	250-529.41
Moderately Resistant (MR)	9	20-33.33	25.86-65.88	10-16.67	450-1350
Moderately Susceptible (MS)	16	31.57-47.06	57.14-100	29.34-38.88	937.5-1714.29
Susceptible (S)	130	40-70.59	63.09-100	39-68.75	825-2625
Highly Susceptible (HS)	38	70-100	59.03-100	70-100	1446.42-3428.57

PDI= Per cent disease incidence; PDS= Per cent disease severity; CI= Coefficient of infection; AUDPC= Area under disease progress curve

2.1.2.1.2 Advanced screening of promising okra germplasm for resistance to YVMD: Twentytwo accessions of okra with less than 40% disease incidence (chosen from 320 accessions sown for preliminary screening during *kharif* 2010) were selected for further screening against YVMD and whitefly, *Bemisia tabaci* (Gennadius), (Hemiptera: Aleyrodidae) in replicated trial during *kharif* 2011. The disease reaction was assessed on the basis of co-efficient of infection (CI) and area under disease progress curve (AUDPC). CI ranged from 6.0 (IC117222) to 85.9 (IC118151). AUDPC value of the resistant (472.0 to 742.9) and moderately resistant accessions (712.8 – 862.7) were observed to be lower than those of susceptible accessions (1052.5 – 2809.0) indicating lesser rate of spread of the disease in resistant and moderately resistant accessions. The superior accessions were given in Table 5. The infestation of whitefly ranged from 3.7 to 9.9 mean number of whiteflies/ 5 leaves. Two accessions IC117265 and IC282284 were found superior as the infestation level was less than 4 mean number of whiteflies/ 5 leaves.

2.1.2.1.3 Evaluation of *Brassica* germplasm against aphid: Seven hundred and thirteen (713) accessions belonging to 10 species of *Brassica* including tolerant and susceptible checks were screened for tolerance against mustard aphid during *rabi* 2010-11. Different species of *Brassica* differed in their susceptibility/ tolerance to aphid infestation. Even within a species, the differential reaction of germplasm accessions ranged from highly susceptible to highly tolerant. The aphid population in different *Brassica* species ranged from 0 in close relatives to 245.33 mean no. of aphids/ top 10 cm inflorescence in *B. rapa* var. toria. The descending order of aphid tolerance in different *Brassica* species was *L. sativum, Diplotaxis* and *S. alba* > *B. oleracea* > *B. juncea* var. *rugosa* > *B. rapa* var. *chinensis* > *B. nigra* > *B. napus* > *B. juncea* > *B. rapa* var. yellow sarson > *B. rapa* var. brown sarson > *B. toria*. Ninetyseven accessions of different *Brassica* species were found highly tolerant to aphid infestation. No aphid infestation was observed in all the six accessions of *L. sativum* a close relative of *Brassica*, and one accession each of *Diplotaxis* and *S. alba*. The superior accessions are given in Table 5.

2.1.2.1.4 Evaluation of brinjal germplasm for resistance to fruit and shoot borer: A total of 200 accessions of brinjal evaluated for resistance to FSB, during *rabi* 2010-11, the per cent infestation ranged from 3.33 to 100 by number basis and the per cent infestation on weight basis ranged from 2.38 to 100. Twentyseven accessions were found promising recording <15% infestation both by number and weight basis. The superior accessions are given in Table 5.

2.1.2.1.5 Advanced screening of promising accessions of brinjal for fruit and shoot borer (FSB): Twentythree accessions comprising (ten susceptible, nine resistant and four checks selected based on the preliminary screening of four hundred accessions of previous year) were screened for resistance to fruit and shoot borer. The infestation of FSB ranged from 3.03 to 72% on number basis and from 3.39 to 66.19% on weight basis. Four accessions such as IC099723, IC280954, IC111013 and EC038474 were found resistant as the infestation level was less than 10% both by number and weight basis. Correlation studies with biochemical parameters revealed significant positive correlation between infestation and protein, sugars and moisture content, whereas, phenols, flavonol and starch showed significant negative correlation with fruit and shoot borer infestation.

2.1.2.1.6 Evaluation of pearlmillet germplasm against blast, downy mildew and rust diseases: Preliminary screening of 223 accessions of pearl millet against diseases such as blast, downy mildew and rust was done during *kharif* 2011. Blast disease appeared from early stages of crop growth and the accessions were screened following 0-9 scale. Overall disease reaction for blast was moderate (Location Severity Index, LSI=4). Fiftyone accessions were found tolerant to blast (Score 1). Downy mildew was observed in later stage of crop growth. A total of 119 accessions were free from downy mildew disease. Malformed inflorescence was observed in 114 accessions and number of malformed inflorescence varied from 1 to 4 per plant. Out of 114 infected accessions 15 were severely infected where 3-4 malformed inflorescence were observed. Rust disease appeared at later stages of crop growth and severity was observed at crop maturity. Screening was done following 1-5 scale. Overall disease reaction for rust was very severe (LSI=4.87). The superior accessions against blast, downy mildew and rust are given in Table 5.

2.1.2.1.7 Evaluation of tomato germplasm against fruit borer: A total of 582 accessions along with 4 checks were screened for resistance to fruit borer,

Helicoverpa armigera (Hubner) (Noctuidae: Lepidoptera) in ABD during *rabi* 2010-11, the infestation ranged from 1.57 to 67.54% on number basis and 3.17 to 77.19% on weight basis. A total of 105 accessions showed infestation less than 10% both by number and weight basis. The superior accessions are given in Table 5.

2.1.2.1.8 Evaluation of black gram germplasm against yellow mosaic disease: A total of 344 accessions of black gram were evaluated against yellow mosaic disease. The disease reaction was assessed based on Co-efficient of Infection (CI). Only 32 (9.3%) of total accessions showed resistant reaction (CI d" 10.0) of which two accessions had no symptoms, 11 accessions were highly resistant and 19 accessions resistant (Table 4). The superior accessions are given in Table 5.

2.1.2.1.9 Evaluation of chickpea for *Fusarium* wilt, *Ascochyta* blight and rootknot nematode: Seventy accessions of chickpea were screened against *Fusarium* wilt resistance using 1-9 rating scale under wilt sick plot consecutively for two years (*rabi* 2010-11 and 2011-12) at Division of Genetics, IARI, New Delhi. Out of these four accessions (IC552158, IC552274, IC553471, and IC552056) were recorded as resistant with the rating of one. The same set of germplasm was also evaluated for *Ascochyta* blight at CSKHPKV, Regional Station, Dhaulakuan. Six accessions were recorded as resistant and nine moderately resistant. Likewise, ninety accessions were also screened for rootknot nematode (*Meliodogyne incognita*) under pot culture but none of the accessions were found free from nematode infestation.

2.1.2.1.10 Evaluation of lentil for rust and root knot nematode: Thirty wild lentil accessions were screened for rust resistance using 1-9 scale at CSKHPKV Regional Station, Dhaulakuan. Five lines (ILWL30, ILWL62, ILWL15, ILWL81 and ILWL19) were found resistant. The same accessions were also screened for root knot nematode, *M. incognita* of which two accessions (ILWL18 and ILWL72) were recorded resistant.

2.1.2.1.11 Evaluation of germplasm for resistance to root-knot nematode, *Meloidogyne incognita*
A total of 692 accessions comprising of cowpea (100 acc.), lentil (300 acc.), chickpea (92 acc.) and black gram (200 acc.) were screened for their host status to rootknot nematode, *M. incognita* in pots filled with naturally infested soil (4 juveniles/ g soil). Based on the number of root galls induced by the nematode, 4 and 3 accessions of cowpea and lentil, respectively and 4 accessions each of chickpea and black gram were found promising against *M. incognita*. Similarly, brinjal (200 acc.) and okra (110 acc.) were screened against *M. incognita;* 7 of brinjal and 5 accessions of okra were found promising. The promising accessions are given in Table 5.

Roots of black gram germplasm showing moderately resistant (MR) and highly susceptible (HS) reactions to root-knot nematode, *M. incognita*

Table 4: Reaction of black gram germplasm against yellow mosaic disease

Disease reaction	Total acc.	PDI range	PDS range	CI range
No symptom	2	0	0	0
Highly resistant (HR)	11	3.9 - 20	6.2 - 88.1	1.0 - 5
Resistant (R)	19	6.5 - 40	11.5 - 100	5.2 - 10
Moderately resistant (MR)	38	11.1 - 53.8	17.1 - 100	10.7 - 20
Moderately susceptible (MS)	51	21.7 - 80	26.2 - 100	20.7 - 40
Susceptible (S)	63	40.9 - 100	27.9 - 100	40.9 - 70
Highly susceptible (HS)	157	72.7 - 100	50.1 - 100	71.6 - 100

Table 5: List of superior accessions of various crops against major biotic stresses

Crop (acc.)	Biotic stresses	Criteria	Some of the superior accessions
Preliminary screening			
Okra (200)	Yellow vein mosaic disease (YVMD)	CI from 4.41 – 8.82	IC039141-A, EC169319, IC042484-B, IC332232, EC550848, IC331021, IC039132-A, IC410138, IC433652, IC128089, EC305634, EC305616, EC329369, IC128894
	Leafhoppers	< 20% infestation	EC112274, IC117228, IC117343, EC169358, IC033854-A, EC169421, IC042484-B, EC329369, IC117350, IC128894, EC169366, EC169513, EC169319, EC169443-A, IC033854-B, EC169398, EC329360
	YVMD and leafhoppers		IC042484-B, EC329369, EC169319
Brinjal (200)	Fruit and shoot borer	<15% infestation	IC11379, IC216795, IC364617, IC261798, IC104096, IC190089, IC383090, EC316283, IC330971, IC279555, IC261843, IC394877, IC99723, IC354697, IC144145, IC099630, IC112723, IC111013, IC383195, IC90036, IC090092, IC112714, IC298634, IC112736, IC111056, IC354654, IC261814
Brinjal core set (181)	Fruit and shoot borer	<10% infestation	EC111092, EC304072, EC305048, EC316275, EC379244, IC089837-D, IC089890, IC089923, IC090068, IC090777, IC090785, IC090869, IC111019, IC112322, IC112342, IC112840, IC261793, IC298633, IC345740, IC354140, IC374888, IC374921, IC397299, IC410129, NIC23957, NIC23971, IC090093, IC112741, IC111439
Brassica (713)	Mustard aphid	<50 aphids/ 10 cm inflorescence	*Brassica juncea*: IC265462, IC275106, IC571665, IC571671, IC571691, IC571702, IC296507, IC296701, IC399671, IC399678, IC405234, IC491028, IC310807, IC330543, IC571639, IC538737, IC298024, IC491333, IC571627, IC571634 *Brassica rapa* var. toria*:* IC341114, IC560836, IC261567, IC261574, IC341456 *Brassica rapa* var. brown sarson: IC553126, IC265451, IC278235, IC392643, IC262825 *Brassica rapa* var. yellow sarson: IC280958, IC337380, IC338727, IC341465
Pearl millet (223)	Blast	Score ≤1	IC283677, IC283709, IC283836, IC283917, IC393365, IC306465, IC309055, IC309056, IC309064, IC309066, IC309070, IC310566, IC372561, IC382832, IC335901, IC347565, IC309921, IP13538, IP13539, IP13547, IP12520, IP13500, IP13502, IP13503, IP13512, IP13513, IP13560, IP13565, IP15529, IP257986, IP275069
	Downy mildew	Free from disease	IC283677, IC283709, IC283724, IC283836, IC283866, IC283885, IC283916, IC382832, IC393364, IC393368, IC309056, IC309066, IC310566, IC283745, IC306463, IC306466, IC332700, IC332726, IC343650, IC370481, IC382938, IC420098, IC347565, IP13525, IP13554, IP13542, IP12520M, IP13501, IP15528
	Rust	Score ≤1	IC306466, IC309056

	Blast and downy mildew		IC283677, IC283709, IC283836, IC283866, IC283885, IC309066, IC382832, IP13554, IP15528
	Blast, downy mildew, and rust		IC306466, IC309056
Tomato (582)	Fruit borer	<10% infestation	EC686548, EC638513, EC608356, EC596747, EC675832, EC686554, EC686541, EC677098
Black gram (344)	Yellow mosaic disease	CI (1.0- 5.0)	IC519933, IC1572 (symptomless, CI 0), IC1545, IC20818, IC144901, IC485553, IC485558, IC485665, IC11613, IC007849, IC007544, IC48551, IC250184 (CI 1-5.2) HPU-180, IC20775, IC485556, IC485550, IC250189, IC251961, IC519934, IC530450, IPU99-40-1(Sel.1), IC485638, JB-233-1, IC530474, IC485578, IC485663, IC250262, IC485552, IC530446, IC485579, NG-1119 (CI 5.2 – 10.0)
Advanced screening			
Okra (22)	YVMD	CI < 8.9 are	IC117222, IC118149, IC117088, IC117227
	Whitefly	<4 whiteflies/ 5 leaves	IC117265, IC282284
Brinjal (23)	Fruit and shoot borer	<10%	IC099723, IC280954, IC111013, EC038474
Brassica juncea (30)	Mustard aphid	<50 aphids/ 10 cm inflorescence	IC326353, IC491260, IC491473, IC491416, IC491534, IC491557, IC491414
Screening in pot culture			
Cowpea (100)	Root knot nematode	<10 galls/ root system	IC202803, IC249241, IC253279, IC202780
Lentil (300)	Root knot nematode	<10 galls/ root system	IC266800, IC398691, IC520809
Chickpea (92)	Root knot nematode	<10 galls/ root system	EC720446, EC720465, EC720479, EC720502
Black gram (200)	Root knot nematode	<10 galls/ root system	IC008862, IC251913, IC506655, IC485566
Brinjal (200)	Root knot nematode	<10 galls/ root system	IC090158, IC9090970, IC111003, IC111026, IC126721, IC146654
Okra (110)	Root knot nematode	<10 galls/ root system	IC117074, IC039140, IC022232, IC090184, EC550848

2.1.2.1.3 Detection, characterization and documentation of viruses infecting germplasm of various crops

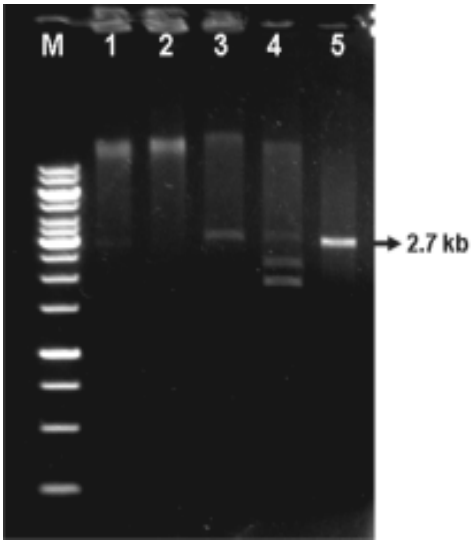
2.1.2.1.3.1 A new isolate of Mung bean yellow mosaic virus from New Delhi in black gram germplasm: *Mungbean yellow mosaic India virus* (MYMIV) is more predominant in northern, central and eastern regions of India whereas, *Mungbean yellow mosaic virus* (MYMV), in southern and western regions. PCR was carried out in DNA of black gram germplasm showing yellow mosaic symptoms using a pair of MYMIV specific primers as this virus was reported earlier to present in New Delhi region. Only 3 out of 10 symptomatic samples analyzed gave positive amplification with these primers indicating presence of MYMIV in those samples. For detection and characterization of virus(es) present in remaining 7 samples, rolling circle amplification (RCA) was performed and 2.7 kb full genomic length fragments generated by *Hind*III were purified and cloned. Two distinct clones (MF1 and MF2) with different restriction profiles were sequenced and deposited in GenBank (www.ncbi.nlm.nih.gov) under the accession number

JQ398669 (DNA A) and JQ398670 (DNA B) respectively. In phylogenetic analysis both these components appeared in a new phylogenetic clad. This virus, a new isolate of MYMV, is the first report of MYMV in black gram from northern India.

2.1.2.1.3.2 First report of occurrence of *Tomato leaf curl New Delhi virus* and *Cucumber green mottle mosaic virus* in ash gourd germplasm: A mild mosaic disease was noticed in 70 germplasm accessions of ash gourd grown during *kharif* 2010. Few accessions also showed yellow mosaic disease with severe stunting of plant. Electron microscopic study with the mild mosaic infected sample revealed presence of a *Tobamovirus* but no particle was seen in yellow mosaic sample. *Cucumber green mottle mosaic virus* (CGMMV), a member of *Tobamovirus* and *Tomato leaf curl New Delhi virus* (ToLCNDV), a member of *Begomovirus* are most important viruses infecting cucurbit crops. Specific primers for coat protein gene of CGMMV were used in RT-PCR for detection of this virus in the mild mosaic infected samples. An expected 500 bp amplicon resolved in agarose gel was cloned, sequenced and sequence was deposited in GenBank under the accession number JQ712998. Phylogenetic analysis showed that this virus clustered with bottle gourd isolate of CGMMV, hence it was considered as a strain of CGMMV.

For detection of *Begomovirus*, a rolling circle amplification (RCA) strategy was employed and 2.7 kb fragment generated by *Bam*HI and *Pst*I were cloned, sequenced and deposited in GenBank under the accession number JN208136 (DNA A) and JN208137 (DNA B). Phylogenetic analysis of DNA A of the virus revealed that this virus is grouped with other ToLCNDV infecting pumpkin in India. These are the first records of occurrence of ToLCNDV and CGMMV in ash gourd.

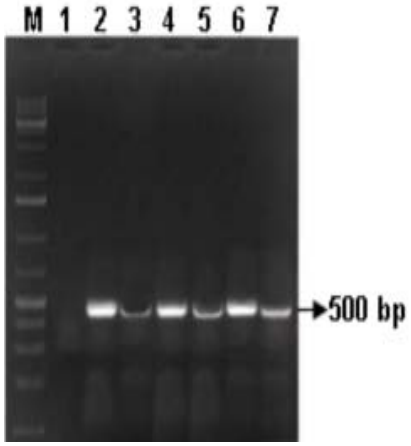
Yellow mosaic disease in black gram germplasm



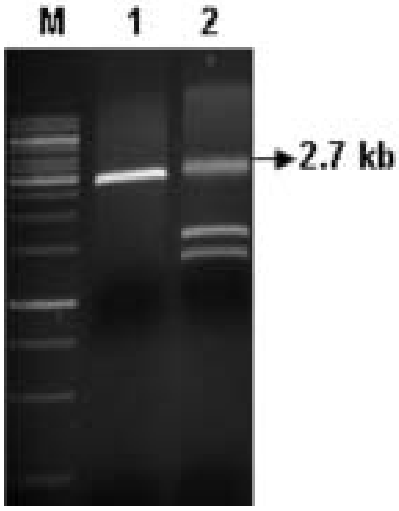
Detection of *Begomovirus* in black gram through RCA product digestion with Lane 1: *Bgl*I, Lane 2: *Eco*RI, Lane 3: *Xba*I, Lane 4: *Pst*I and Lane 5: *Hind*III

Mild mosaic symptom in ash gourd

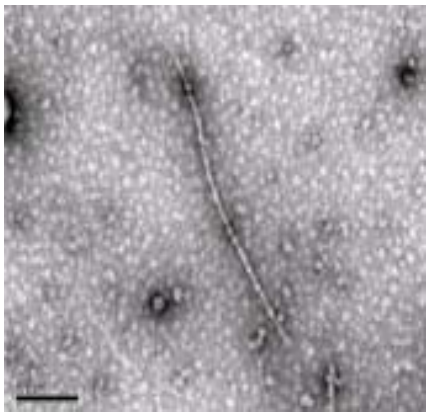
Yellow mosaic symptom in ash gourd



Detection of CGMMV in ash gourd showing mild mosaic symptom through amplification of coat protein gene



Detection of *Begomovirus* through RCA product digestion with *BamH*I (lane 1) and *Pst*I (lane 2)



Electron micrograph showing *Potyvirus* in infected lentil germplasm

2.1.2.1.3.3 Documentation of virus disease in lentil germplasm: A total of 757 germplasm accessions of lentil were evaluated against diseases during *rabi* 2010-11. No significant incidence of disease was observed, however, some accessions showed virus disease symptom such as chlorosis, red tip leaf, smalling of leaf, thickening of leaf and stunting of plants. Electron microscopy studies from the symptomatic samples revealed the presence of *Potyvirus* in them.

2.1.2.2 Evaluation for abiotic stress (terminal heat tolerance) in wheat: A total of 106 released wheat varieties were evaluated for terminal heat tolerance in ABD during *rabi* 2010-11 under normal and late sown conditions. The values of all morpho-physiological traits under late planting condition were lower as compared to those of normal planting due to temperature stress. The details of promising accessions for various traits are given in the Table 6.

Table 6: Promising accessions of wheat for different morpho-physiological traits

Condition	Trait	Promising accession
Normal sown	Physiological maturity (<130 days)	IC282300
	Chlorophyll content at milk stage (>55)	IC282300
	Membrane stability index (>72%)	IC075215
	Relative water content (>72%)	IC128155
	Biomass per plant (>36.9 g)	IC128235
	Seed yield per plant (g) (>13.2)	IC128167
	Seed protein (>15%)	IC122726
	Harvest index (50.28%)	IC128180
Late sown	Physiological maturity (<108 days)	IC296383
	Chlorophyll content at milk stage (>41)	IC574388
	Membrane stability index (>69.52%)	IC565811
	Relative water content (>68%)	IC128155
	Biomass per plant (>25.35 g)	IC075240
	Seed yield per plant (>10.30 g)	IC075240
	Seed protein (>15%)	IC290230
	Harvest index (50.99%)	IC075219

Besides, a total of 35 accessions from PEQN (4,672 acc.) and 23 accessions from 2,434 wheat germplasm were identified for terminal heat tolerance on the basis of erect plant type, stay green colour, long ear head, earliness, high biomass, bold ears and leaf rolling.

2.1.3 Biochemical evaluation

2.1.3.1 Oil content and fatty acid profiling in oilseeds

The quality of oilseeds is dependent on oil content and its fatty acid composition, 413 accessions of rapeseed-mustard consisting of *Brassica juncea* (183), *B. rapa* var. yellow sarson (100), *B. rapa* var. brown sarson (22), *B. rapa* var. *toria* (56), *B. napus* (14), *B. tournefortii* (15), *B. rapa* (9) and *B. nigra* (18) were analyzed for total oil content. The range, mean and value rich accessions for oil content in different species are given in Table 7.

Table 7: Variation in oil content in different *Brassica* species

Brassica spp. (Acc.)	Oil (%)		Value rich accessions
	Range	Mean	
B. juncea (183)	25.17-44.72	35.02	IC491640, IC521378, IC491488
B. rapa var. yellow sarson (100)	30.50-47.22	41.12	IC355305, IC355317
B. rapa var. brown sarson (22)	36.94-46.32	42.7	YSB-25A, BSC-14
B. rapa var. *toria* (56)	34.20-46.51	41.53	IC355401, IC417893, IC491555A
B. napus (14)	20.69-40.04	35.50	IC296747, EC389916-B
B. tournefortii (15)	26.73-31.7	29.3	IC560717
B. rapa (9)	33.94-41.17	38.24	IC363626, IC411659
B. nigra (18)	22.05-32.51	29.29	IC560706

A total of 59 accessions of rapeseed-mustard consisting of *B. nigra* (4), *B. chinensis* (20), *B. juncea* (17), *B. napus* (14) and *Lepidium sativum* (9) were further analyzed for fatty acid profile and the results are given in Table 8.

Table 8: Fatty acid profile in rapeseed-mustard

Crop Parameter	*B. nigra*	*L. sativum*	*B. chinensis*	***B. juncea spp. rugosa***	***B. napus***
Palmitic acid (%)	3.29-6.71	9.26-13.90	2.16-8.36	2.55-4.95	3.34-4.80
Stearic acid (%)	1.59-4.67	2.81-4.22	0.92-2.34	0.79-1.88	1.04-1.9
Oleic acid (%)	10.66-13.79	22.75-29.07	9.98-17.7	10.17-17.87	16.33-19.48
Linoleic acid (%)	21.44-26.06	10.16-13.3	12.80-19.07	12.74.21.32	12.97-15.85
Linolenic acid (%)	13.71-16.78	22.12-30.51	6.68-12.06	7.85-17.21	7.04-7.53
Ecosenoic acid (%)	5.54-7.84	12.66-14.26	2.91-9.54	1.53-7.53	8.20-9.73
Rurecic acid (%)	29.27-38.65	6.85-13.55	43.09-55.3	46.64-53.21	42.71-49.40

2.1.3.2 Quality analysis of walnut, amaranth and buckwheat germplasm: Twelve accessions of walnut, 52 accessions of amaranth and 50 accessions of buckwheat received from NBPGR, Regional Station, Shimla were analyzed for the oil content and fatty acid profile. The value rich accessions are given in Table 9.

Table 9: Oil content and fatty acid profile of walnut, amaranth and buckwheat germplasm

Crop	Trait	Range (%)	Mean (%)	Value rich accessions
Walnut	Oil content	54.43-68.61	63.62	IC020118, IC020067
	Palmitic acid	4.89-6.85	5.95	IC20065, EC038830
	Stearic acid	1.98-4.44	3.04	IC020067, IC316411
	Oleic acid	11.59-26.14	17.69	IC20068, IC20070
	Linoleic acid	52.59-65.52	59.34	IC20117, EC03880
	Linolenic acid	9.92-17.28	14.05	IC020067, IC20070
Amaranth	Oil content	7.87-10.055	9.15	IC38155, IC35433

	Palmitic acid	15.43-20.14	18.75	IC38108, IC38075
	Stearic acid	2.12-8.54	2.98	IC423448, IC35429
	Oleic acid	24.92-30.28	27.35	IC22550-1, IC38113
	Linoleic acid	44.22-52.14	49.01	IC274445, IC329151
	Linolenic acid	1.02-5.14	1.901	IC22553, IC382749
Buck wheat	Oil content	0.75-5.40	2.3	IC16552, EC323723
	Palmitic acid	13.18-18.47	16.06	EC38667, EC323723
	Stearic acid	1.91-6.31	3.46	IC26584, IC17370
	Oleic acid	35.28-47.53	35.28	IC16579, IC125397
	Linoleic acid	30.13-39.95	35.66	IC16552, IC109728

2.1.3.3 Quality analysis of cluster bean, chickpea and faba bean germplasm

Thirty accessions of cluster bean, 190 of chickpea and 180 of faba bean were evaluated for gum content, total protein and total phenol and sugar content respectively. The details of superior accessions are given in Table 10.

Table 10: Biochemical parameters of guar, chickpea and faba bean germplasm

Crop	Parameter (Unit)	Range	Mean	Superior accession
Cluster bean	Gum content (%)	6.3-15.6	8.3	IC421839
Chickpea	Protein (%)	12.0-29.5	20.75	IC268928, IC268966, IC269096, IC269257, IC269265
Faba bean	Phenol (mg/ g)	3.01-15.6	11.15	EC10843, EC05864, ET03128, IC329630, EC591766 (high phenol)
				ET129643, EC117842, EC628946, ET129642 (low phenol)
	Sugar (g/ 100 g)	4.01-10.89	7.25	ET03101, EC117748, EC117765 (high sugar) EC628921, EC374710, EC117842 (low sugar)

2.1.3.4 Optimization of improved method for steroidal sapogenin estimation in fenugreek: Method for estimation of steroidal sapogenin in methanolic extract of fenugreek seeds was optimized. Commonly used method (Baccou *et al*., 1977) for analysis of steroidal sapogenin was not found suitable in fenugreek seeds due to intense background interference caused by chromophores formed in the reaction mixture. Reduction of reaction time from 20 min to 10 min and addition of 0.5 ml of distilled water to the post-reaction solution (*i.e.* after 10 min incubation at 60ºC) increased the stability of absorbance of the reaction mixture significantly at 425 nm. This modified and optimized method was used to estimate total steroidal sapogenin in fenugreek seeds. The details of biochemical and mineral profiling of different crops and superior accessions identified are given in Table 11.

Table 11: Biochemical and mineral profiling of different crops

Crop (Acc.)	Parameter	Range	Mean	Superior accessions
Mucuna (20)	Total phenols (g/ 100 g DW)	2.2-3.7	2.64	EC169813, IC25333-2
	Total Flavonoids (g/ 100 g DW)	0.038-0.069	0.054	EC144995, IC21996A
	Total soluble sugars (g/ 100 g DW)	4.9-9.6	6.8	IC202969, EC1842
	K (g/ 100 g DW)	2.6-3.9	3.2	IC043993, IC009598
	Mg (mg/ 100 g DW)	94.7-157.1	125.7	IC202969, IC021992A
	Cu (mg/ 100 g DW)	1.4-5.1	2.5	IC083298, EC362772
	Fe (mg/ 100 g DW)	5.6-10.9	7.6	IC025333, IC043993
	Zn (mg/ 100 g DW)	2.4-4.4	3.4	EC169813, IC025333
Cucumber (21)	K (mg/ 100 g FW)	119.3-163.1	140.8	IC538126, IC527405
	Mg (mg/ 100 g FW)	9.8-17.4	13.5	IC527434, IC527413
	Cu (mg/ 100 g FW)	0.028-0.078	0.042	IC538121, IC538155
	Fe (mg/ 100 g FW)	0.252-0.612	0.400	IC527405, IC527394
	Zn (mg/ 100 g FW)	0.160-0.275	0.205	IC538121, IC538145
Fenugreek (84)	Steroidal sapogenin (g/ 100 g DW)	0.59 -1.7	1.3	IC143854, IC143885, AM316

Brinjal (24)	K (mg/ 100 g FW)	154.5-283.6	216.3	IC415084, IC112726
	Mg (mg/ 100 g FW)	8.31-12.81	10.95	IC320865, IC545854
	Fe (mg/ 100 g FW)	0.236-0.861	0.512	IC112747, IC545854
	Zn (mg/ 100 g FW)	0.116-0.410	0.181	IC316258, EC038474

DW=Dry Weight; FW=Fresh Weight

2.1.4 Phytochemical evaluation: A total of 315 samples of different medicinal and aromatic plants grown at Issapur Farm and NBPGR Regional Stations were analyzed for their active constituents. The details of major crops and range of active compound present in them along with promising accessions are given in the Table 12.

Table 12: Active components in different medicinal and aromatic plants

Plant name (Acc.)	Active compound (plant part)	Range(%)	Promising accessions
Ocimum sanctum (30)	Essential oil (Herbage)	0.12-0.45 (FW)	IC583284, IC583278, IC583279, IC583281
O. americanum (4)	Essential oil (Herbage)	0.14- 0.29 (FW)	IC583287
Kaempferia galangal (19)	Essential oil (Rhizomes, Roots)	Rhizomes: 0.29-1.95 (DW) Roots: 0.17-0.55 (DW)	IC550136, IC210748
Alpinia galanga (7)	Essential oil (Rhizomes, Roots, Aerial shoots)	Rhizomes: 0.16-0.36 (DW) Roots: 0.10-0.13 (DW)	IC349746, IC265610, IC551549
Mucuna pruriens (38)	L-DOPA(Seeds)	3.29-5.44 (DW)	IC551514, IC331536, IC552857
Andrographis paniculata (30)	Andrographolide (Herbage)	1.02 - 2.99 (DW)	IC520361, IC520395, IC399125, IC369404

FW=Fresh Weight; DW=Dry Weight

2.1.4.1 Analysis of aroma constituents in aromatic plants: The volatile essential oils of 150 samples of aromatic plants were analyzed to identify aroma constituents using GC and GC-MS. The details of major compounds and promising accessions identified are given in Table 13. Chemical profiling of essential oils of *Ocimum basilicum* germplasm (40 accs.) showed presence of 32 aroma compounds and four chemotypes were identified based on major components (%). In addition, 22 samples of *Ocimum* belonging to seven different species/ varieties, viz., *difforme, purpurascence, glabatrum, citridorum, basilicum, pilosum* and *thyriflora,* received from NBPGR Regional Station, Bhowali were analyzed for essential oil composition.

Table 13: Chemical composition of essential oil from aromatic plants

Plant name (Acc.)	Major compounds identified	Promising accessions
Ocimum basilicum(40)	Methyl chavicol, linalool, methyl cinnamate, eugenol, α-pinene, cis-3-hexenol, camphor, linalool oxide, methyl eugenol, â- caryophyllene and borneol	IC469904, IC370846 (Methyl chavicol rich), EC338782, EC387837 (Linalool rich), EC 388893, IC328582 (Linalool and methyl chaviol rich) IC261161 (Methyl cinnamate rich)
O. sanctum (30)	Eugenol, methyl eugenol, â-caryophyllene, â-elemene, á-humulene	IC583281, IC583285 (Eugenol Rich)
Kaempferia galanga (19)	Trans-ethyl cinnamate, ethyl trans p-methoxy cinnamate, 3-carene, borneol, 1,8-cineole, camphor, pentadecane	IC210388 (Trans-ethyl cinnamate rich)
Alpinia galanga (7)	1,8-cineole, á-pinene, â-pinene, á-terpineole	IC402361 (1,8-cineole rich)
Oregano vulgare (10)	Thymol, carvacrol, p-cymene, ã-terpinene, linalool	IC589087, IC589085 (Thymol rich), IC589079 (Carvacrol rich)

2.2 Multilocation Evaluation of Germplasm

In the X-Plan, four crops namely, rice, wheat, pigeonpea and chickpea were identified for multilocation evaluation (MLE) for agro-morphological parameters and trait specific evaluation against biotic and abiotic stresses and quality parameters to identify stable, trait specific germplasm using hot spot locations incollaboration with SAUs and crop based institutes. Subsequently, the MLE was extended to six more crops in the XI Plan considering its importance for trait specific evaluation. During the period under report, a total of 3,784 accessions comprising wheat (1,100), rice (900), maize (170), mustard (240), brinjal (200), okra (200), chickpea (320), pigeonpea (340), lentil (300) and *Tinospora* (14) were evaluated at different locations across the country involving NAGS, AICRPs and SAUs. The details of the trait specific promising accessions identified are given in Table 14.

Table 14: Trait specific promising germplasm accessions indentified through MLE

Crop/ Parameter (Centre)	Trait	Promising accessions
Rice (21)		
Biotic (21)	Plant hoppers (WBPH, BPH)	IC400538, IC353834, IC356010, IC343538
	Gall midge	IC356010, IC332996, IC330699
	Leaf folder	IC326759, IC343981, IC346001
	Blast and bacterial leaf blight	IC372286, IC326489, IC361159
	Sheath blight and *Rice tungro virus*	IC330249
	Sheath blight and Brown Spot	IC319544
Wheat (18)		
Agronomic (8)	Days to maturity (<132 days)	IC08245, IC532112, IC05972
	Grains per spike (>110)	IC059197, IC082158, IC078937
	1000 grain weight (>62 g)	IC055588, IC082211, IC532254
Abiotic (1)	Sodicity tolerant (grain yield at pH 9.1)	IC79058, IC532094
Biotic (8)	Stem rust	IC78962, IC082189, IC532952
	Leaf rust	IC75357, IC532066, IC36857
	Leaf blight	IC532732, IC532855
Quality (1)	Protein (>16%)	
Maize (5)		
Agronomic (5)	Plant height (>250 cm)	IC568272, IC568279, EC477380
	Ear length (>20 cm)	IC568299, IC396385, EC620071
	Tassel branches (>30)	IC568282, EC444422, EC444337
Lentil (15)		
Agronomic (8)	Early flowering (<68 days)	IC560112, IC560266, IC560113 IC560111
	Pods per plant (>120)	IC560143, IC248969, IC560183, IC560113
Biotic (7)	Rust	IC560194, IC560112, IC560326, IC560133
Chickpea (12)		
Agronomic(6)	Seed yield per plant	IC552190, IC552570, IC5582484, IC552329
Biotic (6)	*Ascochyta* blight	IC552082, IC552088, IC552187, IC552284, IC552253
	Dry root rot	IC552054, IC552320, IC553473, IC552332
Pigeonpea (12)		
Agronomic (6)	Seed yield per plant	ICP10315, ICP9796, ICP10773, ICP9773, ICP8947
Biotic (6)	Wilt	ICP6953, ICP6954, ICP7309, ICP7446, ICP7211
	Sterility Mosaic Disease (SMD)	ICP7313, ICP7091, ICP6954

Indian mustard (7)		
Biotic (7)	White rust (Score <2)	IC296685, IC399678, IC401570, IC399824, IC491118, IC491163, IC255498, IC399678, IC338523, IC335847
	Alternaria blight (Score <2)	IC255498, IC296685, IC335847, IC338523, IC360723, IC375924, IC399678, IC491124, IC491163
	White rust and *Alternaria* blight	IC255498, IC296685, IC338523, IC335847, IC399678, IC491124
	Aphid	IC570302, IC570305, IC570321, IC546946, IC546947, IC572873
Brinjal (8)		
Agronomic (4)	Fruit weight (e" 120 g)	IC433547, IC316201, IC090871
	Yield per plant (e" 2.15 kg)	IC261843, IC374904, IC354546, IC090907
Biotic (4)	Shoot and fruit borer (<9%)	IC354546, IC112736
	Bacterial wilt (d" 20%)	IC305048, IC545931
Okra (5)		
Biotic (5)	YVMV (<15%)	IC112501

2.3. Evaluation of Brinjal Core set for Fruit and Shoot Borer Resistance

Out of 181 accessions of core set evaluated for resistance to brinjal fruit and shoot borer, the per cent infestation ranged from 6.9 to 83.33 by number basis and 5.71 to 85% on weight basis. Twentynine accessions were found promising recording < 10% infestation both by number and weight basis. The superior accessions are given in Table 5.

2.4 Pre-breeding and Genetic Enhancement

2.4.1 Evaluation of wild *Lens* germplasm: Sixty wild lentil accessions belonging to various *L.* species (*Lens orientalis, L. odemensis, L. nigricans, L. lamottei, Lens tomentosus* and *L. ervoides*) were characterized and evaluated for various agro-morphological traits for their use as possible donors. The results revealed significant variability for various traits in all the *Lens* species. A wide range of variability in these *Lens* species could be due to their diverse origin. During the cropping period under evaluation accessions of wild *Lens* species were found promising for various traits like high number of pods/cluster (4 pods/ cluster) in *L. nigricans* (ILWL15), shorter internodes in *L. nigricans* (ILWL17), more number of branches/ plant (35-40) in *L. culinaris* ssp. *culinaris* and *L. ervoides* (ILWL117 and ILWL398). However, overall harvest index ranged from 19.45% (*L. ervoides,* ILWL56) to 39.70% (*L. odemensis*, ILWL20).

Wild lentil species, *Lens culinaris* ssp. *culinaris* (ILWL117)

***Lens ervoides* (ILWL398) showing high number of branches/ plant**

2.4.2 Wide hybridization: Seven inter-specific crosses have been attempted between cultivated and wild *Lens* species (L830 x ILWL 7, ILL 10829 x ILWL 7, L830 x ILWL56, L830 x ILWL81, Precoz x ILWL15, ILL8006 x ILWL15 and ILL8006 x ILWL62) for widening the genetic base of cultivated gene pool. The F_1s of these inter-specific crosses were raised to produce the F_2 seeds in the off-season (summer 2011) at CSKHPKV Regional Station, Sangla. Besides these inter-specific crosses, eight intra-specific cross combinations (L830 x PL024, L6183 x PL024, Precoz x PL026, L830 x EC1, L7904 x L6183, L7904 x L830, ILL8006 x Precoz and ILL8006 x L7904) have also been made for the induction of wilt, blight and rust resistance.

2.4.3 Evaluation of wild *Cicer:* Fifty wild accessions of four *Cicer* species (*C. reticulatum, C. echinospermum, C. pinnatifidum* and *C. judaicum*) were characterized and evaluated for important agro-morphological traits under glass house. Substantial variation was observed for various characters in the wild species. Some accessions of *C. reticulatum* (ILWC 36 and ILWC 17121) were found promising for higher number of internodes and branches per plant (28-32).

F_1 hybrid derived by crossing *Lens culinaris* (ILL10829) and *L. culinaris* sp. *odemensis* (ILWL81)

F_1 hybrid (middle) derived by crossing *Cicer arietinum* (Pusa 1103) and *C. reticulatum* (ILWC 46)

Wild chickpea species, *Cicer reticulatum* ILWC 36 (shorter internodes)

***Cicer reticulatum* ICC 17121 (high number of primary branches/plant)**

2.4.4 Wide hybridization: Three inter-specific crosses have been attempted between Pusa 1103 x ILWC46, Pusa 256 x ILWC 46 and Pusa 1103 x ILWC 15 for widening the genetic base of *Cicer* and one intraspecific cross combination was also attempted between ICKG96029 x PB5 for *Ascochyta* blight.

2.5 Documentation

A total of 4,239 accessions of various crops were characterized and evaluated during *kharif* season at NBPGR, New Delhi and its Regional Stations was compiled and documented as "Annual Report on Characterization and Evaluation of *kharif* Crops (2010)". Similarly, a total of 4,626 accessions were characterized and evaluated during *rabi* season at NBPGR, New Delhi and its Regional Stations was compiled and documented in the form of "Annual Report on Characterization and Evaluation of *Rabi* Crops (2009-10)".

Under Multi-location Evaluation Programme conducted during 2004-08, a total of 15,525 accessions comprising of rice (3,770), wheat (6,169), chickpea (3,434) and pigeonpea (2,152) were characterized and evaluated at

different hot spot locations for agro-morphological traits, abiotic and biotic stresses. The promising accessions for different traits were summarized in CDs and distributed to various institutes.

2.6 Germplasm Supply

Utilization of germplasm of various crops by breeders and other scientists in the country for crop improvement programme is an important aspect in sustainability of crop production. During the reporting period, a total of 1,265 accessions of various crop groups namely, cereals (300), legumes (280), oilseeds (238), vegetable crops (323), underutilized crops (21) and medicinal and aromatic plants (103) were supplied to 70 indenters belonging to ICAR Institutes, State Agricultural Universities and other research organizations engaged in crop improvement programmes (Table 15).

Table 15: Supply of germplasm of different crops

Crop group/ Crop		No. of samples (Indenters)
Cereals	Wheat and barley	**2,873 (22)**
Pulses		**210 (9)**
	Cowpea	74(2)
	Pea	52(2)
	Blackgram	62 (2)
	Lentil	5 (1)
	Chickpea	17 (2)
Oilseeds		**238 (14)**
	Rapeseed-mustard	217 (12)
	Linseed	20 (1)
	Safflower	1 (1)
Vegetable crops		**272 (13)**
	Brinjal	62 (2)
	Tomato	100 (2)
	Sponge gourd	20 (2)
	Ridge gourd	70 (5)
	Okra	15 (1)
	Fenugreek	5 (1)
Underutilized crops		**20 (1)**
	Faba bean	**20 (1)**
Medicinal & aromatic plants		**81(11)**
	Basil (*Ocimum* sp.)	20 (2)
	Kalmegh *(Andrographis* sp.*)*	16 (3)
	Ashwagandha *(Withania* sp.*)*	3 (1)
	Ghrit kumari *(Aloe vera)*	22 (2)
	Giloe (*Tinospora* sp.)	20 (3)
	Total	**3,694 (70)**

2.7 Active Germplasm Holding in MTS at GED

A total of 3,7146 accessions of various field crops comprising cereals (18,060), millets and forages (437), pulses (5,470), oilseeds (5,791), vegetable crops (5,670), underutilized crops (1,360), and medicinal and aromatic plants (258) were maintained in medium term storage during the period under report (Table 16).

Table 16: Active germplasm holding in MTS as on 31.12.2011

Crop group (acc.)	Crop (acc.)
Cereals (18,060)	Rice (11,410), Wheat (3,000), Maize (800), Barley (1,700)
Millets & forages (437)	Pearlmillet (200), Sorghum (50), Oats (187)
Pulses (5,470)	Pea (775), Cowpea (1,650), Lentil (500), Mungbean (645), Urdbean (500), Chickpea (100), Pigeonpea (645)
Oilseeds (5,791)`	Rapeseed-mustard (4,535), Sunflower (244), Sesame (550), Linseed (75), Safflower (350), Lepidium (11), Crambe (22) Taramira (4)
Vegetable crops (5,670)	Brinjal (600), Bottlegourd (350), Spongegourd (330), Ridgegourd (310), Bittergourd (55), Ashgourd (100), Raddish (100), Fenugreek (360), Spinach (50), Coriander (100), Onion-seed (90)
Underutilized crops (1,360)	Fababean (300), Rice bean (333), Amaranthus (127), Sesbania (400), Crotolaria (200)
M&AP (258)	*Ocimum* (95), *Mucuna* (55), *Psoralea* (11), *Andrographis* (42), *Catharanthus* (15), *Ashwagandha* (4), *Hyoscymus* (6), *Silybum* (3), Baliospermum (1)
Grand Total	**(37,146)**

Registration of Germplasm: ***Lavendula stoechas*** (IC0449512, NJSSN-2666) germplasm was registered for high camphor content in essential oil isolated from aerial parts (**INGR 10160**).

Research Programme (Programme Code: Title, Leader)

PGR/GEV-BUR-DEL-01.00 Characterization, evaluation, maintenance, regeneration and documentation of germplasm resources of various crops **(M Dutta)**

Research Projects (Code: Title, PI, Co-PIs and Associates)

PGR/GEV-BUR-DEL-01.01: Characterization, evaluation, maintenance, regeneration and documentation of germplasm resources of wheat, barley and triticale **(BS Phogat,** TP Singh, MC Singh, Sundeep Kumar, Sandeep Kumar, YS Rathi)

PGR/GEV-BUR-DEL-01.02: Characterization, evaluation, maintenance, regeneration and documentation of germplasm resources of maize **(Ashok Kumar,** Jyoti Kumari, Sandeep Kumar, Harender Singh and RK Sharma)

PGR/GEV-BUR-DEL-01.03: Characterization, evaluation, maintenance, regeneration and documentation of germplasm resources of pulse crops (**N.K. Gautam**, Sangita Yadav, Mohar Singh, A Roy, Z Khan, TV Prasad, OP Dahiya and Babu Ram

PGR/GEV-BUR-DEL-01.04: Characterization, evaluation, maintenance, regeneration and documentation of Germplasm Resources of oil seeds **(Ranbir Singh,** MK Bag wef. 11.01.2011, Sangita Yadav and Poonam Suneja)

PGR/GEV-BUR-DEL-01.05: Characterization, evaluation, maintenance, regeneration and documentation of germplasm resources of *rabi* vegetable crops **(Gunjeet Kumar** upto 22.3.2011, Pragya wef. 28.12.2010, K K Gangopadhyay, A Roy, Z Khan, TV Prasad, M Arivalagan, M K Bag wef. 11.01.2011, and BL Meena)

PGR/GEV-BUR-DEL-01.06: Characterization, evaluation, maintenance, regeneration and documentation of germplasm resources of *kharif* vegetable crops **(KK Gangopadhyay,** Gunjeet Kumar (upto 22.3.2011), Pragya, SK Yadav, A Roy, Z Khan, TV Prasad, MK Bag (wef. 11.01.2011), M Arivalagan and BL Meena)

PGR/GEV-BUR-DEL-01.07: Characterization, evaluation, maintenance, regeneration and documentation of germplasm resources of medicinal plants **(Ashok Kumar,** SK Pareek, Archana Raina, Arivalagan, Harender Singh and Ombir Singh)

PGR/GEV-BUR-DEL-01.08: Biochemical evaluation of germplasm resources of various field crops **(Sangita Yadav,** Rakesh Bhardwaj, Sandeep Kumar, Ranbir Singh, NK Gautam, Zakir Hussain and Poonam Suneja)

PGR/GEV-BUR-DEL-01.09: Characterization, evaluation, maintenance, regeneration and documentation of germplasm resources of under-utilized crops **(BS Phogat**, Hanuman Lal and Ranbir Singh)

PGR/GEV-BUR-DEL-01.10: Studies on Statistical Techniques for Efficient Management of Plant Genetic Resources **(Hanuman Lal**)

PGR/GEV-BUR-DEL-01.11: Genetic Resources Information Programme **(Hanuman Lal,** Madhu Bala and Rajiv Gambhir)

PGR/GEV-BUR-DEL-01.12: Characterization, Evaluation, Maintenance, Regeneration and Documentation of Germplasm Resources of Aromatic Plant **(Archana Raina**, SK Pareek (till July 31), Ashok Kumar, and Ombir Singh)

PGR/GEV-BUR-DEL-01.13: Development of Core set in Brinjal (*Solanum melongena* L.) **(KK Gangopadhyay**, SK Yadav, Pragya, IS Bisht and Gunjeet Kumar upto 22.3.2011)

PGR/GEV-BUR-DEL-01.14: Prebreeding and genetic enhancement in lentil and chickpea genetic resources **(Mohar Singh**, TP Singh, Jyoti Kumari, M Dutta, IS Bisht, and Mukesh Rana)

PGR/GEV-BUR-DEL-01.15: Evaluation for abiotic stress (terminal heat tolerance) in wheat germplasm **(TP Singh,** Mohar Singh, Rakesh Bhardwaj and Jyoti Kumari)

PGR/GEV-BUR-DEL-01.16: Standardization of agro-techniques of elite medicinal plants (*Giloe and Shatavar*) **(MC Singh,** BS Phogat, SK Pareek (till July 31), Archana Raina, M Arivalagan and BS Panwar)

Externally Funded Projects

- Characterization of the etiological agent of leaf deformity disease of sunn-hemp and development of viral gene constructs for detection and management (ICAR, **Anirban Roy**)
- Harmonizing biodiversity conservation and agricultural intensification through integration of plant, animal and fish genetic resources for livelihood security in fragile ecosystems (NAIP/JEF, **IS Bisht**)
- Pre-breeding and genetic enhancement for breaking yield barriers in centre and kabuli chickpea (DAC- ICARDA –ICAR, **Mohar Singh** and IS Bisht)
- Biochemical and molecular characterization of amaranth and buckwheat genetic resources from north-west Himalaya region (DST, **Sangita Yadav**, Zakir Hussain and JC Rana)

3. GERMPLASM CONSERVATION

Summary: A total of 13,620 accessions of germplasm including varieties to be notified and released and trait-specific registered germplasm of various crops were received for long-term conservation in the National Genebank. These were processed following the genebank standards, adding another 5,131 accessions to the base collection raising the total germplasm holding to 3,88,985. Monitoring of seed germination and quantity in stored germplasm (5,044 accessions) and distribution (1,05,760) for evaluation/regeneration/research/restoration of active collections were the other priority activities. Dormancy breaking methods were standardized for *Andrographis paniculata,* (GA_3 500 ppm for 48 and 72 h) *Capsicum* spp. (GA_3 500 ppm co-applied at 15^{0}C) and *Morinda citrifolia* (clipping treatment + GA_3 1000 ppm for 24 h). Assessment of longevity of ultra-dry seeds of safflower, sesame, chickpea, niger, and groundnut indicate significantly higher germination (64-96%) in seeds with low moisture content (mc) (1.7-3.0 %) than the germination (0-40%) recorded in seeds with next higher level of mc (3.8-5.0%) after 13-15 years of storage at ambient temperature. Agronomic and yield parameters during field evaluation of cotton seeds stored for 15 years at different moistures corroborate the benefit of ultra low seed moisture (< 3%) and low temperature storage. Studies on onset and loss of desiccation tolerance during wheat embryogenesis were initiated in *Triticum aestivum*, *T. durum* and *T. dicoccum*. A total of 88 accessions with unique traits were approved for registration and processed for long- term conservation. Long-term storage (LTS) of seeds of various agricultural and horticultural crops in the National Genebank (-18^{0}C), and medium-term storage (MTS at +8^{0}C) of reference samples of introduced and collected accessions was carried out. In addition, the registration of potentially valuable germplasm and conservation of released varieties and genetic stocks identified under the National Agricultural Research System has been the other important activity to facilitate their use in crop improvement programmes. Efforts were made to update and correct the information on conserved germplasm and port the data for incorporation in the national database. Supportive research directed towards understanding the storage behaviour of hitherto under-explored species, identification and manipulation of factors that prolong the storage life of seeds in a cost-effective manner and overcoming seed germination problems continued.

3.1 Germplasm Augmentation

A total of 13,620 germplasm accessions of various agri-horticultural crops were received for long-term conservation in the National Genebank; of which 5,131 accessions qualified for conservation as per the genebank standards and were conserved at –18^{0}C as base collections. The details are depicted in Fig.1. Cereals comprised a major portion (43%) of the accessions added to the genebank while millets and oilseeds contributed 13 and 12%, respectively. The crop groups *viz.* legumes, vegetables, fibres, forages, spices and condiments and medicinal plants each contributed between 1-9% of the total accessions added to the genebank. These figures also include released varieties (154) and genetic stocks (100). One new species *viz.* *Chrysanthemum coronarium* was added to the genebank during the period. The crop-wise details of the various accessions added to the genebank are listed in Table 1. The total germplasm holdings in the National Genebank has increased to 3,88,985 representing 1,584 species. In addition, a total of 10,324 accessions of exotic germplasm were received and stored as reference samples in the MTS module. The details of the exotic reference accessions added in the genebank (MTS) are depicted in Fig.2. The majority of reference samples were received for cereals (75%) and vegetables (13%) and the other crop groups *viz.* legumes, fibres and forages, oilseeds and spices and condiments each contributing 1- 6%. In addition, accessions of various crops which were received with limited seed quantity were also stored in MTS as they did not qualify the genebank standards for LTS.

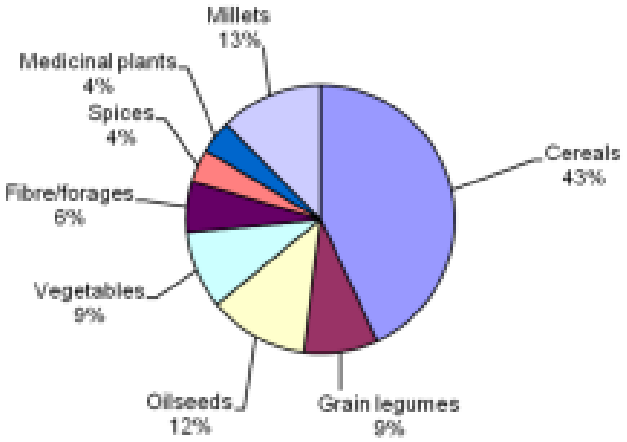


Fig. 1. Crop group-wise accession added to the genebank (LTS)

Table 1: Status of germplasm holdings in the National Genebank (as on 31.12.2011)

Crop Group	No. of acc. added during 1.01.11 to 31.12.11	Present status Total
Paddy	440	91,819
Wheat	738	39,845
Maize	953	8,751
Others	30	11,988
Cereals	**2,161**	**1,52,403**
Sorghum	91	20,386
Pearl millet	31	8,240
Minor millet	444	22,150
Others	58	5,236
Millets and forages	**624**	**56,012**
Amaranth	88	5,539
Buckwheat	-	858
Others	29	377
Pseudo- Cereals	**117**	**6,774**
Chickpea	12	16,881
Pigeonpea	8	11,229
Mung bean	4	3,681
Others	424	25,925
Grain Legumes	**448**	**57,716**
Groundnut	27	14,593
Brassica	128	10,387
Safflower	287	8,030
Others	162	23,469
Oilseeds	604	56,479
Cotton	290	6,751
Jute	2	2,911
Others	13	2,186
Fibre Crops	**305**	**11,848**
Brinjal	28	4,046
Chilli	-	2,011
Others	444	18,792
Vegetables	**472**	**24,849**
Custard apple	-	59
Papaya	-	23
Others	-	448
Fruits		**530**
Opium poppy	1	350
Ocimum	31	433
Tobacco	15	1,482
Others	151	4,337
Medicinal & Aromatic Plants & Narcotics	**198**	**6602**
Coriander	65	655
Sowa	-	91
Others	137	2350
Spices & Condiments	**202**	**3096**
Pongam oil tree	-	395
others	-	2047
Agro-forestry	-	**2442**
Lentil	-	7712
Pigeonpea	-	2523
Duplicate Safety Samples	**-**	**10235**
Total	**5,131****	**3,88,985***

***The figure includes 3964 Released varieties and 2139 Genetic stocks**
No. of crop species conserved – 1584
****The figure includes 154 Released varieties and 100 Genetic stocks**

3.2 Documentation and Database Management

Web-enabled database was developed for National Genebank to integrate the same with main database of NBPGR on plant genetic resources. Updated data of about 3.6 lakh accessions has been ported to new web-enabled database system. Corrections regarding various fields like taxonomic identity, biological status etc.were done for a large number of accessions. Data entry of 5,131 new accessions was done. Passport data of 241 accessions of vegetables i.e. brinjal (105) and okra (136) was updated by referring to the published literature.

3.3 Monitoring of Germplasm

Germplasm stored in the long-term storage module for 10 years or more (7,749 accessions) were monitored for seed viability and seed quantity to ensure the status of the conserved germplasm as per the genebank standards. The details of the viability tests are given in Table 2.

3.4 Distribution of Germplasm

A total of 1,05,760 accessions were distributed for various purposes. Most of the accessions were distributed for regeneration, characterization and evaluation. These include 68,259 samples (comprising wheat 65,921, and rice 2,338) supplied under the National Initiative on Climate Resilient Agriculture (NICRA) Project. The details are given in Table 3.

3.5 Supportive Research

3.5.1 Standardization of germination testing/ dormancy breaking protocols: Thirty accessions of the *Andrographis paniculata* were given 12 treatments to overcome the secondary dormancy induced due to low temperature storage. The treatments pre-soaking in GA_3 (500 ppm) for 48 and 72 h enhanced germination up to 68 and 70 % respectively, over the 6 and 9 % in control. Similarly, in three species of *Capsicum* (*C. minimum*, *C. chinense* and *C. frutescens*) enhanced germination up to 90 % (over 20 % in control) was obtained with GA_3 (500 ppm, co-applied at 15^0C).

Table 2: Details of the monitoring of viability of germplasm conserved in LTS for ≥ 10 and 20 years.

Crop	Number of Accessions	Initial Viability	Present Viability
Safflower	150	95-100	88-100
Sunflower	108	90-100	85-100
Linseed	25	95-100	90-100
Jute	347	95-100	78-100
Niger	50	90-100	80-100
Mustard	202	95-100	80-100
Onion	225	70-100	48-100
Chilli	100	80-85	78-84
Paddy	2190*	80-100	16-100
Paddy	500	92-100	10-100
Maize	336	88-100	84-100
Maize	1056*	88-100	68-100
Barley	600	94-100	92-100
Barley	213*	96-100	92-100
Chickpea	350	85-100	85-100
Pea	136	85-100	85-100
Lablab bean	55	85-100	85-100
Amaranth	138	98-100	90-95
Pearl Millet	197	90-100	88-98
Sorghum	188	90-98	88-94
Finger Millet	212	86-98	88-96
Little Millet	72	90-100	90-96
Proso Millet	88	90-98	90-96
Barnyard Millet	48	90-100	90-96
Kodo Millet	80	86-98	85-100
Foxtail Millet	83	90-96	90-96

Table 3: Distribution of germplasm of different crops for various purposes

Crops (No. of Accessions)	Purpose	No. of Accessions
Rice (1,504), maize (500), castor (243), soybean (500), groundnut (1,134), sunflower (20), sesame (937),safflower (20), fibres (346), forages (312), pigeonpea (1200), urd bean (189), cowpea (193), pearl millet (4,250), ash gourd (50) , ridge gourd (25), sponge gourd (50)	Regeneration and/or evaluation	11,473
Wheat (200), mung bean (379), cowpea (34), tomato (917), cucumber (232), water melon (1,560), long melon (27), round melon (30), pumpkin (50), winter squash (50), summer squash (53)	Multiplication of reference samples	3,532
Chickpea (19,251), pearl millet (250), wheat (23,851)	Characterization	43,352
Amaranth (1,164), *Brassica* spp. (186), *Ocimum* spp. (35) , *Vigna* spp.(60) *Trichosanthes* spp. (13), bottle gourd (150)	Taxonomic (species) identification	1,608
wheat (42,480), rice (2338) horse gram (20), cowpea (6), finger millet (27), pearl millet (2), tomato (7), brinjal (900), *Luffa* spp. (15)	Research	45,795
Total		1,05,760

Dormant seeds of *Morinda citrifolia* were exposed to various physico-chemical treatments such as clipping, hot water, sulphuric acid and growth hormones. Clipping followed by GA_3 (1000 ppm) application for 24 h enhanced germination up to 30% when compared to control (0%); all other treatments did not exhibit any improvement in germination.

3.5.2 Effects of ultra-desiccation on longevity: To develop protocols for cost-effective conservation, observations on storability of seeds dried to ultra-low moisture contents were continued in safflower, sesame, niger, groundnut and chickpea. Seeds stored at different moistures were monitored after 13-15 yrs of storage at ambient and genebank conditions. Significantly higher germination (64-96%) was observed in seeds of safflower, sesamum, chickpea, niger and groundnut seeds with lowest MC (1.7-3.0%) than the germination (0-40%) recorded in seeds with next higher level of MC (3.8-5.0%). Field evaluation of cotton seeds stored for 15 years at different moistures and ambient and genebank temperatures (8°C and -18°C) was done in *kharif* 2011. Yield parameters (seed index, total seed and lint weight) in seeds stored at 2% moisture and ambient temperature were at par with control seeds kept at low temperatures substantiating the feasibility of cost effective ultra- low seed moisture ($\leq$ 3%) storage.

3.5.3 Studies on desiccation tolerance and comparative evaluation of wheat species: Thirteen accessions belonging to three wheat species (*Triticum aestivum, T. durum* and *T. dicoccum*) were evaluated for the onset and loss of desiccation tolerance. Field samples were collected, during *rabi* 2011, at various stages of seed maturation and the extent of desiccation tolerance at each stage was assessed under laboratory conditions. The loss of desiccation tolerance in these accessions, subsequent to germination of mature seeds, was also evaluated.

3.5.4 Taxonomic validation of wild wheat accessions: A total of 54 accessions of wild wheat, including 5 species of *Aegilops* and 10 species of *Triticum,* were grown under net house conditions for validation of their taxonomic identity. Germination and vigour parameters were recorded for comparison with laboratory data.

3.5.5 Comparative assessment of wheat varieties: Some 55 wheat varieties that are currently being multiplied in the certified seed production chain have been identified and grown together under field conditions during *rabi* 2011, for comparative assessment of agronomic and seed quality traits.

3.5.6 Studies on extent of correlation between sporophytic and seed quality traits: Studies have been initiated for analyzing sporophytic traits in specific wheat accessions and further correlating it with the seed quality attributes, so as to explore the possibility of using sporophytic attributes as a reliable marker for screening of germplasm. In this regard, attempts are being made to standardize the protocol for assessment of viability and vigour of wheat pollen.

3.6 Germplasm Registration

With the objective of recognizing the efforts of scientists who have developed or identified promising germplasm (including parent or inbred lines), to safeguard the national germplasm resources with respect to intellectual property rights and to facilitate flow of germplasm among the scientists working in the crop improvement programmes, germplasm with unique traits are registered. Out of 209 proposals received for germplasm registration, 88 were approved for registration by the Plant Germplasm Registration Committee. The details of registered germplasm are given in Table 4.

Table 4: Summary list of germplasm registered with unique traits in various crop groups

Crop group	No. of accessions		
	Registered	Present status	No.of species
Cereals & Pseudo-cereals	24	371	11
Millets	0	67	4
Grain Legumes	13	113	16
Oilseeds	11	137	25
Fibres and Forages	2	76	15
Vegetables	1	60	23
Fruits and Nuts	4	32	14
Medicinal, Aromatic and Spice Plants	3	48	39
Commercial crops	26	59	7
Ornamentals	0	41	17
Tubers	2	23	9
Agro-forestry species	2	3	3
Total	**88**	**1,030**	**183**

Programme (Programme Code: Title, Leader)

PGR/GCN-BUR-DEL-01.00 Ex Situ Conservation of Plant Genetic Resources of Agricultural and Horticultural Crops Using Conventional Method***s*** **(RK Tyagi)**

Research projects (Code: Title, PI, Co PI, Associate/s)

PGR/GCN-BUR-DEL-01.01: Management of Information and National Germplasm Conservation Network (**RK Tyagi**, Anjali Kak, Sunil Archak, BP Dahiya, Rajvir Singh, Rita Rani, Smita Jain and Rajiv Gambhir)

PGR/GCN-BUR-DEL-01-02: Conservation of grain legume germplasm using conventional seed storage methods (**Neeta Singh**, Chitra Pandey)

PGR/GCN-BUR-DEL-01-03: Conservation of paddy germplasm using conventional seed storage methods (**Kalyani Srinivasan**, RK Tyagi, Sherry Rachel Jacob**,** AD Sharma)

PGR/GCN-BUR-DEL-01-04: Conservation of oilseed and fruit crops germplasm using conventional seed storage methods (**J Radhamani**, Neeta Singh)

PGR/GCN-BUR-DEL-01-05: Conservation of cereal germplasm excluding paddy and agro-forestry species, using conventional seed storage methods (**K Srinivasan**, J Radhamani, Sherry Rachel Jacob, Manju Uprety)

PGR/GCN-BUR-DEL-01-06: Conservation of spices, medicinal and aromatic plant, and pseudo-cereals germplasm using conventional seed storage methods (**Veena Gupta**, Anjali kak)

PGR/GCN-BUR-DEL-01-07: Conservation of millets germplasm using conventional seed storage methods (**Sushil Pandey**, Chitra Pandey)

PGR/GCN-BUR-DEL-01-08: Conservation of forage and fibre germplasm using conventional seed storage methods (**Anjali Kak**,Veena Gupta)

PGR/GCN-BUR-DEL-01-09: Conservation of vegetable germplasm using conventional seed storage methods (**Chitra Pandey**, Neeta Singh, Sushil Pandey)

PGR/GCN-BUR-DEL-01-10: Investigating seed dormancy, seed storage behaviour, and physiological and biochemical changes during storage. (**J Radhamani**, Kalyani Srinivasan Neeta Singh, Veena Gupta, Anjali Kak, Chitra Pandey, Sushil Pandey, Sherry Rachel Jacob, Manju Uprety and AD Sharma)

Externally-funded projects

Collection, conservation and genetic diversity analysis of noni (*Morinda citrifolia*) from other than coastal regions of India. (**Veena Gupta**, Anjali Kak, Lalit Arya and Chitra Pandey)

Collection, assembly and conservation of genetic resources of physic nut (*Jatropha curcas* Linn.) (**J Radhamani**)

Implementation of PVP legislation: National Plant Variety Repository (**Kalyani Srinivasan**)

Establishment of national rice resources database (**Kalyani Srinivasan**, Rakesh Singh, Sunil Archak

4. PLANT QUARANTINE

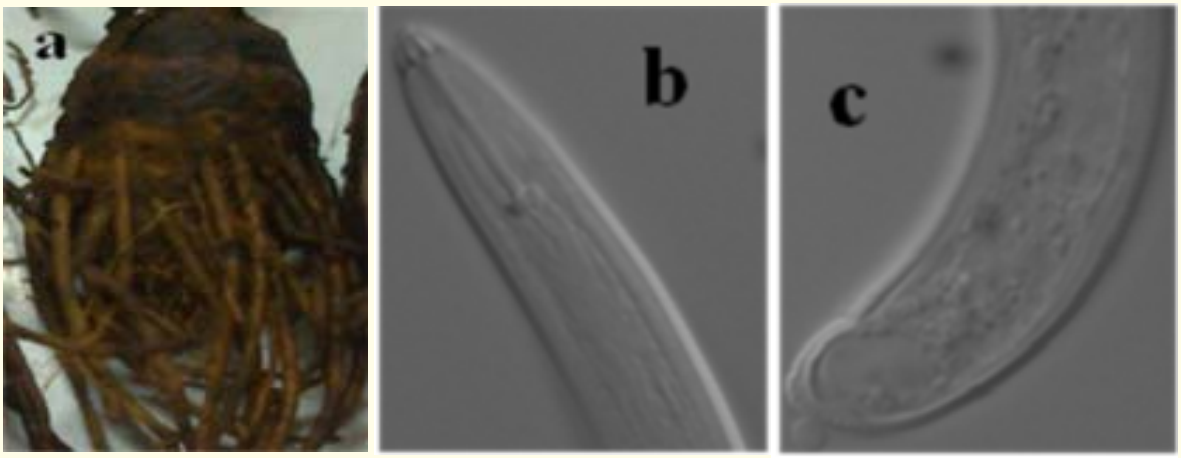
Summary: A total of 1,16,980 samples of imported germplasm accessions as well as trial material entries of various crops and their wild relatives were processed for quarantine clearance. These samples included true seeds, rooted plants, cuttings, rhizomes, suckers, bulbs, nuts and tissue culture plantlets. The infested/ infected samples (1,346)-comprised insects (487), nematodes (119), fungi/ bacteria (644), viruses (27), weeds (69) and several exotic pests. Of the 1,302 infested/ infected/ contaminated samples, 1,270 were salvaged through fumigation, hot water treatment (HWT), X-ray radiography, pesticidal dip, mechanical cleaning and growing-on test. Thirty two samples of *Oryza sativa* from China and USA were rejected due to infection by *Neovossia horrida*, a quarantine pest for India. The remaining infested samples were salvaged through physico-chemical methods. A total of 2,144 samples were processed for export of which 14 infested/ infected samples were salvaged and 15 Phytosanitary Certificates were issued. Fifty six samples of exotic germplasm of different legume crops imported from different countries/ sources were grown in post-entry quarantine (PEQ) greenhouses and the harvest of the plants free from viral symptoms only was released to the indenters. Quarantine processing of 946 samples of imported transgenic planting material revealed, fungi and insect infestation in maize and rice; absence of terminator gene was ensured and all samples were salvaged prior to release. A total of 14,759 samples were received from Germplasm Conservation Division for seed health testing of which 944 samples were subjected to X-ray radiography. A total of 1,060 samples were rejected as they could not be salvaged.

4.1 Import Quarantine

4.1.1 Quarantine examination: A total of 1,16,980 samples comprising germplasm accessions, nurseries/ trial breeding material of various crops including both true seed and vegetative propagules were processed for the detection of associated exotic insect pests, and mites, plant parasitic nematodes, plant pathogens (fungi, bacteria, viruses) and weed seeds by various detection techniques. Of the import samples, 1,120 samples were exposed to X-ray radiography for detection of hidden infestation of bruchids and chalcids. A total of 1,302 samples were found infested/ infected/ contaminated. Of these, 487 samples were found infested with insects/ mite including 231 with hidden infestation; 119 samples infected with nematodes, 644 found infected with fungi/ bacteria, 27 with viruses and 69 with weeds. A number of pests of major quarantine importance were intercepted (Table 1).

4.1.2 Salvaging of infested/ infected/ contaminated germplasm: Of the total 1,302 infested/ infected/ contaminated samples, 1,270 were salvaged by various disinfestation techniques/ treatments like mechanical cleaning to remove damaged/ abnormal seeds, soil clods, plant debris etc., fumigation with ethylene dichloride-carbon tetrachloride (EDCT) mixture @ 320 mg/ litre for 48 h at 30^{0}C under normal air pressure against insect infestation and hot water treatment (HWT) at 52^{0}C for 30 minutes for various seed-borne pathogens and nematodes and X-ray screening for hidden infestation, pesticidal dip/ spray for vegetative propagules. Samples infested with insects/ mites (487) were salvaged through fumigation (152), X-ray radiography (231) and pesticidal dips (104); 119 samples infected with nematodes were salvaged by nematicidal dip treatments; 641 samples infected with fungi/ bacteria were salvaged by fungicidal seed treatment and ethyl alcohol wash; and samples

Exotic Nematode Intercepted in Imported African Potato Germplasm



(a) African Potato (*Hypoxis hemerocallidea)* from Swaziland infested with *Rotylenchus minutus* (b) microphotographs of *Rotylenchus minutus*, showing anterior and (c) posterior regions of female body

Rotylenchus minutus (Sher, 1964) Germani *et al*., 1986 intercepted on African potato (*Hypoxis hemerocallidea*) from Swaziland is not reported from India. African potato reported herewith as a new host record for *R. minutus*. African potato, *Hypoxis hemerocallidea* is native to South Africa, it is a tuberous perennial. The tuberous root stock or corm is the part mostly used for its medicinal properties. The spiral nematode, genus *Rotylenchus* consists of a large number of species of significant economic importance in agriculture and are predominantly found in temperate regions of the world. They are ectoparasite of roots, polyphagus in nature and parasitize a wide-range of hosts, including vegetables, ornamentals, fruit and forest trees. *R. minutes* recorded, apart from type locality (Hattah, Victoria, Australia, in uncultivated sandy soil), in several localities of South Africa, Westem Cape Province, Olifants River at Mica and Ligthelm Nursery, Middelburg, Transvaal.

infected with viruses were salvaged through grow-out test and 69 samples contaminated with weed seeds were salvaged by mechanical cleaning. Thirty two samples of rice (from China and USA) infected with *Neovossia horrida*, were rejected as this pathogen is not yet reported from India.

Prophylactic treatments: A total of 4,799 seed samples were subjected to fumigation and 14,649 samples of paddy and 19 samples of *Brassica* were given mandatory hot water treatment. In order to prevent the introduction of new strains of tobamo viruses through seeds, all the introduced germplasm samples of chilli (517), tobacco (1) and tomato (666) were subjected to prophylactic seed treatment with 10% tri-sodium orthophosphate.

4.1.3 Post-entry quarantine (PEQ) growing in nursery/ greenhouses and inspection at indenter's site: International nurseries trial material (4,673 entries) comprising wheat (3,563) from CIMMYT (Mexico) and ICARDA(Syria) and barley(1,110) from ICARDA (Syria) were grown in PEQ nursery at NBPGR and inspected regularly for presence of disease symptoms.

Loose smut of wheat was detected in one line of wheat (12th SBWYT-171) from CIMMYT (Mexico) and one line of barley (IBON-12-LRA-C-28) from ICARDA, Syria. The infected plants were first covered in a paper bag and then uprooted and incinerated to prevent spread of the inoculum. None of the lines showed the presence of virus-like symptoms.

A total of 56 samples of exotic germplasm comprising *Glycine max* (6), *Phaseolus lunatus* (5), *Vicia benghalensis* (1), *V. hirsuta* (2), *V. villosa* (6), *Vigna* sp. (1), *V. luteola* (5), *V. membranacea* (1), *V. parkeri* (4), *V. racemosa* (3), *V. radiata* (6), *V. reticulata* (4), *V. trilobata* (5), *V. unguiculata* (2) and *V. vexillata* (5) were grown in contained conditions. Also, a total of 214 samples of exotic legume germplasm comprising *G. max* (60), *V. mungo* (2), *V. radiata* (126), *V. unguiculata* ssp. *sesquipedalis* (19) and *V. unguiculata* ssp. *unguiculata* (7) meant for AVRDC-RCSA, ICRISAT Campus, Hyderabad were released on an undertaking and the post-entry quarantine inspection was undertaken at indenter's site. The plants showing virus-like symptoms were tested by electron microscopy and using specific antiserum against 25 seed-transmitted viruses using enzyme-linked immunosorbent assay. The harvest from only healthy plants of different accessions was released to the indenters. The interceptions made are presented in Table-1.

A total of 20 accessions comprising 640 saplings of *Citrus sinensis* from Brazil and meant for Jain Irrigation Systems Ltd., Jalgaon, Maharashtra were processed in the laboratory using illuminated magnifiers and given mandatory prophylactic pesticidal treatments. The material was released on an undertaking for PEQ under isolation at Jain Irrigation Systems Ltd., Jalgaon, Maharashtra and PEQ inspection was undertaken at indenter's site. Two plants showing virus-like symptoms belonging to two accessions did not react with *Citrus tristeza virus* (Indian Strain) and *Indian citrus ringspot virus* and therefore are of exotic origin and of quarantine significance. These two plants were incinerated.

A total of 23 accessions of wheat imported from France and meant for Maharashtra Hybrid Seeds Co. Ltd., Jalna, Maharashtra were released after joint inspection on an undertaking and PEQ inspection was undertaken at indenter's site. The plants were found to be free from quarantine pests.

4.2 Export Quarantine

A total of 2,144 samples of various crops intended for export to various countries were processed for detection of associated pests. Of these, 37 samples were found infected and all were salvaged. The pests detected include *Alternaria padwickii , Drechslera oryzae, Fusarium moniliforme, Neovossia horrida, Ustilaginoidea virens* in *Oryza sativa; Neovossia indica, D. sorokiniana, F. moniliforme* in *Triticum*

aestivum; F. moniliforme in *Brassica* sp.; *Sitophilus oryzae* in *O. sativa* and *T. aestivum; Sitotroga cereallela* and *Rhizopertha dominica* in *O. sativa* and *Trogoderma granarium* in *Brassica* spp.; *Ecinochloa crusgalli* and *Sehima nervosum* in *O. sativa; Phalaris minor* and *Rumex dentata* in *T. aestivum.* Fifteen Phytosanitary Certificates were issued.

***Phoma lingam* on *Brassica* seed**

***Phomopsis* sp. on chili seeds**

4.3 Seed Health Testing for Pest Free Conservation of Indigenously Collected Planting Material

A total of 14,759 samples accessions of indigenously collected seed material and multiplied material at various centres were processed for pest-free conservation. Of these, 978 samples were found infected visually and 1,314 through blotter test and 78 samples were found contaminated with weed seeds. A total of 944 samples were subjected to X ray radiography of which 379 samples were infested with insect pests. Of these 1,060 were rejected as they were heavily infested and could not be salvaged. A total of 13,699 samples were released for pest free conservation. The pests detected are given Table 2.

4.4 Detection of Viruses in *In Vitro* Cultures of Germplasm meant for Conservation

Tested total of 49 *in vitro* samples. *Allium sativum* (31, including 3 *Allium* sp.) samples were indexed against 6 associated viruses viz. *Carnation latent virus* (CLV), *Garlic common latent virus* (GCLV), *Garlic virus C* (GarV-C), *Leek yellow stripe virus* (LYSV), *Onion yellow dwarf virus* (OYDV), *Shallot latent virus* (SLV) and *Shallot yellow stripe virus* (SYSV) using DAS-ELISA and EM. Results revealed the presence of CLV (5), GCLV (8), LYSV (1) and OYDV (1). Result indicated that out of 28 garlic samples tested 15 samples were free from the 6 viruses tested and the 3 *Allium*. sp. viz. *A. albidum*, *A. clarkeii* and *A. schoenoprasm* were found to be free from the 6 viruses tested for conservation and exchange. Electron microscopy revealed the presence of flexuous particles of different size belonging to *Carlavirus* and *Potyvirus* groups in Alliums.

In case of strawberry, 18 accessions were indexed against 7 viruses viz. RBDV, RpRSV, SLRV, SMYEgV, TBRV, TNV and ToRSV. Results revealed the presence *of Raspberry ring spot virus* (RpRSV) in 2 accessions and 16 accessions were found to be free of the 7 viruses tested for conservation and exchange.

4.5 Supportive Research

4.5.1 Isolation and maintenance of fungal culture collection for characterization using different molecular tools: During this year, several fungi were isolated from seed materials and maintained from the import, export and domestic quarantine samples. Some of the seed-borne fungi isolated and maintained in our culture collections are as follows: *Alternaria alternata* (28), *Drechslera oryzae* (29), *D. tetramera* (11), *D. sorghicola* (15), *D. sorokiniana* (8), *Fusarium verticillioides* (8) *F. moniliforme* (26), *F. semitectum* (17), *F. solani* (4), *F. culmorum* (1), *F. equiseti* (1), *F. avenaceum* (1), *Alternaria padwickii* (19), *A. brassicicola* (2), *A. zinniae* (1) and *Curvularia lunata* (2) and further fungal collection is under progress. DNA from *Alternaria alternata* and *F. verticillioides* were extracted and molecular based characterization work is under progress.

4.5.2 Potential quarantine pests for India in grain legumes: Information on pests of grain legumes were compiled on the parameters *viz.*, scientific name of the pest/synonym(s), Order/ Family, pathway of introduction, host range, geographical distribution, economic losses/ physiological variation and phytosanitary risk. Two hundred and forty eight pests (134 insects, 8 mites, 6 nematodes, 31 fungi, 13 bacteria, 27 viruses and 29 weed species) are listed as the potential quarantine pests for India in 39 grain legumes comprising crop species and their wild relatives.

Table 1: Pests intercepted in the exotic germplasm during 2011

Pest	Host	Source/ Country
Insects/mites		
**Bruchus ervi*	*Lens culinaris*	ICARDA (Syria)
**B. dentipes*	*Vicia faba*	ICARDA (Syria)
B. lentis	*L. culinaris*	ICARDA (Syria)
**B.*tristis	*Lathyrus sativus*	ICARDA (Syria)
Callosobruchus chinensis	*Macroptilium atropurpurius*	Ethiopia
Bruchophagus sp.	*Medicago* spp.	New Zealand
Cryptolestis ferrugenius	*Oryza sativa*	Philippines, USA
Polyphagotarsonemus latus	*Annona reticulata*	Taiwan
Rhizopertha dominica	*O. sativa*	Argentina, Philippines
Sitophilus granarius	*Triticum aestivum*	Netherlands
S. oryzae	*O. sativa,T. aestivum*	Philippines, Nepal
S.zeamais	*Z. mays*	Thailand, USA
Sitotroga cereallela	*O. sativaT aestivum*	Argentina,Nepal,USA
Tribolium castaneum	*T. aestivum*	ICARDA (Syria)
Nematodes		
Aphelenchoides besseyi	*O. sativa*	Philippines and USA
Helicotylenchus dihystera	*Annona squamosa*	Taiwan
Rotylenchus minutus and *Xiphinema* sp.	*Hypoxis hemerocallidea*	Swaziland, South Africa
Fungi and Bacteria		
Alternaria zinniae	*Helianthus annus*	USA
A. brassicae	*Brassica oleracea* var. *botrytis*	Netherlands
A. brassicicola	*B. juncea*	Canada
	B. carinata	Australia
	B. oleracea var. *botrytis*	Netherlands, USA
A. padwickii	*O. sativa*	China, Philippines
Colletotrichum dematium	*Capsicum annuum*	Taiwan
Drechslera avenacea	*Avena sativa*	Brazil
D. maydis	*Zea mays*	Egypt, Philippines, Thailand
D. oryzae	*Oryza sativa*	Philippines, USA
D. sorghicola	*Lycopersicon esculantum*	Taiwan
	Raphanus sativus	Australia
D. sorokiniana	*Capsicum annum*	Netherlands
	Gossypium arboreum	Pakistan
	Hordeum vulgare	Syrian Arab Rep., USA
	Helianthus annuus	USA
	Lycopersicon esculantum	Taiwan
	T. aestivum	Australia, Germany, Nepal, USA
Fusarium avanaceum	*Z. mays*	Chile
F. culmorum	*T. aestivum*	Switzerland
F. moniliforme	*Abelmoschus* spp.	Niger
	Arachis duranensis	Ethiopia
	Avena sativa	Brazil
	Brassica carinata	Australia
	B. juncea	Canada
	Calopogonium mucunodes	Ethiopia

	Calotropis ensiformis	Ethiopia
	Capsicum annum	Netherlands
	Carya illinoensis (cuttings)	USA
	Gossypium hirsutum	USA
	Helianthus annuus	USA
	Hordeum vulgare	Syrian Arab Republic
	Lycopersicon esculentum	Taiwan, USA
	Neonotonia wightii	Ethiopea
	Oryza sativa	Philippines, USA
	Pueraria phaseoloides	Ethiopia
	Stylosanthes viscosa	Ethiopia
	T. aestivum	Australia, Mexico, Switzerland, UK
	Vicia benghalensis	Ethiopia
	Zea mays	Brazil, Chile Egypt, Germany, Mexico, Philippines, South Africa, Thailand, USA
F. solani	*Annona reticulata*	Taiwan
	Triticum aestivum	Nepal
	Vicia benghalensis	Ethiopea
	Zea mays	Chile
Macrophomina phaseolina	*Aeschynomene falcata*	Ethiopia
Neovossia horrida	*Oryza sativa*	USA
Puccinia helianthi	*Helianthus annuus*	USA
Sclerotinia sclerotiorum	*C.annuum*	Taiwan
Ustilaginoidea virens	*Oryza sativa*	Philippines
Verticillium albo-atrum	*Capsicum annuum*	Netherlands, Taiwan
	H. annuus	USA
Xanthomonas campestris pv. *campestris*	*Brassica juncea*	Canada
	B. oleracea var. *capitata*	Netherlands
Viruses		
**Arabis mosaic virus*	*Vigna parkeri*	Ethiopia
	V. trilobata	Ethiopia
	V. vexillata	Ethiopia
Bean common mosaic virus	*Phaseolus vulgaris*	Nepal, USA
Blackeye cowpea mosaic virus strain of BCMV	*V. reticulata*[#]	Ethiopia
	V. trilobata[#]	Ethiopia
Broad bean wilt virus	*V. luteola*[#]	Ethiopia
	V. racemosa[#]	Ethiopia
	V. reticulata[#]	Ethiopia
	V. trilobata[#]	Ethiopia
Cucumber mosaic virus	*Glycine max*	AVRDC, Taiwan
	Vigna radiata	Thailand
Southern bean mosaic virus	*P. vulgaris*[#]	CIAT (Colombia)
Tobacco rattle virus	*P. vulgaris*[#]	CIAT (Colombia)
Weed seeds		
Avena sterilis	*Triticum aestivum*	CIMMYT (Mexico)
Bromus diandrus	*T. aestivum*	CIMMYT (Mexico)
**B. tectorum*	*T. aestivum*	Switzerland
**Croton capitatus*	*Oryza sativa*	USA
Emex australis	*T. aestivum*	CIMMYT (Mexico)
Galium aparine	*T. aestivum*	Turkey
G.borale	*T. aestivum*	Switzerland
G.tricornutum	*Lens culinaris*	ICARDA (Syria)
**G.trifidum*	*T. aestivum*	Germany
Ipomoea hederacea	*Oryza sativa*	USA
**Jacquemontia tamnifolia*	*Oryza sativa*	USA
Phalaris minor	*T. aestivum*	Nepal, U. K.
**Polygonum argyrocoleon*	*T. aestivum*	CIMMYT (Mexico)

P. convolvulus	*T. aestivum*	CIMMYT (Mexico), Switzerland, USA
P. hydropiper	*T. aestivum*	ICARDA (Syria)
**Sinapsis arvensis*	*Oryza sativa*	USA
Sorghum almum	*O. sativa*	USA
**Trifolium bifidum*	*Pennisetum purpureum*	Ethiopia
T. incarnatum	*P. purpureum*	Ethiopia
V. angustifolia	*Lens culinaris*	ICARDA (Syria)
V. hirsuta	*L. culinaris*	ICARDA (Syria)
V. villosa	*Hordeum vulgare*	ICARDA (Syria)

* Pest not yet reported from India
# Pest present in India but not recorded on the host on which intercepted

Table 2: Pests intercepted in material meant for pest free conservation

Pests	Host	Source/ Collection Site
Insects		
Acanthoscelides obtectus	*Phaseolus vulgarius*	Uttrakhand
Bruchus lentis	*Lens culinaris*	Uttar Pradesh, Uttrakhand, Jammu & Kashmir , Maharashtra Madhya Pradesh
B. pisorum	*Pisum sativum*	Himachal Pradesh, Gujarat, Haryana, Uttrakhand
Bruchus sp.	*Vicia faba*	Manipur
Callosobruchus analis	*Cicer arietinum*	Madhya Pradesh
	Cajanus cajan	Madhya Pradesh
C. cajanis	*Macrotyloma uniflorum*	Karnataka
	Cajanus cajan	Uttrakhand, Madhya Pradesh
C. chinensis	*Macrotyloma uniflorum*	Andhra Pradesh, Karnataka
	Vigna umbillata	Manipur, Nagaland
C. maculatus	*V. ungniculata*	Uttar Pradesh, Haryana, Jammu & Kashmir
	V. radiate, V. mungo	Rajasthan, Uttrakhand, Karnataka, Chhattisgarh
Callosobruchus sp.	*Cajanus Cajan*	Maharashtra, Mizoram
	Glycine max	Uttrakhand
	Vigna mungo	Uttar Pradesh
	Lablab purpureus	Karnataka
Caryedon serratus	*Arachin hypogaea*	Maharashtra
Immature forms	*Pisum, sativum,*	
	Grossypium hirsutum	Uttar Pradesh, Maharashtra
	Mucuna prunius	Assam
	Vigna radiata	Uttar Pradesh
Spermophagus albosparsus	*Abelmoschus esculentus*	Maharashtra, Uttar Pradesh
Zabrotes subfasciatus	*Lablab purpureus*	Maharashtra
Pathogens		
Alternaria carthami	*Carthamus tinctorius*	Andhra Pradesh
A. padwickii	*Oryza sativa*	Assam
A. raphani	*Anise* spp.	Rajasthan
A. linicola	*Linum* spp.	Maharashtra
Botrytis cinerea	*Lycopersicon esculentum*	NBPGR, New Delhi
Colletotrichum dematium	*Capsicum annum*	Andhra Pradesh; ICAR Res. Complex for North Eastern Region, Jharkhand
Drechslera oryzae	*O. sativa*	Tamil Nadu; Karnataka; Assam; Andhra Pradesh; IARI
Fusarium moniliforme	7 different crops	Various regions
Macrophomina phaseolina	*Capsicum annum*	Andhra Pardesh
Weeds		
Amaranthus viridis	*Triticum aestivum,*	Andhra Pradesh,Madhya Pardesh,NBPGR, New
	Lycopersicon esculentum	Delhi,

Chenopodium album	*Triticum aestivum*	NBPGR, New Delhi,
Echinichloa crusgalli	*O. sativa*	Andhra Pradesh, Delhi, WB, Uttar Pradesh
E.colona	*O. sativa*	Delhi
Lathyrus aphaca	*Pism sativum*	Himachal Pradesh
Medicago denticulata	*P. sativum*	Himachal Pradesh
Melilotus indica	*Brassica* sp.,*T. aestivum*	Himachal Pradesh,NBPGR, New Delhi,
Phalaris minor	*Brassica* sp.,*Trigonella* sp, *T. aestivum*	Haryana, Himachal Pradesh, NBPGR, New Delhi
Polygonum aviculare	*T. aestivum*	Uttarakhand
R. crispus	*Daucus carota,Trigonella* sp	Delhi, Himachal Pradesh
Rumex dentata	*Linum usitatisimum*	Madhya Pardesh
Sesbania	*T. aestivum*	NBPGR, New Delhi,
Sehima nervosum	*O. sativa*	New Delhi
Vicia sativa	*T. aestivum*	Uttarakhand

4.6 Achievements in Externally- funded Projects

4.6.1 National containment/ quarantine facility for transgenic planting material (DBT): With the approval of RCGM, 943 samples of imported transgenic planting material comprising *Arabidopsis thaliana* (255) from USA for Pioneer Overseas Corporation, New Delhi (252), from Japan for Plant Molecular Biology Division, Trivandrum, Kerala (3); *Oryza sativa* (619) from USA for Mahyco, New Delhi (8), from Belgium for Bayer Bioscience, Gurgaon (21), BASF India, Mumbai (584), Devgen Seeds & Crop Technology, Secunderabad (4) and from United Kingdom for Division of Nematology, IARI, New Delhi (2); *Zea mays* (57) from Brazil for Syngenta Bioscience, Pune (1), from Philippiness for Monsanto India, New Delhi (45), from South Africa for Monsanto India Ltd., New Delhi (10) and EI DuPont India, Gurgaon (1); and powder of *Glycine Max* (4) from USA and *Zea mays* (8) from Italy (2) and USA (6) for NBPGR, New Delhi.

The transgenes present in these crops included *cry1A, cry1Ca, cry1C (DG)* for imparting resistance against insect-pests; *SF-19, NP20, PR21, PS22, tublin promoter, NAC domain DNA binding protein, ubiquitin intron, maize cystatin & nos terminator* as cell cycle regulators, *AlaAT* for enhanced nitrogen use efficiency and *bar gene* for resistance to glufosinate amonium herbicides in *Oryza sativa*; *CP4epsps* for tolerance to glyphosate herbicide, *Vip3A* for imparting resistance against insect-pests in *Zea mays*; antifungual *osmotin* gene, osmotic stress tolerance, *CaMv35S* promoter in *Arabidopsis thaliana.*

Seeds of transgenic material were subjected to various tests in containment for detection of insects, mites, nematodes, bacteria, fungi and viruses. Important pests intercepted included, fungus *Fusarium moniliforme* and *Drechslera maydis* in *Zea mays* from the Philippines and USA and *F. moniliforme*, *D. sorokimiana* and *F. semitectum* in *Oryza sativa* from USA and Belgium.

Oryza sativa samples (619) were given prophylactic hot water treatment at 52°C for 30 minutes against various seed-borne pathogens and nematodes. Besides, infected samples of *Zea mays* were salvaged by giving fungicidal treatment with bavistin and thiram.

DNA was extracted from the planting material/seedlings of all the transgenic lines received and were tested for specific events/transgenes/promoters/markers/ terminators and for the absence of terminator technology, using specific primers.

Simplex and multiplex gene-/construct-/event-specific PCRs were standardized for single as well as stacked imported GM maize events *viz.,* MON810, NK603, MON89034, TC1507, GA21, MON89034 x NK603 (stacked event).

- Multiplex PCR in tetraplex format for GM maize event MON810 (*cry1Ab, nptII* marker gene, *CaMV* 35S promoter, *nos* terminator)
- Multiplex PCR in pentaplex format for GM maize event NK603 (*epsps, hsp70, nptII* marker gene, *CaMV* 35S promoter, *nos* terminator)
- Multiplex PCR in hexaplex format for GM maize event MON89034 (*cry2Ab, cry1A.105*, *nptII* marker gene, *CaMV* 35S promoter, *nos* terminator)
- Multiplex PCR in tetraplex format for GM maize

event TC1507 (*cry1F, pat* marker gene, *CaMV* 35S promoter, *nos* terminator)

- Multiplex PCR in tetraplex format for GM maize event GA21 (mepsps, *CaMV* 35S promoter, *nos* terminator)

- Multiplex PCR in heptaplex format for stacked GM maize event MON89034 x NK603 (*cry2Ab, cry1A.105*, *epsps, hsp70, nptII* marker gene, *CaMV* 35S promoter, *nos* terminator)

Real-time event-specific PCR assays were developed for MON810, NK603, MON89034, TC1507 and GA21 imported GM maize events, using TaqMan chemistry.

All these imported lines were also checked to ensure the absence of terminator gene technology employing primers designed for *cre* recombinase gene. None of these lines showed the presence of terminator gene technology.

Seventeen post-entry quarantine inspections were undertaken for *Oryza sativa* (5) from Belgium grown at Devgen Seeds & Crop Technology Medak, A.P. (3) and from Belgium (1) and USA (1) at BASF India R&D centre at Tamil Nadu Agricultural University, Coimbatore; for *Zea mays* (12) from USA at Pioneer Overseas Corporation, Hyderabad (7) and at Monsanto India, Hyderabad (3), from South Africa (1) and Philippines (1) at Monsanto India, Hyderabad. The crops were visually inspected for symptoms of pests/ diseases. Suspected infected leaf and soil samples were tested at NBPGR.

Maize leaves showing virus-like symptoms during growing in containment facility and PEQ inspection were tested against four viruses using ELISA. The results revealed the presence of *Barley stripe mosaic virus* (BSMV) and *Maize chlorotic mottle virus* (MCMV) in samples from USA and *Wheat streak mosaic virus* (WSMV) from South Africa. BSMV, MCMV and WSMV are not reported from India and are of quarantine significance. The infected plants were incinerated and released the harvest only from healthy plants.

Major pests which may accompany the seeds of *Zea mays* from the Brazil, Philippines, South Africa and USA; *Oryza sativa* from Belgium, USA and United Kingdom; and *Arabidopsis thaliana* from USA but not yet reported from India were listed by studying the available literature.

4.6.2 Studies on the potential of electron beam irradiation as quarantine disinfestation treatment against insect-pests in seeds (BRNS, DAE): The results of the present investigations relating to the effect of electron beam irradiation on target pests viz., *Callosobruchus chinensis, C. maculatus, Sitophilus oryzae/ Rhizopertha domnica* infesting green gram, chickpea and paddy respectively, and the effect of treatments on the biochemical parameters of the host seeds were compiled and analysed. Electron beam has potential for disinfestation of green gram seeds infested with *C. maculatus*. Though the mortality is caused at higher doses but sterility is caused at lower doses without affecting the seed quality parameters. No chlorophyll mutation was observed in the plants raised from the irradiated seeds of green gram. EB is an emerging technology which is expected to have positive impacts on agriculture in terms of seed quality improvement/ maintenance. These studies can be further validated to develop the disinfestation protocols to meet the international obligations under the WTO regime in the wake of phasing out of chemical treatments.

4.6.3 Preparation of digitized keys for quick and reliable identification of insect pests of Family Bruchidae of quarantine significance (DAC): A Digital Library on Bruchids comprising digitized keys for identification of seed beetles or bruchids of quarantine significance which are very important pests of pulses, the database on world bruchid genera and the glossary of related morphological terms. This is a free resource and has been developed with the aim to help in quick and reliable identification of bruchids and to provide information on >1500 species of bruchids to all scientists, researchers, teachers and students of Entomology. It also comprises drawings of key characters and images of the > 500 bruchids for ease in identification. The web version of the 'Digital Library on Bruchids' was launched on NBPGR website in June 2011 (http://202.141.12.150/bruchid-library/) and the CD version was released on the foundation day of NBPGR.

View of the homepage

Images of the bruchid

CD on Digital Library on Bruchids

Research Programme (Programme Code: Title, Leader)

PGR/PQR- BUR-DEL-01.00: Quarantine Processing of Plant Germplasm Under Exchange and Supportive Research (**PC Agarwal)**

Research Projects (Code: Title, PI, CoPIs and Associates)

PGR/PQR- BUR-DEL-01.01: Quarantine processing of Germplasm for Joint inspection (**PC Agarwal**, Usha Dev, DB Parakh, Mool Chand Singh, Kavita Gupta, Charan Singh, Dinesh Chand and Ashok Maurya

PGR/PQR- BUR-DEL-01.02: Post-entry Quarantine Processing of Exotic Germplasm (**PC Agarwal,** Arjun Lal, B Lal, DB Parakh, V Celia Chalam, Charan Singh and Ashok Maurya)

PGR/PQR- BUR-DEL-01.03: Quarantine Processing of Imported Transgenic Germplasm and Supportive Research (**Manju Lata Kapur**, Gurinder Jit Randhawa, Shashi Bhalla, Baleshwar Singh, V Celia Chalam, Z Khan and Ashok Maurya)

PGR/PQR- BUR-DEL-01.04: Detection and Identification of Insect and Mite Pests in Quarantine and Supportive Research (**Kavita Gupta**, B Lal (till July 2011), Manju Lata Kapur, Shashi Bhalla and Charan Singh)

PGR/PQR- BUR-DEL-01.05: Detection and Identification of Nematode Pests in Quarantine and Supportive Research (**Arjun Lal** and Z Khan)

PGR/PQR- BUR-DEL-01.06: Detection and Identification of Fungi and Bacteria in Quarantine and Supportive Research (**Usha Dev**, PC Agarwal, Baleshwar Singh and Dinesh Chand)

PGR/PQR-BUR-DEL-01.07: Detection and Identification of Viruses in Quarantine and Supportive Research. (**V Celia Chalam**, DB Parakh and Ashok Maurya)

PGR/PQR-BUR-DEL-01.08: Quarantine Treatments for Disinfestation of Germplasm Under Exchange against Insect and Mite Pests and Supportive Research (**Shashi Bhalla**, B Lal (till July 2011), Manju Lata Kapur, Kavita Gupta, TV Prasad, Charan Singh)

PGR/PQR-BUR-DEL-01.09: Quarantine Treatments for Disinfection of Germplasm Under Exchange against Nematodes and Supportive Research (**Z Khan** and Arjun Lal)

PGR/PQR-BUR-DEL-01.10: Quarantine Treatments for Disinfection of Germplasm Under Exchange against Pathogenic Fungi and Bacteria and Supportive Research (**Baleshwar Singh**, PC Agarwal, Usha Dev, Dinesh Chand)

PGR/PQR-BUR-DEL-01.11: Seed-health Testing for Conservation of Indigenous Germplasm Free from Pests (**B Lal** (till July 2011), Arjun Lal, Usha Dev, Manju Lata Kapur, Veena Gupta, Baleshwar Singh, Shashi Bhalla, Sushil Pandey, Charan Singh, Dinesh Chand, Ashok Maurya and Smita Jain)

PGR/PQR-BUR-DEL-01.12: Detection of Viruses in *In vitro* Cultures of Germplasm Meant for Conservation (**DB Parakh** V Celia Chalam, Sandhya Gupta and Ashok Maurya)

PGR/PQR-BUR-DEL-01.13: Identification of weed seeds intercepted in quarantine and supportive research (**Mool Chand Singh**, Anjula Pandey and Dinesh Chand)

Externally Funded Projects

- National Containment/ Quarantine Facility for Transgenic Planting Material **(DBT)** (**Manju Lata Kapur**, Gurinder Jit Randhawa, V Celia Chalam and Kavita Gupta)
- Studies on the Potential of Electron Beam Irradiation as Quarantine Disinfestation Treatment against Insect-pests in Seeds **(BRNS, DAE)** (till March 2011) (**Shashi Bhalla**, SK Sharma, B Lal, Kalyani Srinivasan and Kavita Gupta)
- Preparation of Digitized Keys for Quick and Reliable Identification of Insect Pests of Family Bruchidae of Quarantine Significance (till September 2011) **(DAC)** (**Kavita Gupta**, B Lal, Manju Lata Kapur, Shashi Bhalla)
- Development of Farmer Friendly Diagnostic Kits for Transgenic Event Seed Purity **(ICAR) (V Celia Chalam)**
- Study of biological control of invasive plant species and Indian natural enemies viz., Component A: Himalayan balsam (*Impatiens glandulifera* and Component B: *Hedychium* spp. complex (*H. gardneriarum*, *H. flavescens*, *H. coronarium*) (**ICAR-CABI collaborative project**) **(Usha Dev,** Kavita Gupta and Mool Chand Singh)

5. GERMPLASM EXCHANGE

Summary: During the period under report 1,22,042 samples were imported which included 31,548 accessions (31,877 samples) of germplasm and 7,044 entries (90,165 samples) of CGIAR nurseries for trials. Requirements for germplasm from abroad were met by arranging material from different Indian sources and 1,303 samples of different crops were exported to ten countries under SMTA/ MTA after the approval of DARE. A total of 4,043 samples of different crops were supplied to national users for utilization in various crop improvement programmes in the country based on requests received from research workers under material transfer agreement (MTA)

5.1 Import of Plant Genetic Resources

The unit continued its efforts for germplasm introduction to meet the specific requirements of scientists working in ICAR research institutes, State Agricultural Universities (SAUs), other public organizations and private sector with R&D and non-governmental organizations (NGOs). Plant genetic resources import/ introduction comprised material obtained on request from the scientists as well as collaborators for international trials to be conducted in India. Introductions of seed/planting material made during the year were as follows.

Germplasm accessions procured and processed	31,548 accessions (31,877samples)
CGIAR nurseries for trials	7,044 entries (90,165 samples)
Transgenic material imported	379 samples
No. of countries involved	36
No. of Import Permit issued	630

5.1.1. Cereals: *Hordeum vulgare* (690) from Syria, (9) from USA; *H. vulgare* subsp. *vulgare* (28) from USA; *Oryza sativa* (50) from Argentina, (4) from Bangladesh, (629) from Belgium, (133) from China, (23) from Colombia, (104) from Indonesia, (5) from Japan, (301) from Kenya, (12567) from Philippines, (274) from Singapore, (2) from UK, and (1084) from USA; *T. aestivum* (200) from Australia, (196) from Germany, (300) from Mexico, (148) from Nepal, (796) from Netherlands, (3) from Switzerland, (166) from Syria, (376) from UK and (14) from USA ; *T. aestivum* subsp. *aestivum* (32) from USA*; Zea mays* (93) from Brazil, (4608) from Chile, (70) from Egypt, (10) from France, (8) from Germany, (65) from Indonesia, (48) from Kenya, (590) from Mexico, (153) from Nigeria, (61) from Philippines, (32) from South Africa, (2133) from Thailand, (30) from Turkey, (18) from Ukraine, (614) from USA and (85) from Zimbabwe.

5.1.2 Millets: *Eleusine africana* (54), *E. indica* (49), *E. jaegeri* (4), and *E. kigeziensis* (8) all from Uganda; *Panicum miliaceum* (4) from USA; *Pennisetum glaucum* (10) from Australia, (478) from Sudan, *P. macrourum* (6), *P. mezianum* (8), *P. procerum* (13), *P. ramosum* (29) and *Pennisetum* sp. (1) all from Uganda, *P. typhoides* (10) from Australia and *P. unisetum* (44) from Uganda; *Setaria italica* (16) from China; *Sorghum bicolor* (34) from France, (65) from Germany, (11) from Mexico, (7) from South Africa, (673) from Sudan and (3) from USA.

5.1.3 Oilseeds: *Arachis duranensis* (1) and *A. pintoi* (1) both from Ethiopia; *Brassica carinata* (35) from Australia and (1) from UK, *B. caulorapa* (1) from Netherlands, *B. cretica* (2), *B. fruticulosa* (5), *B. insularis* (1) all from Australia, *B. juncea* (6) from Australia, (79) from Canada, (1) from UK, *B. montana* (2) from Australia, *B. napus* (6) from Australia, (6) from Canada and (1) from UK; *Helianthus agrestis* (2), *H. angustifolius* (2) both from USA; *H. annuus* (77) from Argentina, (1) from Australia, (99) from Belgium, (350) from France, (8) from Serbia, (3) from Switzerland, (20) from Ukraine, (57) from USA, *H. anomalus* (2), *H. argophyllus* (2), *H.* arizonensis (2), *H. atrorubens* (4), *H. bolanderi* (2), *H. s carnosus* (2), *H. ciliaris* (2), *H. cusickii* (2), *H. debilis* subsp. *cucumerifolius* (3), *H. debilis* subsp. *debilis* (3), *H. debilis* subsp. *silvestris* (2), *H. debilis* subsp. *vestitus* (2), *H. deserticola* (2), *H. exilis* (2), *H. floridanus* (2), *H. glaucophyllus* (2), *H. gracilentus* (2), *H. heterophyllus* (2), *H. hybrid* (1), *H. laciniatus* (2), *H. laevigatus* (2), *H. longifolius* (2), *H. microcephalus* (2), *H. neglectus* (1), *H. niveus* subsp. *canescens* (4), *H. niveus* subsp. *tephrodes* (2), *H. occidentalis* (1), *H. occidentalis* subsp. *occidentalis* (1), *H. occidentalis* subsp. *plantagineus* (3), *H. petiolaris* subsp. *fallax* (2), *H. petiolaris* subsp. *petiolaris* (3), *H. porteri* (2), *H. praecox* subsp. *hirtus* (2), *H. praecox* subsp. *praecox* (3), *H. praecox* subsp. *runyonii* (2), *H. pumilus* (2) *H. radula* (2), *H. resinosus* (3), *H. salicifolius* (2), *H. silphioides* (2),

H. simulans (1), *H. s smithii* (2) all from USA; *Hirschfeldia incana* (5) from Australia; *Linum usitatissimum* (32) from Australia; *Ricinus communis* (71) from USA; *Sinapsis arvensis* (5) from Australia.

5.1.4 Grain legumes: *Cicer arietinum* (65) from Azerbaijan, (1) from Canada, (101) from Syria, *C. bijugum* (28), *C. chorassanicum* (1), *C. cuneatum* (2), *C. echinospermum* (7), *C. judaicum* (42), *C. pinnatifidum* (35), *C. reticulatum* (18), *C. yamashitae* (3) all from Syria; *Dolichos sericeus* (1) from Ethiopia; *Glycine max* (10) from Canada, (1) from Nigeria and (5) from Taiwan; *Lathyrus aphaca* (1), *L. cicera* (4), *L. ochrus* (3) all from Ethiopia; *L. odoratus* (3) from Switzerland; *Lathyrus* sp. (200) from Ethiopia ; *Lens culinaris* (232), *L. culinaris* subsp. *odemensis* (50) , *L. culinaris* subsp. *orientalis* (211), *L. culinaris* subsp. *tomento* (20) , *L. ervoides* (136), *L. lamottei* (8), *L. nigricans* (39) all from Syria; *Vigna luteola* (5), *V. membranacea* (1), *V. parkeri* (4) *V. racemosa* (3) all from Ethiopia; *V. radiata* (6) from Taiwan, (113) from Thailand, *V. reticulata* (4), *Vigna* sp. (1) all from Ethiopia; *V. subterranea* (88) from Nigeria; *V. trilobata* (5) from Ethiopia; *V. unguiculata* (1,570) from Nigeria and *V. vexillata* (5) from Ethiopia.

5.1.5 Vegetables: *Abelmoschus esculentus* (3) from Mali, (14) from Niger, *Abelmoschus* sp. (1) from Niger; *Allium cepa* (2) from Mali and (96) from USA; *Allium sativum* (1) from Korea; *Brassica oleracea* (5) from Australia, *B. oleracea* var. *botrytis* (169) from Netherlands, (1) from UK, (20) from USA, *B. oleracea* var. *capitata* (40) from China, (11) from Netherlands, (1) from UK, *B. oxyrrhina* (2) from Australia, *B. rapa* (2) from UK and *B. tournfortii* (5) from Australia; *Capsicum annuum* (6) from Mali, (388) from Netherlands and (211) from Taiwan, *C. annuum* var. *longum* (4), *C. baccatum* (1) both from Taiwan; *Cucumis melo* (262) from Indonesia; *Cucumis sativus* (5) from Netherlands and (1) from USA; *Lycopersicon esculentum* (2) from Korea,(4) from Mali, (215) from Taiwan, (5) from Thailand and (570) from USA, *L. peruvianum* (114), *L. pimpinellifolium* (183) from Netherlands, (177) from USA; *Raphanus sativus* (3) from Australia; *Solanum arcanum* (6) *S. cheesmaniae* (3) both from USA; *S. chilense* (2) from Taiwan; (8) from USA, *S. chmielewskii* (2), *S. corneliomulleri* (5), *S. galapagense* (3) all from USA; *S. habrochaites* (2) from Taiwan, (5) from USA, *S. huaylasense* (4), *S. lycopersicoides* (3) both from USA; *S. lycopersicum* (5) from Taiwan, (47) from USA, *S. melongena* (3) from Taiwan, *S. neorickii* (3), *S. pennellii* (5), *S. peruvianum* (4) all from USA, *S. pimpinellifolium* (1) from Taiwan, (4) from USA and *S. sitiens* (1) from USA.

5.1.6 Fruits: *Anona reticulata* (1) from Taiwan; *Carya illinoinensis* (5) from USA; *Siraitia grosvenorii* (1) from USA.

5.1.7 Forages: *Aeschynomene americana* (5), *A. brasiliana* (5), *A. falcata* (5), *A. scabra* (1), *A.sensitiva* (3) all from Ethiopia; *Calopogonium mucunoides* (5), *Calotropis ensiformis* (5), *Canavalia brasiliensis* (2) from Ethiopia; *Carrichetra annua* (3) from Australia; *Centrocema macrocarpum* (5) and *C. pubescens* (5) from Ethiopia; *Conringia orientalis* (1) from Australia; *Diplotaxis tenuifolia* (5) from Australia; *Eucalyptus* sp. (56) from South Africa; *Gynanadrosis pentaphylla* (14) from France; *Macroptilium atropurpureum* (4), *M. lathyroides* (5), *M. africanum* (4), *M. axillare* (5) and *Macrotyloma* sp. (3) all from Ethiopia; *Medicago falcata* (4), *M. falcata* x *sativa* (2), *M. sativa* (14), *M. varia* (3) all from New Zealand; *Neonotonia wightii* (5) from Ethiopia; *Phaseolus lunatus* (5), *Pueraria phaseoloides* (5) both from Ethiopia; *Raphanus raphanistrum* (2), *Rapistrum rugosum* (5) both from Australia; *R. densiflora* (1), *R. elegans* (2), *R. malacophylla* (1), *R. minima* (5), *R. reticulata* (1), *Rhynchosia sublobata* (2), *R. totta* (4) all from Ethiopia; *Stylosanthes calcicola* (1), *S. capitata* (5), *S. guianensis* (5), *S. humilis* (5), *S. ingrata* (1), *S. leiocarpa* (1), *S. macrocarpa* (4), *S. macrocephala* (4), *S. mexicana* (1), *S. scabra* (5), *S. viscosa* (5) all from Ethiopia; *Zornia brasiliensis* (1), *Z. diphylla* (5), *Z. glabra* (5), *Z. glochidiata* (3) and *Z. latifolia* (5) all from Ethiopia.

5.1.8 Fibres: *Gossypium arboreum* (6), *G. hirsutum* (17) both from Pakistan; and *G. hirsutum* (556) from USA.

5.1.9 Tubers: *Colocasia esculenta* (50) from Fiji; *Solanum tuberosum* (7) from Australia, (8) from China, (1) from Egypt, (12) from New Zealand and (8) from USA; *Manihot esculenta* (7) from Germany.

5.1.10 Medicinal and aromatic plants: *Aloe ferox* (1) from South Africa; *Hypoxis hemerocallidea* (1) from Swaziland; *Senna alata* (1), *S. alexandrina* (1), *S. angulata* (1), *S. corymbosa* (1), and *S. uniflora* (1) from USA.

5.1.11 Underutilized plants: *Avena sativa* (10) from Brazil; *Vicia benghalensis* (1), *V. hirsuta* (2) and *V. villosa* (6) from Ethiopia.

5.1.12 Narcotics and beverages: *Nicotiana tabacum* (3) from Brazil.

5.1.13 Sugar yielding plants: *Saccharum* sp. (2) from USA.

5.1.14 Others: *Arabidopsis thaliana* (3) from Japan; (245) from USA.

Table 1: Trait specific germplasm introduced during 2011

Crop/EC No./Country	Specific Traits	Distribution
***Triticum aestivum* (Wheat)**		
EC693905 /Canada	PHS tolerant white wheat	CCSMU, Meerut
EC721736/Nepal	Variety Vijay (BL 3063) having good resistance against variants of Ug99, and impressive agronomic performance under both normal and late sown conditions in the Terai region of Nepal, is believed to have terminal heat tolerance. Bold seeded amber colored grains, high protein content (12.5%), and good quality for baking industries	GED, NBPGR, IARI, New Delhi
EC699417-418/ USA	Colored germplasm	National Agri. -Food Biotechnology Institute, Mohali
***Oryza sativa* (Paddy)**		
EC695984/Philippines	Lines for heat tolerance screening	Tamil Nadu Rice Research Institute, Thanjavur, TN
EC699258/ Philippines	Submergence tolerant lines	Birsa Agricultural University, Ranchi
EC714174-176/Philippines	Salinity and submergence tolerant lines	DRR, Hyderabad
EC715643- EC716353/ Philippines	Mapping Populations	SVBPUAT, Meerut
EC716881- EC716911/ Philippines	Blast Monogenic Lines	Ankur Seed Private Ltd, Nagpur
EC717928-937/ Philippines	Bacterial Leaf Blight resistant lines	Rasi Seeds Pvt. Ltd, TN
EC720903-904 / Philippines	Thermogenic Male Sterile lines	KAU, Thrissur
EC720905/ Indonesia	High yielding hybrid variety H512	PHI Seed Private Ltd, Hyderabad
EC699098-9257/Philippines	Salinity tolerant lines	CRRI, Cuttack, Odisha
EC725224- EC725249 / Philippines	Drought tolerant pyramiding lines, salinity tolerant, and low input tolerant	TNAU, Coimbatore
EC725250- EC725252 / Philippines	Submergence tolerant line	TNAU, Coimbatore
***Hordeum vulgare* (Barley)**		
EC698842/ USA	cv Sidney a Russian wheat aphid (RWA) resistant spring, two rowed feed barley	DWR, Karnal
EC698843/ USA	cv. Otis a spring barely well adapted to the high dry plains, is susceptible to RWA	DWR, Karnal
EC698889-95/ USA	Germplasm STARS 0637B to 0643B, source of resistance resistance to RWA (*Diuraphis noxia*, (Mordvilko), They are comparable to their recurrent parents in yield, test weight, plant height, and heading date in the absence of RWA and superior in	DWR, Karnal

	grain yield to their recurrent parents in the presence of RWA.	
***Zea mays* (Maize)**		
EC707957- EC708021/ Indonesia	Tolerant to downy mildew	Devgen Seeds Pvt Ltd., Secunderabad
EC697044-7131/ Mexico	High yielding lines	Monsanto India Limited, New Delhi
***Helianthus annuus* (Sunflower)**		
EC699721/USA	Rust resistant line	DOR, Hyderabad
EC699730- 31, 738, 740, 742, 762, 770-71EC699816/ USA	High oil content	DOR, Hyderabad
EC699748-50, 753-758/ USA	Downy mildew resistant	DOR, Hyderabad
EC699735-36, 756/ USA	High oleic acid content	DOR, Hyderabad
EC699765,67,69/ USA	CMS lines	DOR, Hyderabad
EC699746-47/USA	Orobanche resistant	DOR, Hyderabad
EC699732,760-761 EC699764, 774/ USA	Dwarf types	DOR, Hyderabad
***Vigna radiata* (Mung bean)**		
EC718740- EC718745/ Taiwan	Early maturing lines resistant to *Mungbean yellow mosaic virus*, *Pea yellow mosaic virus* and bold seeded	CIMMYT India Office, New Delhi
***Capsicum annuum* (Chilli)**		
EC695166- EC695175/ Taiwan	Anthracnose resistant lines	Vibha Agrotech, Hyderabad
***Lycopersicon esculentum* (Tomato)**		
EC698821-836/ Taiwan	Homozygous for resistance to Fusarium wilt race 1, 2 & 3	Super Agri Seeds Ltd., Hyderabad
EC699710-718EC700929-939/ Taiwan	Resistant to *Tomato mosaic virus*, fusarium wilt race 1, 2 & 3	Krishidhan Vegetable Seeds India Pvt.Ltd., MaharashtraNath Biogenes (I) Ltd., Nath House, Maharashtra
EC721238- EC721241/ Taiwan	High beta carotene lines	Indo-American Hybrid Seed, Bangalore
EC698844-698875, USA	Segregating lines of tomato with resistance to bacterial wilt	Advanta India Ltd., Bangalore
***Colocasia esculenta* (Taro)**		
EC714177- EC714201, EC719534-541/ Fiji	Taro Leaf blight tolerant and susceptible lines, very good taste	CTCRI, Trivandrum, TCCU, NBPGR
Core collection introduced in		
***Triticum aestivum* (Wheat)**		
EC721309-721684/ UK	Core Collection	PAU, Ludhiana, DWR, Karnal
***Vigna unguiculata* (Cowpea)**		
EC723645-725372/ Nigeria	Core Collection	PEQN
New plant species introduced		
***Hypoxis hemerocallidea* (African potato)**		
EC717953/ Swaziland	A medicinal plant native to South Africa, efficacious in treatment of benign prostatic	Jamia Hamdard, New Delhi, PQD, NBPGR

	hyperplasia, commonly known as African potato or African star grass	
***Siraitia grosvenorii* (Siraitia)**		
EC697455/USA	Best known for its fruit, fruit extract is nearly 300 times sweeter than sugar and has been used as a natural sweetener in China for nearly a millennium, also used in traditional Chinese medicine from USA	NBPGR, Regional Station, Shimla and Bhowali

Table 2: Details of transgenic seed material introduced

Accession No./ Country	Genes/Events	Supplied to
Zea mays		
EC693988-999/ USA	Event MON 810 (*Cry 1Ab* gene)	Pioneer Overseas Corporation, New Delhi
EC694000-694011/ USA	Event NK 603 (*CP 4 EPSPS* gene)	Pioneer Overseas Corporation, New Delhi
EC694012-694021/ USA	Stacked events of TC1507 (*Cry 1F* and *PAT* genes)	Pioneer Overseas Corporation, New Delhi
EC694953-694978 / USA	TC1507 event (*Cry 1F* & *PAT* genes)	Pioneer Overseas Corporation, New Delhi
EC695456- EC695464/ Philippines EC699259- EC699268/South Africa	Event NK 603 (*CP 4* gene)	Monsanto India Limited,, New Delhi
EC699269/ Brazil	*Vip 3A* gene (MIR16 event)	Syngenta Biosciences Ltd., Pune
Oryza sativa		
EC695099-5103/ USA	Construct RPD 13- RPD 16	BASF India Limited, Maharashtra
EC695582/ Belgium	*Cry1C (DG)* gene	Devgen Seeds and Crop Technology (P) Ltd., Secunderabad
EC695104- 123, EC705433-34/ Belgium	*Cry 1Ab (DG)* gene	Devgen Seeds and Crop Technology (P) Ltd., Secunderabad
EC699270- EC699289,EC717062-EC717300/Belgium	Events of gene constructs RPD17 – 25 and null segregants	BASF India Limited, New Delhi
EC714207-208/ UK	Nematode resistant gene	IARI, New Delhi
EC717626- EC717645/ Belgium	*Cry 1Ab, Cry 1Ca* and *bar* genes.	Bayer Bioscience (P) Ltd., Gurgaon

5.2 Export of Plant Genetic Resources

The seed and plant material of agricultural and horticultural crops were exported on the basis of (i) requests received by the bureau/ICAR headquarters (ii) requests received from the scientists working in ICAR institutes/agricultural universities in India under various protocols/ work plans memoranda of understanding with different countries/ CGIAR institutions.

The plant material intended for export were procured from known Indian sources through correspondence and the same were forwarded to the indentors in foreign countries alongwith phytosanitary certificates issued by the Plant Quarantine Division of the Bureau and import permit, if any, only after approval from ICAR/DARE as per the guidelines. The details of export of seed/ planting material during 2011 are indicated below.

Number of countries to which material exported: 10

Number of samples exported : 1,303

Cereals: *Oryza sativa* (56) to IRRI, Philippines; *Triticum aestivum* (407) to National Plant Breeding Centre, Kenya; (189) to Ethiopian Institute of Agricultural Research, Ethiopia, (425) to DAFWA, Australia; *Zea mays* (15) to NARC, Nepal.

Vegetables: *Momordica charantia* (100), *M. subangulata* ssp *renigera* (1), *M. balsamina* (1) to AVRDC, Taiwan.

Grain legumes: *Cicer arietinum* (3) to ICARDA, Syria.

Fibres: *Gossypium* spp. (23) to CCRI, Pakistan

Fruits: *In vitro* cultures and cryo-preserved samples of *Musa* sp (58) to INIBAP, Belgium; *Mangifera indica* (30 saplings of Alfonzo variety) to High Commission of Mozambique.

Country-wise export of PGRs : Australia (425) of *Triticum aestivum*; Belgium (58) of *Musa* sp; Ethiopia (189) of *T. aestivum*; Kenya (407) of *T. aestivum*; Mozambique (30) *of Mangifera indica*; Nepal (15) of *Zea mays*; Pakistan (23) *of Gossypium* spp.; Philippines (56) of *Oryza sativa*; Taiwan (102) *of Momordica* spp.; Syria (3) of *Cicer arietinum.*

5.3 Inland Supply of Plant Genetic Resources

The seed and planting material of diverse agri-horticultural crops were supplied to IARI institutes/ coordinated projects, agricultural universities and other users in India. Based on specific requests received 4043 samples were supplied by the Germplasm Exchange Division of the Bureau as per details given below under the Material Transfer Agreement (MTA).

Crop	Sample	Supplied to	Received from NAGS
Cereals			
Rice	112	NRC PB, New Delhi; North Eastern Hill University, Shillong; TNAU; University Participatory Rural Development Foundation	CRRI, Cuttack GCD, NBPGR, NBPGR RS Shillong
Wheat	934	IARI, New Delhi; IARI RS Wellington; IARI RS Shimla; DWR, Karnal; GBPUAT, Pantnagar; BHU, Varanasi; CSKHPKV, Palampur; UAS, Dharwad; CCSHAU, Hisar; CSUAT, Kanpur; VPKAS, Almora; CSSRI, Karnal	GCD, NBPGR, NBPGR RS Bhowali
Barley	792	DWR, Karnal; CSUAT, Kanpur; ARS Durgapura	GED, NBPGR
Maize	55	CRIDA, Hyderabad	NBPGR RS Hyderabad
Millets			
Foxtail Millet	10	NBPGR	ICRISAT, Hyderabad
Kodo Millet	25	ANGRAU, Hyderabad	NBPGR RS, Hyderabad
Pearl Millet	2	NBPGR	ICRISAT, Hyderabad
Oilseeds			
Sesame	14	SDAU Krushinagar, Gujarat	GCD, NBPGR
Safflower	3	Department of Botany, University of Delhi; Banasthali University,Banasthali	GED, NBPGR, NBPGR RS Akola
Sunflower	1	DOR, Hyderabad	GCD, NBPGR
Linseed	120	Ch. Shivnath Singh Shandilya (P.G.) College, Machhra, Meerut; UAS, Bangalore	GED, NBPGR, NBPGR RS Akola
Mustard	100	GGBPUAT, Pantnagar; DRMR, Bharatpur; CSAUAT, Kanpur ; CCSHAU Bawal ; Bundelkhand University, Jhansi	GED, NBPGR
Grain legumes			
Chickpea	28	Bundelkhand University; Sambalpur University, Orissa; IARI, New Delhi	GED, NBPGR
Pea	52	Sambalpur University, Orissa; IARI, New Delhi; Kisan P.G. College, Simbhaoli	GED, NBPGR, GCD, NBPGR
Lentil	5	Bundelkhand University	GED, NBPGR
Kidney bean	51	Kurukshetra University; SKUAST (K);	NBPGR RS Shimla

(Rajmash)		PAU, Ludhiana	
Pigeon pea	62	NRCPB, New Delhi;CRIDA, Hyderanad	IIPR, Kanpur, NBPGR RS Hyderabad
Lathyrus	10	CCSMU, Meerut	NBPGR RS Akola
Mung bean	2	IARI, New Delhi	GCD, NBPGR
Vigna spp	18	Indian Agricultural Research Institute	NBPGR RS Thrissur NBPGR RS Jodhpur
Cow pea	99	SKUAST (J)-Pulses Research Sub-Station, Samba; SVBPUAT; TNAU	GED, NBPGRIIVR, Varanasi
Dolichos bean	9	PAJANCOA, Karaikal	NBPGR RS Akola
Urdbean	88	SKUAST (J)-Pulses Research Sub-Station, Samba; IARI, New Delhi; ANGRAU, Hyderabad; SHIATS, Allahabad	GED, NBPGR, NBPGR RS Jodhpur, NBPGR RS Hyderabad
Horsegram	71	ANGRAU,Hyderabad	NBPGR RS Hyderabad
Winged bean	100	NBRI, Lucknow	NBPGR RS Akola
Vegetables			
Muskmelon	50	PAJANCOA, Nedungadu	NBPGR RS Jodhpur
Ridge gourd	40	TNAU, Coimbatore; KRC College of Horticulture, Arabhavi	GED, NBPGR
Sponge gourd	40	TNAU, Coimbatore; CIAH, Bikaner	GED, NBPGR
Bitter gourd	55	K.R.C. College of Horticulture, Arabhavi; AAU, Anand; TNAU Coimbatore	NBPGR RS Thrissur
Round Melon	10	RAU, Bikaner	NBPGR RS Jodhpur
Okra	348	AAU, Anand; Navsari Agricultural University; IARI, New Delhi; PDKV, Akola; MPUAT, Udaipur; Mahatma Phule Agricultural University,	NBPGR RS Akola, GED, NBPGR
Snake gourd	43	Kakatiya University; TNAU	NBPGR RS Thrissur
Water melon	10	CIAH, Bikaner	NBPGR RS Jodhpur
Brinjal	162	TNAU, Coimbatore; CCSHAU, Hisar	GED, NBPGR, NBPGR RS Hyderabad
Spine gourd	14	YSPUAF, Solan	NBPGR RS, Hyderabad
Tomato	105	IARI, New Delhi; CCSHAU, Hisar; ARI, Hyderabad	IIHR, Bangalore, GED, NBPGR
Trigonella spp.	5	Bundelkhand University, Jhansi	GED, NBPGR
Cucumber	30	AAU,Jorhat, Assam	NBPGR RS Jodhpur
Citrullus melo	20	TNAU, Coimbatore	NBPGR RS Jodhpur
M&AP			
Kalmegh	16	Jamia Hamdard; SKUAST (J),Main Campus, Chatha; YSPHUAF, Solan	GED, NBPGR
Ashwgandha	6	YSPHUAF, Solan	GED, NBPGR, DMAPR, Anand
Tulsi	20	Jamia Hamdard, New Delhi	GED, NBPGR
Aloe	22	SKUAST (J),Main Campus, Chatha; Osmania University, Hyderabad	GED, NBPGR
Solanum viarum	1	K.R.C. College of Horticulture	GED, NBPGR

Galangal	5	KAU, Kerala; Calcutta University, Kolkatta; Sh. Jitendra Kumar Singh,Village Belwara, P.O. Kamtaul	NBPGR RS Shillong, NBPGR RS Thrissur
Tinospora cordifolia	20	Guru Jambheshwar University of Science & Technology, Hisar	GED, NBPGR
Picrorhiza scrophulariiflora	1	Jaypee University of Information and Technology,Solan	TCCU, NBPGR
Alpinia officinarum	1	Kerala Agricultural UniversityOdakkali, Asamannoor	NBPGR RS, Shillong
Bacopa	1	NBPGR Regional Station-Thrissur	TCCU, NBPGR, New Delhi
Fruits			
Strawberry	51	CITH, Srinagar	NBPGR RS Bhowali
Passion Fruit	4	IIHR, Bangalore	NBPGR RS Shillong
Mango	25	IIHR, Bangalore	NBPGR RS Thrissur
Jackfruit	1	IIHR, Bangalore	NBPGR RS Thrissur
Banana	7	Jawaharlal Nehru University	TCCU, NBPGR
Under-utilized crops			
Guar (vegetable type)	20	PAU, Bathinda	NBPGR RS Jodhpur
Coix lacryma-jobi	4	Hooghly Mohsin College, Chinsurah	GED, NBPGR
Amaranth	60	Utkal University,Bhubneswar; Jamia Hamdard; TNAU, Coimbatore	NBPGR RS Shimla
Jatropha	55	DIBER, Haldwani; Institute of Science, Mumbai; Vinobha Bhave University, Hazaribag	NBPGR RS Jodhpur, AICRP on UU, NBPGR, NBPGR RS Ranchi
Camelina	1	Indian Oil-CREDA Biofuels, Raipur	DIBER, Haldwani
Faba bean	20	CIAH, Bikaner	GED, NBPGR
Rice bean	1	IARI, New Delhi	NBPGR RS Thrissur, NBPGR RS Jodhpur
Spices			
Ginger	2	Jamia Hamdard	NBPGR RS Shillong
Fibres			
Cotton	5	Maitreyi College,University of Delhi,	CICR, Nagpur

Seed material supplied for regeneration/ multiplication/ morphological characterization/ preliminary evaluation from Germplasm Conservation Division

Crop	No. of samples	Sent to
Rice	13,069	DRR, Hyderabad; CSSRI, Karnal; BHU, Varanasi; IGKVV, Raipur
Pearl millet	4284	NBPGR RS Jodhpur
Cowpea	34	NBPGR RS Jodhpur
Chickpea	1,700	NBPGR RS Akola
Mungbean	379	NBPGR RS Jodhpur
Pigeonpea	800	NBPGR RS Akola

Horse gram	120	KAU Research Station
Soybean	1,135	UAS, Bangalore; MPKV, Sangli; BAU, Ranchi; PAU, Ludhiana; Agharkar Research Institute, Pune; MAU
Sesame	907	AICRP on Sesame & Niger, Jabalpur
Groundnut	1,135	DGR, Junagadh; BARC, Bombay
Sunflower	20	DOR, Hyderabad
Castor	243	DOR, Hyderabad
Saffloer	20	DOR, Hyderabad
Brachypodium	59	NBPGR RS, Shimla
Different forage grasses (*Bothriochloa , Cymbopogon, Eriochloa, Heteropogon, Dichanthium, Chrysopogon, Cenchrus, Celosia, Eragrostis, Digitaria* and others)	368	NBPGR RS, Thrissur
Leafy vegetables (cauliflower, cabbage, broccoli)	217	IARI RS Katrain
Spices (coriander, fenugreek, fennel)	484	NBPGR RS, Bhowali
***In vitro* cultures supplied to repositories**		
Turmeric	194	IISR, Calicut
Banana	42	NRC, Banana
Sweet Potato	119	CTCRI, Thiruvananthapuram
Yam	60	CTCRI, Thiruvananthapuram
Taro	95	CTCRI, Thiruvananthapuram
Total	**25,365**	

Programme (Programme Code: Title, Leader)

PGR/GEX-BUR-DEL-01.00- Exchange of Plant Genetic Resources with foreign countries (import/export) and national supplies of the Plant Genetic Resources and related information to the scientist/users in the country **(Arjun Lal)**

Research projects (Code, Title, PI, COPIS and Associate/s)

PGR/GEX-BUR-DEL-01.01: Import, export and inland supply of PGR in Cereals, Pseudo cereals, Oilseeds, Fibers, Medicinal & Aromatic Plants, Millets, Sugar yielding crops and exchange of related information to the scientists and users in the country (**Vandana Tyagi**; Pratibha Brahmi, Anitha Pedapati, SP Singh, Surender Singh)

PGR/GEX-BUR-DEL-01.02: Import, export and inland supply of PGR in Fruits, Grain Legumes, Tubers, Narcotics and Beverages and exchange of related information to the scientists and users in the country. (**Nidhi Verma**; SK Yadav, SP Singh, Surender Singh)

PGR/GEX-BUR-DEL-01.03-Import, export and inland supply of PGR in Vegetables, Forages, Under Utilized Plants, Ornamentals, Spices and Condiments, Plantation crops and exchange of related information to the scientists and users in the country. (**SK Yadav**; Nidhi Verma, Anitha Pedapati, SP Singh, Surender Singh)

PGR/GEX-BUR-DEL-01.04: Documentation and dissemination of information on germplasm both imported and collected in the form of Plant Germplasm Reporter and preparation of Crop Inventories. (**Pratibha Brahmi**, Vandana Tyagi, Nidhi Verma, SK Yadav, Anitha Pedapati, SP Singh, Surender Singh)

PGR/GEX-BUR-DEL-01.05: Survey and assembly of literature on Plant Genetic Resources and its documentation for procurement of elite/trait specific germplasm**. (Arjun Lal**; Vandana Tyagi, Nidhi Verma, SK Yadav , Anitha Pedapati, SP Singh, Surender Singh

6. TISSUE CULTURE AND CRYOPRESERVATION

Summary: During the year, a total of 2,075 accessions belonging to fruit crops, bulb and tuber crops, medicinal, aromatic and rare/endangered plants, spices, plantation and industrial crops, and others were conserved as *in vitro* cultures, under culture room conditions and/or at low temperature. The average subculture duration ranged from 4-24 months, depending on the species. In *Allium tuberosum* and *Picrorrhiza scrophuliflora,* cultures were conserved for 21 and 8 months, respectively at low temperature in dark. In *Kaempferia galanga,* encapsulated shoot bases were stored in cryovials without nutrient medium, up to 4 weeks. Cryopreservation experiments using droplet-vitrification, encapsulation-dehydration or vitrification techniques, led to varying degree of pre-and post-freezing success in *Allium* spp*., Malus domestica and Prunus armeniaca.* The genetic stability assessment was carried out in *in vitro*-conserved plantlets of *A. tuberosum* and *Colocasia esculenta* and, cryopreserved plantlets of *A. tuberosum* and *Morus* sp. using SSR markers. There were no significant differences between the *in vitro*–conserved regenerants and/or post-thaw regenerated plants, and their controls. A total of 91 accessions comprising *Allium sativum* (3), *Dioscorea* spp. (3), *Malus domestica* (35) and *Musa* sp. (50) were cryostored as shoot tips or dormant buds. A total of 59 accessions comprising *Bacopa monnieri* (1)*, Fragaria* x *ananasa* (18), *Musa* spp. (34), *Picrorrhiza scrophuliflora* (1) and *Vaccinium ovatum* (5) were supplied as *in vitro* cultures to various indentors. A total of 381 accessions were cryostored as seeds, embryonic axes and dormant buds during the year, totalling 9,869 accessions in the cryogenebank. Successful cryopreservation was achieved in seeds, embryos and embryonic axes of *Citrus karna*, *C. pseudolimon, C. megaloxycarpa, C. pati-jora (citron), C. jhambiri, C. sinensis* and *Manilkara hexandra.*

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

6.1 *In Vitro* Conservation and Cryopreservation

During the year, 37 new accessions were added in the *In Vitro* genebank and these include: *Allium* spp. (2), *Colocasia esculenta* (10), *Dioscorea* spp. (11), *Gaultheria* sp. (1) and *Malus domestica* (13). A total of 2,075 accessions belonging to different crop groups were maintained *in vitro* and subcultured at periodic interval (Table 1).

6.1.1 Tropical fruits: A total of 415 accessions of *Musa* (in the form of ~ 10,000 cultures*)* were conserved at 25^{0}C under 8/16 h photoperiod. The average subculture period varied from 6-12 months, depending on the genotype.

Under Letter of Agreement between ICAR and Bioversity international, a set of 50 accessions of *Musa* germplasm from International Transit Centre (ITC) KUL, Leuven, in the form of *in vitro* cultures, were transferred to NBPGR. These were cryobanked at NBPGR and 26 accessions shipped back to ITC, Leuven as cryopreserved meristems, to compliment the other accessions already cryopreserved at Leuven. A set of 60 Indian *Musa* germplasm accessions belonging to AA, AB, ABB, AAB and AAA genomic groups were provided to ITC, Leuven, for *in vitro* conservation and virus indexing (prior to their cryopreservation). All the 200 regenerated accessions conserved *in vitro* at NRC on Banana, Trichy and some 75 accessions were pre-indexed for viruses using ELISA and PCR-based methods.

An exercise was initiated for rejuvenation of *Musa* cultures, conserved for 10 or more years under *in vitro* conditions. This was basically to overcome the problems of loss of *in vitro* regeneration capacity and expression of latent/covert endogenous bacteria observed in a few accessions. Plantlets of nearly 20 such accessions were rooted *in vitro,* transferred to pots and hardened in a net house. These plants shall be subsequently used for re-initiation of cultures for their *in vitro* conservation/ cryopreservation.

6.1.2 Bulb crops: A total of 171 accessions belonging to 4 genera (*Allium* spp., *Cicer microphyllum*, *Dahlia* sp. and *Gladiolus* sp.) were conserved in the *In Vitro* genebank through periodic subculture or through resterilization, under culture room conditions or at low temperature.

During the period under report, one accession each of two new species *viz*., *Allium albidum* and *A. clarkeii* were added in the *In Vitro* genebank. Multiple shoots were obtained on B5 medium supplemented with NAA and TDZ, using bulbous shoot bases as explants. In *A. albidum*, although rooting was observed on half-strength B5 or MS basal medium but roots were few. Experiments are continued to improve rooting in aforementioned species. In *A. clarkeii*, shoot cultures are being multiplied to generate shoot stocks for initiating rooting. Regarding medium-term storage of *A. tuberosum,*

following media manipulation, cultures conserved for 21 months at 4^{0}C in dark, resumed normal growth, upon transfer to fresh medium.

Regarding applicability of vitrification protocol, developed thus far, in *A. sativum*, shoot tips isolated from cloves of 25 accessions, procured from NBPGR regional station, Bhowali were subjected to cryopreservation. Preliminary results (owing to limited quantity of germplasm; 15-20 cloves/bulb) indicated that post-thaw survival ranged from 30-100% with shoot recovery varying from 0-50%.

Using vitrification technique, in *Cicer microphyllum,* post-thaw regenerated (20%) shoots, upon transfer to medium in culture tubes, exhibited growth similar to that of non-frozen controls.

In *A. tuberosum* using encapsulation-dehydration technique, 30% regrowth of cryopreserved explants was obtained following pre-growth on high sucrose (10%) and at low temperature. Cryopreserved explants transferred to culture tubes exhibited growth similar to that of mother cultures.

For long term conservation, cryobanking was initiated in 2 more accessions (one replicate each) of *A. sativum.*

6.1.3 Medicinal, aromatic and rare/endangered plants: *In vitro* maintenance of existing cultures of 170 accessions (~4,500 cultures) was achieved through periodic subculture and resterilization (4-24 months) either under culture room conditions and/or at low temperature. During the period under report, one accession of a new genera *Gaultheria* sp. was added to the existing collection.

Regarding *in vitro* conservation, in *Picrorrhiza scrophuliflora* incubation of cultures at low temperature (4^{0}C) could extend subculture duration up to 8 weeks compared to 3 weeks under culture room conditions. In *Kaempferia rotundata*, experiments initiated to induce *in vitro* rhizome formation, indicated swelling of shoot bases in media supplemented with high sucrose (6-10%). Experiments are continued for further optimization. In *K. galanga*, encapsulated shoot bases were stored in cryovials without nutrient medium, up to 4 weeks at 20^{0}C and 25^{0}C (16/8h photoperiod).

6.1.4 Spices, plantation and industrial crops: *In vitro* maintenance of existing cultures of a total of 380 accessions (~5,250 cultures) of spices germplasm comprising 181 of *Zingiber* species, 162 of *Curcuma* species*,* 8 of *Piper* species*,* 5 of *Elettaria cardamomum*, 4 of *Vanilla planifolia,* 12 of *Simmondsia chinensis* (6 each of male and female) and 8 of *Humulus lupulus,* were maintained under short- to medium-term storage. The average subculture period is 8-10 months for *Zingiber* species, 6-10 months for *Curcuma* species, 12-24 months for *Piper* species*,* 14-15 months for *Elettaria* species, 18-22 months for *V. planifolia*, 8-15 months for *S. chinensis* and 6 months for *H. lupulus*.

A total of four accessions (released varieties) of *Curcuma* received from PAU, Ludhiana (Punjab Haldi-1 and Punjab Haldi-2) and CSKHPKVV, Palampur (Palam Pitamber and Palam Lalima) were planted in pots for further establishment in *In Vitro* genebank.

An experiment was initiated to study the effect of four concentrations of TDZ (0.1, 0.25, 0.5 and 1.0 mg/l) on multiplication of *Curcuma* spp. The results indicated that 0.25 mg/l TDZ was better for shoot multiplication using half shoot explants to obtain 6.16 shoots/explants in 60 days. Liquid MS medium with 0.25 mg/l TDZ is superior to semi-solid medium with 0.25 mg/l TDZ, as compared to the control medium i.e. MS + BAP at 2.5 mg/l, in terms of shoot multiplication and duration.

Using the above medium, three accessions of *Curcuma* spp. were multiplied for generating stock cultures for initiating cryopreservation experiments.

An experiment was conducted to study the effect of different gelling agents on conservation of *Curcuma.* Up to 60 days, 75-100% cultures survived in different treatments. Out of six gelling agents tested, the cultures in Gelzen and Isabgol supplemented media were healthy with no degeneration after 12 months of conservation followed by Clarigel and Clarigar. Interestingly, on medium with Clarigar, micro-rhizome formation was observed after six months of conservation.

6.1.5 Temperate and minor tropical fruit crops: A total of 327 accessions (~6,500 cultures) belonging to nine genera and 41 species were conserved as *in vitro* cultures under culture room conditions and/or at low temperature. These are *Actinidia chinensis* (6), *Aegle marmelos* (2), *Fragaria* x *ananasa* (80), *Malus domestica* (24), *Morus* spp. (61), *Prunus* spp. (5), *Pyrus communis* (66), *Rubus* spp. (62) and *Vaccinium* spp.

(21). The average subculture period varied from 6-12 months. During the year, 13 accessions of apple (*Malus domestica)* were added in the *In Vitro* genebank.

Efforts were made to establish exotic accessions of blueberry (*Vaccinium* spp.), blackberry (*Rubus* spp.), strawberry (*Fragaria* spp.), and pear (*Pyrus communis*) in the field for evaluation and further distribution/ utilization.

Using dormant bud explants, droplet-vitrification method was attempted in apricot (*Prunus armeniaca*). In the non-frozen controls, there was 60% regrowth after PVS2 dehydration and up to 30% recovery after LN-freezing.

Cryopreservation experiments were continued with apple dormant buds procured from CITH, Srinagar and NBPGR regional station, Shimla, using two-step-freezing. There was 0-20% recovery following grafting of cryopreserved buds on rootstocks maintained at NBPGR Regional Station, Shimla. However, when encapsulation-dehydration, vitrification and droplet-vitrification techniques were tested for above explants, only 3-4% post-thaw recovery was recorded.

Cryobanking of apple twigs, each bearing three dormant buds (35 accessions), was undertaken using two-step-freezing.

6.1.6 Tuber crops: *In vitro* maintenance of a total of 611 accessions (~9,800) of tuber crops comprising 3 of *Alocasia indica*, 193 of *C. esculenta,* 151 of *Dioscorea* spp., 255 of *Ipomoea batatas* and 9 of *Xanthosoma sagittifolia* was carried out through periodic subculture and resterilization (4-12 months) under culture room conditions. During the year, a total of 21 accessions comprising 10 exotic accessions of *C. esculenta* and 11 of *Dioscorea* spp. were added in the *In Vitro* genebank.

In continuation of attempts to initiate cryopreservation experiments in *C. esculenta,* shoot tip explants were cultured on MS +1.0 mgl^{-1} TDZ for obtaining proliferating meristems as on the medium (MS+10 mgl^{-1} BAP+0.1 mgl^{-1} NAA) tested earlier.

For long-term conservation, cryobanking was done in three accessions of *Dioscorea* spp. (two replicates each) using vitrification technique. Post-thaw regenerated shoots, upon transfer to fresh multiplication medium, exhibited normal growth. Three more accessions were multiplied to obtain adequate number of explants for further cryobanking experiments.

6.2 Genetic Stability of *In Vitro* Conserved Germplasm

The protocol for SSR analysis was standardized using 19 SSR primers in different species of *Allium*. The SSR analysis was done in two accessions (5 samples each) of

Table1. Status of *in vitro*-conserved germplasm (as on December 31, 2011)

Crop Group	Genera (no.)	Species (no.)	Cultures (no.)	Accessions (no.)
Tropical fruits (banana)	2	14	10,000	**416**
Temperate and minor fruits (apple, apricot, blackberry, blueberry, pear, strawberry)	9	41	6,700	**327**
Tuber crops (sweet potato, yam, taro)	5	12	9,800	**611**
Bulbous and other crops (garlic, gladiolus)	4	12	3,300	**171**
Medicinal and aromatic plants (Species of *Coleus, Rauvolfia, Tylophora, Valeriana*)	21	28	5,000	**170**
Spices and industrial crops (ginger, turmeric, pepper, cardamom, hops, jojoba)	7	27	5,800	**380**
TOTAL	**48**	**134**	**40,680**	**2,075**

A. tuberosum for 19 SSR loci. A total of 40 alleles were identified, ranging one to 3 alleles per loci in a total of 10 samples. Genetic stability analysis of cultures of two accessions stored at 4 ^{0}C for 21 months was also done using SSR markers. No differences were observed in the profiles of cryopreserved/*in vitro* conserved plantlets (regenerated) and their respective controls. Genetic stability assessment was done in six accessions (5 samples each) of taro (*C. esculenta*), using 13 simple sequence repeats (SSR) loci. Based on screening of 13 loci, a total of 30 alleles were identified, ranging from two to five alleles per loci. There were no significant differences in the SSR profiles of *in vitro*-conserved plants and their respective controls.

Table 2: Status of cryopreseved germplasm (As on December 31, 2011)

Categories	Accessions (no.)
Recalcitrant & Intermediate	
Fruits & Nuts	2,831
Spices & Condiments	151
Plantation Crops	22
Agro forestry & Forestry	1,640
Industrial, Medicinal & Aromatic Plants	1,325
Sub-total	**5,969**
Orthodox	
Cereals	240
Millets and Forages	287
Pseudo-cereals	76
Grain Legumes	636
Oilseeds	471
Fibers	66
Vegetables	433
Medicinal & Aromatic Plants	923
Narcotics & Dyes	34
Miscellaneous	16
Sub-total	9,151
Dormant buds	373
Pollen grains	345
TOTAL	**9,869**
Wild relatives*	**997**
Rare & endangered plants*	**80**
Varieties*	**654**
Elite*	**4**
Registered germplasm*	**22**
Number of species	**729**

*- Included in respective categories stored as orthodox seeds

The genetic stability assessment was done in a cryopreserved accession of mulberry using six SSR markers. No differences were observed in the SSR profiles of post-thaw regenerated plantlets and their respective controls.

6.3 *In Vitro* Germplasm Supply

During the year, a total of 59 accessions comprising *B. monnieri* (1), *Fragaria* x *ananasa* (18), *Musa* spp.(34) *P. scrophuliflora* (1) and *V. ovatum* (5) were supplied to various indentors for field evaluation and/or research purposes.

6.4 Seed, Pollen and Dormant Bud Cryopreservation

A total of 9,869 accessions comprising orthodox and non-orthodox (intermediate and recalcitrant) seed species were conserved in the cryogenebank (Table 2). A total of 220 accessions of diverse germplasm were received from NBPGR regional stations, Central Sericultural Germplasm Resources Centre (CSGRC), Hosur and Network project partners and also through collection trips and explorations. These belonged to fruits and nuts, industrial crops, medicinal and aromatic plants and dormant buds of temperate and sub-temperate species. During the year, three exploration trips were undertaken and 111 accessions of germplasm of non-orthodox seeds of *Citrus* species and tropical underutilized fruits were collected from Upper Assam, Nagaland, Himachal Pradesh and Punjab.

A total of 380 accessions were cryostored as seeds and embryonic axes during this period at temperatures between –160 to –180°C. Cryostored accessions comprised temperate fruits and nuts (203), industrial crops (64), spices (3) and M&AP (74) which also included wild species and wild relatives of crop plants. In addition, 36 accessions were cryostored as dormant buds.

Studies on seed viability, moisture content, desiccation and freezing sensitivity were conducted on seeds of *Manilkara hexandra,* several *Citrus* species viz., *C. karna*, *C. pseudolimon, C. megaloxycarpa, C. patijora (citron), C. ichangensis* and *C. limonia.* Two-step freezing and encapsulation-dehydration techniques were attempted in dormant buds of almond (*Prunus amygdalus)* and walnut (*Juglans regia*), procured from Central Institute of Temperate Horticulture (CITH),

Optimization of recovery percentage in cryostored *Morus* spp. using antioxidants was attempted which led to only marginal improvement (20%). A total of 148 accessions belonging to *Citrus* species and underutilized fruit spp. were characterized for fruit and seed characters as per IPGRI descriptors. Successful cryopreservation was achieved in seeds, embryos and embryonic axes of *C. karna*, *C. pseudolimon, C. megaloxycarpa, C. pati-jora (citron), C. jhambiri, C. sinensis* and *Manilkara hexandra.* Periodic testing for viability of 217 accessions of orthodox and non-orthodox seeds and for dormant buds of 15 accessions of *Morus* species revealed retention of original viability (20-75%) in most of the accessions, after 2 to 8 years of cryostorage.

6.5 Transfer of *In Vitro* Conserved Germplasm to Crop Based Institutes

As a follow up of recommendation no. 14b of the Brainstorming session on 'Management of Horticultural Crop Genetic Resources' at NBPGR on April 21, 2009, 274 accessions of tuber crops (*C. esculenta*, *I. batatas* and *Dioscorea* spp.) were transferred to Central Tuber Crops Research Institute (CTCRI), Trivandrum, in two batches. ginger and (27) of turmeric 50 accessions were transferred to Indian Institute of Spices Research (IISR), Calicut and turmeric (55) and ginger (30) are being multiplied for onward shifting to IISR, Calicut.

Programme (Code, Title and Programme Leader)

PGR/TCCU-BUR-01 *Ex situ* conservation of genetic resources of vegetatively propagated crops using *in vitro* and cryopreservation techniques **(RK Tyagi)**

Research Projects (Code: Title, PI, Co-PI and Associates)

PGR/TCCU-BUR-01.01: *In vitro* conservation of tuber crops with special reference to sweet potato, yams and taro (**Neelam Sharma**, Zakir Hussain, DK Nerwal)

PGR/TCCU-BUR-01.02: *In vitro* conservation of spices, plantation and industrial crops (**Anju Jain,** RK Tyagi, RP Yadav)

PGR/TCCU-BUR-01.03: *In vitro* conservation of bulbous and ornamental crops.(**Ruchira Pandey**, Neelam Sharma)

PGR/TCCU-BUR-0104: *In vitro* conservation of medicinal and aromatic plants with special reference to rare and endangered species. (**Neelam Sharma**, Ruchira Pandey)

PGR/TCCU-BUR-01.05: *In vitro* conservation of tropical fruit crop species (**Anuradha Agrawal**, RK Tyagi)

PGR/TCCU-BUR-01.06: *In vitro* conservation of temperate and minor tropical fruit crops (**Sandhya Gupta**, K Pradheep)

PGR/TCCU-BUR-01.07: Studies on genetic stability of *in vitro* conserved and cryopreserved germplasm (**Zakir Hussain**, RK Tyagi, DK Nerwal)

PGR/TCCU-BUR-02: *Ex situ* conservation of plant genetic resources of agricultural and horticultural crops using cryopreservation of seeds, dormant buds and pollen **(Rekha Chaudhury)**

PGR/TCCU-BUR-02.01: Cryopreservation of non-orthodox and orthodox seed species in various forms using standard protocols (**Rekha Chaudhury**, SK Malik, DK Nerwal)

PGR/TCCU-BUR-02.02: Investigating desiccation and freezing tolerance in non-orthodox seed species, dormant buds and pollen for cryopreservation (**SK Malik**, Rekha Chaudhury, Z Abraham)

7. PGR POLICY PLANNING

The PGR Policy Planning unit is functioning at NBPGR since 1996 with the objective to document and collect literature on concurrent international and national developments concerning plant genetic resources and related fields such as biosafety, germplasm utilization, exchange, and quarantine and to provide analytical inputs are per requirements of the policy makers for negotiations and formulations of policies at various national and international levels on issues related to PGR management.

7.1 PGR Management and related Issues

7.1.1 Processing application of extant varieties for registration (Protection) with the PPV&FR Authority

a. 83 Applications of Extant-notified and New Varieties of ICAR- SAU system of crops notified by PPV& FR Authority, were scrutinized, documented and submitted to PPV &FR Authority during 2011. A total of 821 applications have been submitted so far.

b. All concerned Project Coordinators/ Project Directors, Directors and SAUs were sensitized about the process of filing applications. Inputs on correct filing procedure were provided on request for the new crops including oilseeds, vegetables and spices.

c. In a meeting of PPV&FRA Authority and DUS Centres, role of NBPGR in Plant Variety application process was presented.

7.1.2 An analysis of Geographical Indication laws of different countries was undertaken with a view to study the Indian Act in light of provisions in other countries.

7.1.3 The first meeting of **National Advisory Board on Management of Genetic Resources (NABMGR)** was organized on 13 December, 2011 at NBPGR.ICAR has recently constituted a high level National Advisory Board on Management of Genetic Resources (NABMGR) to advise on issues related to efficient management of genetic resources especially the Agro- biodiversity. The Board is chaired by renowned Scientist and Former DG, ICAR Dr. R.S. Paroda, currently heading the Haryana Farmers Commission and is Co-Chaired by Dr S. Ayyappan, Secretary DARE and DG, ICAR. The Member Secretary to the Board is Director NBPGR, with a Secretariat based at NBPGR. Other eminent members include Dr P.L. Gautam, Chairman PPV&FRA, Dr B. Pisupati, Chairman National Biodiversity Authority, and Dr M. Mahadevappa, Former Chairman ASRB. The 1st meeting of the Board was held at NBPGR on December 13, 2011. The agenda included policies and procedures for exchange of plant genetic resources, adoption of International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), strategies for sharing information in public domain, exploration and evaluation of horticultural crops and role and participation of bureaux in international meetings.

7.1.4 Technology Management Committee (ITMC)

Two meetings of the ITMC were organized and guidelines for sharing benefits received at the Institute after technology transfer cases were discussed and developed as per ICAR guidelines.

7.1.5 Technical inputs on the following PGR Policy issues provided to ICAR and other Ministries and Departments

- Inter-ministerial meeting for firming up India's position for the 4th GB meeting of the ITPGRFA held at Indonesia.
- Access and Benefit Sharing (ABS) template developed by National Biodiversity Authority.
- Draft Intellectual Property (IP) document of CG Centres and on comments received on the document from eight other countries for DARE/ ICAR.
- Draft Access and Benefit Sharing (ABS) protocol to be discussed at CoP-10 meeting at, Japan.
- Drafted the Tripartite MoAs for storage of Bt Brinjal seed at NBPGR Genebank, on request from MoEF.
- Development of MTA for exchange of material among SAARC Nations and establishment Regional Seed Bank for SAARC nations.
- Cabinet Note on Nagoya protocol.
- Export Facilitation Committee of NBPGR for cases of export of PGR under collaborative research projects and other categories.

7.2 Inputs on Policy Issues related to Biosecurity

7.2.1 Inputs provided to Department of Agriculture and Cooperation, MoA: Provided input to the Department of Agriculture and Cooperation on Plant Quarantine (Regulation for Import into India) Order 2003 on

- On Establishment of National Agricultural Biosecurity System under the MoA, prepared comments and provided inputs during a Workshop on developing the NABS
- Prepared comments on import of certain biocontrol agents, algae, bacterial cultures, bumblebees and other biocontrol agents
- Provided inputs during the Indo-Canadian Joint Working Group Meeting at DPPQS, Faridabad for import of pulses into India
- Reconfirmed the proposed phytosanitary arrangement between the 'Department of Agriculture and Co-operation' (DAC) India and the Canadian Food Inspection Agency (CFIA) for Canadian Pulse Imports into India
  - Under the agreement; Canada would not be responsible for (a) testing (b) reporting or declaring pulse consignments as nematode free
  - Fumigation with Methyl Bromide on arrival; suggested and applied by DPPQS / DAC for nematodes is not effective
  - Extension of derogation, beyond September' 2010 and signing of agreement on shipping of consignments under 'Phytosanitary Arrangement between the Two Countries for Pulse Imports' needs to be reviewed

7.2.2 Inputs to Development Consortia for Invasive Species Compendium of CABI

- Launch of beta version of the Invasive Species Compendium and made efforts to give a future direction of the project within the research community.

7.2.3 Input to APAARI/ APCoAB

- Participated and provided inputs on status of biotechnology, biosafety and biosecurity in the Asia Pacific Region during the Expert Consultation on Biotechnology, Biosafety and Biosecurity organized by APAARI and Ministry of Agriculture and Cooperation, Chinese Taipei held at Taiwan Agricultural Research Institute (TARI), Taichung, Chinese Taipei in October 2011

7.2.4 Inputs to MoEF

- Inputs provided to Ministry of Environment and Forests on invasive alien species and its impacts on agricultural biodiversity in the AHTEG meeting held in Geneva Switzerland in February 2011
- Inputs for inter-ministerial meeting on BWC Preparatory Committee for the Seventh Review Conference held on March, 2011
- Inputs on Brief for the Indian Delegation for Fifteenth Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA-15) held in Montreal, Canada in November 2011
- Inputs on Second National Report on the implementation of the Cartagena Protocol on Biosafety to be presented in the Meeting of Parties of the CBD in December 2011

7.2 5 Inputs to MoCI: Inputs also provided to Ministry of Commerce and Industries (MoCI) on current issues on export of Basmati Rice, Grapes and Honey to European Union- in an Inter Ministerial Meeting.

7.2.6 Inputs to ICAR:

- On suggestions by National Seeds Association of India for revision of the New Policy on Seed Development 1988.
- On measures taken and progress made in research and development to address SPS issues

7.2.7 Inputs to NDMA, Ministry of Defence: As Member of the Task Force on agroterrorism and Biodisaster mitigation and road map provided to NDMA.

Research Programme (Programme Code: Title, Leader)

PGR/PPU-BUR-DEL-01: Policy planning and back-up research (**Pratibha Brahmi**)

Research Projects (Project Code, Title, Project Leader; Associates

PGR/PPU-BUR-DEL-01-01: PGR management and related issues (**Pratibha Brahmi**, Vandana Tyagi)

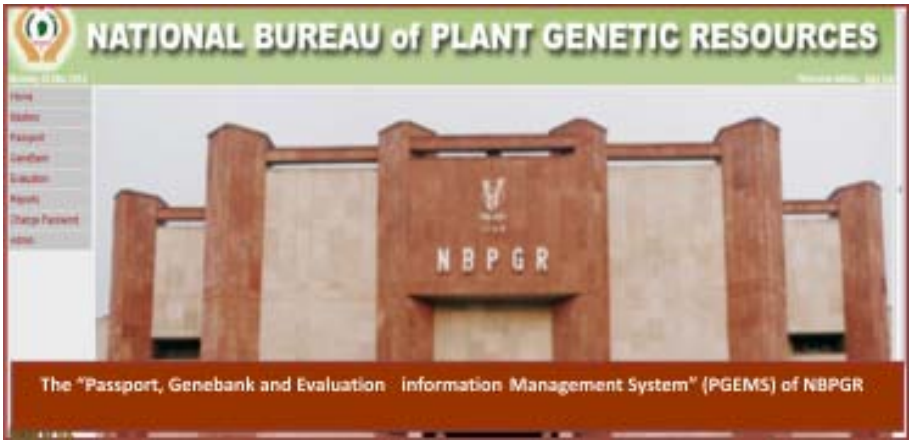
PGR/PPU-BUR-DEL-01-02: Policy issues related to plant biosecurity (**PC Agarwal**, Kavita Gupta)

8. AGRICULTURAL KNOWLEDGE MANAGEMENT

Summary: The AKMU (formerly ARIS Cell) at NBPGR is the centre of PGR informatics activities of ICAR. The Unit successfully developed the "Passport, Genebank and Evaluation information Management System" (PGEMS) as a comprehensive web-enabled PGR information system. Online portal for accessing the information was also developed and is under alpha testing. The database was populated with data on 18,317 indigenous collections, 37,386 exotic collections, 1,67,550 genebank holdings and 57,000 germplasm characterization/evaluation. The Unit maintained five independent information systems and hosted ten important URLs on the local servers and carried out service activities including email, LAN, e-circulars and web hosting.

8.1 PGR Informatics

8.1.1 Development of web-enabled PGR database: The "Passport, Genebank and Evaluation information Management System" (PGEMS) has been made operational and is currently accessible through intranet on login basis for PGR researchers from NBPGR. The database has been populated with data on about 4,30,000 indigenous collections, 7,00,000 exotic collections, 3,60,000 genebank holdings and 71,000 germplasm characterization/evaluation data. The data entry / editing jobs on all PGR related tables are now being carried upon directly in the database. This has effectively reduced the operational redundancies of data entry in excel sheets and then in the SQL server. Structures for descriptors of more than 200 crops were created and evaluation data of 565 experiments have been entered.



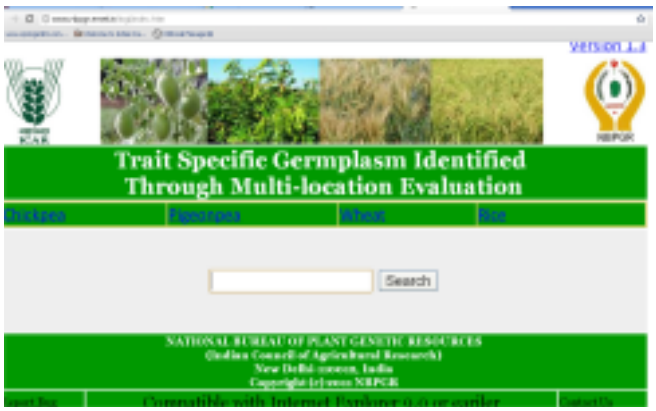
8.1.2 Maintenance of database and information system: AKMU maintains the following database/information system and servers:

Information System	Activity	Entries in 2011	Total entries
PGR management system (only intranet)	IC numbers allotted	18,317	4,37,871
• Indigenous collections (IC)	Data ported	1,67,5503,67,550	
• Genebank collections	Data entered	57,000	71,000
• Evaluation data			
Germplasm Exchange and Quarantine Information System (http://www.nbpgr.ernet.in/geq)	EC numbers alloted	37,386	7,32,611
Plant Germplasm Registration System (http://www.nbpgr.ernet.in/grpvr/login.aspx)	Germplasm registered		
ICAR Plant Variety information System (http://www.nbpgr.ernet.in/pvrs)	Varieties documented		
Notified and Released Varieties of India (http://www.nbpgr.ernet.in/norv/index.aspx)	Varieties documented	85	7,393

8.1.3. Development of tools and web pages

The PGEMS web portal was developed in asp.net with C# as front-end and database management system is SQL Server 2008 at back-end. The interface is meant to provide an access to the interested parties including general public through internet about information on passport data of indigenous collections and exotic introductions as well as availability of the germplasm material in the genebank. The system is currently under alpha testing and is accessible through intranet with/ without login basis.

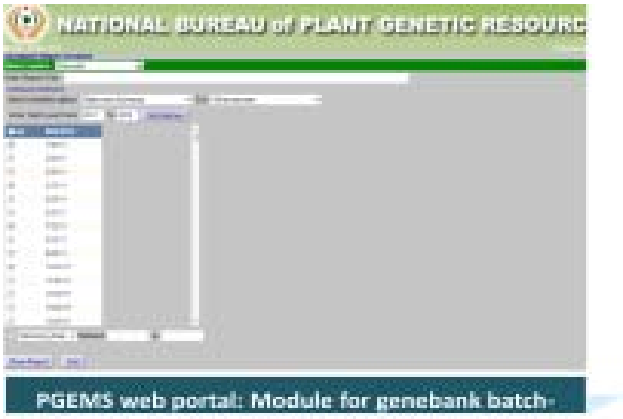
Portable search engines were developed for "Inventory of Registered Crop Germplasm" (http://www.nbpgr.ernet.in/IRCG%20Search/index.htm); "Trait Specific Germplasm Identified through Multi-location Evaluation" (http://www.nbpgr.ernet.in/tsgi/

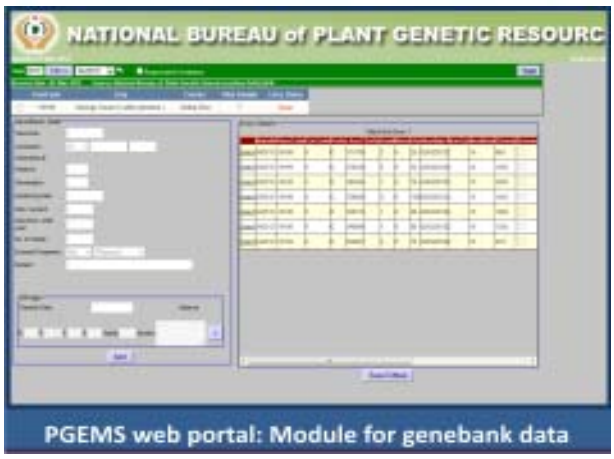


index.htm), and *"Inventory of cryo-preserved germplasm"* (yet to be populated).

8.1.4. Genebank data entry

A majority of material available in the genebank is either being or lined up for regeneration so, a new data entry module has been added to the system for making data





entry for fresh and regenerated material has been added to the gene bank module. Provision has also been included to access a report on batch(es) information.

8.1.5. National Rice Resource Database (NRRD)

NRRD was designed, developed and implemented on server. The database consists of 15,000 records of rice passport data and provision for evaluation and circulation data of accessions among five locations over five years for 3000 accessions. A Program based, data entry sheet (for 21 qualitative and nine quantitative traits) has been designed and developed to ensure error free data collection from evaluation centers.

A new application designed in SQL server was developed to decipher anomalies related to accession entries and curate the gene bank data of rice. The application was used to generate clean accessions data of various crops.

8.1.6. Bioinformatics Software Portal and Molecular Binary Data Analysis Software

Server based web portal was updated with information and link of (i) online software for sequence alignment and genetic analysis; (ii) online databases for nucleotide sequences and plant databases; (iii) online bioinformatics tools, and (iv) Perl programs for concatenation, transcription and reverse complement.Molecular Binary Data Analysis software was updated with interface for uploading MS Excel data and for carrying out 12 different types of statistical analyses.

8.1.7. Service

a) **NBPGR Webpage**: NBPGR webpage is locally hosted and maintenance and backup operations are of continuous nature. In the year under report, 39 webpages of scientists (53 in all) were created. As many as 113 tender documents (352 total), 20 work awards (69 total), and 28 advertisements of interviews and trainings (104 total) were uploaded.

b) **LAN**: Maintenance of 250 nodes created to connect computers, printers and servers at NBPGR headquarters was carried out as per the following list: Directorate(10), Administration Section (11), Finance and Audit Section (10), Division of Germplasm Evaluation (25), Germplasm Exchange Unit (10), Division of Germplasm Conservation (25), Tissue Culture and Cryo-preservation Unit (20), Division of Plant Quarantine (25), Division of Exploration and Germplasm Collection (20), NRC on DNA Fingerprinting (30), AKMU (50), PG Computer Lab (5), Library (4) and others (5).

c) **Email, e-circulars and E-governance**: As many as 61 new email accounts (total 213) werecreated on the NBPGR mail server for official use of NBPGR staff. During the period, 61 e-circulars are made available on the user's desktop of which about 22 related to the NBPGR Regional Stations. Through E-governance, a total of 338 accounts are maintained for leave management of which 28 new accounts were created during the period under report.

d) **Digital publications**: AKMU hosted English and Hindi versions of NBPGR Newsletters (total 10) belonging to the years 2010 and 2011; Annual report on characterization and evaluation (2005-06, 2006-07; 2007-08) of Rabi crops and Horticultural crops; and monthly progress reports of the divisions/units.

e) **Others:**The Statistical Analysis System (SAS) acquired from IASRI under NAIP was installed on 15 computers for use by Bureau's researchers; Quarterly RTI returns were uploaded to the Annual RTI Return Information System of the Central Information Commission for first three quarters of the year under report; and data backup PGR database, Germplasm Registration, RPF Information System, NORV database and DUS Information System etc. was maintained periodically.

Important URLs maintained on AKMU Servers

NBPGR Homepage	www.nbpgr.ernet.in
Online Submission of request for Import Permit and EC data search	http://www.nbpgr.ernet.in/geq/
IC Data Search (only intranet)	http://database_rx/nbpgr/SearchPassport.aspx
Plant Variety Registration System	http://www.nbpgr.ernet.in/pvrs/
NBPGR - RPF Information System	http://www.nbpgr.ernet.in/rpf/
Invitro Genebank Management System	http://www.nbpgr.ernet.in/invitro/
Germplasm and Plant Varieties	

Registration System	http://www.nbpgr.ernet.in/grpvr/login.aspx
Inventory of Registered Crop Germplasm	http://www.nbpgr.ernet.in/IRCG%20Search/index.htm
Digital Library on Bruchids	http://202.141.12.150/bruchid-library/
Trait Specific Germplasm Identified through Multi-location Evaluation	http://www.nbpgr.ernet.in/tsgi/index.htm

Research Programme (Programme Code: Title, Leader)

PGR/ARIS-BUR-DEL-01.00: Genetic Resources Information Programme (**Sunil Archak)**

Research Projects (Project Code, Title, Project Leader; Associates

PGR/ ARIS - BUR-DEL-01.01: Molecular Data Analysis Software (**Madhu Bala Priyadarshi)**

PGR/ ARIS - BUR-DEL-01.02: Bioinformatics Software Portal (**Madhu Bala Priyadarshi** and Soma S Marla**)**

Externally funded project

Utilization of *ex situ* collections and climate analogues for enhancing adaptive capacity to climate change (**Sunil Archak**, Sushil Pandey, DP Semwal, BS Phogat)

9. DNA FINGERPRINTING

Summary: For genetic variability and characterization of germplasm in *Jatropha curcas,* 285 selected accessions were analyzed using AFLP and SSR markers. In addition 18 RAPD and 24 SRAP primers were used to analyze 37 Pongamia accessions. SSR genotyping information was generated in *Cucumis*, mothbean and *Lathyrus*. Eleven polymorphic functional markers (EST-SSRs) were used for genetic diversity analysis in 12 germplasm lines of finger millet of Indian and African origin for genetic variability studies. Genetic characterization of *Morinda tomentosa* accessions were analyzed using 21 ISSR primers. Seventy ISSR markers used for characterization of collected accessions of *Luffa* species. Molecular diversity among 24 released varieties and germplasm lines of wheat have been demonstrated with 32 identified SSR markers having high PIC value. A total of 391 cotton samples were fingerprinted using 25 genome-wide microsatellite loci. In 94 accessions of *Linum* microsatellite fingerprinting was carried out.

For molecular mapping and QTL analysis in sesame germplasm, large-scale DNA sequence information was generated using next generation sequencing approach. The contigs generated were mined for SSR markers. The RILs comprising 210 lines in F8 generation in sesame were evaluated for 20 morphological traits at Delhi conditions for two seasons. In wheat, a 237 promising germplasm lines showed near immunity for leaf rust resistance in nine different locations across the climatic zones in India. A new program was initiated to develop mapping populations for heat and drought tolerance in wheat during 2010 summer at IARIRS, Wellington, Tamil Nadu and NBPGR, New Delhi.

Over 200 candidate gene sequences were screened in the contrasting accessions of *Cucumis, Lathyrus* and mothbean for development of SNP markers. Novel promoter region targeted marker CBDP (CAAT box derived polymorphism) and Start Codon Targeted (SCoT) polymorphism markers were developed and demonstrated their utilization in cultivars of *Corchorus capsularis* and *C. olitorius*. SRAP (Sequence-Related Amplified Polymorphic) marker was also standardized in jute. Genomic SSR markers have been developed in finger millet. Ten Resistance gene analogue polymorphism (RGAP) markers were demonstrated in finger millet to produce polymorphic profiles in 32 finger millet accessions. Sixty SSR markers have been demonstrated for transferability from cucumber to characterize 40 bottle gourd germplasm lines. Eight SSR enriched library has been developed each for Giloe and Andrographis using different combination of biotin labeled repeat sequences. Ninety eight microsatellite primers in jute were custom synthesized and screened for amplification in a representative panel of eight genotypes. Twenty nine new microsatellite loci have been identified through genomic library enrichment and sequencing for identification of microsatellite markers in bittergourd.

Under the genomic resources development from plant genetic resources activities Transcriptome profiling in *Cucumis, Lathyrus* and mothbean has been carried out and stress response genes has been classified. Cloning of a novel cold tolerance gene *COR14* from white clover (*Trifolium repens*) has been carried out. A carotenoid pathway gene, phytoene synthase 1, was amplified (750bp amplicons) and sequenced from red pulp black seeded watermelon line DRB-669 using degenerate primers from conserved region of *psy*1 gene. Sixteen Resistance gene candidates (RGCs) has been isolated and characterized from ToLCND Virus tolerant sponge gourd genotype and submitted to GeneBank. A Carbonic anahydrase gene has been amplified and characterized from the young leaves of cowpea cv. PUSA Kamal. Allelic variations of the CA gene have been demonstrated in cowpea genotypes. In mothbean SSH library has been developed for moisture stress.

For biosystematics and species evolution survey of different eco-geographical regions has been conducted for occurrence of *Vigna, Cucumis* and *Abelmoschus*. Molecular taxonomic studies have been carried out for species delineation and differentiation of *Cucumis* and *Abelmoschus* species based on cpDNA, mtDNA and rDNA sequences. Separately species relationship studies have been conducted in *Luffa* spp.

Multiplex-PCR based diagnostic tools have been developed for GM-maize events. Event-specific Real-time PCR protocols have also been developed in Bt Brinjal and Bt cabbage. A real time PCR-based diagnostics of GM event in imported transgenic planting materials has been conducted. DNA fingerprinting services has been provided to agencies and resources were generated through the service.

9.1 Genetic Variability and Characterization of Germplasm

9.1.1. Genetic variability in Jatropha: *Jatropha curcas,* 285 selected accessions were analysed using AFLP and SSR markers. In addition 18 RAPD and 24 SRAP primers were used to analyse 37 Pongamia accessions collected under NOVODB project. Scoring and data analysis was also done to estimate the level of genetic diversity in these accessions. Further, Sequences from microsatellite enriched genomic DNA library and large contigs of *Jatropha curcas* SSRs were identified and primers designed. Using the minimum criteria of finding SSR repeats, 375 SSRs were found. Out of these, 347 SSRs primers were designed. A total of 43,425 EST sequences were also downloded from NCBI. From the EST sequence 5,474 SSRs primer was designed. Analyses were done with the set

of highly polymorphic primer pairs identified. Results indicated presence of 5 distinct and diverse groups for the germplasm accessions analysed.

9.1.2. Genotyping of core collections in *Cucumis, Lathyrus* and mothbean: SSR genotyping information was generated for the sets as indicated: *Cucumis* – 35 SSRs, mothbean – 20 SSRs and *Lathyrus* - 15 SSR markers. Moderately high diversity for Cucumis and low diversity for mothbean and *Lathyrus* were observed.

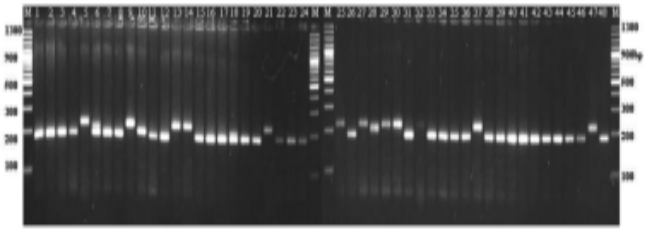


Fig.1. SSR profiles for 48 of the 225 accessions of *Cucumis* genotyped, indicating the extent of polymorphism for the alleles

9.1.3. Genetic diversity in finger millet: Eleven polymorphic functional markers (EST-SSRs) were used for genetic diversity analysis in 12 germplasm lines of finger millet of Indian and African origin. Number of alleles ranged from 2 to 3 with an average Jaccard's similarity coefficient of 0.62. Jaccard's similarity coefficient based UPGMA dendrogram grouped the germplasm lines into two clusters one having only African and the second cluster having Indian as well as African germplasm lines. This is expected since the African germplasm have distinct morphological features such as large panicles, higher finger number, early vigour, robust plant growth, large leaves, and higher grain density not normally found in Indian lines and also Indian finger millet had primarily originated from African material. This study adds a set of eleven novel informative functional SSR markers to the existing finger millet SSR repertoire and would be useful in germplasm analysis, linkage mapping, diversity studies and phylogenetic relationships, and so forth, in *Eleusine coracana* as well as other *Eleusine* species.

For molecular characterization of finger millet minicore using microsatellite markers eight microsatellite markers including two genomic and six functional SSR markers were used to characterize finger millet minicore.

9.1.4. Genetic variability of *Morinda* collections: Genetic characterization of 31 accessions of *Morinda*

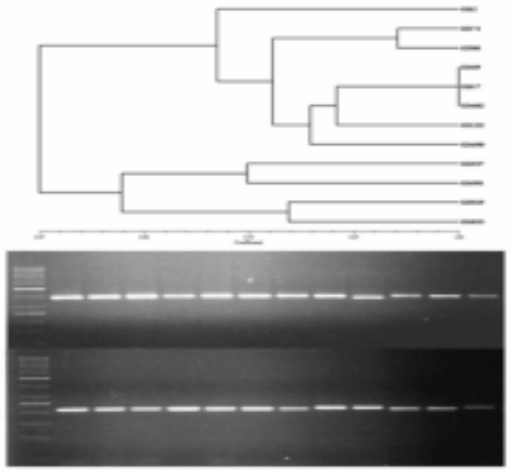


Fig.2. Dendrogram and gel picture (FM302 and FM 70) based on polymorphic EST-SSR data of 12 germplasm lines of finger millet (50 bp ladder)

tomentosa collections from Guajrat were analyzed using 21 ISSR primers. The selected primers generated 191 ISSR bands. Out of the 191 bands generated, 146 (76.4 %) were found polymorphic. The average number of polymorphic bands per primer was 6.95. All the accessions could be distinguished using this set of 146 polymorphic markers and would be useful for diversity analyses of other *Morinda* accessions. The genetic similarity among the accessions was determined on the basis of Jaccard's similarity coefficients and the values ranged from 0.323 to 0.829 with a mean JSC value of 0.607. Overall, ISSR results showed 1) geographical patterning with some exceptions 2) distinctness of accession from Popatpura 3) 40% level of variation in the accessions collected from Gujarat.

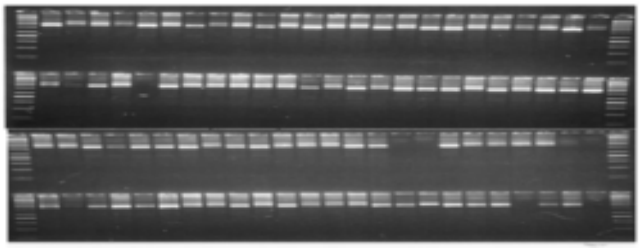


Fig.3. Gel picture showing allelic variation in finger millet minicore with functional (EST-SSR) marker FM93

9.1.5. Genetic diversity in *Luffa* species: Collected accessions of four *Luffa* species; namely *acutangula, hermophrodita, aegiptica* and *echinata* were studied for genetic diversity with ISSR markers. Seventy ISSR markers were screened with 5 accessions of *Luffa.* Thirty eight accessions have been profiled with 15 ISSR markers that yielded clear bright and intense bands.

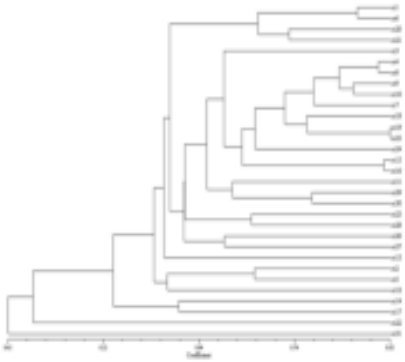


Fig.4. Dendrogram showing genetic relatedness among 31 accessions of *Morinda tomentosa* collected from Gujarat

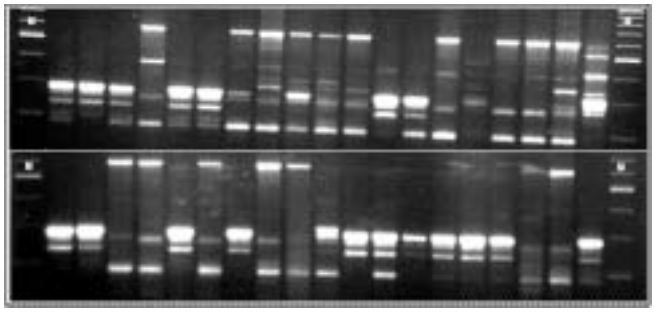


Fig.5. ISSR profile for 38 accessions of *Luffa* species with primer 888.M is 1 kb ladder

9.1.6. Molecular genetic variability in wheat: Molecular diversity among 24 released varieties and germplasm lines of wheat viz., KH Local, HD2009, K-65, K-402, K-424, K-9351, K-9644, K-9851, AKW-381, PUW-4106, MP-4160, MP-4131, MP-4147, MP-4136, MP-4150, MP-4152, MP-4153, GP-37, GP-113, GP-191, GP-193, GP-282, GP-213 and GP-288 have been demonstrated with 32 identified SSR markers having high PIC value.

9.1.7. Molecular characterization of cotton germplasm: Under Technology Mission on Cotton project entitled "Molecular Characterization of Cotton Germplasm" a total of 391 samples were fingerprinted using 25 genome-wide microsatellite loci representing different chorosomes of the cotton genome. PCR amplification products were resolved using 8% polyacrylamide gel electrophoresis and stained with ethidium bromide. Stained gels were photographed using gel documentation system. Using 35 primer-pairs a total of 220 amplification products were obtained, of which 96% were found to exhibit polymorphism. Fifteen of the total SSR markers in the study amplified two loci. Clustering of all accessions of working collection revealed monophyletic origin within many sub-clusters.

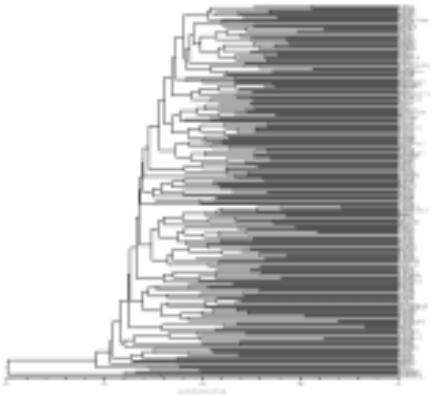


Fig.7. Dendrogram showing genetic relationships among working collection accessions of cotton

9.1.8. Molecular characterization of flax (*Linum usitatissimum* L.): In 94 accessions of *Linum* which included 50 germplasm lines and 40 extant varieties, microsatellite fingerprinting was carried out. PCR

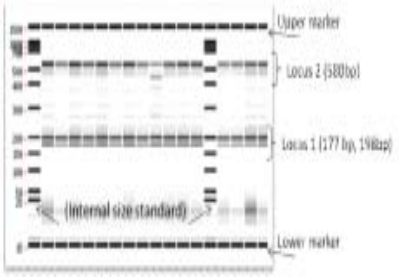


Fig. 8. Profile of selected 16 *Linum* samples run on LabChip$_{GX}$ from M/S Caliper Life Sciences

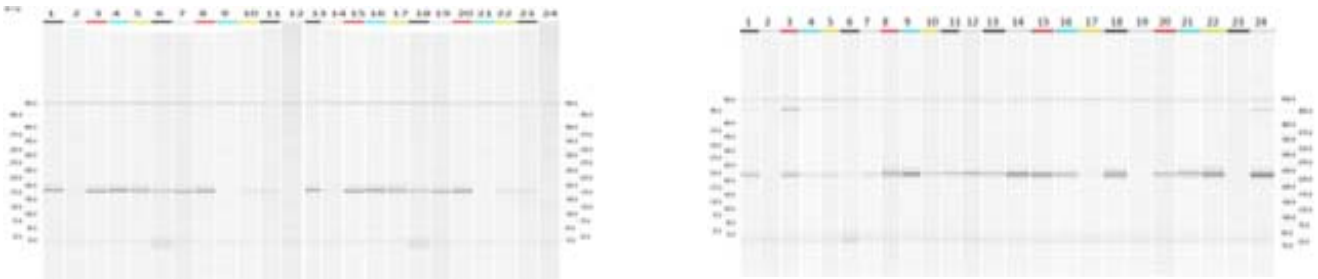


Fig.6. Amplification profile with BARC 84 and BARC 20

conditions were standardized for 15 markers and ten were used for amplification across 94 accessions. PCR products were resolved for the first time on an automated electrophoresis system (LabChip$_{GX}$) from Caliper Life Sciences, wherein 1-2 bp fragments could be resolved easily (Figure 8). Characterization using additional markers is in progress which would be further followed by data analysis.

9.2. Molecular Mapping and QTL Analysis in Germplasm

9.2.1. Saturated linkage mapping and yield related QTLs in sesame: Considering occurrence of low polymorphism for molecular markers in sesame in general and specifically in the mapping population, large-scale DNA sequence information was generated using next generation sequencing approach. The contigs generated were mined for SSR markers and 33,947 SSRs were identified. From this a subset of 1048 SSRs were selected based on a minimum repeat length of 7 and above so that the PCR products obtained might be polymorphic. Flanking primer were designed and as a test case 10 of these were used to test the extent of polymorphism between the parental lines and it was observed that one out of the ten tested were polymorphic between the parental lines of mapping population. Further, all ten primers amplified to optimum levels. It was observed that more than 54% of the SSRs discovered were (AT)n type. A brief break-up of the SSRs type and frequency identified are presented below: The set of 1048 SSRs selected are being used for construction of molecular linkage map in sesame in addition to the 43 markers already mapped.

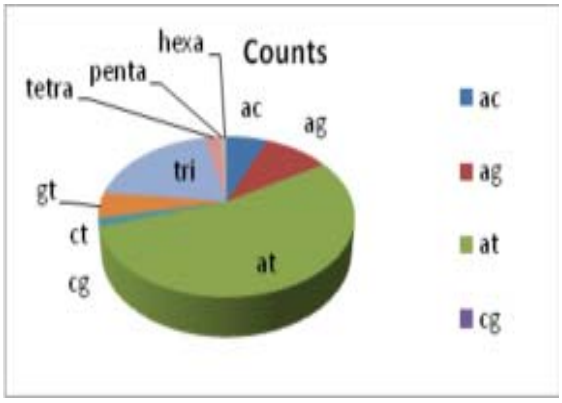


Fig. 9. Pie diagram indicating abundance of dinucleotide repeats in sesame genome. The relative abundance of repeats is: at>ag>ac>gt>ct>aat>att>ata

9.2.2. Mapping of QTLs for economically important traits in sesame: The RILs comprising 210 lines in F8 generation were evaluated for 20 morphological traits at Delhi conditions for two seasons. The traits scored were – days to flowering, days to 50% flowering, capsules per node, capsules per plant, hairiness of capsules, leaf hairiness, seed color, first capsule bearing node, leaf type, plant height, internode length for first five nodes, stem girth, capsule diameter, capsule length, days to maturity, 1000 seed weight, seed yield for 5 plants. Screening of 101 SSR primers for parental polymorphism resulted in identification of 43 polymorphic SSR markers; out of which segregation distortion was observed for 8 markers. A linkage map was constructed with the help of MAPMAKER/EXP set to LOD score of 4.0 included 24 markers in 2 linkage groups. The first linkage group had a total length of 942.5 cM and contained 13 markers while the second linkage group had 11 markers covering a length of 241.5 cM, while 11 markers were found unlinked. The software JOINMAP was also used for linkage map construction which resulted in a single linkage group comprising 22 markers over a length of 903.2 cM. Finally, a linkage map constructed with LOD score set to 5.0 and it included 23 markers in 3 linkage groups. The lengths of linkage groups were 466.4 cM, 416.3 cM and 99.5 cM respectively.

The interval mapping approach helped in localization of 12 QTLs for 9 important traits, namely, number of branches per plant, date of 50% flowering, seed weight per capsule, seed yield per plant, internode length L_1, stem girth, capsules per node, days to maturity and node with capsule. These QTLs were localized on to the two linkage groups identified in sesame. A frequency plot of the three important traits mapped is presented below which indicated normal distribution for these quantitative traits.

The linkage map below depicts the position of the QTLs localised in relation to the molecular markers. The total linkage group size, relatie positions etc are expected to improve with greater saturation of the linkage groups

9.2.3. Characterization of wheat germplasm for rust resistance genes: A 237 promising germplasm lines showed near immunity for leaf rust resistance in nine different locations across the climatic zones in India *viz.*, PAU, Ludhiana; GBPUA&T, Pantnagar; BHU,

Varanasi; NDAU&T, Kumarganj; WRS (GAU), Vijapur; JNKVV, ARS, Powarkheda; ARI, Pune; UAS Dharwad; DWR, Karnal were characterized for the presence of historically proven rust resistant genes *viz.*, *Lr34, Lr46* and *Lr51* through linkage analysis. Only 32 germplasm lines showed the presence of three resistance genes i.e., *Lr34, Lr46* and *Lr51* based on linked SSR markers.

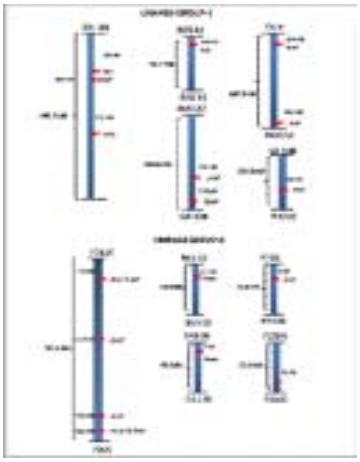


Fig.11. Localization of 12 yield related QTLs and flanking SSR markers in sesame

9.2.4. Terminal heat tolerant wheat germplasm and mapping populations: A new program was initiated to develop mapping populations for heat and drought tolerance in wheat during 2010 summer at IARI RS, Wellington, Tamil Nadu. At present, 12 mapping populations (F_3 generation) for drought and terminal heat tolerance have sown in New Area Research farm, NBPGR, New Delhi. These mapping populations will be used in mapping QTLs for drought and heat tolerance in wheat. Due to change in climatic conditions in last two decades, terminal heat has emerged as number one problem in wheat. Keeping this thing in view, an exploration trip was organized during 3rd -10th March 2011. A total of 22 accessions comprising *Triticum durum* (21) and *T. aestivum* (1) which may have the terminal heat tolerance, were explored from Bagalkot, Bijapur, Dharwad, Gadag, Koppal and Yadgir districts of Karnataka. Later the seeds of these accessions were multiplied in off-season nursery at IARI RS, Wellington.

Evaluation of wheat germplasm lines for association mapping of the traits associated with heat tolerance: Rising temperatures are putting high stress on wheat during anthesis and grain-filling stages leading to huge losses in yield and quality. A total of 188 germplasm lines of wheat including checks were procured from NBPGR, four sets were prepared and sent for sowing at four locations viz. Delhi, Jodhpur, Varanasi and Dharward in collaboration with Germplasm Evaluation Division, NBPGR; NBPGR Regional Station, Jodhpur and respective universities in two dates of sowing. Data was recorded for chlorophyll content, canopy temperature, kernels per spike, thousand kernel weight (gm) and seed yield/m^2 (gm) for wheat lines grown at different locations for association mapping of the traits related to heat tolerance. Few wheat lines have been identified based on the data recorded. These lines were also molecularly characterized using microsatellite markers.

9.3. Development of Molecular Markers for Characterization of Plant Genetic Resources

9.3.1. SNP development from candidate genes for stress tolerance in *Cucumis*, mothbean and *Lathyrus*: In addition, based on the information available

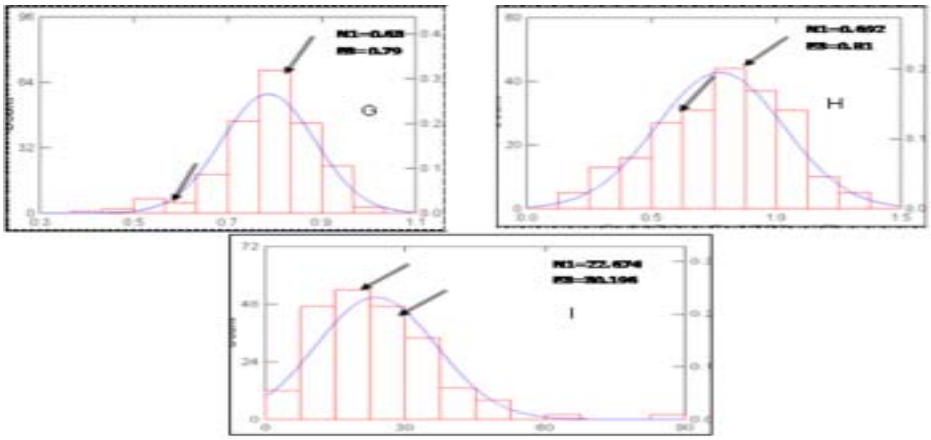
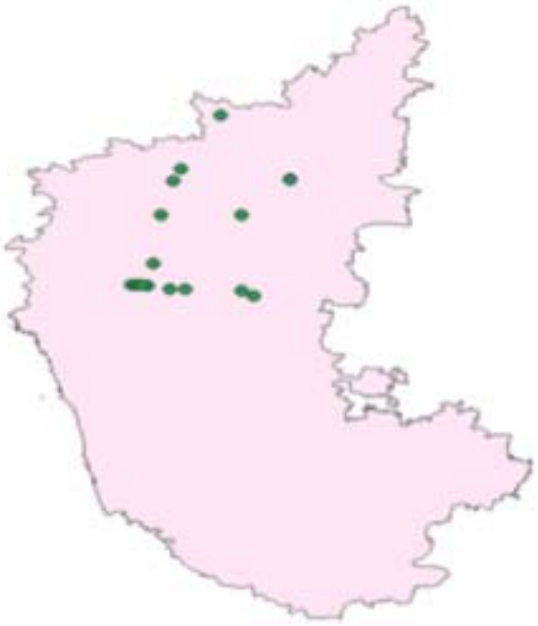


Fig.10. Distribution of yield related traits 100 seed weight (G), capsule seed weight (H) and 5 plant seed weight (I) in a RIL population of sesame. Parental values are indicated by arrow and given at the top

Table 1. List of accessions showing the presence of all three (*Lr 34, Lr 46* and *Lr 51*) leaf rust resistance genes

IC11659	IC111912	IC138479	IC252455	IC290046	IC290222	IC335704
IC12856	IC128457	IC252439	IC252456	IC290184	IC290305	IC427210
IC73591	IC128526	IC252445	IC252458	IC290186	IC290309	
IC111771	IC128594	IC252448	IC252611	IC290190	IC290311	
IC111783	IC128638	IC252450	IC290022	IC290197	IC290314	



in literature, over 200 candidate gene sequences were screened in the contrasting accessions in the three target crops (*Cucumis, Lathyrus* and mothbean). For detection of SNPs and indels with putative role in differential response of genotypes to moisture stress, sequencing of candidate genes in selected 20 genotypes each in *Cucumis, Lathyrus* and mothbean were under taken. Based on the results indels and SNPs in the genic regions have been identified. These SNPs and indels are being

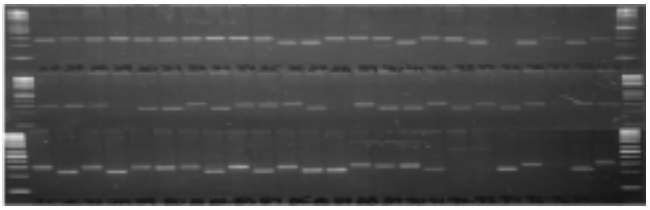


Fig.12. Gel picture showing allelic variation in wheat germplasm with Xgwm 533 forassociation mapping of the traits associated with terminal heat tolerance

genotyped in the core collections. Further, this candidate gene analyses is also being conducted for the genes for identifying SNPs for association analysis in the core collections.

9.3.2. Development of a novel promoter targeted marker technique: A novel promoter region targeted marker technique CBDP (CAAT box derived polymorphism) was developed using nucleotide sequence of CAAT box of promoters of plant genes. This technique like RAPD (Random amplified polymorphic DNA), uses single primer in polymerase chain reaction for generating markers. CBDP primers consisted of conserved CCAAT nucleotides as a central core flanked by filler sequence towards 5' end and either di or trinucleotides towards 3'end. Initially, these primers were tested in a representative set of eight cultivars of jute for marker generation and assessment of genetic

Crop	Genes with high level of expressions analyzed for SNPs
Cucumber and melons	Kinase; Ascorbate Peroxidase (Apx); Calcium dependent Protein Kinase (CDPK); Heat Shock Protein
Mothbean	Ascorbate peroxidase; Superoxide dismutase; Cationic peroxidase ; Peroxisomal hydroxypyruvate reductase Dehydration Related Binding Element; Dehydration responsive protein; Desiccation-related protein Lb_13-62 Catalase; Pyrroline-5-carboxylate synthase; Proline dehydrogenase; Proline transporter 2; heat shock protein 70; Heat-shock protein 80; WD-repeat cell cycle regulatory protein; Glyceraldehyde-3-phosphate dehydrogenase A subunit; Glyceraldehyde-3-phosphate dehydrogenase B subunit; NADH-dependent glyceraldehyde-3-phosphate dehydrogenase; Plasma membrane proton pump; MYB transcription factor MYB93; NADH-plastoquinone oxidoreductase subunit 6
Lathyrus spp.	Mitogen activated protein kinases; Calcium dependent protein kinases; Heat shock protein; Pyrroline-5-carboxylate synthetase; Dehydrin; Drought responsive protein; Dehydration responsive element binding protein

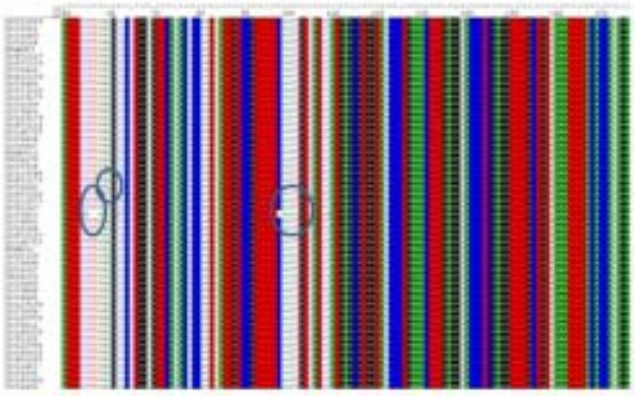


Fig.13. SNP and indels in Catalase 2 gene sequences (D13557) in selected mothbean accessions

diversity. All the 25 CBDP primers designed using different fillers and selective nucleotides, generated markers in jute cultivars. A representative profile of markers generated using primer CBDP15 is given in Figure below UPGMA cluster analysis grouped them into two clusters, consisting four cultivars of *Corchorus capsularis* and *C. olitorius* respectively. Grouping of the jute cultivars was consistent with genetic relationship established for these cultivars using other molecular DNA markers. These primers also generated markers in linseed and cotton cultivar. Moreover, CBDP markers profiles were found reproducible, which could be attributed to longer primer length, higher annealing temperature and touchdown PCR. Since the markers are derived from the region universally found in plants, it should be able to generate markers in other plant species as well.

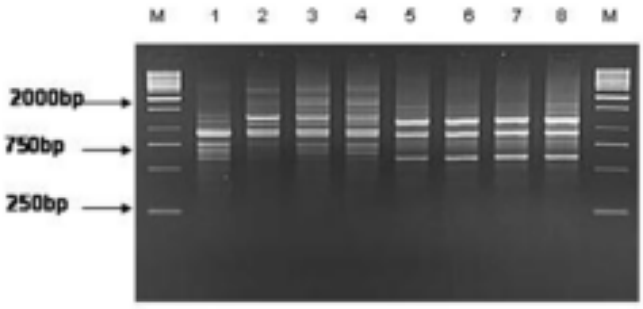


Fig.14. Gel profiles of markers generated using CAAT box derived primer, CBDP15 in jute. Cultivars in the *lanes:* 1. JRO524, 2. TJ-40, 3. Sudan Green, 4. Chinsurah Green, 5. JRC212, 6. JRC321, 7. JRC80, 8. D154. .M- 1kb DNA ladder

9.3.3. SCoT marker in jute: Start Codon Targeted (SCoT) polymorphism is a technique based on the short conserved region in plant genes surrounding the ATG translation start (or initiation) codon. This marker technology was standardized for diversity analysis in jute. Total genomic DNA from 31cultivars belonging to two cultivated species, namely, *Corchours olitorius* and *C. capsularis* was extracted using CTAB method. Thirty-six SCoT primers were used for PCR amplification of which 22 produced sharp and scorable 165 bands (see Figure 5 for representative profile). The results obtained using SCoT markers were comparable with the results reported earlier using other marker techniques like RAPD, AFLP and SSRs. The percent polymorphism in *C. olitorius* and *C. capsularis* was found to be 67.3% and 62.4%, respectively. Genetic dissimilarity of *C. olitorius* cultivars was slightly more compared to *C. capsularis* cultivars. Cultivars could be unequivocally differentiated from one another and the gene-targeted SCoT markers were found useful for diversity analysis and for identification of jute cultivars.

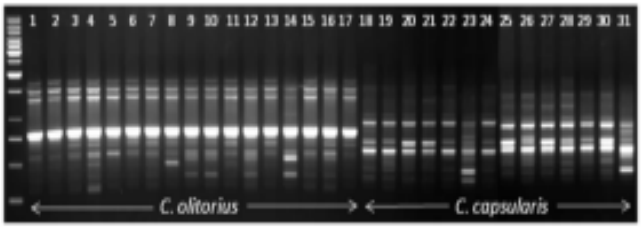


Fig.15. PCR amplification of 31 jute cultivars belonging to two cultivated species of jute using a representative SCoT primer. Numbers 1-31 on top represent cultivar numbers. Left-most lane is 1 kb DNA size standard (MBI Fermentas)

9.3.4. SRAP markers in jute: SRAP (Sequence-Related Amplified Polymorphic) marker technology was standardized in jute. Forty-three combinations of forward and reverse primers were used. These produced a total of 394 bands with an average of 9 bands per primer pair, of which 89% were found to be polymorphic (see Figure 7 for representative profile). Average genetic diversity, based on Jaccard's coefficient, in the cultivars of *C. olitorius* and *C. capsularis* was found to be 7.2% (range 2.8 -12.3%) and 7.6% (range 2.2 – 13.1%), respectively. UPGMA cluster analysis grouped all cultivars into two clusters which were representative of *C. olitorius* and *C. capsularis* species. All the cultivars could be unequivocally differentiated from one another (Figure 18). Twenty-four out of 31 cultivars could be identified uniquely. The probability of identity of molecular profiles of any two cultivars by chance was found to be in 6.95×10^{-07} and 2.23×10^{-07} in cultivars of *C. capsularis* and *C. olitorius*, respectively. SRAPs could be used as an effective molecular marker technology in assessing jute genetic diversity and cultivar identification.

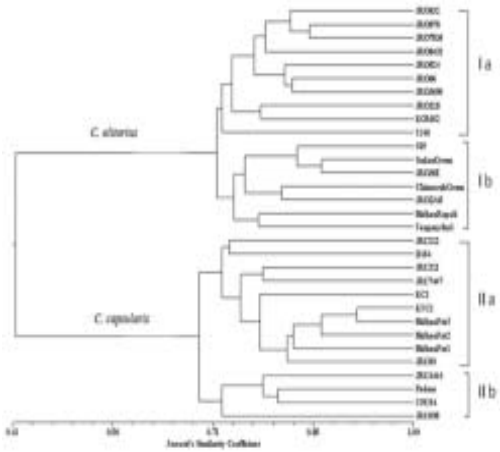


Fig.16. Genetic relationships among 31 jute cultivars based on 165 SCoT markers generated with 22 primers

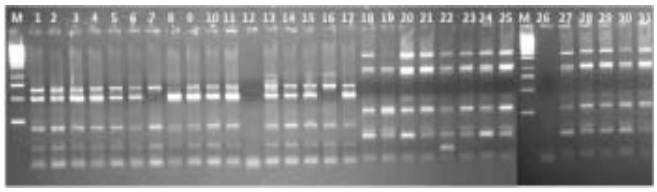


Fig.17. SRAP profile of 31 jute (*Corchorus* sp.) cultivars generated using EM4-ME1 primer-pair. M is 1kb molecular weight standard (MBI, Fermentas)

9.3.5. Resistance gene analogue polymorphic markers: Blast disease in finger millet is one of the serious diseases resulting into great yield loss. In order to develop candidate gene based molecular markers for genetic diversity estimation and MAS in finger millet 40 different resistance gene analogue polymorphism (RGAP) primer combinations were screened in 34 contrasting finger millet reference genotypes known to vary for blast disease response. Six different RGAP primer combinations were found to produce satisfactory polymorphism results.

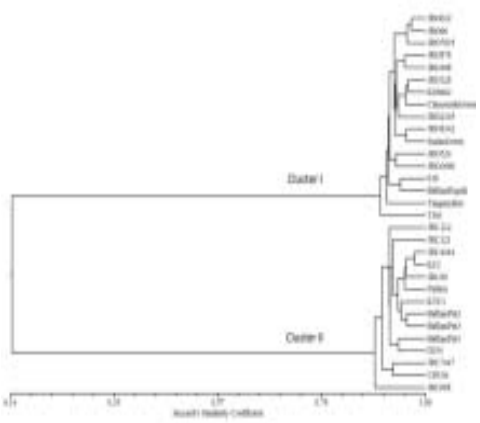


Fig.18. UPGMA clustering-based dendrogram depicting genetic relationships among 31 jute (*Corchorus* sp.) cultivars

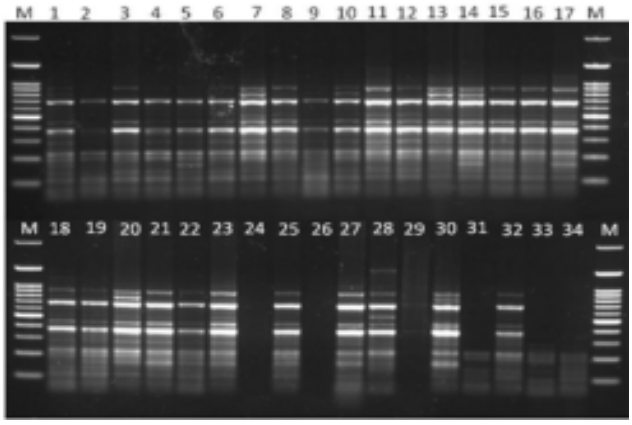


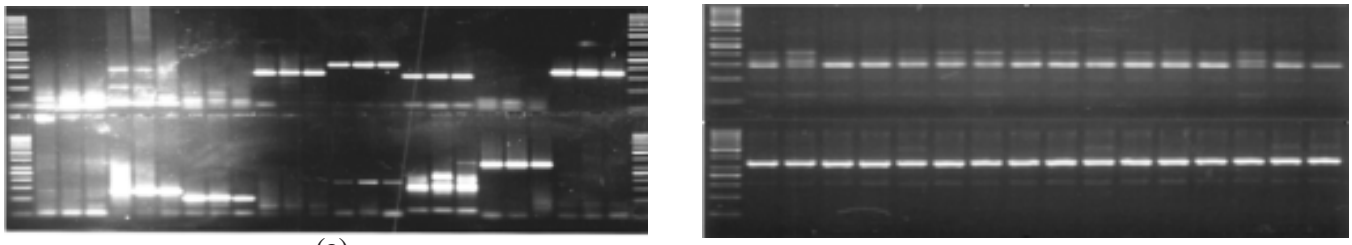
Fig.19. A representative gel figure showing RGAP primer amplification profiles in 34 finger millet lines

9.4 Development of SSR Markers

9.4.1 Development of genomic SSR markers in finger millet (*Eleusine coracana* L. Gaertn.): Genomic library was constructed for SSR marker development in finger millet and positive clones were sequenced for marker development. These sequences were used for designing primers flanking microsatellite repeats. A total of 49 primer pairs were designed. The reaction conditions for primers synthesized were optimized for PCR amplification using two released varieties PR202, HR 911 (*Eleusine coracana*) and one *E. africana* accession (EC 541532). Ten primer pairs resulted into amplicons of desired size range and tested for polymorphism in 17 finger millet germplasm lines of diverse origin. Only one primer pair was showing polymorphism.

9.4.2 SSR Marker development and validation in bottle gourd: SSR marker development through data mining / transferability is very cost effective. Hence, this approach was utilized to develop SSR markers in bottle gourd. Further SSR marker development in bottle gourd by transferability from cucumber yielded 60 SSR markers. For validation of these markers twelve have been profiled in 48 genotypes of bottle gourd. Seven of these yielded polymorphic profiles. Further profiling is in progress.

9.4.3 Testing and validation of SSR primer pairs designed from genomic library constructed from Giloe *(Tinospora cordifolia):* Eight SSR enriched library has been developed each for Giloe and Andrographis using different combination of biotin labeled repeat sequences. 236 clones from SSR enriched library



(a) (b)

Fig.20. Gel photographs showing genomic SSR markers developed (a) and polymorphism study (b) in 17 finger millet germplasm lines using FMgSSR14 and FMgSSR15

$(GT)_n$ each for Giloe and Andrographis has been sequenced. 30% clones showed presence of repeat regions in Giloe whereas, 15% clones showed presence of repeat regions in Andrographis. 21 SSR markers were designed from genomic library constructed from Giloe (*Tinospora cordifolia*), 12 were showing robust amplification which can be used to characterize the entire collection of Giloe for diversity at molecular level.

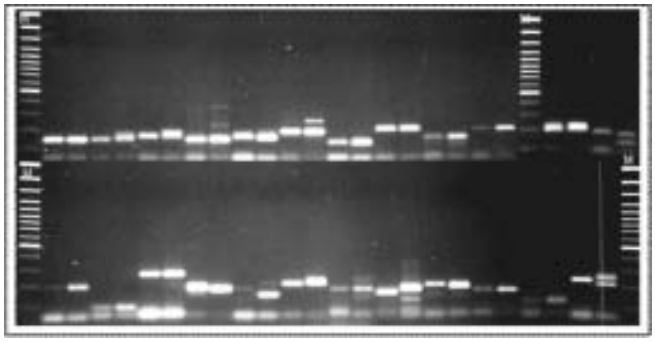


Fig.21. A representative gel photograph showing mapped cucumber primers transferred to bottle gourd. Lane M is 50 bp ladder

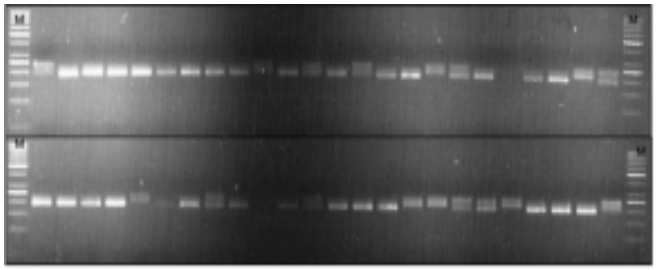


Fig.22. A representative gel photograph showing SSR profile of one of the transferred bottle gourd SSR markers in 48 genotypes. Lane M is 50 bp ladder

9.4 4 SSR marker development in Jute (*Corchorus* spp.): Ninety eight microsatellite primers in jute were custom synthesized and screened for amplification in a representative panel of eight genotypes (Figure 2). Nearly 80% primers gave amplification but 18 primers were further screened for finding out suitable annealing temperature using gradient PCR. Ten primers providing bands which were sharp, reproducible, scorable and in the known size range of microsatellites were used for profiling 31 jute cultivars (see Figure 3 for representative profile). Eight percent polyacrylamide gel electrophoresis (PAGE) at 100 Volts for 2 hours was carried out to resolve the amplified fragments.

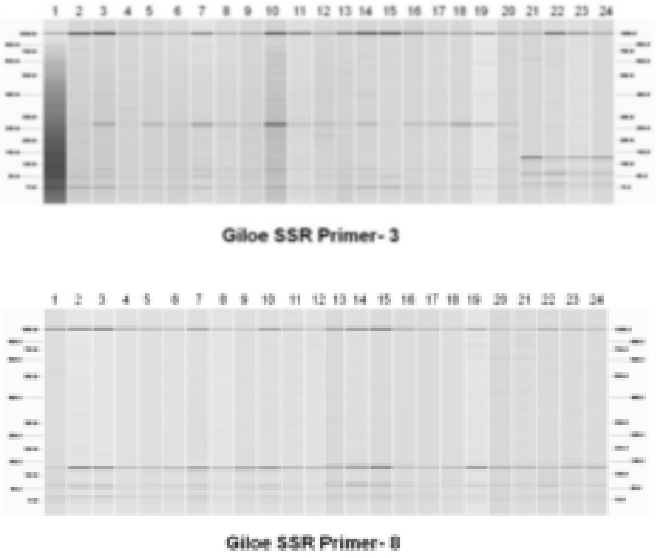


Fig.23. SSR primer amplification in *Giloe*

9.4.5 Development of SSR markers in bittergourd: Twenty nine new microsatellite loci have been identified through genomic library enrichment and sequencing for identification of microsatellite markers. These have been tested for amplification of the expected band through optimization of the PCR parameters. Figure shows amplification of 26 accessions of bittergourd with SSR primer $Mc4\_AT_{12}$. Three hundred more clones have been sequenced for designing of more SSR primers.

9.5. Development of Genomic Resources from Plant Genetic Resources

9.5.1. Generation of genomic resources for prospecting of genes for moisture stress tolerance

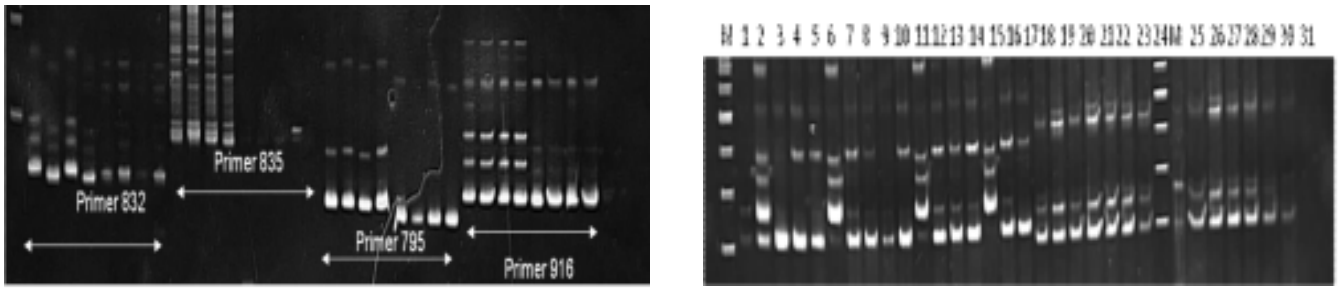


Fig.24. Screening of SSR markers in jute and microsatellite profile of jute cultivars using standardized primer

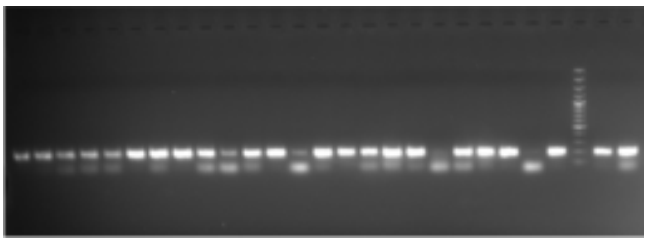


Fig.25. PCR Amplification of 48 bittergourd accessions with SSR primer Mc4_AT$_{12}$

and allele mining in *Cucumis* and mothbean: One moisture stress tolerant and one susceptible genotype each were selected on the basis of their field performance and used for transcriptome profiling in *Cucumis, Lathyrus* and mothbean. The total mRNA from the samples were isolated and checked for quality before sequencing with Roche 454 GS FLX technology and ABI Solid technology. The sequence reads generated were processed further as indicated below and the transcriptomes were assembled. Annotation of the transcripts was done using standard softwares and databases available. The process resulted in a total of ~76 million and ~77 million raw reads for transcriptomes of *Cucumis melo* control and moisture stress conditions were generated, after processing resulted in identification of 12,859 and 13,448 transcripts respectively. For mothbean, a total of 179,979 reads of transcriptomes for control sample and 201,888 reads for stress subjected sample were generated, after processing resulted in identification of 5,047 and 5,016 transcripts respectively.

Similar analyses were also conducted in *Cucumis* and *Lathyrus* for identification of transcripts with significant contributions to moisture stress tolerance. The analysis resulted in identification of transcripts with antioxidant activity and majority of the transcripts were related to catalytic activity and binding role.

A comparison of the transcripts specific to moisture stress response above indicates that 295 were common to both tissues and conditions while 223 were unique to control and 268 were specific to stress conditions. The study further will concentrate on these stress-specific transcripts. The classification of annotated transcripts is presented below which shows that these are several unique transcripts which may have substantial role in the drought hardiness of *Lathyrus*.

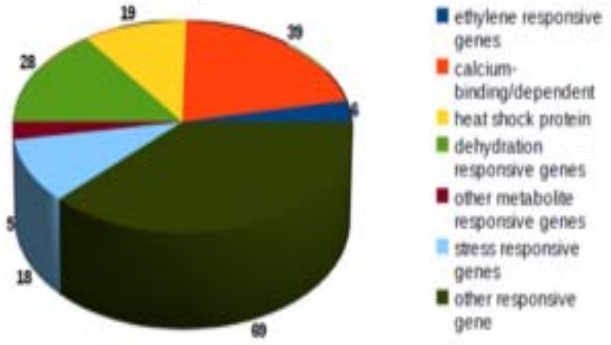


Fig.26. Classification of stress responsive genes among the transcripts sequenced in mothbean is presented in the figure.

9.5.2. Cloning of a novel cold tolerance gene *COR14* from white clover (*Trifolium repens*) Initially, a cold tolerance gene *TRICAS15* was isolated from a cold tolerant ecotype of white clover. Further to isolate more number of cold tolerance genes from white clover, different combinations of primers for known cold tolerance genes in the databases were designed and tested for amplification. One of the primer combinations amplified an amplicon which was cloned in TOPO T/A cloning vector and sequenced. The obtained sequence was searched for the homology with the nucleotide sequences in the database using BLAST program, which showed homology with cold responsive gene sequences of plant species. Complete open reading frame of the gene was cloned using primer walking. Full length coding sequence of this gene was 372 bp long, which encoded for a 123 aa long polypeptide with a calculated mass of 14kDa. Homology search of the isolated full length sequence with nucleotide sequence in databases revealed high similaity in a small strech with cold acclimation

specific genes of *Medicago truncutula M. sativa, M. fulcata* and *Oxytropis maydelliana* cold induced dehydrin. So far, majority of the cold responsive gene sequences are named on the basis of molecular weight of peptide encoded by them, therfore we designated this gene as *TRICOR14*. Multiple alignment of *TRICOR14* with similar cold responsive sequences found in other species is given in Fig 27.

9.5.3. Amplification and cloning of carotenoid pathway genes from watermelon: A carotenoid pathway genes phytoene synthase 1, a key gene for synthesis of Lycopene, was chosen for isolation and characterization. Degenerate primers from conserved region of *psy*1 gene amplified a 750bp amplicon from the cDNA of 20 day old developing fruit of a red pulp black seeded watermelon line DRB-669. This amplicon was cloned in a T/A cloning vector and

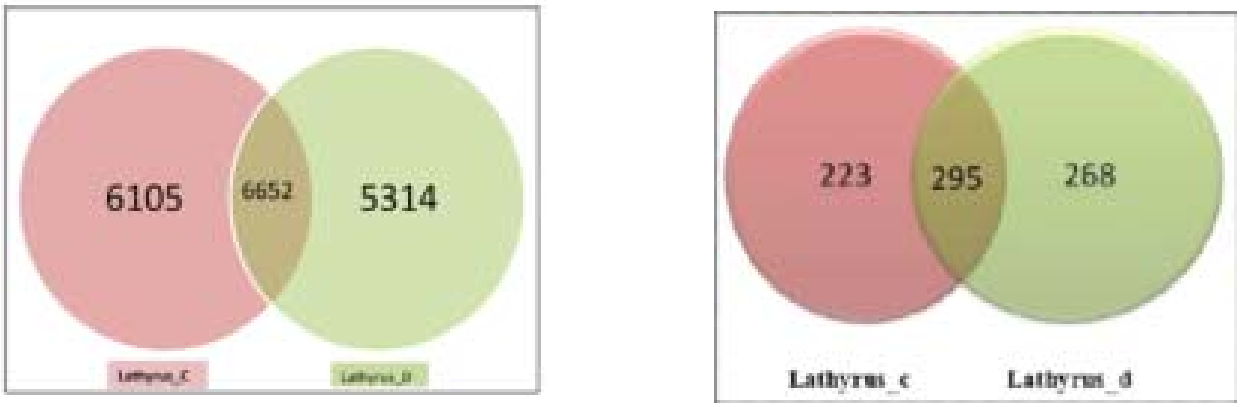


Fig.27. Venn diagram of the transcripts *Lathyrus* indicate that 6652 contigs were common to both control and stress, 6105 was specific to control while 5314 were unique to stress tissue.

Table 2. Classification of the annotated transcripts from controls and stress induced *Lathyrus* tissues with proven role in overcoming moisture stress.

Stress Reponsive Protein Class	*Lathyrus C*	*Lathyrus D*
Late Embryogensis Abundant Protein (LEA)	4	7
RAB GTP pase	5	3
Sucrose Non Ferments-able protein	5	8
Tata Bindnind Protein Like Protein (TLP)	6	5
WRKY-domain binding trascription factor	6	8
Cold acclimation protein	8	3
Betaine aldehyde dehydrogenase	8	8
Temperature associated proteins.	10	16
Phenylalanine ammonia-lyase	12	4
MYB Trascription Factor	22	36
Superoxides	24	6
Dehydration responsive assocated protiein	29	23
Ascorbate related protein	32	30
Stress-induced	39	28
Proton Pump associated protein	48	38
Heat Shock binding protein	263	243
Transporter functioning like protein	283	285
Total	**848**	**794**

sequenced to reveal similarity to *psy* gene from *Cucumis melo*. 5' and 3' RACE primers were designed to obtain the full length gene.

Fig. 28. Multiple alignment of *TRICOR14* with cod responsive genes found in plant species.

9.5.4. Isolation of resistance gene candidates (RGAs) from sponge gourd: Sponge gourd (*Luffa cylindrica*) genotype DSG-6 tolerant to Tomato leaf curl New Delhi virus (ToLCNDV) was chosen for isolation of resistance gene candidates (RGCs) with NBS-LRR domains and their phylogenetic characterization. Sixteen NBS-LRR domain containing partial gene fragments with non-redundant sequence and uninterrupted ORFs were isolated using four sets of degenerate primers from conserved domain of *R*-genes. The candidate resistance genes were sequence verified using NCBI-BLAST analysis. All the sixteen NBS-LRR sequences from sponge gourd were analyzed through program MEGA5 to identify two classes, namely Toll Interleukin Receptor (TIR) proteins and non-TIR proteins. The conserved domains of the sponge gourd RGCs were analyzed using the MEME software. All the sixteen RGCs from sponge gourd were deposited in the GenBank under the accession numbers JQ432525- JQ432540.

Fig.29. A gel photograph showing the 750 bp amplicon of phytoene synthase (indicated by arrow) from cDNA of red pulp watermelon line and its DNA sequence. Lane M is 50 bp ladder.

9.5.5. Cloning and expression analysis of carbonic anhydrase gene from cowpea (*Vigna unguiculata*): Around 50% of Indian soil is Zinc deficient that ultimately effects severely to children, women health. Although, carbonic anhydrase is well-known as zinc deficiency responsive gene, yet it is not cloned from cowpeas, which are important legumes crops of India. Thus in order to clone the same, a degenerate primer was designed which amplified 990 bp from the young leaves of cowpea cv. PUSA Kamal. The fragment was cloned to pGEM-T and sequenced. It had 97% DNA sequence and 95% protein sequence similarity with *Vigna radiata* CA gene. Further, it was also found that expression of this gene was up-regulated under drehydration but down regulated under Zn deficient condition in cowpea as revealed by RT-PCR analysis. Additionally, to find out the allelic variation, 6 cowpea genotypes (IC202801, IC588972, IC20574, IC588976, IC93782, BKS/YR/KAP P-1) were selected from different origin and full length carbonic anhydrase genes were cloned and sequenced. Potential non-synonymous SNPs were detected.

9.5.6. Drought stress related genomic resources from Horse gram: Preliminary drought screening of horse gram accessions for moisture stress tolerance was executed *in vitro* (PEG screening, *in vitro* screening, pot culture), in pots and field. Based on their contrasting response to drought, accessions were selected for biochemical, anatomical and phenotypic characterization. Selected moisture stress responsive accessions were used for differential library development and its subtraction efficiency was tested using confirmation PCR. SSR library construction work is in progress to develop markers. SSH- ESTs were analyzed and being submitted in NCBI database. So far 33 NCBI dbest accession numbers were received.

9.6. Species Relationships and Phylogeny

9.6.1. Biosystematics of the genera *Vigna, Cucumis* and *Abelmoschus*: Survey of different eco-geographical regions for species occurrence: Rajasthan, Odisha, Chhatisgarh, Madhya Pradesh and Southern peninsular regions were surveyed intensively for *Vigna, Cucumis* and *Abelmoschus* species. Several new records of occurrence were noted. Among these notable ones are new record of *Cucumis dipsaceus* for India from Maharashtra. Collection of 10 species and four varieties of *Cucumis* out of 13 species and five varieties from Peninsular India. Collection of 6

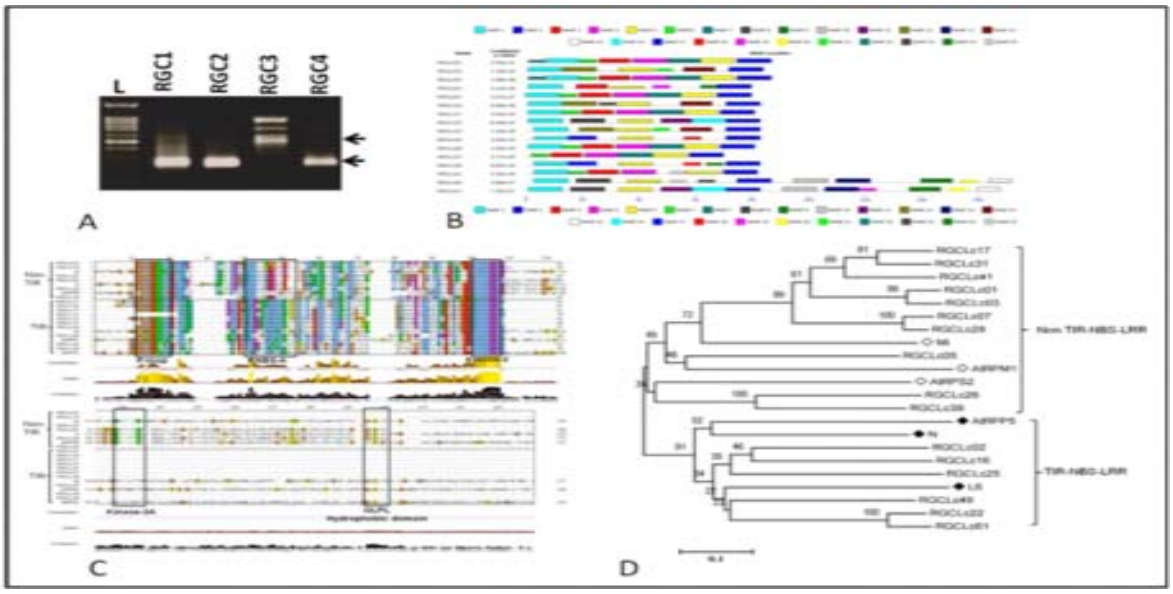


Fig.30. Resistance gene candidates from ToLCNDV resistant sponge gourd. A. PCR amplicons of four sets of degenerate primers (RGC1-4) cloned for sequencing. B. Conserved motifs in the 16 cloned LcRGC amino acid sequences. C. The conserved Nucleotide Binding Site (NBS) regions were shaded after ClustalW alignment. D. The phylogenetic clustering of 16 LcRGCs with six known *R*-genes showing TIR and non-TIR classes of RGCs.

species and two varieties of *Abelmoschus* out of seven species and three varieties from Peninsular India. Deposition of germplasm, dried flowers, silica dried leaf material to NBPGR, New Delhi for further studies. Description writing, habit photography, microphotography and illustrations have been done of seven species of *Cucumis* and four species and tow varieties of *Abelmoschus*. Collection of one species of *Vigna- V. hosei,* microphotography of five species of *Vigna,* and seedling morphology of three species of *Vigna.*

9.6.1.1 Establishing molecular basis for taxonomic delineations of *Vigna, Cucumis* and *Abelmoschus* species.

Differentiation of *Cucumis* species based on *cpDNA, mtDNA and rDNA sequences*

Continuation of the studies from previous period resulted in 10 informative cpDNA sequences in *Cucumis, Vigna* and *Abelmsochus*. In *Vigna*, the analysis indicated existence of wider differentiation of the African species from Asiatic species. Further, within the Asiatic species, members of the major groups such as *V. mungo var. silvestris, V. radiata var. sublobata, V. aconitifolia, V. umbellata* etc were distinct from each other. So far, trnL-F and rbcL regions were sequenced in 228 samples representing 15 *Vigna* species from India.

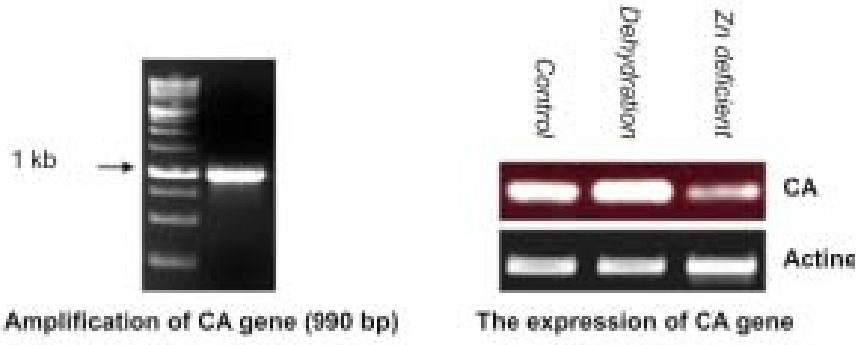


Fig.31. Cloning of full length gene of carbonic anhydrase (CA) from cowpea (A) Amplification of CA fragment, (B) expression analysis under dehydration (6h) and Zn deficiency stress (21 days)

Major accomplishments in molecular taxonomic studies in the *Vigna, Cucumis* and *Abelmoschus* were identification of molecular probes suitable for FISH studies to describe genomic differentiations in *Vigna, Cucumis* and *Abelmoschus* and their cloning. Further, DNA sequence variation in ITS1, ITS2, 3 cpDNA and 2 mtDNA regions analysed to describe species identities and relationships all 3 genera. A brief overview is presented in terms of the final results below:

In *Vigna*, the analysis indicated existence of wider differentiation of the African species from Asiatic species. Further, within the Asiatic species, members of the major groups such as *V. mungo var. silvestris, V. radiata var. sublobata, V. aconitifolia, V. umbellata* etc were clearly distinct from each other, this is clearly indicated by the analyses presented here. Further, trnL and rbcL regions were sequenced for 228 samples representing 15 *Vigna* species from India. Sequence information was generated in 251 population samples representing the 23 *Vigna* species assembled. The data generated is being analysed for drawing inferences on phylogeny and identity of the species.

In *Cucumis*, analysis was performed on 145 accessions of following *Cucumis* Species: *C. sativus var. hardwickii, C. sativus, C. callosus, C. utillissimus, C. melo* var. *melo, C. melo* var. *momordica, C. cantaloupensis, C. trigonus, C. agrestis, C. setosus, C. melo* var. *conomon* and *C. prophetarum*. The regions sequenced were - *ITS1 & 2* region of nuclear DNA, *psbA-trnH, trn L-F* and *trn E-F* inter-genic spacer region of chloroplast DNA. The taxa under the four major groups of *Cucumis*, namely, *C. sativus, C. melo, C. prophetarum* and *C. setosus* were observed to be well differentiated for the genomic regions analysed. A total of 96 samples representing 20 species of *Cucumis* were analysed for sequence variation in *trn*L- *trn*F; *psb*A – *trn*H intergenic spacer regions from the chloroplast genome; and from the nuclear genome two regions, namely, *ITS1; ITS2* from the rDNA region were analysed. The samples analysed include all the species of *Cucumis* available in India.

In *Abelmoschus*, analysis of the ITS1 and ITS2 sequence variation supports earlier reports on origin of okra – *moschatus/tetraphyllus* and *tuberculatus* genome contributions. The work accomplished included analyses of 101 samples of 10 *Abelmoschus* species for the loci, *ITS-1, ITS-2; trnL-F, trnL exon, rbcL, rpoC1, psbA-trnH; nad B1* and *rps14 –cobr.* Analysis of the ITS1 and ITS2 sequence variation supports earlier reports on origin of okra – *moschatus /tetraphyllus* and *tuberculatus* genome contributions. A. *moschatus* and *tetraphyllus* share 16_{II}s while *tuberculatus* and *ficulneus* share with *esculentus* 28_{II}s each. The work accomplished included primer screening and optimization for *MatK*, *Nad1*exon, *Rbcl*, *TrnL-F*, I*TS* region, *PsbA-trnH* and *trnC-D* regions and analyses of 81 samples of 13 *Abelmoschus* species. Sequence variation data has also been generated for 5 chloroplast genomic regions, two mitochondrial regions and two rDNA spacer regions in the 81 selected accessions representing the 13 *Abelmoschus* species.

9.6.2. Species relationship in *Luffa* genus: Total eight authentic species of *Luffa* were procured, 10 accessions from each species were selected for barcoding and their genomic DNA was isolated. Initially three loci (chloroplast *rbc*L, *mat*K and genomic ITS) were selected. Two accessions from each of eight species were initially used for PCR amplification of *rbc*L locus and the amplified products were sequenced. The pariwise multiple alignement were made between the sequences and the evolutionary divergence were calculated using Jukes-Cantor method. The phylogenetic tree shows that except *L. tuberose* other *Luffa* sps. were clustered together. The species *L. tuberose* clustered along with outgroup *Memordica dioca* thus questioning taxonomic status *L. tuberosa* in the genus *Luffa*. This result need further phylogentic confirmation with other barcoding loci and morphological studies.

9.7 Marker Development for Transgene Detection

9.7.1. Development of transgene detection tools Transgene/promoter/marker/endogenous gene specific simplex PCR based detection protocols have been developed for six GM maize Events and four stacked GM maize Events; such as (a) MON89034 Event : For *cry2Ab*, *cry1A.105* genes, *nptII* marker gene, *FMV* promoter, *nos* terminator and *hmg* endogenous reference gene, (b) GA21 Event: *For mepsps* gene, rice actin promoter, *nos* terminator and *hmg* endogenous reference gene, (c) NK603 Event: For *CP4epsps* gene, HSP70 gene, *nptII* marker gene, *CaMV* 35S promoter, *rice actin* promoter, *nos* terminator and *hmg* endogenous reference gene , (d) TC1507 Event: For *cry1F* gene, *CaMV* 35S promoter and *hmg* endogenous reference gene, (e) MON810 Event: For *HSP70* gene, *CaMV* 35S promoter,

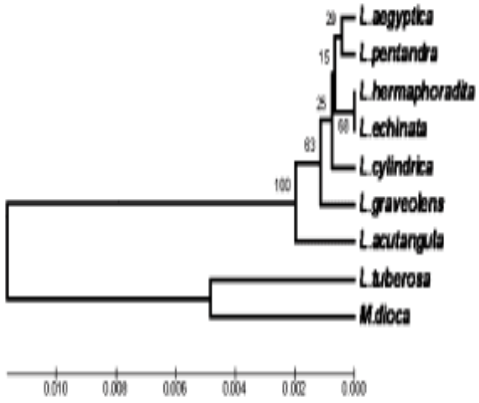


Fig.32. Phylogenetic dendrogram of *Luffa* spp.

nos terminator and *hmg* endogenous reference gene, (f) Bt11 event: For *pat* marker gene, *CaMV* 35S promoter, *nos* terminator and *hmg* endogenous reference gene, (g) Bt11× GA21 Event: For *CaMV* 35S promoter, rice actin promoter, *pat* marker gene, *nos* terminator and *hmg* endogenous reference gene, (h) MON89034× NK603 Event: For *cry2Ab* gene, *cry1A.105* gene, *CP4epsps* gene, *HSP70* gene, *nptII* marker gene, *CaMV* 35S promoter, FMV promoter, *nos* terminator and *hmg* endogenous reference gene , (i) TC1507× NK603 Event: For *cry1F* gene, *CP4epsps* gene, *HSP70* gene, *nptII* marker gene, *CaMV* 35S promoter, rice actin promoter, *nos* terminator and *hmg* endogenous reference gene , (j) *TC1507*× MON810 Event: For *cry1F* gene, HSP70 gene, *pat* marker gene, *nptII* marker gene, *CaMV* 35S promoter, *nos* terminator and *hmg* endogenous reference gene.

Multiplex PCR assays have been developed for seven GM maize Events; namely (a) NK603 Event (Hexaplex

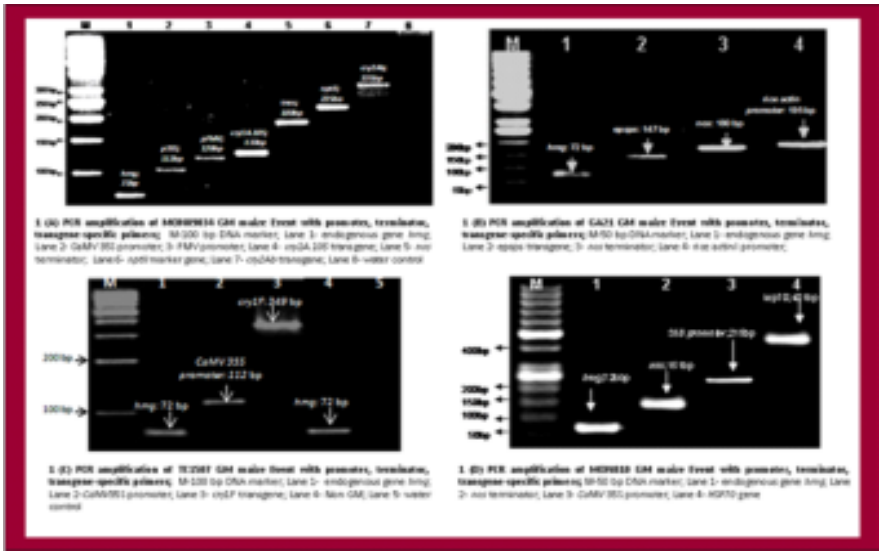


Fig. 33. Transgene/promoter/marker/endogenous gene specific simplex PCR based detection

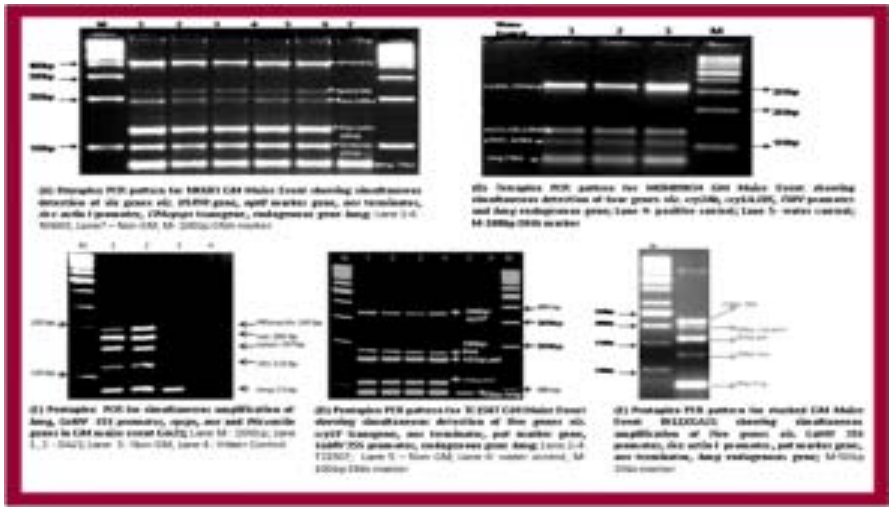


Fig.34. Multiplex PCR assays developed for GM maize

format): For *CP4epsps* gene, *nptII marker* gene, *HSP70,* rice actin promoter, *nos* terminator, *hmg* endogenous gene, (b) GA21 Event (Pentaplex format): For *mepsps gene,* rice actin promoter, *CaMV* 35S promoter, *nos* terminator, *hmg* endogenous gene, (c) TC1507 Event (Pentaplex format): For *cry1F* gene, *pat* marker gene, *CaMV* 35S promoter, *nos* terminator, *hmg* endogenous gene, (d) Bt11 Event (Tetraplex format): For *pat* marker gene, *CaMV* 35S promoter, *nos* terminator, *hmg* endogenous gene, (e) MON89034 Event (Tetraplex format): For *cry2Ab* gene, *cry1A.105* gene, FMV promoter, *hmg* endogenous gene, (f) Bt11×GA21 Event (Pentaplex format): For *pat* marker gene, *CaMV* 35S promoter, *rice actin* promoter, *nos* terminator, *hmg* endogenous gene, (g) MON89034× NK603 Event (Tetraplex format): For *cry1A.105* gene, *HSP70* gene, rice actin promoter, *hmg* endogenous gene.

A Construct-specific PCR based detection protocols have been developed using nested PCR in Bt Brinjal and Bt Cabbage

Event-specific Real-time PCR protocols have been developed in Bt Brinjal and Bt cabbage: namely for *cry1Ac* (Event EE); c*ry1Ab*; *cry1Fa* genes; *cry1Ac* gene (for cabbage). A Taqman and SYBR-green based Real time PCR protocols have been developed for GM maize events; NK603, TC1507, MON89034, GA21, & MON810.

9.7.2. Molecular testing of imported transgenic planting materials: Four-hundred and twenty-nine samples of total eighteen imports including transgenic *Oryza sativa* (313 accessions-10 imports) from Belgium

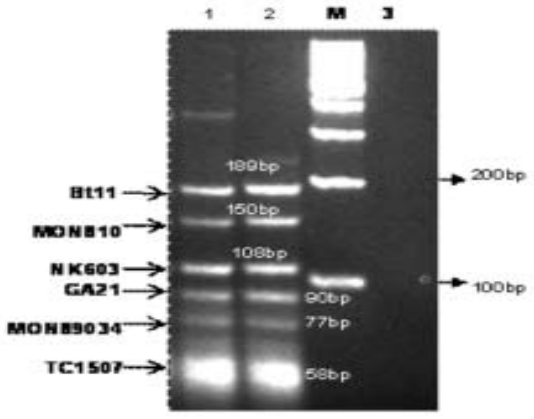


Fig.35. Hexaplex PCR pattern showing simultaneous detection of six GM Maize events *viz.* Bt11, MON810, NK603, GA21, MON89034, TC1507; M- 100bp DNA marker; Lane 3- water control

(306) for insect resistance and cell-cycle regulators from United Kingdom (2) for nematode resistance, from U.S.A (5) for cell cycle regulators; *Zea mays* (116 accessions-8 imports) from Philippines (45), South Africa (10) for herbicide tolerance, from U.S.A (58) and from Brazil (1) for insect resistance, were received for molecular testing.

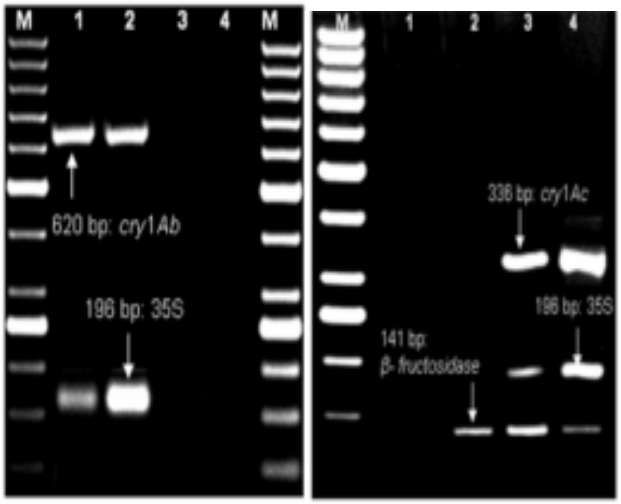


Fig.36. Duplex and triplex PCR in Bt Brinjal with simultaneous detection of cry1Ab and 35S promoter & cry1Ac, 35S promoter, â- fructosidase. M- 50bp ladder

All four-hundred and twenty-nine imported transgenic lines were tested for specific transgene/promoter/terminator/marker genes and also to ensure the absence of embryogenesis deactivator gene by PCR with primers specific to the *cre-lox* system.

Twelve GM Events, along with their endogenous genes, were validated on the ready-to-use multi-target analytical system with specific primers and probes for these events and endogenous genes using real time PCR assays-

5 Cotton Events: MON531, MON15985, MON88913, 281-24-236, 3006-210-23
7 Maize Events: MON89034, MON810, NK603, Bt176, Bt11, GA21, TC1507

9.7.3. Comparative/proficiency testing at International Level: Internationally, the GM detection lab in NBPGR has successfully executed proficiency testing, for testing the unknown GM contents in the powdered samples of different GM Events using Real Time PCR assays, during 2011. These proficiency testing were organized by:

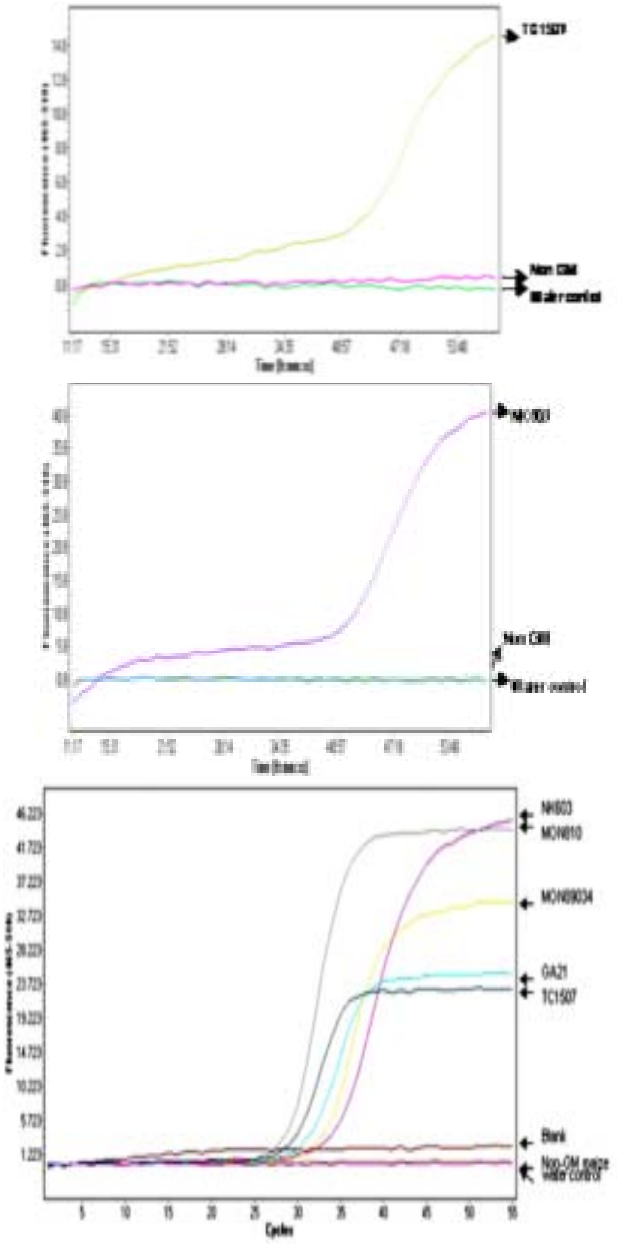


Fig.37. Taqman and syber green-based Event specific Real time PCR for imported GM Maize Events

i) European Commission Reference Laboratory, Joint Research Centre, Italy, under ISO/IEC 17043:2010 accreditation

ii) Grain Inspection, Packers and Stockyards Administration (GIPSA), United States Department of Agriculture (USDA)

In the month of April 2011, two powdered samples of GM Soya Event 40-3-2 were received from EURL for determination of GM content. The analysis was done using Real time PCR based on Taqman chemistry, and GM content was estimated to be 1.56% and 6.04% in soybean powder level 1 and soy bean powder level 2 respectively.

9.8. Development of Database and Bioinformatics

Database on varietal seed material obtained from different institutes of ICAR and SAUs including breeders, Project Directorates, Project Co-coordinators, Directors of Research was conceived and maintained. Database consists mainly the records on variety name, crop group, identity number, botanical name, donor name and address, pedigree, year of release, area of adaptation etc. DNA fingerprinting data being generated using particularly with microsatellite markers would be later appended with this information.

Bioinformatics data analysis tools are being designed employing in-house designed computer scripts (Degenarate PCR primer tool and Genome Data annotation pipeline. Genome annotation of Phytopthora infestans, late blight pathogen of potato is being analysed in collaboration with CPRI, Shimla. Cleaning, analysis and assembly of Phytopthora raw genome resulted in prediction of nearly 14,000 genes. These pathogen affectors are translated and the amino acid sequences are being annotated to elucidate functions involved in late blight disease. Pigeon pea sequenced genomic data is downloaded from online repositories. Contigs were cleaned, trimmed length wise and assembled. So far 104 genes responsible for Disease resistance were predicted.

9.9. Transfer of Technology and DNA Fingerprinting Services

DNA fingerprinting services were provided to Pioneer Overseas Corporation, Hyderabad; CCS Haryana Agricultural University, Hisar; Directorate of Maize Research; Customs Department; Division of Genetics, IARI, New Delhi; Advanced Center for Research on Chickpea, Agricultural Research Station, Durgapura, Jaipur; Rasi Seeds (P) Ltd. Resources; Mahatma Phule Agricultural University, Rahuri.

9.10. Development of Infrastructure Facilities

Online data submission, storage & retrieval forms facilitating user web interface were designed using PHP, .NET and Perl language scripts. Webpage for the repository constructed (http://www.nbpgr.ernet.in/repository/home.htm) Forms of deposition, requisition, MTA etc finalized:(http://www.nbpgr.ernet.in/repository/deposit.htm)(http://

S.No.	Events/Endogenous genes	Set 1	Set 2
	Cotton		
1	281-24-236	√	√
2	3006-210-23	√	√
3	MON15985	√	√
4	MON531	√	√
5	MON88913	√	√
	Sah 7 (endogenous)	√	√
	Maize		
1	TC1507	√	√
2	Bt11	√	√
3	Bt176	√	√
4	MON810	√	√
5	GA21	√	√
6	MON89034	√	√
7	NK603	√	√
	Hmg (endogenous)	√	√

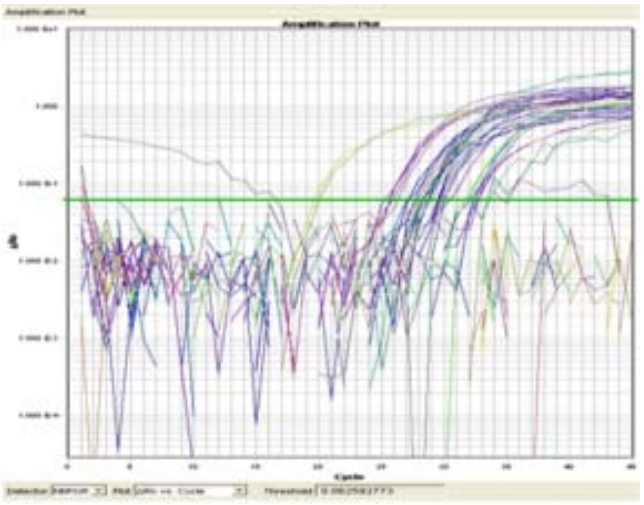


Fig.38. Real time PCR based amplification plot for Multi-target Plate analysis

www.nbpgr.ernet.in/repository/request.htm. High Performance Computational facility has being acquired under National Agricultural Bioinformatics Grid.

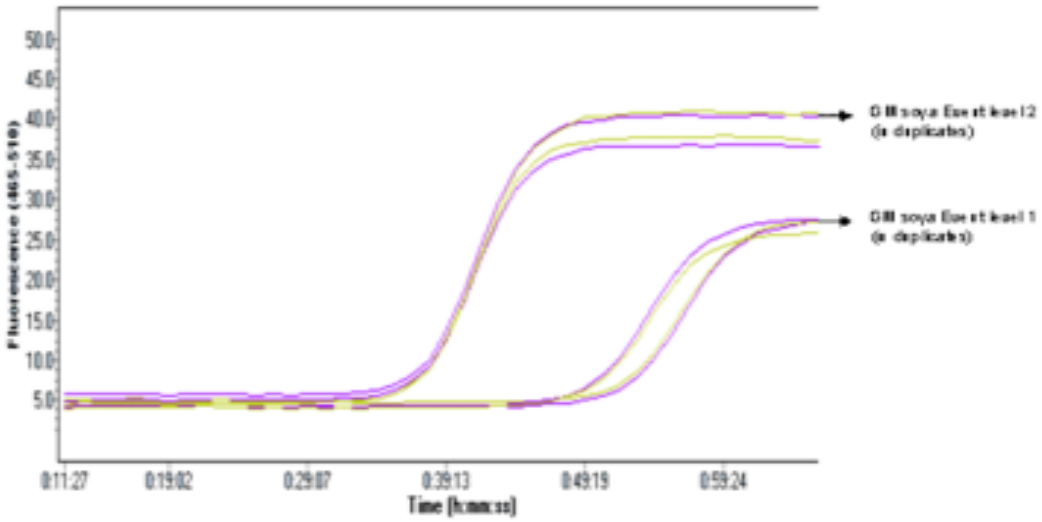


Fig.39. Real time-based estimation of GM contents in the powdered samples of Soybean for different GM Events.

Programme (Programme Code: Title, Leader)

PGR/DFP-BUR-DEL-01: Development of genomic tools for the enhanced utilization of PGRs (KV Bhat)

Research Projects (Code: Title PI, CoPIs and Associates)

PGR/DFP-BUR-DEL-01.01: Development of genomic tools for discovery and validation of genes of economic importance for enhancing the use of plant genetic resources of pulses and oilseeds.(**KV Bhat**, MK Rana, J Yasin, R Kumar, J. Radhamani; M Latha (Trichur); A Nissar (Akola); R Singh and M Singh (GED)

PGR/DFP-BUR-DEL-01.02: Development of genomic tools for enhanced utilization of fiber and forage crops (**MK Rana** , AK. Singh, TK Mondal; and JC Rana (Shimla)

PGR/DFP-BUR-DEL-01.03: Development of genomic tools for enhanced utilization of cereal and millets (**L Arya**, M Verma, C Ram, M Yadav, S Kumar, D Saha, TK Mondal, AK Singh, B.S. Phogat, S Yadav, (GED), NK Dwivedi, JC Rana, S. Pandrawada (Hyd) and F Hussain (IARI)

PGR/DFP-BUR-DEL-01.04: Development of genomic tools for enhanced utilization of cucurbitaceous crops (**M Verma**, L. Arya, C Ram, D Saha, M Grover, G Kumar and R Bharadwaj (GED)

PGR/DFP-BUR-DEL-01.05: Development of genomic tools for enhanced utilization of medicinal and aromatic plants (**R Singh**, AK Singh, S Marla, S Kumar, N S Pawar, A Raina, and A Kumar (GED)

PGR/DFP-BUR-DEL-01.06: Development of genomic tools for enhanced utilization of under-utilized crops (**S Archak**, AB Gaikwad, AK Trivedi (Bhowali); JC Rana, (Shimla); and NK Dwevedi (Jodhpur)

PGR/DFP-BUR-DEL-01.07: Development of genomic tools for enhanced utilization of horticultural crops (**AB Gaikwad**, KS Negi (Bhowali) and J John (Thrissur)

PGR/DFP-BUR-DEL-02: Establishment and maintenance of National Genomic Resources Repository (S Archak)

Research Projects (Code: Title PI, CoPIs and Associates)

PGR/DFP-BUR-DEL-02.01: Establishment and maintenance of National Genomic Resources Repository (**S Archak**, KV Bhat, GJ Randhawa, M Yadav, AB Gaikwad, MK Rana, R Singh, M Verma, L Arya, S Kumar, TK Mandal, D Saha, S Rajkumar, R Kumar, AK Singh, R Parimalan, C Ram and J Yasin; and R Chaudhury, (TCCU)

PGR/DFP-BUR-DEL-02.02: Documentation and maintenance of data base for National Genomic Resources Repository (**SS Marla**, RC Agrawal, M Bala, M Grover and Dayashankar **)**

PGR/DFP-BUR-DEL-03: Development of diagnostics for transgene detection and biosafety assessment in crop plants (GJ Randhawa)

Research Projects (Code: Title PI, CoPIs and Associates)

PGR/DFP-BUR-DEL-03.01: Molecular diagnosis of GM crops (**GJ Randhawa,** S Archak and R Parimalan)

PGR/DFP-BUR-DEL-03.02: Screening ex-situ germplasm collections for adventitious presence of transgenes (**GJ Randhawa**, S Archak and R Parimalan)

PGR/DFP-BUR-DEL-04: Exploitation of molecular genetic tools for species delineation and genetic erosion studies in agri-horticultural crops (MC Yadav)

Research Projects (Code: Title, PI, CoPIs and Associates)

PGR/DFP-BUR-DEL-04.01: Development of DNA bar-codes for identification of wild relatives and molecular phylogeny in important crops (**MC Yadav**, R Singh, S Rajkumar, and K.J Yasin; DR Pani, (Cuttack)

PGR/DFP-BUR-DEL-04.02: Monitoring temporal variation in genetic diversity for devising effective PGR management strategies in safflower (**S Rajkumar**, MC Yadav, KJ Yasin, and J Radhamani)

Externally Funded Projects:

- Application of Microorganisms in Agriculture and Allied Sectors (AMAAS) ICAR (**KV Bhat**)
- Referral Centre for molecular diagnosis of transgenic planting material DBT (**GJ Randhawa**)
- Development of STMS and SCAR markers in bittergourd (*Momordica charantia* L.) and their utilization for genetic characterization and tagging of gynoecious trait DBT (**AB Gaikwad**)
- Molecular characterization of cotton germplasm Technology Mission on Cotton – Mini Mission I ICAR (**MK Rana**)
- DNA Fingerprinting and Molecular Characterization of Jatropha Germplasm Collected from Diverse Agroclimatic Zones of India NOVOD Board (**KV Bhat**)
- 038-NAIP-DFC-KVB-08- Molecular Tools for Exploitation of Heterosis, Yield and Oil Quality in Sesame NAIP (**KV Bhat)**
- Biosystematics of the Genera *Vigna, Cucumis* and *Abelmoschus* NAIP (**KV Bhat**)
- Development of STMS markers and construction of framework map in greengram (*Vigna radiata* L. Wilczek) DBT (**KV Bhat**)
- Prospecting of genes and allele mining for abiotic stress tolerance NAIP (**KV Bhat**)
- Rationalisation of selected set of rice collections originating from major areas of diversity and allele mining for biotic, abiotic and quality traits using molecular markers. ICAR. (**R Singh**)
- Establishment of National Rice Resource Database. DBT. (**R Singh**)
- Establishment of National Agricultural Bioinformatics Grid. NAIP. (**S. Marla;** M. Grover; S. Archak)

10. REGIONAL STATION, AKOLA

Summary: Undertook two exploration and collection missions under NEH programme during the reporting period. A total of 101 accessions of germplasm comprising *Oryza nivara* (17), *O. rufipogon* (16) and *O. sativa* L.(68) were collected during two explorations in Chattisgarh and adjoining Uttar Pradesh under NICRA and West and South Tripura district in the state of Tripura. A total of 2,465 accessions were characterized, out of which a total of 1,361 accessions of germplasm comprising of grain amaranth (1,170), of vegetable amaranth (85), linseed (52) and safflower (55) accessions were characterized during *rabi* 2010- 2011 and 1,104 accessions of germplasm comprising finger millet (273), niger (443), castor (288) and winged bean (100) were characterized during *kharif* 2011. Sesame (1,662), pigeon pea (793), green gram (641) and *Abelmoschus* spp. (237) during the *kharif* 2011 were regenerated and multiplied. In all 330 accessions of germplasm comprising sesame (307) and grain amaranth (23) accessions were multiplied and sent for conservation in the National Genebank. A total of 969 accessions of germplasm of various crops/species were supplied to 22 indenters from different user agencies for their research and improvement programmes within the country. A total of 19,849 accessions comprising millets (1,094), pulses (4,844), vegetables (2,120), oilseeds (10,002), wild relatives of crop plants (630), underutilized crops (1,155) and others (4) are being maintained in the medium term storage module under controlled conditions at 7 ^{0} C .

The objective of this Regional Station is to explore, collect, evaluate, maintain and conserve the plant genetic resources of different agri-horticultural crops of the Central Indian region i.e. Maharashtra, Chhattisgarh, Madhya Pradesh and adjoining regions of Gujarat and Karnataka. This Station provides the desired germplasm to the breeders and scientists of different institutes/ universities in India and abroad for their research work focused to improve the agri-horticultural crops. It is one of the co-operating centers for All India Co-ordinated Research Project on Under Utilized Plants.

10.1 Plant Exploration and Germplasm Collection

During the reporting period two explorations, one under NICRA and another under NEH project were undertaken. A total of 101 accessions of germplasm comprising *Oryza nivara* (17), *O. rufipogon* (16) and *O. sativa* (68) were collected. The exploration-wise details and variability observed are discussed.

10.1.1: Collection of wild rice germplasm from parts of Chhattisgarh and Uttar Pradesh under NICRA project (NICRA -03).: An eleven days exploration program w.e.f. 31Octo ber 2011 to 10 November 2011 were undertaken from all the three agro-climatic zones of the State of Chhattisgarh (Bastar plateau, Northern Hill Region and Plains of Chhattisgarh) and parts of Uttar Pradesh. The latitude of the surveyed area varied from 18^{0} 59' 346 to 25^{0} 14' 868 and longitude 80^{0} 21' 350 to 83^{0} 12' 676. The topography of the surveyed area was very diverse. Different districts covered for collection of targeted germplasm/ species includes Raipur, Durg, Rajnandgaon, Mandirasod, Mahasamund, Dhamtari, Narharpur, Kanker, Balod, Sarona, Bhanupratappur, Bastar, Antagarh, Jagdalpur, Dantewada, Bhairamgarh, Kodagaon, Bilaspur, Kota, Lamna, Katghora, Surguja, Wadrafnagar, Mohan Sarai, Aurai, Wadrafnagar, Ambikapur, Lakhanpur, Udaypur, Tara, Madai-Korba, Janjgir-Champa areas of Chhattisgarh and Sonbhadra, Mirzapur and Maheshpur area of Varanasi districts of Uttar Pradesh. A total of 27 accessions of germplasm comprising 17 accessions of *Oryza nivara* and 10 accessions of *O. rufipogon* were collected during the survey. During the exploration, emphasis was given on collecting *O. nivara* and *O. rufipogon*. The areas where only *O. sativa* var. *spontanea* were observed were not collected. The *spontanea* is a natural cross between either *O. nivara* and *O. sativa* or *O. rufipogon* and *O. sativa* as the cultivated, *O. sativa* is sympatric with its progenitor species *O. rufipogon* and *O. nivara*. It has the same characteristics of either the parent's i.e *O. nivara* or *O. rufipogon* but differs in vigour and long bold black grains. Morpho-agronomical characteristics of the species and passport information were recorded from the site of collection. Introgression was observed between *O. nivara* and *O. sativa* and *O. rufipogon* and *O. nivara.* Locally these introgressed populations (*O. sativa* var. *spontanea*) are called as Karga. *O. nivara* is locally called as Pasher, Pasaher, Kapni,Tini where as *O. rufipogon* as Tetangi, Chaha and sometimes Pasher. Significant diversity in *O. nivara* and *O. rufipogon* differing in morpho-agronomic characteristics *were* observed during the exploration. Hence, this well planned and timely collection will not only preserve wild gene pool of cultivated rices but also may help identification of suitable donor for submergence tolerance or for grassy stunt virus.

10.1.2 Collection of wild gene pool of rice from West and South Tripura under NEH exploration programme (NEH-19): West and south districts of Tripura were explored for wild gene pool of rice from 13 to 22 December 2011 in collaboration with CRRI, Cuttack and under the liaison of KVK, West Tripura and collected six accessions of *Oryza rufipogon a*nd 68 accessions of primitive landraces of rice. Mohanpur, Teliamura, Chebri, Padmabil, Bagabil, Jirania, Barjala, Bishalgarh, Sepahijala, Melaghar, Pandabpur in West Tripura and Belonia, Hrishyamukh, Satchand, Rupaichari and Manubazar areas of South Tripura were explored. The explored area i.e. West and South Tripura is located between 22^0 56' and 24^0 $3$2' N latitude and 91^0 ^{0}9'-92 ^{0}20' east longitude with an altitude ranging from 50 to 300 ft above mean sea level.

Collecting *Oryza nivara* from Darrabhata, Champa, Chhattisgarh

***Oryza rufipogon* showing length of the plant**

Perennial forms of wild rice namely *Oryza rufipogon* were collected from five different locations of West Tripura whereas only one accession of *O.rufipogon* was collected from South Tripura. The aquatic bodies were observed to be occupied by *Scirpus, Cyperus,* and dominant species S*acciolepis*. The weedy species in rice ecosystem in Tripura included *Digitaria adscendens*, *Echinochloa colona*, *Eleusine indica*, *Eragrostis tenella*, *Panicum repens*, *P. incomtum* etc. Noteworthy accessions are *Signal* for good to taste, *Lighta, Bajal*- deep water, *M1mi Reang, Kali khasa, Adma Kiting , Kalokhasa, Sada kalojira, Govindbhog* and *kalojira*-scented types.

Long spikelets with anthers of *Oryza rufipogon*

10.2 Characterization of Germplasm

A total of 1,361 accessions of germplasm comprising grain amaranth (1,170), vegetable amaranth (85), linseed (51) and safflower (55) were characterized during *rabi* 2010- 2011 and 1,104 accessions of germplasm comprising finger millet (273), niger (443), castor (288) and winged bean (100) were characterized during *kharif* 2011 with suitable checks. The details of quantitative traits are given in the following tables- 1-6.

10.2.1 Germplasm characterization *(Rabi* 2010-2011): During *Rabi* 2010-11, a total of 1,361 accessions of germplasm comprising 1,170 accessions of grain amaranth, 85 accessions of vegetable amaranth, 55 accessions of Safflower and 51 accessions of linseed were characterized during *rabi* 2010-2011.

Grain Amaranth: 1,170 accessions of grain amaranth germplasm were grown in *rabi* 2010-11 in augmented design using Suvarna as check were evaluated for nine qualitative and 11 quantitative traits. The qualitative traits studied include early plant vigour, plant growth habit, leaf colour, inflorescence colour, inflorescence compactness, stem colour, stem surface, inflorescence shape and inflorescence spininess. The quantitative traits includes

Table-1: Range, mean, SE and phenotypic CV (%) of quantitative traits in grain amaranth germplasm

Characters	Range	Mean ± SE	CV (%)
Leaf length (cm)	5.23-23.54	12.12 ± 0.08	21.16
Petiole lenght (cm)	1.90-20.64	7.40 ± 0.06	24.78
Days to 50% flowering	42-109	55.83 ± 0.20	11.62
Stem thickness (mm)	5.04-27.39	12.24 ± 0.08	21.44
No. of branches per plant	0-10	3.64 ± 0.04	38.87
Plant height (cm)	34.04-172.86	104.03 ± 0.72	22.03
Lateral spikelets length (cm)	4.48-39.68	20.54 ± 0.19	29.64
Inflorescence length (cm)	6.94-50.34.	24.71 ± 0.19	24.64
Days to maturity	97-122	111.75 + 0.14	4.01
Seed yield per plant (g)	0.88-40.36	9.74 ± 0.15	48.29
1000 seed weight (g)	0.40-0.76	0.580 ± 0.002	10.62

plant height (cm), leaf length (cm), petiole length (cm), stem thickness (mm), number of branches per plant, inflorescence length (cm), lateral spikelet length (cm), days to 50% flowering, days to maturity, 1,000-seed weight (g) and seed yield per plant (g).

Vegetable amaranth: 85 accessions of vegetable amaranth germplasm belonging to *Amaranthus tricolor, A. viridis, A.dubius* and *A. spinosus* were characterized for morpho-agronomiical traits as per the Minimal Descriptors published by NBPGR.

Table-2: **Range, ,mean, SE and phenotypic CV (%) of quantitative traits in 51 accessions of linseed germplasm**

Characters	Range	Mean ± SE	CV (%)
Plant height (cm)	36.28-60.01	43.22 ± 0.65	10.68
No. of capsules/ plant	46.50-115.00	73.44 ± 2.19	21.27
Days to 50% flowering	56-70	61.43 + 0.43	5.06
Days to 80% maturity	93.50-108.00	99.67 + 0.32	2.26
100 seed weight (g)	0.24-0.63	0.45 ± 0.01	19.34
Seed yield/plant (g)	0.38-3.18	1.63 ± 0.08	36.34

Linseed: Fifty one accessions of linseed germplasm were grown in a randomized block design in 3.0 metre row length with two rows each per accession and a row gap of 60 cm. Checks used were Kiran, Garima and H-local. Eight qualitative and six quantitative traits were recorded.

Safflower: Fifty five accessions of safflower germplasm were grown in randomized block design in 3.0 metre row length and row to row spacing of 60 cm. The checks used were A-1, AKS-207 and Bhima. Nine qualitative and seven quantitative traits were recorded. The traits studied included early plant vigour, plant growth habit, leaf margin, branching habit, angle of branches, extent of leaf spininess, corolla colour and corolla colour of dry flower. The quantitative traits included plant height, number of capitula per plant, diameter of primary capitulum, number of seeds/capitulum, 100 seed weight (g) and yield per plant (g).

Table-3: **Range, Mean, SE and Phenotypic CV (%) of quantitative traits in 55 accessions of safflower germplasm**

Characters	Range	Mean	Phenotypic CV (%)
Plant height (cm)	35.3-120.8	73.3	23.23
Productive tillers	3-18	9.0	28.30
Leaf length (cm)	18.52-44.76	31.34	13.50
Leaf width (cm)	0.50-2.35	1.02	16.94

10.2.1 Germplasm characterization *kharif* 2011

Finger millet: A total of 273 accessions of finger millet germplasm were grown in an augmented design in 3.0 metre row length of 3 rows each during *kharif* 2011. Ten qualitative and eleven quantitative traits were recorded. The qualitative traits recorded were growth habit, plant pigmentation, finger branching, ear shape, ear size, discontinuity of spikelets on finger, spikelet shattering ,lodging susceptibility, grain colour and grain shape, The quantitative traits recorded are days to flowering, days to maturity, plant height, productive tillers, leaf sheath length, leaf width, finger length, finger width, 100-seed weight and yield per plant. The variability parameters are given in Table -4.

Table-4. Range, mean and phenotypic CV(%) of quantitative traits in 273 accessions of finger millet germplasm.

Characters	Range	Mean ± SE	CV (%)
Plant height (cm)	59.77-117.39	82.58 + 134	12.10
No. of capitula/plant	17.40-50.20	34.11 + 0.90	19.60
Diameter of primary capitulum (mm)	15.46-26.67	18.86 ± 0.30	12.05
No. of seeds/capitulum	10.00-46.10	26.24 + 0.87	24.60
100- seed weight (g)	1.30-4.91	3.35 ± 0.10	22.64
Yield/plant (g)	11.75-12.26	5.62 ± 0.30	39.99
Finger length (cm)	4.73-13.60	7.25	16.24
Finger width (mm)	0.44-1.32	0.96	19.24
100 seed weight (g)	0.02-2.00	0.20	20.19
Yield per plant (g)	2.02-23.42	7.67	57.43

Niger: A total of 443 accessions of niger germplasm were sown during *kharif* 2011 in augmented design in three rows of three metre row length and row to row spacing was 60 cm. Checks used were CHH-1, CHH-2, JNC-6**.** Seven qualitative and six quantitative traits were recorded. The qualitative traits studied were early plant vigour, branching habit, flower colour, leaf colour, leaf margin, stem colour and lodging tendency. The range, mean and CV % of quantitative traits in respect of 443 accessions of niger germplasm are given in Table -5.

Table-5. Range, Mean and Phenotypic CV (%) of quantitative traits in 443 accessions of Niger germplasm

Characters	Range	Mean	Phenotypic CV (%)
Plant height (cm)	41.3-205.7	111.18	27.82
Leaf length (cm)	6.30- 20.80	14.05	21.38
Leaf width (mm)	0.40-12.06	4.35	33.44
No. of primary branches	1.0-18.4	7.67	44.15
100 seed weight (g)	1.0-18.4	7.67	44.15
Yield per plant (g)	0.45-6.47	4.84	58.13

Okra: Incidence of jassids and *Yellow vein mosaic virus* (YVMV) reduces the fruit yield and fruit quality considerably in cultivated okra besides damaging the immune system. A total of 1,067 accessions of okra germplasm were screened for incidence of jassids and YVMV under natural condition in the experimental farm of NBPGR Regional Station, Akola. The infestation was recorded as per the Minimal Descriptors of Agri-Horticultural Crops (Part-1) published by the NBPGR, 2000. Seven accessions for jassids and 486 accessions were shown very low or no visible sign of susceptibility (Table -6 &7).

Table-6. Screening of okra germplasm for jassids (*kharif* 2011)

Severity of incidence	No. of accessions	Percentage
Very low or no visible sign of susceptibility	7	0.66
Low	211	19.77
Intermediate	305	28.58
High	351	32.90
Very high	193	18.09
Total	**1,067**	

Table-7. Screening of okra germplasm for YVMV (*kharif* 2011)

Severity of incidence	No. of accessions	Percentage
Very low or no visible sign of susceptibility	486	45.55
Low	149	13.96
Intermediate	350	32.80
High	82	7.69
Total	**1,067**	

10.2.2 Regeneration and multiplication: Regenerated and multiplied 3,333 accessions of germplasm for LTS / MTS. These included Sesame (1,662), pigeon pea (793), green gram (641) and *Abelmoschus* spp. (237) during the *Kharif* 2011.

10.3 Conservation of Germplasm in the National Genebank

A total of 330 accessions of germplasm comprising 307 accessions of sesame and 23 accessions of grain amaranth were multiplied and sent for conservation in the National Genebank.

Table 8: Germplasm supplied to users

Crop/ Species name	No. of accessions
Okra	191
Abelmoschus tuberculatus	32
A. moschatus	3
A. tetraphyllus	4
A. ficulneus	4
A. caillei	1
A. angulosus	2
Horse gram	363
Foxtail millet	1
Winged bean	114
Linseed	100
Grain Amaranth	79
Sponge gourd	23
Ridge gourd	18
Luffa acutangula var. *amara*	4
L. tuberosa	1
L. hermaphrodita	1
Carthamus lanatus	1
C. oxycantha	1
Safflower	1
Grass pea	10
Cucumis hardwikii	9
C. callosus	5
C. setosus	1
Total	**969**

Table 9: Status of germplasm holdings (MTS)

Crop/Crop group	No. of Accs.
Millets (1,094)	
Sorghum	50
Pearl millet	21
Kodo millet	105
Barnyard millet	169
Little millet	118
Foxtail millet	288
Finger millet	343
Pulses (4,844)	
Chick pea	1,010
Grass pea	126
Green gram	641
Black gram	15
Horse gram	983
Pigeon pea	2,052
Moth bean	17
Vegetables (2,120)	
Okra	1,664
Winged bean	244
Lablab bean	212
Oilseeds (10,002)	
Sesame	6,927
Castor	83
Safflower	1,425
Niger	583
Linseed	838
Soybean	146
Miscellaneous (4)	
Canavalia spp.	2
Mucuna pruriens	1
Psoralea corylifolia	1
Wild relatives of crops (630)	
Sesamum spp.	150
Carthamus spp.	74
Moth bean	17
Abelmoschus spp.	406
Underutilized crops (1,155)	
Okra	1,664
Amaranthus spp.	1,155
Winged bean	244
Total	**19,849**

10.4 Germplasm Supply

A total of 969 accessions of germplasm of various crops/ species were supplied to 22 indenters through germplasm Exchange Unit under MTA from different user agencies for their research and improvement programmes within the country. The crop/species name and number of accessions supplied are listed in table -8.

10.4.1 Medium term storage of germplasm in the Regional Genebank: A total of 19,849 accessions of germplasm comprising millets and millets (1,094), pulses (4,844), vegetables (2120), oilseeds (10,002), wild relatives of crop plants (630), underutilized crops (1,155) and others (4) are being maintained in the medium term storage module under controlled conditions at 7 ^{0}C .

Research Programme (Code, Title and Programme Leader)

PGR/GEV-BUR-AKO-01.00: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources in the Central Indian Plains **(M Abdul Nizar)**

Research Projects (Code: Title, PI, Co-PIs and Associates)

PGR/GEV-BUR-AKO-01.01: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources of pulses (pigeon pea and chickpea), vegetables (okra) and under utilized crops (winged bean and amaranth) (**M Abdul Nizar**, N Dikshit)

PGR/GEV-BUR-AKO-01.02: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources of oil seeds (sesame, niger, castor, ground nut, safflower, soybean and linseed), millets and small millets (**N Dikshit**, M Abdul Nizar)

11. Regional Station, Bhowali

Summary: Two crop-specific explorations and excluding one survey and identification (26 acc. tagged) tour were undertaken and 58 accessions were collected which include landraces and primitive cultivars of cereals (32) and Fruits (26) from remote areas of Uttarakhand hills under National Exploration Programme. A total of 942 accessions were received from for regeneration, characterization and maintenance. Some of the elite seed samples and live rooted plant material *viz.* M & AP and WEUPS (Wild Economically Useful Plant Species): *Hedychium spicatum* (300 nos.), *Pelargonium graveolens* (4576 nos.), *Origanum vulgare* (335 nos.), *Rosmarinus officinalis* (49156 nos.), *Valeriana jatamansi* (300 nos.), Horticultural Plants: Kiwi (1174 nos.), Kiwi seedlings (200 nos.), Kiwi fruits: 265 kg. (Grade – A: 136 kg. + Grade – B: 126 kg. + Grade – C: 03 kg.), Strawberry (5.250 Kg + 540 nos.), Kagazi nimbu (788 nos. + 06 kg.); Agricultural Crops: Green pod peas (56 kg), Horsegram (17 kg.), Paddy mix (70 Kg), Rice bean mix (17 Kg), Soybean (38 kg.) were supplied to different farmers / indentors. A total of 54 accessions were supplied to user scientists in the country and 425 accessions deposited in National Genebank for conservation.

11.1 Plant Germplasm Exploration and Collection

11.1.1 Exploration and collection of field crops: One crop specific (wheat and barley) exploration tour was conducted in collaboration with VPKAS, Almora and 17 accessions of wheat and 15 accessions of barley were collected from Uttarkashi, Tehri, Rudraprayag and Chamoli of Uttarakhand.

11.1.2. Exploration and collection of horticultural crops: Two crop specific (peach and pear) exploration tours (One exploration and collection and second survey and identification) were conducted in collaboration with CITH, Regional Station, Mukteshwar (Nainital). In the first exploration tour 12 accessions of peach 14 accessions of pear were collected from Champawat and Pithoragarh district of Uttarkahand. In the second exploration tour (survey and identification) 12 accessions of peach and 14 accessions of pear having unique and desirable traits were tagged in district Champawat and Pithoragarh for collection in the coming winter season (February 06-10, 2012).

11.1.3. Exploration and collection of M&AP and wild economically useful plants: Eight accessions of assigned M&AP were recollected from districts Uttarkashi, Tehri, Rudraprayag and Chamoli of Uttarakhand.

11.1.4 Germplasm enrichment: A total of 942 accessions comprising of paddy (03), *Siraitia grosvenorii* (01), *Glycine max* (286), garlic (01), rice bean (09), blueberry (07), coriander (320), fenugreek (143), *Ocimum* spp. (20), fennel (21), winter wheat genotypes (131) have been received from NBPGR, R/S Phagli, Shimla; GEX, NBPGR, New Delhi; HOD, GCD NBPGR New Delhi; VPKAS, Almora; CSKHPKV, Palampur and GBPUA&T, Hill Campus Ranichauri, Tehri Garwal; NFTCR, New Delhi and Division of Genetics, IARI, New Delhi.

11.2. Germplasm Characterization and Evaluation

11.2.1 Germplasm characterization, regeneration and seed multiplication of field crops: The germplasm

Table 1. Explorations Undertaken During 2011 by NBPGR, R/S Bhowali under National Exploration Programme

S.No.	Crop/Crop group	Collaborative institute	Areas Explored	Germplasm collected	I Cereals	II M&AP	III Fruits
1.	Crop Specific (Pear and Peach)	CITH, Mukteshwar	District Champawat and Pithoragarh, UK	26 (Scion wood)			26
2.	Crop Specific (Wheat. barely and assigned M & AP germplasm)	VPKAS,	District Uttarkashi, Tehri, Rudraprayag and Chamoli, UK				
			Total	**58**	**32**	***08**	**26**

* 08 accessions of M & AP. recollected;

accessions collected from Kumaon and Garhwal regions of Uttarakhand were grown at Bhowali for characterization, regeneration and multiplication during *kharif* 2011 and *rabi* seasons 2010-2011 (Table 2).

Table 2. Germplasm characterization during *kharif* 2011

Crop	No. of Acc.
Rice bean germplasm	56
Soybean Germplasm	25
Paddy (Rainfed)	207
Total	**288**

Table 3. Multiplication/Seed Increase for Long Term Storage (LTS) in National Gene Bank during *kharif* 2011

Crop	Accessions
Amaranth	61
Bitter gourd	04
French bean	20
Ridge gourd	07
Paddy (Rainfed)	51
Soybean germplasm	25
Soybean germplasm (Regeneration)	291
Fennel voucher samples from NGB	26
Arabidiopsis thaliana voucher samples from NGB	23
Total	**508**

Table 4. Promising accessions identified in field crops during *rabi* 2010-2011 and *kharif* 2011

Crop	Main attributes	Accessions identified for specific/desired traits
Wheat (New Collections) – *Triticum aestivum* (40 acc.) Checks: 05 (VL-616, VL-892, VL-738, VL-832, VL-907)	Days to 80% spike emergence	IC585652 (121), IC585666 (122.67) IC585656 (123.33)
	Plant height (cm)	IC585648 (144.67), IC585651 (143.33), IC573165 (142.33), IC573158 (141.00) & IC585633 (140.33)
	No. of effective tillers/ plant	IC585655 (15.00), EC675843 (14.67), IC585659 (14.00), IC585641 (13.33) IC585652 (12.67)
	Grain yield/ plant (g)	IC573159 (34.30)
Barley-New collections (36 acc.) Checks: 04 (VLB-56, VLB-64, VLB-1 & VLB-85)	Days to 75% spike emergence	IC573160 (109.67)
	No. of effective tillers/ plant	IC585634 (12.33), IC585664 (12.33), IC573161 (11.33), IC585662 (11.00), IC573130 (11.00) IC573135 (11.00)
	Plant height (cm)	IC585658 (130.67), IC585650 (129.33), IC573171 (126.00), IC573161 (124.00) IC585649 (122.67)
	No. of grains/spike	IC585657 (79.67), IC573171 (78.67), IC573133 (74.33), IC585650 (71.33) IC585653 (68.33)
	Days to 80% maturity	IC573160 (159.33), IC585664 (165.00), IC585667 (170.67), IC573147 (171.00) IC585665 (171.33)
	Grain yield/ plant (g)	IC585664 (21.18), IC573135 (20.11), IC573131 (19.93) IC573130 (19.48)
	100 grain weight (g)	IC585650 (4.29) IC585647 (4.23)
Lentil – 174 Checks: 06 (VL-1, VL-105, VL-108, VL-830, VL-406 & PL-639)	Days to 50% flowering	IC277173 (108.00) IC212556 (110.00)
	Plant height (cm)	IC281600 (54.10), EC78421 (45.60), EC299632 (44.60), IC274611 (43.50), IC338761 (43.10) IC78506-C (43.00)
	No. of pods/ plant	IC279685 (191.00), IC268234 (155.00), EC78458 (141.00), EC78534 (139.00) IC282828 (130.00)
	Days to 80% maturity	IC268236 (114.00), IC512249 (158.00), EC78458 (166.00)
	100 seed weight (g)	EC225495 (5.23), EC267557-D (5.19), EC267574-A (5.06), EC223232-B (4.41) EC27659 (4.12)
Amaranth – 61 Checks: 04 (Annapurna, Swarna, VL-44 & PRA-1)	Days to 80% maturity	NC-59967 (102), IC021931 (107), IC041767 (107), IC042265-2 (107)
	Plant height (cm)	IC042265-3 (202), IC42281-13 (195), IC42281-11 (194), IC42281-15 (183), IC42290-13 (182)
	100 seed weight (g)	NC-59976 (1.03), IC042264-16 (0.98), IC42315-8 (0.97), IC42281-15 (0.94)

	Seed yield/plant (g)	IC041991 (81.10), IC022276-81 (48.5), IC042276-18 (45)
Cold tolerant paddy (Rainfed)-67Checks: 05 (Majhera-7, VL-206, VL-207, VL-208, VL-209)	Days to 75% panicle emergence	NMJO-3013 (134), NMJO-3073 (135), NMJO-3095 (135), NMJO-3097 (135), NMJO-3020 (135)
	Plant height (cm)	NMJO-3094 (147), NMJO-3013 (146), NMJO-2995 (138), NMJO-3098 (138), NMO-2982 (136)
	Days to 80% maturity	NMJO-3020 (152), NMJO-3021 (154), NMJO-3023 (154), IC444258 (156)
	Panicle length (cm)	NMJO-3013 (31.9), NMJO-3094 (27.6), NMJO-3096 (27.1), NMO-2982 (27)
	No. of tillers/ plant	NMJO-3092 (18.0), NMJO-3083 (15.8), NMJO-3095 (15.2), NMO-2981 (11.0)
	No. of grains/ panicle	NMJO-3094 (305), NMJO-3093 (242), NMO-2975 (233.2), NMO-2973 (219.8), NMJO-3087 (194.2)
	100 grains weight (g)	NMJO-3021 (3.51), NMJO-3075 (3.32), NMJO-3013 (3.27)
	Grain yield/plant (g)	NMO-2973 (19.4)
	Days to 50% flowering	EC39177-A (41), EC26738 (46), EC34381 (46), EC34394 (46), EC34395 (46)
Soybean germplasm (regeneration) (82) Checks: 04 (VLS-2, VLS-21, VLS-47, VLS-54)	No. of pods/ plant	EC39730-A (192), EC39512 (163), EC39513 (159), EC39501 (153), EC39795 (153), EC30197 (143)
	Days to 80% maturity	EC26738 (98), EC37111 (98)
	Plant height (cm)	EC25683 (166), EC39486 (164.8), EC39718 (159.8), EC25167 (149.4), EC38125 (148.0)
	100 seed weight (g)	EC18737 (25.1), EC39740 (23.0)
	Seed Yield/ plant (g)	EC55898 (275.0), EC39375 (56.2), EC39512 (56.2), EC39510 (53.3)
	No. of pods/ plant	MK-23 (108), MGHP-1154 (96), MGHP-1152 (93), MK-10 (91)
Soybean germplasm (25) Checks : 04 (VLS-2, VLS-21, VLS-47, VLS-54)	Plant height (cm)	MGHP-1146 (185.9), MGHP-1154 (184.9), MK-15 (179.9), MGHP-1147 (175.2)
	Yield/plant (g)	IC574377 (38)
	Days to 50% flowering	LRB-461 (79)
	No. pods/ plant	LRB-491 (221), LRB-492 (186), LRB-493 (186), LRB-474 (145), LRB-498 (142), LRB-497 (135)
Rice bean germplasm (50) Checks: 03 (PRR-01, PRR-02 & RBL-06)	Plant height (cm)	LRB-497 (195), LRB-497 (193.6)
	Days to 80% maturity	LRB-474 (127), LRB-472 (130), LRB-473 (130)
	Total plot yield (g)	LRB-472 (250), LRB-474 (250), LRB-493 (225)

Table 5. Range, mean and coefficient of variation in field crops during *rabi* 2010-2011 and *kharif* 2011

Crop	Character	Range		Mean	PCV%
		Min	Max		
Amaranth (61 acc.)	Leaf length (cm)	13.90	22.30	17.84	10.55
	Days to 80% maturity	114.23	102	128	6.10
	Plant height (cm)	14.26	202	148.11	19.33
	100 seed weight (g)	0.55	1.03	0.78	12.90
	Total Plot yield (g)	20.00	680.00	127.87	86.09
	Seed Yield/plant (g)	1.90	81.10	14.78	91.77
Wheat (New Collections)– *Triticum aestivum* (40 acc.)	Days to 80% spike emergence	121	165.33	145.87	7.00
	Plant height (cm)	76.27	144.67	121.69	16.32

	No. of effective tillers/ plant	6.33	15.00	10.95	17.07
	Grain yield/plant	2.21	34.30	12.18	44.18
Barley-New collections	Days to 75% spike emergence	109.67	141.00	124.88	4.80
(36 acc.)	No. of effective tillers/ plant	5.67	12.33	8.80	20.94
	No. of spikelets/spike	17.00	26.67	22.17	8.86
	Plant height (cm)	106.67	130.67	116.01	4.76
	No. of grains/spike	46.67	79.67	60.32	13.40
	Days to 80% maturity	159.33	178.33	173.41	2.09
	Grain yield/plant (g)	9.26	21.18	15.27	18.10
	100 grain weight (g)	2.70	4.29	3.39	9.37
Lentil – 174	Days to 50% flowering	108.00	135.00	120.48	5.40
	Plant height (cm)	14.50	54.10	31.38	21.91
	No. of pods / plant	15.00	191.00	57.30	55.54
	Days to 80% maturity	114.00	178.00	168.07	6.74
	100 seed weight (g)	1.02	5.23	2.18	29.54
Soybean (82)	Days to 50% flowering	41	94	76	21.0
	Days to 80% maturity	98	169	134.95	12.52
	Plant height (cm)	28.50	166.0	90.87	40.86
	100 seed weight (g)	6.80	25.10	15.15	28.55
	Seed yield/plant (g)	1.60	275.0	26.47	117.41
	No. of pods/ plant	12.0	192.0	92.89	39.36
Soybean (25)	No. of pods/plant	61	108	78.7	13.97
	Plant height (cm)	68.5	185.9	133.4	32.78
	Yield/plant (g)	7.6	38.4	16.8	53.82
Cold tolerant paddy (207)	Days to 75% panicle emergence	134	172	147	6.45
	Plant height (cm)	51.4	147	118	12.5
	Panicle length (cm)	13.3	31.9	21.5	15.60
	No. of grains / panicle	73	305	140.7	29.5
	Days to 80% maturity	152	201	174	5.8
	100 grains weight (g)	0.99	3.51	2.26	21.5
	Grain yield/plnat (g)	0.08	19.4	8.39	52.1
	No. of tillers/ plant	4.00	18.00	8.00	30.1
Rice bean (50)	Days to 50% flowering	79	126	98	7.74
	No. pods / plant	28	221	87	49
	Plant height (cm)	62.00	195.0	137	24.73
	Days to 80% maturity	127	155	141	5.28
	Total plot yield (g)	0.5	250.0	82	76.06

Table 6. Germplasm evaluation and characterization during *rabi* 2011-12

Crop	No. of Acc.	Date of Sowing	Checks Used
Lentil	44	10.11.2011	VL-01, VL-105, VL-108, VL-830, VL-406 & PL-639
Winter wheat	09	24.10.2011	HB-208, VL-616 & VL-738
Wheat characterization and seed increase	41	24.10.2011	VL-616, VL-738, VL-832, VL-892 & VL-907
Wheat disease screening nursery	131	11.11.2011	—
Wheat voucher samples from NGB for regeneration	200	24.10.2011	VL-616, VL-738, VL-832, VL-892 & VL-907
Pea germplasm	50	16.11.2011	Rachna, Harbhajan, Selaction – 18, VL-08,

(*Pisum sativum*)			Lincon, Bhowali local - B
Pea germplasm (*Pisum arvense*)	50	16.11.2011	Champawat local, Rudraprayag local, Pithoragarh local, Uttarkashi local
Barley	33	24.10.2011	VLB-1, VLB-56, VLB-64 & VLB-85
Coriander voucher samples from NGB	332	04.11.2011	ACR – 41, Pant horit, Panipat Melakot, Kashipur Block-44, Bhowali local
Coriander characterization and seed increase	152	04.11.2011	ACR – 41, Pant horit, Panipat Melakot, Kashipur Block-44, Bhowali local
Fenugreek voucher samples from NGB	142	21.11.2011	Pant early, C-74, Champawat Local, P.E.B., Bageshwar local
Fenugreek characterization and seed increase	62	21.11.2011	Pant early, C-74, Champawat Local, P.E.B., Bageshwar local

11.2.2. Evaluation under All India Co-ordinated Trial: All India Co-Ordinated Trial of Initial Varietal Trial, Advance Varietal Trial I & II–Hills of rice bean consisting of 11 varieties with three checks (PRR-1, PRR-2 & RBL-06) was conducted. And VRB-3 (38 q/ha), IC141077 (31 q/ha), BRS-1 (29 q/ha.) were performed better in grain yield than other entries i.e., PRR-1(25 q/ha), PRR-2 (17 q/ha) and RBL-6 (20 q/ha). Other entries performing well in Grain yield (q/ha) - VRB-3 (37.5), IC141077 (30.8), BRS-01 (29.2) , 100 seed weight (g) - IC563980 (14.2) and number of pod/plant - RBHP-35 (88), IC141077 (88), RBHP-30 (76), LRB-460 (75) whereas range were recorded

Table 7. Range, mean and superior genotypes in fruit crops during 2011

Crop	No. of Acc.	No. of Descriptors	Characters	Range of Variation			Superior Genotypes
				Min.	Max.	Mean	
Apricot (*Prunus armeiniaca*)	14	21	Fruit length (cm)	1.4	5.43	3.41	IC319186
			Fruit width (cm)	1.4	5.5	3.7	IC360694
			Fruit weight (g)	250	687	432	IC360692
			Fruit volume (cc)	100	406	238	IC247428
			Fruit per plant	4	122	23.3	IC360699
			TSS (^{0} Brix)	12	15.3	14	IC319186
Peach (*Prunus persica*)	08	21	Fruit length (cm)	4.91	11	6.69	IC360689
			Fruit width (cm)	5.2	5.9	5.5	IC360690
			Fruit weight (g)	400	1080	881	IC360690
			Fruit volume (cc)	91	135	112	IC360184
			Fruit per plant	6	360	140	IC360683
			TSS (^{0} Brix)	6	11	9	IC360680
Pear (*Pyrus communis*)	12	21	Fruit length (cm)	1.96	7.77	5.81	IC319202
			Fruit width (cm)	2.02	7.81	5.17	EC528118
			Fruit weight (g)	200	8249	1468	IC319200
			Fruit volume (cc)	49.67	210.3	107.7	EC528118
			Fruit per plant	14.00	560.6	96.94	IC318033
			TSS (^{0} Brix)	8.00	15.67	11.42	IC319202
Plum (*Prunus domestica*)	06	21	Fruit length (cm)	2.07	4.31	3.14	IC247424
			Fruit width (cm)	1.87	4.36	3.07	New Plum
			Fruit weight (g)	49.67	330	176.8	New Plum
			Fruit volume (cc)	24.67	153.3	94.7	New Plum
			Fruit per plant	16	641	231.9	New Plum
			TSS (^{0} Brix)	8.33	18.0	13.07	IC247424

in Grain yield (19.7 – 37.50 q/ha) , 100 seed weight (5.10 – 14.2 g) and No. of pod/plant (47 – 88) with PCV% 21.54, 32.18 and 18.02 respectevily.

11.2.3 Germplasm characterization, regeneration and seed multiplication of horticultural crops

Fruit crops germplasm characterization and evaluation: Four fruit crops viz., Apricot, Peach, Pear and Plum were evaluated with 21 descriptors. Range of variation and superior genotypes are given in the table 6:

11.2.4 Vegetable germplasm characterization and evaluation: Chilli (*C. annuum*-20 acc.) were sown in randomized block design (RBD) with four checks – Pant C-1, Pant C-2, JCA-283 and LCF-206 in three replications where row length, row spacing and plant to plant distance was 2.10 m, 50 cm and 30 cm respectively. The range of variation for plant height (58-84.40 cm), number of fruit /plant (15-40), fruit length (5.6-8.0 cm), fruit width (0.78-1.04 cm), yield /plant (26.67-83.0 g) and number of seed per fruit (49 - 88) were observed and promising accessions over check is given in table 7 .

Table 8. Promising accessions identified in chilli during *kharif* 2011

Character	Best Checks	Promising Accessions Identified
Days to 50% germination	Pant C-2 (<23)	IC538029 (20), IC538038 (20), IC538085 (20), IC538030 (21)
Plant height (cm)	JCA-283 (>73.1)	IC537581 (84.40), IC537596 (82.9), IC469836 (78.9), IC598009 (78.0)
Plant canopy (cm)	Pant C-2 (>2972)	IC383150 (11405), IC537596 (3857), IC538091 (3277), IC53810 (3073)
Yield per plant (g)	Pant C-2 (>43)	IC469836 (83), EC517101 (72), IC383150 (60), IC598009 (53)
100 seed weight (g)	Pant C-2 (>0.69)	IC538029 (0.73), IC538030 (0.72), IC469836 (0.71)
Leaf length (cm)	Pant C-1 (>8.25)	IC537595 (9.79), IC537581 (9.5), IC537596 (9.3), EC517101 (8.9)
Leaf width (cm)	Pant C-1 (>3.73)	IC537581 (5.01), IC537595 (4.1), IC538030 (4.0)
Petiole length (cm)	Pant C-2 (>3.62)	IC537581 (4.35), IC537595 (4.2), IC598009 (4.1)
Fruit width (cm)	JCA-283 (>2.83)	IC469836 (1.0), IC537581 (1.0)
No. of fruit / plant	Pant C-2 (>25)	IC383150 (40), EC517101 (34), IC537596 (30), IC537581 (27)

11.2.5 Multiplication/seed increase of vegetable and floriculture plants for Long Term Storage (LTS) in National Gene bank during *kharif* 2011: A total of 124 acc. viz. chilli (105) and tagetes (19) acc. were multiplied and sent to LTS in National Gene Bank, NBPGR, New Delhi.

11.3 Germplasm Characterization, Regeneration and Seed Multiplication of the M&AP and Wild Economically Useful Plants

11.3.1. Preliminary evaluation of *Allium* spp.: A total of 41 accessions of *Allium* spp. (wild only) and garlic 123 acc. with four check viz. Lohit, Bhowali local & VGP-S/VLG-1(C)are being maintained and evaluated in field gene bank.

11.3.2. Determination of percentage of essential oil: A total of 93 accessions and 13 spp. of aromatic plants were extracted for percentage of essential oil in different seasons through steam and Hydro (Clevenger apparatus) distillation unit. The range of oil percentage observed in different species is as follows: **Steam Distillation Unit:** *Cymbopogon flexuosus* (0.13 water extract; 0.17-0.54), *Cinnamomum camphora* (0.11 water extract; 0.56), *Tagetes patula* (0.06-0.08) & *Zanthoxylum armatum* (0.03 - 0.04); **Hydro Distillation Unit (Clevenger apparatus):** The range of oil % is observed during the months of January to December 2011 as: *Hedychium spicatium* (FWB 0.48; DWB 2.4), L*avendula stoechas* (FWB-0.82-1.13; DWB 2.2), *Origanum vulgare* (DWB 0.08-2.86; FWB 0.02-0.58), *Ocimum basilicum* varieties (DWB 0.21-0.80; FWB 0.07-0.21), *Pelargonium graveolens* (DWB-0.35), *Rosmarinus officinalis* (Italian) (DWB 2.4; FWB 0.82) & *Rosmarinus officinalis* (French) (DWB 0.9), *Thymus serphyllum* (FWB 0.28; DWB 0.46), *Tagetes petula* (DWB 0.23) and *Valeriana jatamansi* (DWB-1.12; FWB-0.35).

11.3.3. Registration of germplasm: French Lavender (*Lavendula stoechas* L.*;* Lamiaceae) for high camphor content (NJSSN-2666/IC449512). High camphor content (52.12%) and fenchone rich (11.96%) in essential oil

11.3.3. Taxonomic identification of *Ocimum* spp. germplasm (34 acc.)

Name of Species/Variety	National ID	No. of Acc.	Trade Name
Ocimum basilicum var. difforme	EC388896, EC387838, EC388892, EC338772, EC174527, IC112548, IC110267, EC386947, EC383447	09	Curly leafed basil, white basil
O. basilicum var. purpurascence	EC388895, EC388897, EC388888, EC388894,	04	Violet-Red basil, Purple basil
O. basilicum var. glabaratum	EC388891, EC388887, EC387837, EC338788	04	Common white basil, glabrous basil
O. basilicum var. *basilicum*	EC388890, EC388889, EC333788, EC388893	04	Holy basil
O. basilicum var. thyrsiflora	EC387839, EC338794	02	Compact flower basil
O. basilicum var. pilosum	EC387836, EC387835, EC387834, EC338775, EC338773, EC338776	06	Pilose basil, hairy basil
O. citriodorum	EC388884	04	Lemon basil
Origanum vulgare	EC388885, EC386948, EC388886, EC338785	01	Oregano
Total		**34**	

isolated from plant inflorescence / aerial parts. Essential oil content varies from 0.86-1.27% was observed from season to season was registered.

11.4. Germplasm Conservation

11.4.1. Conservation of field crops germplasm: A total of 425 accessions of different crops *viz. Rabi* 2010-11 (289 acc.): *Aegilops* spp. (12), Wheat – *Triticum aestivum* (55), Wild Wheat - *Triticum* spp. (15), Winter wheat varieties - *T. aestivum* (32), Oat/Avena – *Avena* spp. (07), Barley (25), Pea (07) and Lentil (136); Germplasm of exploration and *kharif* 2010 (136 acc.): Paddy (112 acc), Soybean (17), French bean (05) and Ridgegourd (02) were supplied to LTS (NGB) for conservation.

A total of 12586 accessions of germplasm have been maintained in MTS of NBPGR, R/S Bhowali. The details are here under: Cereals (4251), pseudocereals (604), minor millets (570), pulses (3938), oil seeds (578), vegetables (398), spices and condiments (1663), M. & AP. (206) and wild relatives of crops (356).

11.4.2. Conservatiion of horticultural crops germplasm: fruits-338 acc. [(*Prunus amygdalus* (03), *Emblica officinalis* (04), *Malus baccata* (02), *Malus sylvestris* (16), *Malus domestica* (06), *Prunus armenica* (13), *Aegel mormelos* (01), *Prunus avium* (03), *Castania sativa* (01), *Cotoneaster microphylla* (01), *Ficus auriculata* (02), *Ficus carica* (04), *Elaegnus latifolia* (02), *Vites vinifera* (04), *Vitis jacquomontii* (01), *Corylus avellana* (01), *Myrica esculenta* (01), *Diospyrus kaki* (03), *Averrhoe carambola* (01), *Carissa carandus* (02), *Actinidia chinensis* (07), *Cordia mixa* (01), *Eriobotrya japonica* (01), *Morus serrata* (01), *Citrus sinensis* (20), *C. decumana* (02), *C. jambhiri* (05), *C. aurantifolia* (25), *C. reticulata* (14), *C. medica* (12), *C. aurantium* (02), *C. limettiodes* (02), *Poncirus trifoliate* (01), *C. hybrid* (01), *C. obovoidea* (01), *C. shunkokan* (01), *Prunus persica* (19), *Pyrus communis* (15), *Pyrus phasia* (04), *Prunus domestica* (05), *Punica grantum* (10), *Passiflora edulis* (01), *Rubus ellipticus* (03), *Rubus foliolus* (03), *Rubus nivens* (05), *Fragaria vesca* (78), *Fragaria nubicola* (01), *Juglans regia* (27)]; vegetables 1225 (*Capsicum annuum*-1,225), ornamental crops 72 (Dahalia 19, Gladiolus 31, *Tagetes* spp. 22) are maintained in MTS, greenhouse (plants in 2500 pots and 7,000 polythene packets)/Field Gene Bank/MTS at R/S Bhowali.

11.4.3. Conservation of medicinal and aromatic plants germplasm: A total of 445 accessions (indigenous -304 + exotic-141:vegetatively propagated - 125; seed producing- 320) comprising 260 species belonging to 153 genera of 37 families have been conserved in the field gene bank/herbal garden of the station.

11.4.3.1. Maintenance of arborescent plants: A total of 190 accessions of arborescent plants belonging to 150

species (92 genera of 50 families of both exotic and indigenous origin) have been maintained in the station's Biodiversity Botanical Garden.

11.4.3.2. Maintenance of Bamboosetum: A total of 41 accessions comprising of 18 species belonging to seven genera are maintained.

11.4.3.3. Maintenance of temperate forage grasses: A total of 54 accessions of temperate forage grasses have been maintained in the field genebank.

Uttaranchali Kaku

***Kiwi* for root stock mulptiplication/ regeneration**

11.5. Germplasm Supply

11.5.1. Fifty four accessions of different crops were supplied to various Research organisations/indentor s under MTA: *Triticum sphaerococcum* (01 acc.) to Dr. R.N. Singh, Associate Professor, Centre of Advanced Study, Department of AIHC and Archaeology, Banaras Hindu University, Varanasi (UP); Wild horse gram (IC212722 – 01 acc.) to Scientist Plant Breeding, Crop Improvement Division, VPKAS, Almora; *Abelmoschus crinitus* (NMOJ- 3068 – 01 acc.) to Indian Institute of Horticulture Research (IIHR), Hassarghatta Lake Post, Bangalore- 560 089, Karnataka; Strawberry (51 acc.) to CITH, Mukteshwar, Nainital, Uttarakhand.

11.5.2. NBPGR supply/ exhibition: Different crops were also supplied with in Bureau and other institute for exhibition/research purposes i.e. Allium spp.- bulbs/ rhizomes (05 acc.) to Tissue Culture & Cryo-Preservation Unit (TCCPU), NBPGR, Pusa Campus, New Delhi. Herbarium specimens (04 acc.) of wild *Allium* spp. to Germplasm Exploration & Collection Division, NBPGR, Pusa Campus, New Delhi.

11.5.3. Farmers/ indentors supply: Seed samples and live rooted plant material *viz.* Agr. Crops: Bold Soybean (10 g.), French bean (1.00 kg), Green pod peas (56 kg), Horsegram (17 kg.), Paddy mix (70 Kg), Rice bean mix (17 Kg), Soybean (38 kg.), Soybean – (07 kg. and a total number of 181 crosses were made and 78 fruit set (pods) deposited to Seed Science and Technology, IARI, New Delhi), Wheat mix (29 Kg). Hort: Cryptomeria japonica (03 nos.), Green chillies (13.5 kg.), Gladiolus spikes-360 nos., Kiwi-1174 nos., Kiwi seedlings (200 nos.), Kiwi fruits: 265 kg. (Grade – A: 136 kg. + Grade – B: 126 kg. + Grade – C: 03 kg.), Kagazi nimbu (788 nos. + 06 kg.), Malta (04 nos.), Red June Peach (120 kg), Plum (50 kg), Passion fruit-257 nos., Santra (90 nos.), Strawberry (5.250 Kg + 540 nos.),; M. & AP: *Acorus calamus* (10 nos.), Asparagus (20 nos.), Achillea spp. (10 nos.), Celary (35 nos.), *Centella asiatica* (07 no.), Fennel (01 no.), *Ginkgo biloba* (12 nos.), Garden sage (05 nos.), Geranium - 4576 nos., *Hedychium spicatum* (300 nos.), *Juniper* (02 nos.), Lavender (501 nos)., Lemon grass (60 nos.), Marjoram (10 nos.), *Origanum vulgare* (335 nos.), *Ocimum sp.* (30 nos.), Rosmary -49156 nos., Rose-130 nos., Rose water (05 ltr.), Sevia-35 nos., *Taxus baccata* (08 nos.), Thyme (15 nos.), *Valeriana jatamansi* (300 nos.), *Viola serpense* (300 nos), *Withania sominefera*-100 g + 04 nos.; WEUPS: *Ficus* sp.(02 nos.), Bamboo (44 log), were supplied to different farmers/indentors.

11.6. Externally Funded Projects

11.6.1. Management and Multiplication of Plant Genetic Resources of Kiwi and Kagazi Nimbu under Horticultural Mission for North East and Himalayan States, Mini Mission I (08/ICAR/BHW-SKV-04)

Regeneration/ Multiplication Nursery management : Kiwi (EC64093, EC24672, EC64094, EC64090, EC137263, EC64092) and *Uttaranchali Kagzi Nimbu* (*Citrus aurantifolia*) IC319045 were regenerated through cuttings, grafting and other vegetative means and through seeds for onward supply to different indenters.

Distribution of quality planting material: Quality planting material of grafted Kiwi plants were distributed in the ratio of 1:4 male and female plants. A total of 706 plants of *Kagazi nimbu* and 206 plants of kiwi fruit were supplied to VPKAS Almora and among farmers of Uttarakhand.

Distribution of quality planting material from adopted farmer's field: Technical know-how for propagating kiwi fruits (grafting and cuttings) was provided time-to-time to selected farmer's under HMNEH MM-I at different places in Nainital, Uttarakhand. Total plants raised and distributed by the farmers at their own level under technical guidance of NBPGR Regional Station, Bhowali "under Mini Mission I of the HMNEH MM-I Project were 10,337– Hill lemon (312), Kiwi (6,378), *Malta* (904), Peach (1,870), Plum (99), *Santra* (774) and *Uttaranchali Kagazi Nimbu* (8509).

11.6.2. Establishment of mother block for bud wood production of citrus and kiwi fruit under horticultural mission for North East and Himalayan States, Mini Mission I

Five plants each of five varieties of Citrus (viz., *C. aurantifolia, C. jambhiri, C. medica, C. reticulate* and *C. sinensis*) and Kiwi fruit (Female varieties: Allison, Abbott, Bruno and Hayward Male variety: Tomuri) were planted in new block to established mother block for Bud wood Production of Citrus and Kiwi fruit.

11.6.3. Studies on relationship between ecogeography of the chemotypic variation of nine important but highly threatened medicinal plant species and prospects of their cultivation (041/ NAIP/BHD/KSN/08)

Germplasm Registration filed for *Hedychium spicatum* (02 nos.), *Origanum vulgare* (02 nos.) and *Valeriana jatamansi* (01 no.).Development of agro-techniques for *H. spicatum, O. vulgare* and *V. jatamansi* are in progress. Re-collection of elite chemotypes of assigned plant species and their ecological study of natural habitats were observed. Morphological study of all accessions in field gene bank as well as in natural habitat and identification of elite chemo-types were studied. Seed material of *H. spicatum* (24 acc.) and *O. vulgare* (31) were deposited for medium term storage (MTS) at NBPGR R/S Bhowali and for long term storage (LTS) at NBPGR, Pusa Campus New Delhi.

Identification of plant species with elite chemotypes from Indian Himalayan Region:

Out of 34 accessions of *H. spicatum*, 02 accessions, viz., IC573208/NKSK-07 for high 1, 8-cineole content in essential oil were identified. One unique genotype IC573223 /NKO-24 identified for bold seeds, early emergence and late senescence in *Hedychium spicatum*.

Out of 34 accessions of *O. vulgare*, 02 accessions, viz., IC589087/NKO-68 for high thymol content and IC589079/MMBO-3055 for high carvacrol content in essential oil were identified.

Out of 25 accessions of *V. jatamansi*, 02 accession, viz., IC573206/NKSK-03 for high Maalliol and IC574510/ NKO-47 for high Valerenic acid content in essential oil were identified.

A total of five proposals have been submitted for germplasm registration in NBPGR (ICAR), Pusa Campus, New Delhi.

11.6.4. Biosystematics of the genera *Vigna, Cucumis* and *Abelmoschus* (044/NAIP/KVB/08)

During 2011-12, a total of 10 accessions and two checks, DC-I and Bhowali Local, of *Cucumis sativus* spp. *hardwickii* were crossed. A total of 111 crosses were made in *C. sativus* spp. *hardwickii* X *C. sativus* and harvested 10 fruit of crossing output.

In F1 generation a total of 52 crosses were made and 03 set fruits were harvested. In F2 generation a total of 47 crosses were made and 04 set fruits were harvested. In reciprocal crossing, a total of 04 crosses (of F1 generation) were made and no fruit setting was observed.

Shape and size with morphological variation were

observed in plants obtained in first and second filial generation. The harvested material is under progress.

11.6.5. Popularization of Geranium, Lavender and Rosemary Among Local Farming Communities of Uttarakhand under Horticultural Mission for North East and Himalayan States, Mini Mission I

(I) Regeneration/Multiplication/Nursery management: Geranium (IC236494 Cv Kelkar/ Egyptian, NIC23413 Cv Almoria, Cv Cimpawan); Lavender (IC212822 Cv Carlova, IC273870, Cv Sher-E-Kashmir, IC449508, IC449514, IC449512); Rosemary (NIC23416 Cv French, IC449513 Cv Italian, IC334572) were regenerated through cuttings and other vegetative means for onward supply to different indenters.

(II) Distribution of elite planting material/ germplasm

i. From NBPGR Regional Station, Bhowali, Nainital, Uttarakhand: A total of 44059 rooted plants/ cuttings of Geranium - 315 nos. (140 - Almoria + 175 - Egyptian), Lavender – 439 nos., Rosemary– 43305 nos. (French – 43060 + Italian - 245) were distributed to different indentors and farmers.

ii. From farmer's field: So far three progressive farmers villages Sunderkhal, Dingri, Jageshwar and Rovra, Jyolikote have been identified for nucleus nursery of Geranium, Lavender and Rosemary. Technical know-how for regeneration/multiplication/nursery management was provided time-to-time to selected farmers.

Programme (Code, Title and Programme Leader)

PGR/PGC-BHO-01.00- Augmentation, Characterization, Evaluation, Maintenance, Regeneration, Conservation and Documentation of Genetic Resources of the Northern Himalayas and Adjoining Plains (KS Negi, (upto December 28, 2011); **SK Verma**, w.e.f. December 29, 2011).

Projects (Code: Title, PI, Co-PIs and Associates)

PGR/PGC-BHO-01.01: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources of field crops with emphasis on etheno botanical aspects (KC Muneem (upto June 30, 2011), KS Negi, (w.e.f. July 01, 2011 to December 28, 2011), **SK Verma**, (w.e.f. December 29, 2011), KS Negi, AK Trivedi, PS Mehta.

PGR/PGC-BHO-01.02: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources of temperate horticultural crops (AK Trivedi, (upto December 28, 2011), **SK Verma**, w.e.f. December 29, 2011, KC Muneem, KS Negi, and Sandhya Gupta).

PGR/PGC-BHO-01.03: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources of medicinal and aromatic, wild economically useful, rare and endangered species (**KS Negi**, KC Muneem, (upto June 30, 2011), AK Trivedi, S K Verma, (w.e.f. December 29, 2011) and Archana Raina.

12. BASE CENTRE, CUTTACK

Summary: During the reporting period, five explorations were undertaken and a total of 261 accessions comprising cultivated rice (drought tolerant-59; cold tolerant-43; salt tolerant-63), cotton (29), *Crotalaria* (10) M&AP (49), Chilli (01), Sesame (01) and wild relatives of crop plants (06) were collected from 193 collection sites covering Odisha, Mizoram, Arunachal pradesh and West Bengal (Sundarban). Wide range of variability was observed for various morphological and agronomical traits among cultivated rice and other collected germplasm. The significant collections among rice germplasm include drought tolerant land races (*Kusuma, Chingerdhan, Kuliha, Kumarmani, Dasaramatia, Muridanra, Kundadhan*), cold tolerant land races (*Lahi, K. Botha, Sikota lahi and Dal boradhan*) and salt tolerant land races (*Getu, Nonabokra, Talmugur, Kalonunia, Darsal, Marisal* and *Dudheswar*). The significant collection of medicinal and aromatic plants, wild relatives of crops and wild economic plants viz. *Mucuna nigricans, Solanum erianthum, S. violaceum, Adenanthera pavonina, Rubus ellipticus, Argyreia nervosa, Crotalaria micans, Gossypium barbadense, Ocimum americanum* were made during the exploration. Ethno-botanical survey was carried out and indigenous knowledge on less known/ unreported uses/ practices of plant species for tribal healthcare and livelihood support was recorded. A total of 1,927 acc comprising cultivated rice (1,500), green gram (57), black gram (41), *Ocimum* species (30), *Mucuna pruriens* (12), wild *Oryza* species (254) and other wild relatives of crops (33) were characterized for various agro-morphological traits. A set of 1,149 accessions of cultivated rice was evaluated and screened against bacterial leaf blight in collaboration with CRRI, Cuttack out of which, 18 accessions have been identified as tolerant against BLB. In addition, 254 acc of wild rice germplasm and 33 acc of wild relatives of vegetable crops were grown for characterization and a total 2516 acc comprising cultivated rice, sesame, *Trichosanthes*, tubers, *Ocimum* spp., *Andrographis paniculata*, *Mucuna pruriens* and other medicinal plants were multiplied for conservation in LTS. A total of 22 herbarium specimens were supplied to National Herbarium of Cultivated Plants, NBPGR, New Delhi for conservation.

12.1 Exploration and Germplasm Collection

During the reporting period five exploration missions were undertaken and a total of 261 acc comprising cultivated rice (165), cotton (29), *Crotalaria* (10) M&AP (49), Chilli (01), sesame (01) and wild relatives of crop plants (06) were collected from Odisha, Mizoram, Arunanchal Pradesh and West Bengal (Sundarban). The exploration wise details are given below:

Table-1: Details of exploration and germplasm collection during 2011

Crops/Species	Areas	Collaboration	Collection Sites	Period of Collection	No. of spp.	No. of Acc
M&AP	Mahendragiri, Lakhari sanctuary (Gajapati) & Ganjam	AICRP on M&AP, OUAT, Bhubaneswar	41	28 March to 5 April, 2011	14	53
Drought tolerant rice	Sonepur, Bolangir, Kalahandi, Nuapada, Kandhamal (Odisha)	CRRI, Cuttack	47	7 -15 October, 2011	01	59
Cotton & Crotalaria	Aizawl, Serchip, Mamit & Kolasib (Mizoram)	CICR, Nagpur	26	29 November to 14 December, 2011	08	43
Cold tolerant rice	Lohit, Lower Dibang Valley & Anjaw (Arunachal Pradesh)	-	31	12 -21 December, 2011	01	43
Saline tolerant rice	Sundarban-North and South 24-Parganas (WB)	CRRI, Cuttack	48	26 December, 2011 to 4 January, 2012	01	63
	TOTAL	**-**	**193**		**25**	**261**

12.1.1.Collection of medicinal and aromatic plants: A total of 53 acc comprising *Ocimum sanctum* (11), *O. canum* (9), *O. basilicum* (7), *O. gratissimum*(3), *Mucuna pruriens* (10), *M. nigricans* (01), *Andrographis paniculata* (03), *Solanum* species (05) and four other medicinal species (*Mallotus philippensis, Argyreia nervosa,*

Adenanthera paronina and *Rubus ellipticus*) was collected from 41 collection sites in tribal dominated areas of Mahendragiri, Lakhari sanctuary (Gajapati district) and northern & central Ganjam district of Odisha. Wide range of variability in different attributes in *Ocimum* species, *Andrographis paniculata* and *Mucuna pruriens* such as number of pods/cluster, pod pubescence(profuse dense sparse/very less), hair colour(brown, reddish brown, dark brown/black with a red base), pod size and shape, seed colour (black, brown, dark brown with uniform and mosaic variegated spots), number of seeds/pod etc. was recorded. A prominent scar line mark on the pod was also recorded in two accessions viz. IC589220, 589212.

12.1.2 Range of variability observed:

Ocimum sanctum: Three major variants were collected such as (i) dark purple to black (Krushna tulsi) (ii) greenish to white (Sweta tulsi) and (iii) purple-green (intermediate). The stem/leaf colour varies from light green, dark green to purple-violet and corolla ranges from purple to white.

***O. basilicum*:** Variability in leaf shape (ovate, lanceolate, linear) and length of spikes (11.5 - 28.5 cm) was recorded.

O. canum: Variations are found in shape of leaves, length of spikes; highest recorded 14.5 cm and number of whorls/spike to a maximum of 21 in IC589213.

***O. gratissimum*:** The maximum height of the plant (more than 8 ft.) along with length of spike (11-22.5 cm.) against the normal range of (9-12 cm.) was recorded during exploration.

Mucuna pruriens: Variation in pod pubescence (profuse dense sparse/very less), hair colour (brown, reddish brown, dark brown/black with a red base), pod size and shape, seed colour (black, brown, dark brown with uniform and mosaic variegated spots) etc. was recorded. A prominent scar line mark on the pod was also recorded in two accessions viz. IC589220, 589212.

12.1.3 Ethno-botanical study*:* Ethno-botanical survey was carried out in these areas and indigenous knowledge on less exploited/economic uses of plant resources for healthcare, food and other necessities was collected from 50 informants belonging to *Saura* and *Kandha*

***Mucuna nigricans*, a rare medicinal plant, collected from damp forest of Gajapati district**

Variability in seeds of *Mucuna pruriens* collected from Ganjam & Gajapati district

tribes of 18 villages. During the exploration, few species of *Solanum* viz. *S. erianthum*, (a rare species found inside the forest and the tribes use the leaves and fruits medicinally and also consume fruits after cooking), *S.violaceum* and *S.viarum* (fruits used for medicinal value) were collected. Inventory and cataloguing of indigenous diversity of ethno-medicinal plants and other useful species have been made during the exploration mission.

12.1.4 Collection of trait specific rice germplasm: Drought tolerant rice germplasm from Western Odisha: A total of 59 acc of rice germplasm was collected from 47 collection sites in five drought affected districts of western Odisha. The exploration was conducted during October, 2011 in collaboration with CRRI, Cuttack under National Initiative on Climate Resilient Agriculture (NICRA) project. The district wise collections include Sonepur (03), Bolangir (12), Kalahandi(23), Nuapada (15), Kandhamal (06). Variability in duration (65-125 days), plant height (dwarf,

Drought tolerant rice germplasm (*Kusuma*) grown in farmers field at Junagarh,Kalahandi

intermediate), lemma palea colour (black, red, straw), awning (short, medium, long), grain type (size/shape) and yield (low-high) was recorded during the exploration. The landraces viz. *Kusuma, Chingerdhan, Kuliha, Kumarmani, Dasaramatia, Muridanra, Kundadhan* are recorded as highly drought tolerant which will be further screened in collaboration with Central Rice Research Institute, Cuttack.

Cold tolerant rice germplasm from Arunachal Pradesh: A total of 43 acc of cold tolerant rice germplasm was collected from 31 collection sites covering three districts in cold affected areas of Arunachal Pradesh. The district wise accessions collected include; Lohit (21), Lower Dibang Valley (15) and Anjaw (07). The exploration was conducted during 12th -21st Dec., 2011 with support of KVK, Namsai (Lohit) under North East Region exploration programme. Variability in duration (late, very late), plant height (intermediate, semi tall, tall), lemma palea colour (black, red, straw), awning (absent, short, medium, long), grain size (short, medium and long) and grain shape (slender and bold) was recorded during the exploration. The landraces viz. *Lahi, K. Botha, Sikota lahi and Dal boradhan* are recorded as cold tolerant germplasm in reproductive stage which will be further screened in collaboration with Central Rice Research Institute, Cuttack. The passport data, route map and photographs were recorded for future use.

Grain variability among drought tolerant rice germplasm collected from western Odisha

Variability in husk colour among cold tolerant rice germplasm collected from Arunachal Pradesh

Salt tolerant rice germplasm from Sundarban region: A total of 63acc of salt tolerant rice germplasm was collected from high coastal salinity areas of Sundarban Biosphere Region covering 48 collection sites in two districts (North and South 24-Parganas) of West Bengal. The district wise collections include North 24-Parganas (09) and South 24-Parganas (54)) and the block wise distribution includes Basanti (07), Canning (12), Sandesh khalli (09) and Gosaba (35). The exploration was conducted in collaboration with CRRI, Cuttack under National Initiative on Climate Resilient Agriculture (NICRA) project during 26th Dec., 2011 to 4th Jan., 2012. Variability in duration (late, very late), husk colour (black, red, brown, straw), awning (absent, present), awn type (long, short, intermediate), grain size (short, medium and long), grain shape (slender and bold) and aroma (scented, non-scented) was recorded during the exploration. The named landraces such as *Getu, Nonabokra, Talmugur, Kalonunia, Darsal, Marisal* and *Dudheswar* were recorded as salt tolerant germplasm which are to be further screened and evaluated for identification of potential salt tolerant rice genetic resources.

12.1.5 Collection of cotton & *Crotalaria* spp.: A total of 43 acc comprising cotton (29), *Crotalaria* (10), M&AP (02), chilli (01) & sesame (01) were collected from 26 collection sites from Aizawl, Serchip, Mamit & Kolasib districts of Mizoram in NEH region during 29th Nov. to 14th Dec., 2011 in collaboration with CICR, Nagpur. Good variability in cotton were observed in plant height, leaf and flower morphology, epicalyx segments,

boll length, lint quality, floss type etc. More than 100 herbarium specimens of cotton, *Crotalaria* and potential food & economic crops were collected and preserved at this base centre.

Variability in grain types among salt tolerant rice land races collected from Sundarban region

Salt tolerant rice variety *Getu* grown in high salinity soil at Gadkhalli, Gosaba, Sundarban region

Specific observations & germplasm collections: A. Cotton: Although there is vast potential for cultivation of cotton in the state, it is grown as a subsidiary and mixed crop in Mizoram. Only two species i.e. *Gossypium arboreum* (annual cotton) and *G. barbadense* (perennial/ tree cotton) were found in sporadic patches in different explored parts of the state. *G. arboreum* is sown broadcast as a mixed crop in jhum lands on the hill slopes along with other kharif crops. Where as *G. barbadense* (perennial cotton) was found as solitary/ isolated patches at village or farmyards or house yards or some times on hill slopes at abandoned jhum fields and also cultivated since many years at some places. No color cotton (khaki cotton- locally called "La uk") is being cultivated now, as color fabrics from Burma is arrived at a cheaper rate at door step as reported by some of the traders of Mizoram.

a) *G. arboreum* (locally called as La): Sixteen accessions of *G. arboreum* germplasm were collected and variability on different traits viz. plant height(3ft. in RCM/TRL/04 to 6ft in RCM/TRL/25), branches (purple, green, glabrous, pubescent), leaf lamina size (small 4.4 cm in RCM/TRL/25 to big 9.5cm in RCM/TRL/12), leaf shape (ovate, orbicular, 3 to 5 palmate-lobed/parted), leaf lobes(linear-lanceolate, oblong), epicalyx segments (united, remotely 3-5 toothed), Petals(light yellow, purple) and length of boll (4cm in RCM/TRL/12 to 11.1cm in RCM/TRL/07).

b) *G. barbadense* (Locally called as La pui):Thirteen accessions were collected from different sites either as a plant of solitary occurrence or isolated patches from abandoned sites near forest periphery, village yards, homesteads, farmyards, old/abandoned jhum fields and isolated plantation sites having 22 plants in a patch inside forest areas near Dairam. The plant height varies from 3.0ft. (RCM/TRL/36) to18.0 ft (RCM/TRL/26. The corolla is normally yellow with purple centre but at one place the corolla is yellow without purple centre (RCM/TRL/37). The epicalyx segments are lanceolate, 11-15 toothed, linear finely acuminate. The people use to prefer this species, as the lint quality is fine, soft and only less (15-22) seeded/ boll.

B. *Crotalaria* spp.: Samples of 4 species of *Crotalaria* such as *C. tetragona, C. micans (*syn. *C.anagyroides), C. pallida and C. ferruginea* were collected from Mizoram.

***C. micans* (syn. *C. anagyroides*) –locally called "Tumthang suak":** This species is common in forest areas and varies from 4ft. to 11ft high. Five seed samples were collected from different sites such as hill slopes, pediments and gullied lands at different elevations. The color of the ripe pod varies from brown to black.

***C. tetragona* (locally called "Tumthang"):** Since the plants were in flowering/ pod initiation / early pod stage only plant parts (twigs) were collected from forest areas and cultivated sites of Mizoram for herbarium.

***C. pallida*:** Five seed samples were collected from different landscapes. It is said that there is no use of this plant except green manure and the local people do not utilize it frequently.

C. ferruginea: All the plants were in flowering and early pod stage, thus the matured seeds could not be

collected. The samples for herbarium and the photograph from field were collected.

Ethno-botanical studies: The tribal people of northern Mizoram collect a number of wild plant resources from the forests and use as food materials and herbal medicines for their livelihood and primary healthcare. During the exploration a number of specific uncommon and less-exploited plants of about 70 species were observed which are being often regularly used by the tribes as food items and medicine. The samples of plant species were collected and identified, information on the modes of consumption/ administration were documented, cross checked and authenticated by other informants. The specimens were dried and preserved as herbarium.

12.2 Germplasm Characterization & Evaluation

A total of 1,673 accessions comprising cultivated rice (1,500), black gram (41), green gram (57), medicinal and aromatic plants (42), wild relatives of crops (33) was grown for characterization during 2011. Wide range of variability was recorded and promising accessions for various attributes have been identified in the germplasm of different crops.

12.2.1 Characterization of cultivated rice: A set of 1500 accessions of rice germplasm was grown for characterization along with six checks (Panidhan, Ketakijoha, Tulsi, Kalajira, Jyoti, Geetanjali) during *kharif,* 2011. Each accession was maintained in four rows in non replicated augmented design. Observations on various morpho-agronomic characters were recorded as per the minimal descriptor. The range of variability and promising accessions identified for various agronomic traits are given in Table 3 & 4

Longest boll (11.1 cm) of *Gossypium arboreum* collected from Phuibhung, Mizoram

***Gossypium barbadense,* a tall plant (16 ft. high) at Saipum, Mizoram**

A Mizo tribe collecting cotton (*Gossypium arboreum)* from jum field, Phuibhuang, Mizoram

***Gossypium barbadense*, flower without purple centre at Dairam, Mizoram**

***Crotalaria pallida*, an allied fibre species collected from Chawnpui, Mizoram**

Table-3: Range of variation in quantitative traits in rice germplasm

Traits	Range		Mean	Promising Lines	Best Check
	Minimum	Maximum			
Plant height (cm)	56.20(IRGC-34331)	180.62 (IRGC-10134)	121.14	IRGC-12437, 9850, 10134	Kalajira (161.31)
EBT	2.80(IRGC-20588)	13.40 (IRGC-10030)	8.8	IRGC-11164, 10052, 10030	Panidhan (8.85)
Leaf length (cm)	17.14(IRGC-34331)	83.10 (IRGC-10012)	48.72	IRGC-10142, 5838, 10012	Kalajira (57.26)
Leaf width (cm)	0.42(IRGC-10012)	1.46 (IRGC-20706)	0.92	IRGC-9850, 20445, 20706	Panidhan (1.04)
Panicle length (cm)	14.90(IRGC-34317)	31.28 (IRGC-9936)	24.03	IRGC-9982, 12765, 9936	Kalajira (31.07)
Panicle wt. (g)	0.4(IRGC-34203)	7.65 (IRGC-46933)	5.27	IRGC-46933, 53725, 46677	Panidhan (5.63)
100 grain wt. (g)	0.82(IRGC-46363)	3.94 (IRGC-46489, 467356)	2.65	IRGC- 467356, 52639, 45562	Jyoti (3.22)

Table-4: Variability and frequency distribution among qualitative traits in cultivated rice germplasm

Traits	Frequency	Per Cent	Traits	Frequency	Per Cent
Basal leaf color					
Green	1120	74.7	Light P.P.	64	4.3
PP lines	165	11.0	Purple	150	10.0
Blade color					
Pale green	80	5.3	P.P. tips	6	0.4
Green	1322	88.2	P.P. margin	46	3.1
Dark green	24	1.6	Purple	12	0.8
Ligule color					
White	1399	93.3	Purple	31	2.0
PP lines	61	4.1			
Collar color					
Pale green	337	22.4	Purple	92	6.1
Green	1062	70.8			
Auricle color					
Pale green	1316	87.8	Green	159	10.6
Internode color					
Green	1166	77.8	Purple lines	178	11.8
Light gold	144	9.6	Purple	21	1.4
Panicle type					
Compact	18	1.2	Open	46	3.1
Intermediate	1387	92.4			
Awning					
Short & partly	208	13.9	Long & partly	24	1.6
Short & fully	43	2.9	Long & fully	9	0.6
Awn color					
Straw	239	15.9	Red	3	0.2

Brown	31	2.0	Purple	15	1.0
Apiculus color					
White	09	0.6	Red apex	92	6.1
Straw	1029	68.6	Purple	187	12.4
Brown	129	8.6	P.P. apex	6	0.4
Red	12	0.8			
Glume color					
Straw	1332	88.8	Red	28	1.8
Gold	06	0.4	Purple	95	6.3
Stigma color					
White	1090	72.7	Lt. P.P.	104	6.9
Lt. green	06	0.4	Purple	116	7.8
Yellow	09	0.6			
Lemma palea color					
Straw	1044	69.6	P.P. fur. on straw	9	0.6
Gold/gold furrows	12	0.8	Black	40	2.7
Br. Spots on straw	129	8.6	Purple	6	0.4
Br. furrows	37	2.4	Reddish to lt. P.P. Red	61	4.1
Brown	110	7.3	P.P. spots on straw	9	0.6
Seed color					
White	1172	78.2	Brown	98	6.5
Light brown	132	8.8	Red	31	2.0
Seckled brown	06	0.4			
Scent					
Non scented	1420	94.7	Scented	12	0.8
Light scented	40	2.7			

Table-5: Range of variation and promising accessions for quantitative traits in green gram germplasm

Traits	Range		Mean	Promising Lines	Best Check
	Minimum	Maximum			
Days to 50% flowering	35.0 IC343860	48.0 IC569082	40.35	IC569021,569088, 569082	PDM-54 (43.0)
Plant height (cm)	17.76 IC343907	61.52 IC382812	37.24	IC565270, 569082, 382812	K-851 (47.43)
No. of cluster/plant	2.62 IC343907	12.2 IC426772	7.71	IC565241, 565264, 426772	Pusa Vishal (6.45)
No. of pods/cluster	2.0 IC343907	4.2 IC568946	2.98	IC343864, 565287, 568946	K-851 (3.25)
No. of seeds/Pod	7.6 IC343907	11.2 IC565268	8.95	IC565264, 519604, 565268	K-851 (10.55)
Pod length (cm)	4.34 IC343907	6.91 IC565268	5.20	IC565264, 565287, 565268	K-851 (6.63)
100 seed wt. (mg)	1.60 IC343904	3.48 IC343907	2.15	IC519604, 565287, 343907	K-851 (3.23)

12.2.2 Characterization of green gram: A set of 57 accessions of green gram germplasm collected from Odisha along with five standard checks (ML-267, K-851, Pusa Vishal, LGG-460, PDM-54) were grown in RBD with three replications during *rabi*, 2011 for characterization. Observations on various agro-morphological traits were recorded as per the minimal descriptor. The range of variability and promising accessions for different quantitative traits are given in Table 5 & 6.

Table-6: Variability and frequency distribution among qualitative traits in green gram germplasm

Traits	Frequency	Per Cent	Traits	Frequency	Per Cent
Leaf color			**Seed color**		
Green	31	50	Light green	42	72
Dark green	31	50	Dark green	5	9
Leaflet shape			Brown	7	12
Entire	62	100	Dark green mosaic	1	2
Pod pubescence			Brownish green	3	5
Puberulent	36	62			
Moderate	22	38	**Plant surface**		
Pod color			Pubescent	62	100
Straw	1	2			
Brown	8	14	**Pod shape**		
Brown & Black	38	66	Straight	28	48
Black	11	19	Curved	30	52

Table-7: Range of variation and promising accessions for quantitative traits in black gram germplasm

Traits	Range		Mean	Promising Lines	Best
	Min.	Max.			Check
Days to 50%	43.0	47.0	44.2	IC565240, 565244,	PDU-1
flowering	IC257808	IC568947		568947	(43.0)
Plant height (cm)	13.9	26.8		IC426768, 343942,	PDU-1
	IC519819	IC565256	19.05	565256	(23.64)
No. of cluster/plant	2.0	22.35		IC426768, 343936,	PU-30
	IC565240	IC565291	11.45	565291	(7.57)
No. of pods/cluster	2.0	3.9		IC541882, 382811,	PU-19, PDU-1
	IC565220	IC565272	2.43	565272	(3.46)
Pod length (cm)	3.5	4.65		IC382811, 541882,	PDU-1
	IC565260	IC343942	4.47	343942	(4.58)
No. of Pods/plant	6.5	42.5		IC565291, 565272,	PDU-1
	IC565244	IC343936	23.15	343936	(29.45)
No. of seeds/pod	3.0	6.50		IC565294, 568947,	PU-30
	IC565220	IC565286	4.55	565286	(6.36)
100 seed wt. (mg)	0.49	4.51		IC541882, 519836,	T-9
	IC565260	IC382811	2.34	382811	(4.25)

12.2.3 Characterization of black gram: A set of 41 accessions of black gram germplasm collected from Odisha along with six checks (T-9, LBG-20, PDU-1, PU-30, PU-35, PU-19) were grown in RBD with three replications during *rabi*, 2011 for characterization. Observations on various agro-morphological traits were recorded as per the minimal descriptor. Wide range of variability was recorded for various agro-morphological characters viz., no. of pods/cluster, no. of pods/plant, no. of seeds/pod, pod length (cm) and 100 seed wt. (mg). On the basis of best check value of different attributes the promising accessions were identified and given in Table-7 & 8.

Table-8: Variability and frequency distribution among qualitative traits in black gram germplasm

Traits	Frequency	Per Cent	Traits	Frequency	Per Cent
Leaf color			**Pod color**		
Green	63	97	Brown	11	24
Dark green	02	3	Brownish black	20	44
Primary Leaf shape			Black	14	31
Acute	06	9	**Seed shape**		
Lanceolate	08	12	Drum shaped	45	100
Ovate	51	79	**Seed color**		
Pod pubescence			Greenish brown	3	7
Glabrous	03	7	Brown	14	31
Puberulent	13	29	Black	27	60
Moderate pubescent	29	64	Mottled	1	2

Table-9: Range of variation in morpho-agronomic traits of *Mucuna pruriens*

Traits	Range	
	Minimum	Maximum
Odd leaflet length	6.32 (IC589220)	16.7 (IC589230)
Odd leaflet width	3.9 (IC589220)	10.94 (IC589208)
Inflorescence length	3.5 (IC589182)	14.84 (IC589230)
No. of pods/cluster	5.0 (IC589182)	19 (IC589194)
No. of pods/plant	44 (IC589182)	131 (IC589221)
Pod length (cm)	5.1 (IC589182)	9.38 (IC589197)
Pod width (cm)	1.7 (IC589212)	1.86 (IC589221)
No. of seeds/Pod	4.0 (IC589182)	6.0 (IC589230)
Seed length	0.96 (IC589202)	1.16 (IC589194)
100 seed wt.(gm.)	23.09 (IC589182)	40.2 (IC589230)
No. of flowers/ inflorescence	5.0 (IC589182)	12 (IC589194)
Seed color	Black-brown, dark brown, white with uniform and mosaic variegated spots	

12.2.4 Characterization of wild Oryza species: 254 acc of wild *Oryza* species received from Germplasm Conservation Division, NBPGR, New Delhi was grown for characterization and species identification. On the basis of the characterized data the germplasm was identified as introgressed lines between *Oryza nivara* and *O. sativa* (167), *O. rufipogon* and *O. sativa* (52).

12.2.5 Characterization of wild relatives of cucurbitaceous plants: A total of 33 accessions comprising *Trichosanthes cucumerina* (07), *T. anguina* (10), *T. lobata* (06), *Luffa hermaphrodita* (3), *Momordica charantia* (5) and *Gymnopetalum chinense* (2) collected from Odisha were grown in bonded rows during *kharif* 2011 for characterization, seed multiplication and biosystematics study. Observations on various vegetative, flowering and fruiting parameters were recorded for further study.

12.2.6 Characterization of *Ocimum* species: A total of 30 acc of *Ocimum* species comprising *Ocimum basilicum* (07), *O. canum* (09), *O. sanctum* (11) and *O. gratissimum* (03) were grown in bonded rows during 2011 for preliminary characterization in respect of 27 qualitative and quantitative agro-morphological characters. Variability on vegetative, flowering and fruiting parameters were recorded.

12.2.7 Characterization of *Mucuna pruriens*: Twelve accessions of *Mucuna pruriens* were multiplied and grown during 2011 and these were characterized in respect of 28 qualitative and quantitative agro-morphological characters. Observations on various vegetative, flowering and pod characteristics were

observed and recorded (Table-9).

12.3 Germplasm Evaluation

12.3.1 Evaluation of cultivated rice: A set of 1149 accessions of cultivated rice was grown at CRRI, Cuttack for screening against bacterial leaf blight with susceptible checks viz. *TN-1* and *Tapaswini* through artificial inoculation by clipping method. A total of 18 accessions have been identified as tolerant against BLB and will be confirmed during this *kharif*-2012. In addition, a set of 12 acc of cultivated rice collected from flood affected areas of Odisha was evaluated for submergence tolerance along with four checks (FR-13A, FR-46B, IR-42 and Panidhan) in collaboration with CRRI. Seedlings of 30 days old were planted in RBD with two replications in cemented tanks of one metre depth. After 21 days of crop establishment the seedlings were submerged for 14 days and observation on stem elongation and survival percentage was recorded. The varieties viz. *Baliadadha* (IC568957), *Champeisali* (IC568918) and *Bhuta* (IC568854) were resulted with 100 percent survival against 98% mortality of susceptible check (IR-42) and 94% survival of the best check (FR-13A).

12.3.2 Validation of medicinal plants: Phyto-chemical screening of fruits of five species such as *Diplocyclos palmatus, Mukia maderaspatana, Solena amplexicaulis, Cucumis sativus* var. *hardwikii* and *Momordica dioica* used as drug plants were validated for their ethno-medicinal properties documented from tribal informants of Odisha.

12.4 Seed Multiplication

A set of 2516 accessions comprising cultivated rice (2318), sesame (68), *Trichosanthes* (33), tubers (38), *Ocimum* spp. (30), *Andrographis paniculata* (03), *Mucuna pruriens* (12) and other medicinal plants (14) were multiplied during 2011.

12.5 Germplasm Exchange

A total of 252 accessions comprising Mucuna (11), M&AP (33), niger (36), *Trichosanthes* (12), taro (63), cultivated rice (9), drought tolerant rice (59) and cotton (29) was supplied to seven institutes for research purposes and 224 accessions of wild *Oryza* spp. and pulses(50) were received from Germplasm Conservation Division, NBPGR, New Delhi and NBPGR RS, Hyderabad respectively.

12.5.1 Herbarium specimens supplied: A total of 22 herbarium specimens comprising wild relatives of crop plants(7), M&AP(9), spices/condiments(3) and minor fruits/leafy vegetable (3) collected during different exploration trips were supplied to National Herbarium of Cultivated Plants, NBPGR, New Delhi for conservation.

12.6 Germplasm Conservation

A total of 239 accessions comprising cultivated rice (45), drought tolerant rice (54), M&AP (85), wild relatives (37) and *Trichosanthes* (18) were deposited for long term conservation in NGB, NBPGR, New Delhi.

12.7 Germplasm Maintenance

A total of 3,250 acc comprising cultivated rice (2,356), sesame (54), wild *Oryza* species (297), medicinal and aromatic plants (448), other wild relatives of crops (27), tuber/aroid crops (38), economic plants of agro-forestry importance (24) and horticultural crops (06) are being maintained in the experimental field and FGB of the centre.

Herbarium preservation: The herbarium of the Base Centre has been enriched with more than 500 herbarium specimens of medicinal and aromatic, rare/endangered, wild relatives of crops and wild economic species collected during different exploration mission.

Programme (Code: Title and Programme Leader)

PGR/EXP- BUR-CUT- 01.00- Augmentation, characterization, evaluation, maintenance, regeneration, conservation documentation and distribution of plant genetic resources of Odisha and adjoining regions **(DR Pani)**

Projects (Code: Title, PI, CoPIs and Associates)

PGR/EXP-BUR-CUT- 01.01: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources of agricultural and horticultural crops in Odisha and adjoining regions (**DR Pani,** RC Misra)

PGR/EXP-BUR-CUT- 01.02: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources of medicinal & aromatic plants, wild economically useful and rare and endangered plants of Odisha and adjoining regions (**RC Misra**, DR Pani)

13. REGIONAL STATION, HYDERABAD

Summary: During the year 2011, a total of 43,232 samples consisting of 14,901 import samples and 28,331 export samples were processed for quarantine clearance and a total of 106 phytosanitary certificates were issued. Several pathogens of quarantine importance were intercepted, of these, downy mildew (*Peronospora manshurica*) of soybean and bacterial speck of tomato (*Pseudomonas syringae* pv *tomato*) are quarantine pests for India. The import samples (2,625) that were found infested/infected with pests/pathogens could be salvaged and released to the consignees except thirteen detained/rejected samples (sunflower-1; tomato-2 & soybean-10). In exports, 103 samples were rejected due to the association of quarantine pests/pathogens. Quarantine service was extended to 46 organizations in South India. Post-entry quarantine inspection was conducted on 2,103 samples of different crops meant for ICRISAT (1,002), and private industry (1,101), which include transgenics also. A total of 14 explorations (including 8 explorations in Adilabad district under the NAIP) were undertaken and 1461 collections made in various crops; 1231 accessions of different crops were characterized/evaluated and multiplied in *rabi* 2010-11 and 1715 accessions in *kharif* 2011 and *rabi* 2011-12. A total of 329 accessions of different crops were supplied to researchers in India under MTA; a promising accession of *Dolichos lablab* having resistance to anthracnose and aphids was registered (INGR 110311)

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 serves as an exploration base centre for the collection of agri-horticultural crops in Andhra Pradesh and adjoining areas.

13.1 Quarantine

A total number of (43,232 samples 14,901-imports & 28,331-exports) were received for quarantine processing during the period under report, the details of which are given under.

During the year 2011, a total of 43,232 samples of different crops were received and processed for quarantine clearance. Out of these, 14,901 samples (paddy-7,448; wheat-30; maize-3,970; sorghum-771; pearl millet-859; foxtail millet-16; prosomillet- 4; finger millet-115; green gram--74; black gram-2; chickpea-66; yard long bean-19; cowpea-7; soybean-83; sunflower-627; castor-88; chilli-117; tomato-155; okra-3; onion-2; Bambara nut-88, *Aloe ferox*-1 and *Eucalyptus* spp. -56) were imported from different countries and the rest 7,731 (sorghum-2,694; pearlmillet-423; chickpea-1637; pigeonpea- 445; groundnut-291 and small millets-427 and maize-1814) were meant for export to different countries. In addition, a set of 20,600 samples and 900 duplicate samples for viability tests of ICRISAT mandate crop germplasm (sorghum-8,600, pearl millet-4,300, finger millet-40, foxtail millet-71, prosomillet-120, little millet-21, kodo millet-100, barnyard millet-89, chickpea-4,000, pigeonpea-559 and groundnut-2,700) meant for export to Norway for conservation in the Svalbard Global Seed Vault, was examined from seed health angle. Samples were found free from pests.

13.1.1 Import Quarantine Interceptions: All the import samples were subjected to various seed health tests like visual examination, blotter test, X-ray radiography, Enzyme Linked Immunosorbent Assay (ELISA), centrifugation and microscopic examination. The following pathogens were intercepted during the reporting period.

Pests and Pathogens	Crop	Country
Aphelenchoides besseyi, Alternaria padwickii and *Khuskia oryzae*	Paddy	Indonesia
A. padwickii, Tillitia barclayana	Paddy	China
Drechslera oryzae	Paddy	Columbia
D. maydis	Maize	Kenya, South Africa and USA
Fusarium oxysporum	Maize	Indonesia and USA
Rhizoctonia solani	Maize	Thailand, Kenya, Mexico and South Africa
A. solani	Sorghum	France
A. solani and *Rhizoctonia solani A. porri*	Pearlmillet	Belgium and Uganda
A. porri	Fingermillet	Uganda
D. maydis, *R. solani* and *F. oxysporum*	Chickpea	Azerbaizan

A. solani, Pseudomonas syringae pv *tomato*	Tomato	Taiwan
A. solani, R. solani	Chilli	Taiwan
Botrytis cinerea, Phoma sp *R. solani*	Sunflower	Argentina, Belgium and France
P. manshurica, R. solani	Soybean	Canada
A. ricini	Castor	USA
Pestalotia sp	*Eucalyptus* sp.	South Africa

The healthy accessions were released after giving the necessary salvaging treatments.

13.1.2 Imports processed and released: One sunflower sample (EC699912) imported from Argentina was detained due to *Botrytis cinerea* infection and two tomato accessions (EC705523; EC705553) from Taiwan were detained due to the presence of *Pseudomonas syringae* pv *tomato*. One consignment (10 samples) of soybean imported from Canada was rejected due to the presence of *Peronospora manshurica* infection.

13.1.3 Import Germplasm: Salvaging details

Total number of samples infected:	2,638
(Fungi: 2,433; Bacteria: 54; Viruses: Nil; Nematodes: Nil; Insects: 44)	
Number of samples salvaged:	2,625
Number of samples detained:	3
Number of samples rejected:	10

13.1.4 Post-entry Quarantine Observations

13.1.4.1 Crop samples grown in post-entry quarantine isolation area (PEQIA)-ICRISAT farm: Post-entry quarantine inspection was conducted on 640 accessions consisting of sorghum (374 from France, Mali, USA, Kenya), pearlmillet (261 from Niger) and fingermillet (5 from Kenya) and grown in ICRISAT, Patancheru, Andhra Pradesh on weekly intervals. Incidence of zonate leaf spot was noticed on sorghum accessions (EC670270 and 670249 from France and Mali and rust on two accessions (EC669630 and EC669652) of pearlmillet from Niger. Remaining plants were found healthy.

Post-entry quarantine inspection was conducted on 34 accessions of sorghum from France. All accessions have shown zonate leaf spot (*Gloeocercospora sorghi*) symptoms. Eleven sorghum accessions from Mexico and seven from South Africa were also inspected and found healthy.

Post-entry quarantine inspection was conducted on 84 accessions consisting of sorghum (9 from South Africa; 11 from Mexico and 64 from Germany), and maize (2 from Ghana) grown in the PEQIA of ICRISAT, Patancheru, Andhra Pradesh at weekly intervals. Leaf bits of sorghum accessions from South Africa, showing disease symptoms revealed the presence of *Alternaria* spp., *Bipolaris sacchari*, *Curvularia lunata* and *Periconia byssoides*. Remaining plants were found healthy. The sorghum field was full of weeds, hence advised the consignee to keep the field clean by implementing timely the intercultural operations.

Post-entry quarantine inspection was conducted at weekly intervals on 115 accessions of finger millet (*Eleusine africana* and *E. indica*) from Uganda, grown in the PEQIA of ICRISAT, Patancheru, Andhra Pradesh. All accessions were found healthy.

Weekly inspections were conducted on 127 accessions consisting of soybean (73), mung bean (26), blackgram (2), yard long bean (19) and cowpea (7), grown in the green house of AVRDC, ICRISAT campus. All plants were found healthy. Another consignment of 113 accessions of mung bean imported by AVRDC from Thailand and grown in the glasshouse of ICRISAT was inspected. One accession (EC699690) exhibited yellow mosaic symptoms and was uprooted for incineration. The infected sample was brought and tested for sap transmissibility on cowpea and french bean and found no sap transmission. These accessions were also inspected again on 21.07.2011 by a Pathologist of the station and a Virologist from NBPGR, Delhi and leaf samples suspected with seed borne viruses were collected for testing by the virologist. No quarantine significant viruses were recorded on the released samples during post-entry quarantine inspection.

13.1.4.2 PEQ undertaken for private industry: Post-entry quarantine inspection was conducted on 56 accessions of sunflower imported from Argentina and grown in the PEQ field of Syngenta India Pvt Ltd.,

Ranebennur, Karnataka on 17.01.11. Samples suspected with disease problems were collected for examination and all plants were found healthy. Based on these observations, the remaining treated seed was released to the consignee.

PEQ inspection of sowing of treated maize (108 accs.) from Mexico, in the farm of Atash Seeds Pvt Ltd., Hyderabad was conducted on 5.1.11 to check the isolation distance. Another inspection was conducted on 01.04.11 and all plants were found healthy.

Post-entry quarantine inspection was conducted on five accs. of maize imported from Guatemala and grown in the PEQ field of Advanta (I) Ltd, Secunderabad on 21.02.11. All plants were found healthy and recommended for release.

Post-entry quarantine inspection was conducted on one accs. of maize imported from Germany and grown in ICRISAT, Patancheru, Andhra Pradesh on 18.03.11. All plants were found healthy.

Post-entry quarantine inspection was conducted on nine accs. of maize imported from Malaysia and grown in the PEQ field of Amareshwara Agri Tech., Medchal, Andhra Pradesh on 23.03.11. All accessions were found healthy.

Post-entry quarantine inspection was conducted on 288 accessions of pearl millet imported from Belgium and grown in the PEQ field of Devgen Seeds, Medchal, Andhra Pradesh on 12.04.11. All accessions were found healthy.

Post-entry quarantine inspection at the time of sowing was conducted on 15 treated accs. of maize imported from France (10) and Thailand (5) and grown in the field of Atash Seeds Pvt Ltd., Girmapur, Ranga Reddy dt., Andhra Pradesh on 05.05.11. Second inspection was conducted on 12.07.11 during active crop growth period. Performance of France hybrids was very poor. Shoot borer incidence noticed in all accs., while leaf blight caused by *Drechslera* sp noticed on LGE-1108 accs. No disease of quarantine significance was noticed.

Post-entry quarantine inspection at the time of sowing was conducted on 20 treated accs. of pearlmillet imported from Australia and grown in the field of Advanta India Ltd., Vavilala, Ranga Reddy dt., Andhra Pradesh on 28.06.11.

Post-entry quarantine inspection was conducted on six accs. of chillies imported from AVRDC, Taiwan and grown in the farm of Hi Gene Seeds Pvt Ltd., Hyderabad on 16.07.11. No disease of quarantine significance was noticed.

Post-entry quarantine inspection was conducted on 385 accs. of Tobacco imported from USA and grown in the field of ITC Ltd., Hunsur, Karnataka on 28.07.11. Incidence of *Tobacco mosaic virus*, blank shank and aphid infestation noticed. Soil samples were brought to check the nematode activity.

Post-entry quarantine inspection was conducted to inspect the sowing of one treated accession of sunflower from Australia, grown in the field of JK Agrigenetics, Ravalkol, Ranga Reddy dt on 7.9.2011. Isolation distance of 200 mt followed. Another inspection was conducted during active crop growth period and leaf spot symptoms noticed, which revealed the presence of *Alternaria helianthi, A. zinniae*, *Periconia bessoides* and *Cercospora* sp. Paddy accessions (225) from Philippines were also inspected and the brown spots on paddy seed revealed the presence of seedborne fungi, *viz., Drechslera carbonum* and *D. oryzae* etc.

Post-entry quarantine inspection was carried out on 85 treated samples of maize imported from Zimbabwe during sowing at Vibha Agrotech Pvt Ld., Manoharabad, Ranga Reddy dt., Andhra Pradesh and isolation distance of 200 mt was followed.

13.1.4.3 PEQ inspection undertaken for imported transgenics: Post-entry quarantine inspection was conducted on 65 accs. of transgenic maize imported from USA and grown in the DBT approved polyhouses of Monsanto India Pvt Ltd., Patancheru, Andhra Pradesh on 31.01.11. Samples suspected with disease problems were collected for examination.

Inspection of ~550 plants of transgenic maize imported from South Africa (10 accs.) and Philippines (9 accs.), released by NBPGR, New Delhi, grown in the DBT approved glass house of Monsanto India Pvt Ltd., Nandigama village, Patancheru, Andhra Pradesh was carried out along with a virologist from Delhi on 21.07.2011. All plants were found healthy. Leaf samples suspected with virus infection were collected for testing. Post-entry quarantine inspection was carried out on 37 samples of transgenic paddy imported from Belgium and grown in the DBT approved glass house at Bayer

Bioscience Pvt. Ltd., Patancheru and all were found healthy.

13.1.5 Export Quarantine

13.1.5.1 Pre-export crop inspection: Pre-export crop inspection was carried out at ICRISAT on sorghum (1,000 accs.) covering 2.3 ha and chickpea (4,309 accs.) covering 2.6 ha. Stem borer incidence (0.1%), downy mildew (*Peronosclerospora sorghi*) incidence was observed in sorghum field and the infected plants were uprooted and destroyed and metalaxyl was sprayed to prevent spread of the disease. Sclerotial and Fusarial wilt incidence upto 10% and *Rhizoctonia* crown rot (1%) were noticed in chickpea fields and the infected plants were uprooted and destroyed.

13.1.5.2 Export germplasm processed: A total of 7,731 samples of ICRISAT mandate crops consisting of sorghum (2,694), pearl millet (423); foxtail millet (257); fingermillet (170), chickpea (1637); pigeonpea (445); groundnut (291) and CIMMYT maize (1,814) samples were processed for export to different countries. In addition, a set of 20,600 samples and 900 duplicate samples for viability tests of ICRISAT mandate crop germplasm (sorghum-8,600, pearl millet-4,300, finger millet-40, foxtail millet-71, prosomillet-120, little millet-21, kodo millet-100, barnyard millet-89, chickpea-4000, pigeonpea-559 and groundnut-2700) meant for export to Norway for conservation in the Svalbard Global Seed Vault, was examined from seed health angle. Samples were found free from pests.

A total of 103 seed samples (sorghum-20, pearl millet-28, foxtail millet-7, finger millet-3, chickpea-27, and pigeonpea-18) was rejected due to pathological reasons. The remaining 7, 628 healthy samples were exported to different countries. In all, 106 phytosanitary certificates were issued during the reporting period.

The rejections in the export germplasm of ICRISAT mandate crops were mainly due to failure of germination, seed contamination by *Acremonium* sp., *Bipolaris setariae, Bipolaris* spp., *Botryodiplodia theobromae, Cercospora* sp., *Colletotrichum* sp., *Colletotrichum graminicola, Drechslera maydis*; *Fusarium udam, Phoma* sp., *Phyllosticta cajani*, *Rhizoctonia bataticola, R. solani,* and *Verticillium* sp, bacteria of unknown etiology and uncertainty on FAO designated status.

13.1.5.3 Quarantine services provided to various organizations International- ICRISAT- Patancheru, Hyderabad, AVRDC-RCSA, (ICRISAT campus), Hyderabad and CIMMYT (ICRISAT campus), Hyderabad

ICAR/CSIR Institutes- Directorate of Rice Research, Hyderabad; Indian Agricultural Research Institute, Wellington, Tamil Nadu

Universities/ State Government Organisations- Anbil Dharmalingam Agricultural College and Research, Trichy, Tamil Nadu; Annamalai University, Tamil Nadu; Centre for Plant Molecular Biology, TNAU, Coimbatore; College of Agriculture, Trivandrum, Kerala; Kerala Agricultural University, Kerala; Tamil Nadu Agricultural University, Coimbatore; Rice Research Station, Tirur, Tamil Nadu; TNRRI, Aduturai, Tamil Nadu; ARS, TNAU, Thirupathisaram, Kanyakumari, Tamil Nadu; UAS, Raichur, Karnataka; RARS, Warangal, Andhra Pradesh; ZARS, University of Agricultural Sciences, Dharwad, Karnataka; University of Agricultural Sciences, Mandya, Karnataka; Karnataka University, Dharwad, Karnataka; ZARS, Jharkhand; College of Agricultural Sciences, Bangalore; Osmania University, Hyderabad;

Private Industries- Advanta India Pvt. Ltd., Hyderabad; Atash Seeds Pvt., Ltd., Cherlapally Hyderabad; Barwale Foundation, Hyderabad; BIOSTADT MH Seeds Ltd, Hyderabad; Bayer Bioscience (P) Ltd., Hyderabad; Bioseed Research (I) Pvt. Ltd., Hyderabad; Charoen Pokphand Seeds (I) (P) Ltd., Bangalore; Devgen Seeds & Crop Technology Pvt Ltd, Hyderabad; Ganga Kaveri Seeds (P) Ltd., Hyderabad; Hi-Gene Seeds (I) P. Ltd., Secunderabad; Indo-American Hybrid Seeds Pvt. Ltd., Bangalore; ITC R&D Centre, Karnataka; JK Agri-genetics, Hyderabad; Kaveri Seeds Company Ltd., Secunderabad; MAHYCO, Hyderabad; Metahelix Life Sciences Pvt. Ltd., Bangalore; NRI Agritech (P) Ltd., Guntur, Andhra Pradesh; Nirmal Seeds Pvt Ltd., Jalgaon, Maharashtra; Pioneer Overseas Corporation Pvt.Ltd., Hyderabad; PHI Seeds (I) (P) Ltd., Hyderabad; Rasi Seeds (P) Limited, Tamil Nadu; Syngenta (I) Ltd, Hyderabad; Super Agri Seeds (P) Ltd., Hyderabad; Vibha Agrotech pvt Ltd., Hyderabad; Vittal Malya Scientific Research Foundation, Bangalore.

13.1.6 Supportive Research

13.1.6.1 NAIP project on Virology: As part of validation of antiserum produced under the project, 954 samples consisting of tomato (222), chilli (241), groundnut (372), bitter gourd (1) and field bean (118) leaf samples from the fields of NBPGR RS, Hyderabad, ANGRAU and ICRISAT, were ELISA tested against *Groundnut bud necrosis virus* (GBNV), *Peanut mottle virus* (PMV), *Cucumber mosaic virus* (CMV), *Papaya ring spot virus* (PRSV) and *Tomato leaf curl virus* (ToLCV). The details of results obtained are given in the following table.

13.1.6.2 Seed health testing: Four seed samples of paddy submitted by Bayer Bioscience Pvt Ltd., Hyderabad (3) and Devgen Seeds and Crop Technology Pvt Ltd., Hyderabad (1) were tested for their health status and three samples were found infected with white tip nematode, the target pest.

Inspection of cotton plants (2320) grown in the greenhouses of Monsanto India Pvt Ltd, Kallakal, Andhra Pradesh, meant for export of lyophilized samples, was conducted on 20.05.11 by a Pathologist of the station. Out of total plants inspected, 63 plants suspected with viral infection, angular leaf spot and fungal infection were rejected.

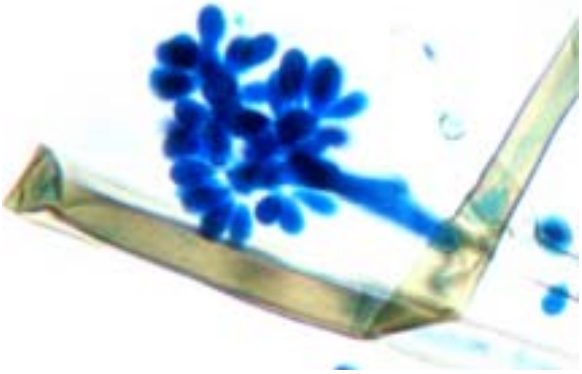
Three paddy samples, meant for export to Thailand, submitted by Advanta India Ltd., have been tested for their health status and found free from target pests.

Two paddy samples, meant for export to Mozambique, submitted by JK Agrigenetics Pvt Ltd., have been tested for their health status and one sample was found infested with white tip nematode (*Aphelenchoides besseyi*), the target pest.

Seed health testing of one paddy sample, meant for export to Mozambique, submitted by JK Agrigenetics

Crop	Number of samples	Infected samples (No)					
		GBNV	PMV	CMV	PRSV	ToLCV	TSV
Chillies	206 35	14 2	Not tested	8 Not tested	Nil Not tested	No reaction Not tested	Not tested Not tested
Tomato	52 170	1 62	Not tested Not tested	40 Not tested	Not tested Not tested	No reaction No reaction	Not tested Not tested
Groundnut	205(ICRISAT) 167 (CRIDA)	76 36	48 Nil	Not tested	Not tested	Not tested	Nil 1
Field bean Bittergourd	118 1	Nil Nil	Not tested Not tested	1 Nil	16 Nil	Not tested Not tested	Not tested Not tested
Total	**954**	**91**	**48**	**49**	**16**		

Oospore crust of *Peronospora manshurica* on soybean seeds from Canada (left); View of oospore under compound microscope (right)



Conidiophore and conidia of *Botrytis cinerea* on sunflower seed from Argentina

Conidia of *Alternaria helianthi* on sunflower seed from Argentina

Conidia of *Alternaria helianthi* obtained on sunflower leaves from Australia collected during PEQ inspection

Sclerotial wilt incidence noticed in chickpea field during pre-export crop inspection

Pvt Ltd., was tested and given mandatory hot water treatment and released.

13.1.6.3 Smart delivery of pesticides by seed coating through electro-spun nano fibers/ particles

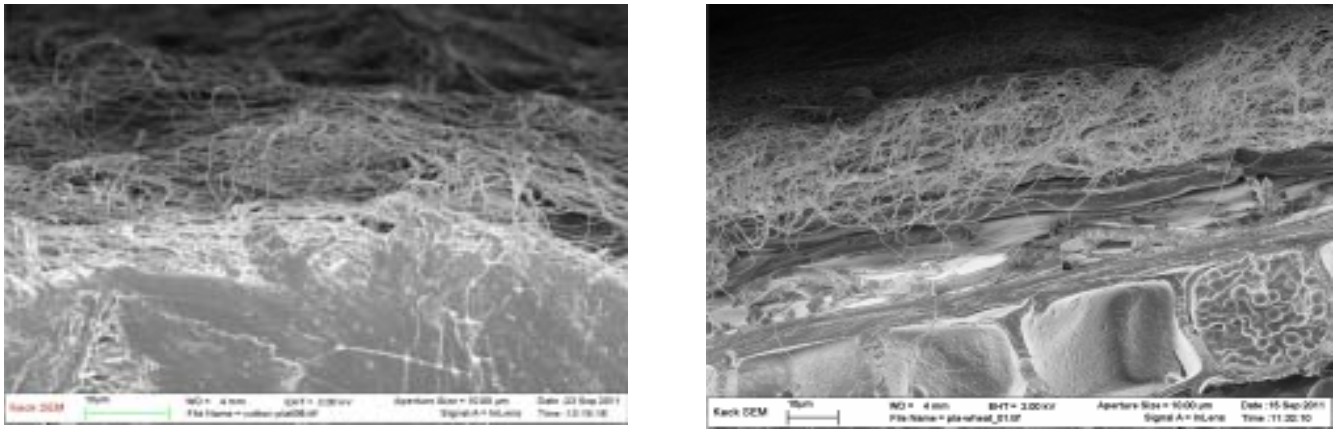
A novel seed coating protocol was standardized in which systemic pesticides were incorporated into a biodegradable nano-polymer system and coated on the surface of seeds using electro-spinning / electro-spraying process with an aim to improve the delivery system of the pesticide by controlled-release mechanism. Imidacloprid, a systemic insecticide and tebuconazole, were incorporated into polymer system involving PLA and PLGA nanofibers / particles and further coated onto the cotton and wheat seeds by the electro-spinning / electro-spraying. By virtue of their nano-scale diameter and very large surface area, electro-spunûbers/ particles offer a number of additional advantages like enhanced bioavailability of the pesticides, improved specificity, improving the timed release of pesticide molecules and ease and safety in handling.

The morphology of the pesticide loaded electro-spunfibres collected on the surface of the seed was observed by field emission scanning electron microscopy (FESEM) (Gemini LEO 1550).The size of spun fibres ranged from 130 nm to 210 nm in diameter and the coating thickness ranged from 18.6 µm to 20.49 µm (Fig. 2) on the seeds. Seeds germination tests were conducted to test the viability of the treated seed by top of the paper method. The results showed that, the seed coating process by electro-spinning and electro-spraying did not affect the germination of seeds in both wheat and cotton. 100 % seed germination was observed on all coated seed by 96 h of observation.

13.2 Plant Genetic Resources Activities

13.2.1 Plant Exploration and Germplasm Collection: A total of six explorations were undertaken for the collection of agri-horticultural crops including leafy vegetables, cereals and pulses, small millets, buckwheat, french bean, wild edible legumes, cold tolerant paddy, spine gourd and *neti donda.* In addition, as collaborators

Seeds of coated and uncoated wheat (a) & coated and uncoated cotton (b)by electro-spinning



Scanning electron microscope (SEM) micrograph of nanofibers on cotton seed cross section (a) and wheat seed cross section (b)

also associated with the Directorate of Onion and Garlic, Pune, in two surveys for the collection of onion and garlic from parts of Tamil Nadu and Karnataka; and with the Agricultural College & Research Institute, Tamil Nadu Agricultural University for the collection of Palmyrah palm. A total of 658 collections were made, the details of which are as given below:

13.2.1.1 Leafy Vegetables: An exploration was undertaken in Tumkur, Chitradurga and Bellary districts of Karnataka and Kurnool and Anantapur districts of Andhra Pradesh for the collection of leafy vegetable germplasm. A total of 98 accessions including Amaranth (37), Spinach (12), Roselle (13), Sorrel (11), Pigweed (2), Anise (8), Lamb's quarters (4), Fenugreek (4), Coriander (6) and Oxalis (1) were collected during the survey. Some important collections are IC588858 *Amaranthus tricolor*, which is a popular leafy vegetable among the *Besta* community of Kurnool district of Andhra Pradesh. IC588860, a landrace of *Amaranth* collected from traditional leafy vegetable growing farmers from Bandimetta in Kurnool district. IC588886, *Anise*-a leafy vegetable that is cultivated in only some pockets of the surveyed region, in the same area. IC 588891 an endemic leafy vegetable collected from pockets of Karnataka. Seed of all 98 accs. of leafy vegetables has been sent to National Gene Bank (NGB) for conservation.

13.2.1.2 Wild Edible Legumes: An exploration was undertaken for collection of wild edible legumes from parts of Rayalaseema region of Andhra Pradesh (Anantapur and Kurnool) and adjoining regions of Karnataka (Bidar, Bellary, Bijapur, Belgaum, Dharwad, Chitradurg, Gulbarga). A total of 21 accs. including *Cassia* spp, *Canavalia ensiformis*, *Mucuna pruriens*, *Crotalaria juncea*, *Sesbania grandiflora* and *Tephrosia purpurea* were collected.

13.2.1.3 Onion (*Allium cepa*): Two explorations were undertaken for the collection of onion and garlic as collaborator, one from parts of Tamil Nadu and the other from parts of Karnataka with Directorate of Onion and Garlic Research, Pune as the lead centre. In the first

survey, where the Department of Vegetable, Tamil Nadu Agricultural University also collaborated, a total of 43 accessions of onion including 36 aggregatum types, and 8 common onion types were collected from parts of 7 districts of Tamil Nadu including Tiruppur, Cuddalore, Namakkal, Erode, Coimbatore, Dindigul and Perambalur. Variation was observed in colour, size, shape and number of bulblets (2 – 12). In the second exploration where the Department of Horticulture, UAS Dharwad collaborated, germplasm of onion and garlic was collected from parts of North and Central Karnataka including Chickballapur, Chickmangalur, Chitradurga, Bagalkot, Belgaum, Bijapur, Davanagere, Dharwad, Gadag and Haveri districts. Pune, Maharashtra. A total of 80 accessions including 75 of Onion (common onion- 58 accs.; multiplier onion- 8 accs., rose onions – 9 accs.) and 5 accessions of Garlic were collected from 10 districts of Karnataka including Bagalkote (14), Belgaum (3), Bijapur (5), Chickballapur (18), Chickmagalur (2), Chitradurga (20), Davanagere (2), Dharwad (3), Gadag (3) and Haveri (10). Eight seed samples collected were sent for long-term conservation in the National Gene Bank. Significant variability was observed in onion for bulb colour, size, shape and number of bulblets (2-8) and garlic for clove colour, size and number of cloves (12-15).

IC436542 a green gram accession with long pods

IC582850 yardlong bean accession from Jeypore Orissa released as 'Arka Mangala

13.2.1.4 Palmyrah palm (*Borassus flaberrifer*): Collaborated in an exploration for collection of palmyrah palm germplasm from parts of Guntur and Prakasam districts of Andhra under the auspices of Agricultural College & Research Institute, Tamil Nadu Agricultural University, Killikulam, Tamil Nadu under the AICRP on Palms. The Department of Horticulture, Tamil Nadu Agricultural University and Andhra Pradesh Horticultural University also collaborated in the survey. A total of 15 acces. were collected. Significant diversity collected both for qualitative and quantitative traits. One set each of the collected germplasm (fruits) was shared between the Horticultural Research Station, Andhra Pradesh Horticultural University, Pandirimamidi, Rampachodavaram, East Godavari District, Andhra Pradesh and Agricultural College & Research Institute, Tami Nadu Agricultural University, Killikulam, Vallanadu, Thoothukudi District, Tamil Nadu for initial establishment, characterization, evaluation and utilization.

13.2.1.5 *Zehneria angulata* and *Momordica dioica*: An exploration was undertaken for the collection of underutilized vegetable species - *Zehneria angulata* (*neti donda*) and *Momordica dioica* (*spine gourd*) germplasm from parts of East Godavari, Visakhapatnam, Vizianagaram and Srikakulam districts of Andhra Pradesh. The Department of Horticulture, Andhra Pradesh Horticultural University collaborated in the survey. A total of 78 collections were made including *Zehneria angulata* (45 accs.) and *Momordica dioica* (33 accs.). Variation was observed and collected for leaf colour, serration, margin, size and shape; no. of ridges on stem; no. of stems/ tuber; fruit shape, size, angling and spine density; tuber size and shape etc.

13.2.1.6 Cereals and Pulses: A survey was undertaken in collaboration with Sanjeevani, an NGO, for the collection agri-horticultural crop germplasm especially from tribal areas of Araku region of Visakhapatnam district of Andhra Pradesh including mandals of Paderu, Araku valley, Hukumpeta, Dumbriguda. A total of 119 accessions comprising the different crop groups *viz.* cereals, millets, pulses, oilseeds and vegetables were collected during the survey. Some of the important landraces collected include *Kakijonna, Veerajonnal* and *Pottajonna* in sorghum; *Mettadhanyam, Moulkucchi, Yerrasannadhanyam,*

French bean (Pon Jiju) (SRS-13443

Variation in French bean from Arunachal Pradesh

Esukaravvalu, Amberkotdhanyam, Limaliser and *Panturdhanyam* in paddy; *Peddasama* and *Chinnasama* in little millet; *Peddachodlu, Peddanallachodlu, Punasachodlu* and *Militarychodlu* in finger millet; *Chirikandulu* in pigeonpea; *Nakchana* in chickpea; *Kolothkandhulu* and *Gurramulavalu* in horsegram and *Devagummadi* in pumpkin.

13.2.1.7 Small millets, buckwheat and French bean: A region specific exploration was undertaken in NEH region & adjoining areas for the collection of small millets, buckwheat and french bean. The survey was undertaken in collaboration with AIC Small Millets Improvement Project, Bengaluru, Karnataka and KVKs of Seppa, Tawang, Dirang, Arunachal Pradesh. TNAU, Coimbatore, Tamil Nadu also collaborated in the survey. Parts of South and South-Western Arunachal Pradesh were surveyed including districts of East Kameng, Tawang and West Kameng.

A total of 148 accs. were collected including 60 accessions of small millets (finger millet (48), Italian millet (8), proso millet (1), *Eleusine indica* (1) and *Setaria viridis* (2)); 26 accessions of buckwheat / allied species (common buckwheat (7) and tartary buckwheat (19)) and 62 accessions of french bean / allied species (french bean (59) and lima bean (3).

Diversity sampled: The tribal groups from whom the germplasm was sampled from were *Aka, Miji, Monpa, Dung Karpa,* and *Nyishi* from the targeted region.

Mallikuruvai, a scented cold tolerant rice germplasm with short bold kernels

Rannebennur Local Garlic

Variation in finger millet from Arunachal Pradesh

Landraces collected in different crops included Finger millet (*Cham/ Gacheyn/ Katcham/ Kichae/ Kijan/ Kong Pu/ Madua/ Tame/ Tami*); Italian millet (*Kyung/ Nichak/ Tiya/ Yangra/ Zhu*); Common Buckwheat (*Gruching/ Grunjun/ Jhum/ Kyap*); Tartary Buckwheat (*Brasum/ Brem/ Mamia*) and French bean (*Bachhui/ Changli Be/ Chingro Phomba/ Grep/ Jambre/ Jhijhu/ Orise/ Sem*).

13.2.1.8 Cold tolerant rice: One exploration for collection of cold tolerant rice germplasm was undertaken under the NICRA (2011-12) Project. Collaborating Institutes included the Directorate of Rice Research (DRR), Hyd. & TNAU, Coimbatore. Parts of the Western Ghats region including the districts of Nilgiris (Gudalur), Wayanad & Dindugal (Palani Hill ranges) of Tamil Nadu and Kerala were surveyed. A total of 56 samples of cold tolerant rice germplasm including landraces and released varieties adapted to cold climate were collected. Diversity sampled: *Adukkan,Aiyrankanni, Channa, Cherutti, Chettuvali, Chinthamani, Edavaka, Ghandkasala, Jeerakasala, Kadaikannan, Karunellu, Karuvali, Kattathondi, Kudaivali, Kudaivilaiyan, Kuruvatti, Malainellu, Mallikuruvai, Mannuvilaiyan, Maranellu, Mullampunjan, Navara, Palthondi, Pavalam, Thondi, Valisuri, Vellainellu, Wayanad Ghandakasala* and *Wayanad Jeerakasala* are the important cold tolerant landraces collected. Improved cultivars and released varieties *viz*., Adhira, Bharathy and IR-20 adapted to cold climate were also collected. Diversity in plant height, numbers of tillers, grain colour (red/white) and size (short bold/medium bold/medium slender), glume colour (black/straw), presence of awns, crop maturing period were observed. *Pavalam, Malai nellu* and *Karunellu* are the landraces grown during *rabi* season with long crop duration of 9-10 months. Scented landraces (*Gandhakasala, Jeerakasala* and *Mallikuruvai*) were also collected.

Variation in aggregatum onion from Tamil Nadu.

Onion diversity Karnataka

13.2.1.9 Explorations and collections under the NAIP Biodiversity Project: Under NAIP-Biodiversity project a total of eight explorations were undertaken in Adilabad district covering 53 mandals which resulted in the collection of 803 accessions of agri-horticultural crops which include sorghum (89), pigeon pea (67), dolichos bean (63) and green gram (61) among others. The wild relatives collected include *Abelmoschus ficulneus, Abrus precatorius, Abelmoschus manihot, Canavalia ensiformis, Cassia senna, Clitoria ternatea, Cucumis pubescens, Jatropha curcas, Luffa acutangula* var.*amara, Oryza rufipogon, Soalanum incanum, Solanum xanthocarpum*, *Trichosanthes bracteata, Trichosanthes cucumerina.*

13.2.2 Promising accessions identified for on-farm field trials of different crops (based on agro-morphological characterization and evaluation during *rabi*, 2010-11 and *kharif*, 2011):

1. Dolichos bean- RJR-150- For marketable pod yield per plant ((709.7) Best check: RND-1 (447.8)) and

RJR-150

Number of pods per plant (112.2) Best check: RND-1 (74.63)

2. Field bean- PSRJ-13031-01 for total pods/plant (no): (103) (Best check: IC-426988 (68.5)

PSRJ-13031-01

RJR-055

3. Maize- RJR-055 For Grain yield/ plant (g): (85.8) (Best check: DHM-117 (63.8)

4. Sorghum- PSRJ-13076 For Brix %: (21.4) (Best check: CSV-15 (19.1) and Yield/ plant: NAIP-56 (48.3) (Best check: CSV-15 (36.1)

NAIP-56

PSRJ-13076

RJR-230

NSJ-125

5. Black gram- RJR-230 for total pods/ plant (no): (131.33) (Best check: LBG-402(102.33) and NSJ-350 for Seed yield / plant (g): NSJ-350(33.91) (Best check: LBG-402 (27.54)

6. Green gram- NSJ-125 for 100 seed weight (g): (6.5) (Best check: ML-267(3.8) and Yield per plant (g): PSR-13287(32.6) (Best check: ML-267(15.5)

3.2.3 Germplasm Characterization and Evaluation

A total of 504 accs. of landraces belonging to crop groups cereals, millets, small millets, pulses and vegetables during *kharif*, 2011 and 299 accs. of millets, pulses and vegetables are handled for characterization, evaluation and multiplication during the year 2011-12.

3.2.3.1 *Rabi,* 2010-2011*:* A total of 1,231 accessions of sorghum (428), horsegram (135), linseed (65), brinjal (45), chillies (45), dolichos bean (56), tomato (149), field bean (42), yardlong bean (39) and amaranths (40) were grown in the field along with appropriate checks for characterization/evaluation/multiplication. In addition wild legumes including *Canavalia ensiformis* (44), *Mucuna pruriens* (14), *Crotalaria juncea, C. retusa, C. verrucosa* (10), *Cajanus lineatus, C. heynii, C. scarabaeoides* and *Glycine wightii* (19) were also raised for seed multiplication and initial characterization.

Linseed: A total of 65 accessions including the check varieties (KIRAN, GARIMA, H-LOCAL, J-23-10 & RLC-6)) was characterized. Accessions identified superior to the checks include IC096519; IC096696, IC096703, IC118850, IC118855, IC118880 for plant height (51 -70 cm); IC058417-A, IC118884, IC356581, EC001475 for length of capsules (>8.5mm) and IC096513 (7.0 g), IC096570 (6.9 g), IC118850 (7.6g), IC118885 (7.4g), IC345391 (7.2 g) for 1000-seed weight.

Sorghum: A set of 384 accessions of world sorghums was characterized and evaluated and a wide range of variation was observed for different traits as days to 50% flowering (46 – 130); total number of leaves (4 – 13); panicle length (5.8 - 54cm and panicle width (2.8 – 35cm). Racial identity was confirmed for the 384 accessions.

13.2.3.2 *Kharif* 2011: A total of 1,247 accessions of barnyard millet, finger millet, little millet, greengram, cowpea, yardlong bean, chillies, brinjal, *Canavalia*

ensiformis and *Mucuna pruriens* were grown in the field along with checks for characterization/evaluation/multiplication.

Promising accessions in comparison to check varieties in different crops were identified as follows

Finger millet:
Finger length: PSR10095-sel-1 (8.83) (4.83-8.83)
Finger width: NSS7928-sel-2 (1.66) (1.2-1.6)

Little millet:
Basal tillers: IC298412 (17.33) (3.6-17.3)
Length of inflorescence: IC426674 (41.66) (13.3-41.6)

Barnyard millet:
Basal tillers: IC257799 (26.33) (3-26.3)
Length of inflorescence: IC426595 (28.5) (10.6-28.5)
Width of inflorescence: IC426594 (10.63) (2.13-10.63)

Italian millet:
Basal tillers: IC283718 (30) (1-30)
Ear length: IC257885 (45.83) (11.53-45.83)
Ear width: IC283720 (6.43) (1.53-6.43)

Brinjal:
Fruit length: IC89903, IC545844 (23.1 cm); IC112991 (20.3cm); NSKA/06/300 (23.0cm)
Fruit breadth: PSR 13292 (9.0 cm)
Plant height: IC136422 (99.8 cm); IC90806 (98.0cm); IC446748 (92.0cm); NSKA/06/344 (95.0cm)
Plant spread: IC203602 (160 cm); IC89903 (138 cm); PSR13310 (135 cm); IC548892 (124 cm)

Cowpea: A wide range of variation for different traits was observed including days to 50% flowering (41.7 - 63.3), plant height (61.7 - 304.8), clusters per plant (4.6 - 20.6), pods per plant (6.5 - 37.4), pod length (11.8 - 20.3), seeds/pod (11.6 - 18.5) and 100 seed weight (5.7 - 14.1). Accessions found promising for various traits included IC343959, IC519603 and IC399001 for maximum clusters per plant (17.4 – 20.6); IC519762, IC436897 and IC343959 for longest pods (19.1cm - 20.3cm); IC519737, IC436875 and IC399001 for maximum number of seeds per pod (17.3 – 18.5) and IC 519762, IC519750 and IC519698 for highest 100 seed weight (11 – 14g).

Green gram: A wide range of variation for different traits was observed including days to 50% flowering (34.3 – 45.0), plant height (25.8 - 86.4), clusters per plant (9.3 - 18.0), pods per plant (29.8 - 78.7), pod length (6.6 - 11.1), seeds/pod (11.0 - 20.8) and 100 seed weight (2.8 - 6.9). Accessions found promising for various traits included IC343959, IC519603 and IC399001 for maximum clusters per plant (17.4 – 20.6); IC 436542, IC436557 and IC436664 for longest pods (10.7cm – 11.1 cm); IC436542, IC436557 and IC436528 for maximum number of seeds per pod (15.9 – 20.8) and IC436700, IC343948 and IC436557 for highest 100 seed weight (6.0 – 6.9g).

Yardlong bean: An accession IC582850, collected from Jeypore, Orissa in an exploration survey undertaken in 2009 in collaboration with IIHR was approved for release as a variety 'Arka Mangala' at the Institute level from IIHR. The variety was evaluated at IIHR over two seasons and recorded a yield of 24.7 t/ha with an increase of 24% and 30% pod yield over the check varieties Lola and Vyjayanthi respectively. The accession is pole type, photo insensitive variety with green smooth pods.

13.2.3.3 *Rabi* 2011-2012*:* A total of 368 accessions of sorghum, horsegram, linseed and french bean were grown in the field along with checks for characterization/evaluation/multiplication. In addition, 100 accessions of wild edible legumes including pilliepsara bean, *Canavalia ensiformis* and *Mucuna pruriens* were also raised for evaluation of important agro-morphological traits.

13.2.3.4 Studies on traits of resistance to thrips and mites in chilli: Twenty-two accessions of chilli germplasm with varying degree of resistance are further being tested under the controlled conditions with artificial inoculation of the test insects to screen the reactions of the accessions against the insect infestation. Individual accessions grown in pots are covered with insect proof mylar film cages and inoculated with test insects scored using the leaf curl index (LCI) in the scale 0-4. Bio-chemical analysis was carried out to quantify total phenols in the 20 selected accessions of chillies in identifying traits of resistance to thrips and mites. The total phenol content was in lower in the susceptible check; 2.94 mg/g (CA 960)– 3.62 mg/g (LCA 334). It ranged from 6.90 mg/g (EC391082) to 7.60 mg/g (EC599994) in the resistant accessions.

13.3 Germplasm Conservation

13.3.1 Sent to NGB for long-term storage: A total of 258 germplasm accessions including 145 exotic tomato accessions received from NBPGR, New Delhi along with barnyard millet (34), green gram (3), chilli (67) and kodo millet (9) were multiplied at the station and sent

for long term conservation in the National Gene Bank (NGB). In addition, 12,712 SVALBARD voucher samples of six crops from ICRISAT were also processed and sent for long term storage to NGB.

13.3.2 Shared with NAGS: Ninety eight accessions of leafy vegetables germplasm from parts of Andhra Pradesh and Karnataka in a collaborative survey with Andhra Pradesh Horticultural University (APHU) has been shared with APHU.

13.3.3 Additions to MTS, Hyderabad: A set of 98 accessions of leafy vegetable germplasm, eight onion seed samples along with 22 accessions of wild edible legume germplasm were conserved in the medium term storage of NBPGR, Hyderabad.

13.3.4 National Herbarium of Cultivated Plants: A total of 30 herbarium specimens of variation in pillipesara bean, *Canavalia ensiformis* and dolichos bean were prepared and added to NHCP, New Delhi.

13.4 Germplasm Distribution

A total of 329 accessions including bitter gourd (15), ridged gourd (18), bottle gourd (3), kodo millet (25), cowpea (20), green gram (25), black gram (25), horsegram (50), pearlmillet (6), brinjal (100) and tomato (42) were supplied. In addition, 7,888 samples of Sorghum (SVALBARD Vouchers) were submitted to Directorate of Sorghum Research for research, utilization and multiplication for long-term storage in the NGB, New Delhi.

13.4.1 Germplasm registration: "INGR 11031I" - a promising dolichos bean (*Lablab purpureus* (L.) Sweet) germplasm accession field resistant to Anthracnose (*Colletotrichum lindemuthianum* (Sacc. And Magn.) Scrib.) and Aphids (*Aphid craccivora* Koch.) was registered with NBPGR, ICAR.

Research Programmes (Programme Code: Title, Leader)

PGR/PQR- BUR-HYD-01.00: Quarantine Processing of Plant Germplasm Under Exchange and Supportive Research (KS Varaprasad (till April 30), **S K Chakrabarty** (w.e.f May 1))

PGR/PQR- BUR-HYD-02.00: Augmentation, Characterization, Evaluation, Maintenance, Regeneration, Conservation, Documentation and Distribution of Genetic Resources of South East Coastal Zone (KS Varaprasad (till April 30), **S K Chakrabarty** (w.e.f May 1))

Research Projects (Code: Title, PI, Co-PI, Associates)

PGR/PQR-BUR-HYD-01.01: Detection, Identification and Control of Pests Associated With Import and Export of Seed/ Plant Material.(**K Anitha,** KS Varaprasad (till April 30), S K Chakrabarty, B Sarath Babu, N Somasekhar, N Sivaraj, K Rameash and Babu Abraham

PGR/PQR-BUR-HYD-01.02: Developing a Database on Pests and Pathogens of Quarantine Significance (**B Sarath Babu,** KS Varaprasad (till April 30), and K Anitha)

PGR/PQR-BUR-HYD-01.03: Quarantine Treatments for Germplasm under Exchange and Developing Detection Techniques and Treatment Schedules for Seed Borne Pathogens (**SK Chakrabarty** and K Anitha)

PGR/PQR-BUR-HYD-01.04: Post-entry Quarantine Processing of Imported Germplasm (***KS Varaprasad*** (*till* April 30), *SK* Chakrabarty, B Sarath Babu, K Anitha, K Rameash and Babu Abraham)

PGR/PQR- BUR-HYD-02.01: Augmentation, Characterization, Evaluation, Maintenance, Regeneration, Conservation, Documentation and Distribution of Genetic Resources of Agricultural Crops (Cereals, Millets, Pulses, Oilseeds etc.) and their Wild Relatives. (**Kamala Venkateswaran,** SR Pandravada, N Sivaraj, N Sunil and Babu Abraham

PGR/PQR- BUR-HYD-02.02: Augmentation, Characterization, Evaluation, Maintenance, Regeneration, Conservation, Documentation and Distribution of Genetic Resources of Horticultural Crops (Vegetables, Fruits, Species, Medicinal and Aromatic Plants etc.) and their Wild Relatives (**Someswara Rao Pandravada**, K Venkateswaran, N Sivaraj, N Sunil and Babu Abraham

PGR/PQR- BUR-HYD-02.03: Characterization and Evaluation of Wild edible Crops of Leguminosae **(N Sivaraj,** SR Pandravada, K Venkateswaran, N Sunil and Babu Abraham)

Externally Funded Projects

- Improvement of brinjal and chillies for root knot nematode resistance using molecular markers (DBT)
- Collection, assembly and conservation of genetic resources of physicnut (*Jatropha Linn* (DBT)
- Novel strategies for molecular diagnosis of plant viruses (NAIP)

14. REGIONAL STATION, JODHPUR

Summary: Exploration trip was undertaken for the collection of landraces of major crops, minor fruits, M&AP and economic potential species from Rana Chowki, Jhakham Dam, Balmikhi Ashram, Dhulia Khem and Sari Pipli collection sites at Sitamata forest area Sanctuary (Pratapgarh, Chittaurgarh Districts of Rajasthan) during October 2011. The identification of these plants was confirmed by taxonomist at BSI, Jodhpur and the specimens (AKS/JD/SMS 01 to 90) are kept in the MTS Jodhpur Station of NBPGR. A total of 90 accessions, including rare and endangered species, were collected, namely, cereals (07), minor millets (01), pulses (06), oil seeds (07), minor fruits (06), fiber yielding (01), vegetables (12), medicinal and aromatic plants (30), and economically potential tree plants (20). One biodiversity survey and germplasm collection trip was undertaken under NAIP (Harmonizing Biodiversity) project in Udaipur. Twenty four landraces were collected, *viz*., bhindi (02), bottle gourd (03), cow pea (01), gram (02), long melon (01), maize (05), mung (01), muskmelon (01), pumpkin (01), rice (01), sesame (01), sponge guard (03) and urd (02) from Block Salumber, District Udaipur (Rajasthan). Also, 81 germplasm collections of different crops, maize landraces (68) [Malan (28) and Sathi (40)], Urd (04), Sorghum (08) and Horse gram (01) were raised in *kharif* 2011 under NAIP (Harmonizing Biodiversity) project. In all 4,596 germplasm accessions were grown for characterization, evaluation and multiplication. Twenty-one genetic stocks are identified in the five mandate crops of the station, suited for the arid and semi-arid climate like Jodhpur and its adjoining areas, most suited for 250-350 mm rainfall and also can resist 48 -50°C temperature. A total of 33,856 germplasm accessions were conserved in the MTS facility. A total of 751 germplasm accessions of different taxa are maintained in the field gene bank. Seed samples of 6,134 accessions were received from different sources and 386 germplasm accessions were supplied to various inventors. One germplasm field day was organized.

14.1 Exploration and Collection

14.1.1 Exploration (One) from Sitamata Forest Sanctuary, Rajasthan

Exploration and collection of landraces of major crops, minor fruits, M&AP and economic potential species from Sitamata forest sanctuary Pratapgarh, Chittaurgarh Districts of Rajasthan, (16.10.2011 to 24.10.2011). Plant materials were collected from Sita Mata Wildlife Sanctuary forest area, Pratapgarh and Chittaurgarh districts of Rajasthan (24 °10.123-24 °18.886 N, 074 °30.063 - 074 °30.063 E), India. The identity of these plants was confirmed by taxonomist at BSI, Jodhpur and the specimens (AKS/JD/SMS 01 to 90) are kept in the MTS, Jodhpur.

14.1.2 Collection of rare and endangered species: Thirty two accessions of rare and endangered species were collected from Sita Mata Wildlife Sanctury. These include *Ceropegia* spp. (Wild Potato), *Cedrus deodara* (Chitral), *Sterculea urens* (Kadaya-Gum), *Feronia limonia* (Rana), *Centella asiatica* (Brahmi), *Aegle marmelos* (Pawan Bel), *Dioscorea bulbifera* (Mula Kand), *Curcuma longa* (Adak Haldi), *Terminalia chebula* (Hard), *Zingiber officinale* (Jangli Adrak), *Colocasia esculenta* (Jangli Arvi), *Dioscora* spp.

Table 1: Germplasm collection of different crop/ plant species

Crop/ plant species	**Sita Mata Wildlife Sanctuary** Pratapgarh and Chittaurgarh districts of Rajasthan	**Number of collections**
Cereals	**Collection Sites:**	07
Minor millets	(24 °10.123 - 24 °18.886 N	01
Pulses	074 °30.063 - 074 °36. 63 E)	06
Oil seeds	16-24 October, 2011	07
Minor fruits	Site A : Rana Chowki	06
Fiber yielding	Site B : Jhakham Dam	01
Vegetables	Site C : Balmikhi Ashram	12
Medicinal and aromatic plants	Site D : Dhulia Khem	30
Economically potential tree plants	Site E : Sari Pipli	20
	Total	**90**

(Samber Bel), *Aciarjanthes aspera* (Lat Zera), *Pongamia pinnata* (Karanj), *Leucaena leucocephala* (Subabul), *Albegia procera* (Safed Serus), *Diospyros melonoxylon* (Tandu Patta), *Tectona grandis (*Sagwan), *Holarrhena antidysenterica* (Kala Kadva), *Bryonia laciniosa* (Jata Shankeri), *Abrus precatorius* (Chrmi), *Martynia annua* (Kan Bisia), *Manilkara hexandra* (Khirni), *Lannea coromandeica* (Karmela), *Hibiscus cannabinus* (Ambadi), *Zingiber officinale* (Gingia), *Moringa oleifera* (Sonjana), *Butea monosperma* (Dhak), *Balanites aegyptiaca* (Hingota), *Terminalia belerica* (Baheda), *Sapindus laurifasius* (Reetha) and *Grewia astatica* (Munjal).

14.2 Germplasm Characterization and Evaluation

14.2.1 *Rabi*: Wheat trial of 195 accessions including seven checks was sown in two sets, under normal and late sown conditions. Each material is sown in three rows of 3 m each. The material is to be characterized for terminal heat tolerance considering certain parameter. New collections (45) of maize germplasm were raised in replicates were harvested.

14.2.2 *Kharif*: A total of 4,596 accessions were sown in the field (Table 2). Out of which 2,645 accessions, namely, moth bean (112); bajra (312) guar (121), mung bean (100), bajra HQ (2000) were characterized; 1238 accessions, namely, mung bean (38), moth bean (500), guar (500), sesame (200) were multiplied. In addition, 386 accessions received from HQ, *viz*., cowpea (36), mung bean (350); promising accessions (25); were grown for multiplication/ evaluation/ rejuvenation.

14.2.3 Horticultural crops: Several economically important plants are revived and maintained in the field genebank. *Jatropha curcas* (81) (Germany); *Atriplex canascens* (03) (Maryaland, USA); *A.halimus* (03) (Maryaland, USA); *Acacia Senegal* (15) (Indigenous); *Zizyphus mauritiana* (01); *Bombax ceiba* (01).

- **Transplantation:** Saplings of pomegranate (11), phalsa (5) and mulberry (5) were transplanted in the field gene bank.
- **Cutting sowing:** Cuttings of *Capparis decidua* (10), *Cordia myxa* (7), mulberry (7) and phalsa (5 acc.) were sown in pots.
- **Data recording:** Data of sprouting and survival was recorded in *Capparis decidua* (10), *Cordia myxa* (7) mulberry (7) and phalsa (5). Monthly data on plant height, flowering and canopy was recorded in aonla, bael, ber, *Carissa carandus*, *C. edulis*, *C. grandiflora,* custard apple, date palm, guava, jamun, ker, lasora, lemon, mulberry, phalsa, pomegranate and tendus. Flowering and fruiting were recorded in *Carissa* spp. and *Capparis decidua* germplasm.

14.2.4 Economic plants:

- **Transplantation**: New germplasm of three species of *Atriplex* received from USA were raised in net house in field conditions. Harsringar seed were sown; only 50% seeds germinated. *Jangli piazza* and *Musali* were cultivated in pots.
- **Seed harvesting:** Fruits and seeds were harvested from *Abutilon indicum* (2), *Acacia nilotica* (2), *Argeria nervosa* (1), *Asparagus racemosus* (1), *Eclipta alba* (1), Grasses (13), Jojoba (66), *Moringa concanensis* (1), *M. oleifera* (1), *Tinospora cordifolia* (2), *Tylophora indica* (2), *Withania somnifera* (1), *Jatropa curcas, Sida* sp., wild *Zizyzipus* and *Cucumis profetrum.*
- **Data recording:** Seed germination and survival percentage was recorded for various accessions, *viz*., *Ceropagia bulbosa* (1), *Crotolaria* spp. (28) *Moringa oleifera* (6), *Tylophora indica* (1) and *Tinospora cordifolia* (2). Flowering and fruiting was recorded in *Ceropagia bulbosa* during July and September-October, 2011, respectively. Observations on plant height, canopy, flowering and fruiting were recorded in *Acacia senegal*, *Barleria acanthoides*, *Jatropha curcas*, *J. gossypifolia*, *Jojoba*, *Leptadenia reticulata* (2), *L. pyrotechnica* (1), *Moringa concanensis*, *M. oleifera* (15), *Prosopis cineraria*, *Putrangia roxburgii*, *Saraca asoca* and *Withania coagulens*.
- **Maintenance:** All economic plants in various blocks *Acacia* spp., *Aloe barbadensis*, *Agave* spp., *Asparagus racemosus, Barleria acanthoides, Bougainvellia* spp., *Cassia* spp., *Commiphora wightii, Datura alba*, *Euphorbia* spp., Grasses, *Jatropha* spp., Jojoba, *Leptadenia* spp., *Moringa* spp., *Marerua oblongifolia, Murraya koenigii, Nyctanthes arbor-tristis, Prosopis cineraria, Putrangiva roxburghii, Saraca asoca, Tinospora cordifolia, Tylophora indica, Vitex negundo, Withania coagulens* and *W. sonmifera* are being maintained in the field. *Argeria nervosa* (1), *Pergularia daemia* (1 acc.), *Tinospora cordifolia* (2) and *Tylophora indica* (2) being maintained in the shed

Table 2: Germplasm accessions of various crops grown during *kharif*

Crop	No. of accessions	Checks	Activity
Pearlmillet	2312	CZP-9802, Raj-171, Pusa 383, JBV-2	Characterization (312) Characterization (2000)
Cowpea	262	FTC-27, GC-3, V-585,V-240 Rejuvenation (184)	Characterization (42) Evaluation (36)
Guar	621	PLG- 85, RGC-197, RGC-1066	Characterization (121) Rejuvenation (500)
Mothbean	612	Jadiya, Jwala, Maru Moth, RMO-40	Characterization (112) Multiplication (500) (fodder types)
Mungbean	600	M1319B, Pusa Vishal, Pusa-105	Characterization (138) Rejuvenation (350) Student Cha. (112)
Sesame	200	T-25 and RT-46	Multiplication (200)
Promising material	25	Moth bean (03);Cowpea (05); Guar (06) and Sesame(11)	Evaluation (25)
Total	**4596**		

and on fence and trees. While *Caralluma edulis, Ceropagia bulbosa, Cissus quadriangularis,* different species of cactii and *Sarcastemma acidum* are being maintained in pots.

- **Effect of climate change:** Occurrence of numerous *Tribullus terestris* plants was found in the experimental field no. 1 during *kharif* season and flowering in *Tecomella undulata* and *Tinospora cordifolia* in early winter and germination of sesame seeds during winter season were noticed.

Table 3: Germplasm maintained in the field gene bank

Crop/ taxa group	Number	
	Crop/ taxa	Acc.
Fruits	26	263
Ornamentals	10	53
Oil yielding plants	6	212
Medicinal & Aromatic plants	38	147
Multipurpose trees	17	44
Fiber yielding plants	1	8
Forage grasses	5	14
Others	9	10
Total	**112**	**751**

14.3 Germplasm Conservation

14.3.1 Field Gene bank: In total, 751 accessions belonging to 112 crops/ taxa are being maintained in field gene bank (Table 3).

14.4 Germplasm Exchange

14.4.1 Germplasm received: A total of 6,134 germplasm accessions of wheat (181), pearlmillet (5,030), multi crops (151), horticultural crops (262), NAIP-HB (131) and economic plants (440) were received from different sources during the year 2011 (Table 4).

14.4.2 Germplasm supplied: During 2011, a total of 386 germplasm accessions including cereals (13), millets (01), legumes (230), oil seeds (133) and horticultural crops (94) were supplied to different indenters (Table 5).

Table 4: Germplasm received from different sources

Crop	Source (*crop species)	Accessions
Pearlmillet	CAZRI, Jodhpur	590
	ACPMIP, Mandore, Jodhpur (Three Boxes) Box 1 (7+8=15); Box 3 (37 DUS Testing Material); Box 4 (101 Advance Genetic Gain Material)	153
	Head, Germplasm Conservation Division, NBPGR, New Delhi	4247
Wheat	HQ New Delhi (181+7 Checks) for Trail Heat tolerance	181
	Pearlmillet (09)-Nigeria , *Seteria* sp. (22)-USA and *Eleusina* sp (09) HQ, NBPGR, New Delhi	40
NAIP(HB)	Dr. Pancha Ram (Udaipur collections)	131
Multi-crops	Dept. of Botany, JNV University, Jodhpur (**Rhynehoria aurea, Mimosa Himalayana, Crotolaria burhia* and *Tephrosia faleidformis*)	04
Soump	Progressive Farmer-Ishaq Ali, Sirohi ,Rajasthan	440
Musk melon	Dr. Arjun Lal HQ, New Delhi (**Cucumis melo* L.)	262
Multi-crops	Collections from Sita Mata wildlife Sanctuary (AKS)	70
Mungbean	Field evaluation (Gujarat Collections-AKS/BR)	16
	Total	**6134**

Research Programme (Code, Title, Programme Leader and Associate)

PGR/GEV-BUR-JOD-01.00: Augmentation, characterization, evaluation, maintenance, regeneration, conservation, documentation and distribution of genetic resources in arid and semi-arid regions (**NK Dwivedi,** AK Singh)

Research Projects (Code: Title, PI, Co-PI and Associate)

PGR/GEV-BUR-JOD-01.01: Augmentation, characterization, evaluation, maintenance, regeneration, conservation, documentation and distribution of genetic resources of cereals, pearl millet, minor millets and horticultural crops (**AK Singh,** NK Dwivedi)

PGR/GEV-BUR-JOD-01.02: Augmentation, characterization, evaluation, maintenance, regeneration, conservation, documentation and distribution of genetic resources of legumes and oilseeds (**AK Singh,** NK Dwivedi)

PGR/GEV-BUR-JOD-01.03: Augmentation, characterization, evaluation, maintenance, regeneration, conservation, documentation and distribution of genetic resources of fodder, fuel, medicinal and aromatic and other economic plants (**NK Dwivedi**, AK Singh).

Externally Funded Projects

Harmonizing Biodiversity Conservation and Agricultural Intensification through Integration of Plant, Animal and Fish Genetic Resources for Livelihood Security in Fragile Ecosystems- NAIP Comp. 3: SRLS (**NK Dwivedi**, Co-PI)

15. REGIONAL STATION, RANCHI

Summary: Three explorations were undertaken in the areas of Dumka, Jamtara, Pakur and Deoghar districts of Jharkhand during 2011 and 113 samples of different plant species were collected. A total of 411 accessions comprising kulthi (362), *Mucuna* (39) and *Cajanus cajan* (10) were multiplied and evaluated. A total of 669 accessions of mandate crops, namely, jack fruit tamarind, jamun, bael, barhal, aonla, mango, *Lawsonia indica*, moringa and several medicinal and aromatic plant species were maintained in the Field Genebank. Accessions of *Jatropha* spp. were maintained in National Jatropha Germplasm Garden. In all, 60 germplasm samples were sent for cryopreservation. These included *Costus speciosus*, *Guizotia abyssinica*, *Atylosia scarabaeoides*, *Sida acutifolia*, *Spilanthes paniculata*, *Abelmoschus moschata*, *Cardiospermum helicacabum*, *Celestrus paniculatus, Chlorophytum*, *Asparagus racemosus*, *Thespesis lampus*, *Sida rhombifolia*, *Cassia alata*, *Adenanthera pavonona*, *Achyranthes aspara*, *Abrus precatorius*, *Cassia absus*, *Averva lanata*, *Luffa cylindrica*, *Ludwigia perinnis, Ocimum gratissimum, Cucumis hardwikii, Clitoria ternatia, Abutilon indicum, Ocimum sanctum, Abelmoschus moschatus, Plectranthus incanus, Ocimum basilicum and Momordica charantia.*

15.1 Exploration and Collection

Three explorations were undertaken in the Jharkhand during 2011.

15.1.1 First exploration: was undertaken from 10 to 18 October, 2011 in the areas of Nala, Kundahit, Fatehpur, Jamtara, Narayanpur, Sarath, Mohanpur, Deoghar, Devipur blocks of Jamtara and Deoghar Districts and 42 accessions were collected. The details are as *Abrus precatorius* (1), *Acorus calamus* (3), *Alpinia galangal* (1), *Amorphophallus* sp.(1), *Andrographis paniculata* (4), *Aristolochia indica* (1), *Asparagus racemosus* (5), *Bacopa monierii* (1), *Boswelia serreta* (3), *Chlorophytum arundinaceum* (2), *Clerodendron serretum* (1), *Curcuma amada* (1), *Ipomeia* sp. (1), *Mallotus phillipinensis* (1), *Ocimum gratissimum* (1), *Semecarpus anacardium* (1), *Smilex* sp. (1), *Soymida fabrifuga* (1), *Sterculia* sp. (1), *Symplocos racemosa* (1), *Tinospora cordifolia* (2), *Typhonium trilobatum* (1), *Vitex pedencularis* (1), *Aromatic plant* (1), *Chidia kanda* (1), *Bhimraj tulsi* (1), *Chidia kanda* (1), *Bhui chaw* (1), *Ban padum* (1).

15.1.2 Second exploration: was undertaken from 21 to 29 October, 2011 and total 30 collections were made from the areas of Dumka, Shikaripada, Khatikund, Jamua, Gopi kindar, Jarmundi, Sariya and Ramgarh Blocks of Dumka District. The details of collections are as *Abelmoscus crinitus* (2), *Abelmoscus* sp. (3)., *Acorus calamus* (1), *Andrographis paniculata* (1), *Asparagus racemosus* (4), *Bambusa* sp. (1), *Barleria* sp. (1), *Chlorophytum arundinaceum* (1), *Curcuma angustifolia* (1), *Lassia hetrophyla* (1), *Ocimum* sp. (1), *Pandanus* sp. (1), *Pentapetes phoenisia* (1), *Rauvolfia serpentine* (1), *Tinospora cordifolia* (2), *Trichosanthes* sp. (1), *Typhonium* sp. (1), *Urginia indica* (3), *Zingiber cassumunar* (1), *Zingiber zerumbet* (1), *Sohra* (1).

15.1.3 Third exploration: was undertaken from 03 to 11 November, 2011 in the areas of Godda, Sunderpahari, Porya, Boarijor, Mehgama, Pakur, Maheshpur, Amdapada and Pakuria blocks of Godda and Pakur Districts. In all, 41 collections were made. The details of collections are as *Acacia catechu* (1), *Acorus calamus* (2), *Aloe vera, Andrograpais paniculata* (6), *Asparagus racemosus* (6), *Buetteneria herbacea* (1), *Chlorophytum aurandinaceum* (2), *Costus speciosus* (1), *Hedychium spicatum* (1), *Ocimum gratissmum* (2), *Pentapetes phoenisia* (1), *Psoralea corylifolia* (1), *Rauvolfia serpantina* (2), *Soymida fabrifuga, Symplocos racemosa* (2), *Tinospora cordifoium* (5), *Urginia indica* (1), Bhimraj (1), Mardraj (1), Raini (1), Tueipinach (1), Bhimraj (2).

15.2 Germplasm Evaluation

15.2.1 *Kulthi*: In all, 362 accessions of *Kulthi* germplasm were sown on 12 July, 2011 for evaluation in augmented design. Number of rows per accession was kept 3 with a row length of 2.5 m. The space between two accessions was kept 80 cm and space between two rows of same accession was kept 40 cm. Two checks Madhu and Birsa Kulthi-1 (BK1) were used in the experiment. The observations on 10 plants of each accession are to be recorded. The observation on primary branches per plants, days to 50% flowering, pods/ plant, pod length (cm), plant height (cm), no. of seeds/ pod, yield/ plant (g), 100-seed weight (g), growth habit, growth pattern, leaf colour, leaf surface, pod shape, pod surface and seed colour were recorded and presented in the table below:

Table 1: Evaluation of Kulthi Germplasm

Character	Min.		Max.		Average
No. of primary branches	2.0	(361649, 110666)	18.0	(139520)	8.52
Days to flowering	53.0	(120753, 341314, 385921, 361648)	110.0	(139528, 267942, 347182)	80.81
Pod/ plant	7.0	(361649)	146.0	(342125)	52.19
Pod length (cm)	2.7.0	(139555)	5.5	(139542)	4.50
Plant height (cm)	9.0	(336439)	138.0	(561024, 561025)	76.83
Seed/ pod	4.3	(203206)	6.1	(561048, 341293)	5.11
Yield/ plant (g)	6.33	(398701)	40.13	(22829)	16.66
100-seed weight (g)	2.17	(22826)	5.54	(347894)	2.57

15.2.2 *Mucuna*: A total of 39 accessions of *Mucuna* germplasm were sown on 05 July, 2011 for evaluation in RBD with two replications. Spacing between two accessions was kept one meter and spacing between two rows of same accession was kept 50 cm. A row length of 4 m was maintained. Number of rows in each accession was kept two. The observations are to be recorded on plant height, leaflet shape, odd leaflet length, odd leaflet width, days to flower initiation, inflorescence length, no. of inflorescence per plant, flower per inflorescence, flower colour, no. of pods/ cluster, no. of pod cluster/ plant, pod pubescence intensity, pod pubescence colour, pod shape, pod length, pod width.

Colour variation in flowers of *Mucuna*

***Mucuna* pod green with white pubscence**

***Mucuna* pods brown**

***Mucuna* pods with different colour patches**

Table 2: Evaluation of *Mucuna* Germplasm

Character	Min.		Max.		Average
Odd leaf length (cm)	6.53	(552853)	16.32	(385841)	10.71
Odd leaf width (cm)	4.83	(EC1842)	15.31	(396648)	9.95
Days to flower initiation	72.00	(395793)	133.00	(551514)	108.97
No. of inflorescence/ plant	12.00	(551510)	64.50	(424885)	32.18
No. of flower/ inflorescence	6.80	(471876)	19.42	(369144)	13.28
Inflorescence (raceme) length (cm)	2.35	(326953)	17.45	(265577)	7.74
Number of pods/ cluster	2.30	(369144)	7.67	(552860)	4.77
Total number of pod clusters/ plant	10.50	(552858, 424884)	50.00	(471876, 392241,424885)	27.26
Pod length (cm)	5.53	(552858)	13.74	(385841)	8.20
Pod width (cm)	1.28	(552856)	1.95	(392241)	1.56
No. of seeds/ pod	4.40	(392241)	5.70	(551521)	5.12
Days to complete pod maturity	178.00	(552807)	203.50	(551522)	194.02
Seed yield/ plant (g)	76.96	(385844)	1518.24	(326953)	479.95
100-seed weight (g)	2.51	(385844)	174.76	(391885)	67.66

15.2.3 *Cajanus cajan*: Eleven accessions of *Cajanus cajan* were sown on 04 July, 2011 in two replications. The number of rows per accession was kept 5 with a spacing of 50 cm x 10 cm. Row length was kept 7 m and spacing between accessions was kept at 1 m. Two checks: one national (NDA-1) and other local (Bahar) were used.

15.3 Germplasm Conservation

15.3.1 Field Genebank: Germplasm maintenance in field gene bank, *viz*., jackfruit (154), tamarind (51), jamun (46), bael (53), barhal (14), aonla (19) *Mangifera* (19) *Musa* sp. (34) *Lawsonia indica* (25) *Moringa oleifera* (14) Medicinal & Aromatic plants (240 species).

15.4.1 Cryobank: The following material was sent in cryobank for long-term conservation.

- *Costus speciosus* (8), *Guizotia abyssinica* (5), *Atylosia scarabaeoides* (1), *Sida acutifolia* (1), *Spilanthes paniculata*(1), *Abelmoschus moschata* (1), *Cardiospermum helicacabum* (1), *Celestrus paniculatus* (1) on 23 December, 2010 for Cryobank
- 12 samples of *Chlorophytum*, eight samples of *Asparagus racemosus*, one sample each of *Thespesis lampus*, *Sida rhombifolia*, *Cassia alata*, *Adenanthera pavonona*, and *Achyranthes aspara* for cryopreservation on 21 January, 2011.

Pod Colour Variation in *Bixa orellana*

Variability in flower colour in arhar

- Two samples of *Abrus precatorius,* two samples of *Cassia absus*, one sample each of Averva lanata, *Luffa cylindrica*, *Ludwigia perinnis*, *Ocimum gratissimum*, *Cucumis hardwikii*, *Clitoria ternatia, Abutilon indicum, Ocimum sanctum, Abelmoschus moschatus, Plectranthus incanus, Ocimum basilicum* and *Momordica charantia* were sent for Crybank on 2 March, 2011

15.4 Germplasm Supply

- *Abelmoschus crinitus* (2) and *A. cancellatus* (1) were given NRC on DNA Fingerprinting, for research purposes.
- 12 samples of *Alocasia macrorhiza*, seven samples of *Amorphophallus paeoniifoliius*, 19 samples of *Colocasia esculenta*, two samples of *Curcuma longa*, 16 samples of *Dioscorea alata*, 03 samples of *D. bulbifera*, 01 sample each of *Urginia indica*, *Xanthosoma sagittifolium* and *Zingiber officinale* to CTCRI, Thiruventhapuram, Kerala.
- *Jatropha tanjorensis*- cutting (5), *J. curcas*- cutting (5), seed (5), *J. gossipifolia*- cuttings (5), *J. gossipifolia eleganus*- cuttings (5), *Jatropha podagrica* cuttings- (5) were supplied to Deptt. of Botany, Vinoba Bhave Univ., Hazaribagh.

Research Programme (Code, Title, Programme Leader)

PGR/PGC-BUR-RAN-01.00 Augmentation, characterization, evaluation, maintenance, regeneration, conservation, documentation and distribution of genetic resources in Bihar, Jharkhand and adjoining areas (**JB Tomar**)

Research Project (Code: Title, PI, Co-PI and Associates)

PGR/PGC-BUR-RAN-01.01: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources of agriculture crops, their wild relatives and economic species including medicinal plants (**JB Tomar**, SK Bishnoi and AK Gupta)

PGR/PGC-BUR-RAN-01.02: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources of horticultural crops & perennial medicine (**JB Tomar**, SK Bishnoi and AK Gupta)

Externally Funded Projects

- Genetic Improvement of *Jatropha curcas* for adaptability and oil yield (NMITLI)
- Bio-survey, Inventorisation & Conservation of endangered, threatened and rare Medicinal and Aromatic Plants (MAPS) and Associated Indigenous Traditional Knowledge (ITK) in Tribal Region of Jharkhand. (Funded by DRDO) (**JB Tomar**)

16. REGIONAL STATION, SHILLONG

Summary: Three explorations were conducted in Manipur, Mizoram and Sikkim during 2011. A total of 41 aromatic rice (chakhao rice) germplasm were collected from Manipur. Collection of multi-crop germplasm comprising vegetables (14), rhizomatous crops (6), fruits (4), cereals (4) and 10 other crops were made from Mamit, Aizawl and Champhai districts of Mizoram. From the exploration trip in the East, West and South districts of Sikkim crop germplasm such as maize (46), rice (17), buckwheat (22), *Vigna* spp. (37) were collected. The station also collaborated in two other explorations to Arunachal Pradesh under NEH exploration plan. A total of 1082 accessions of different agri-horticultural crops comprising maize (151), upland paddy (273), lowland paddy (229), rice bean (155), *Coix* (54), *Perilla* (40), buckwheat (85) and chilli (95) were characterized for agro-morphological traits. Lowland paddy germplasm were evaluated for leaf blast incidence and considerable variation was observed for percent disease incidence (4.4-77.8%). In field gene bank, 610 accessions of various horticultural crops and M&APs were maintained. A total of 434 germplasm of lowland paddy (157), upland paddy (125), maize (95), *Perilla* (34) and *Coix* (25) were sent to NGB for long term conservation. Seventy three accessions of rice and M&APs were supplied to different indentors for research purpose.

16.1 Exploration

During the period under report three explorations were led by the station and two other explorations were undertaken in collaboration. These explorations were undertaken as a part of NEH exploration programme – 2011. Both crop/trait specific and multicrop explorations were conducted in Arunachal Pradesh, Manipur, Mizoram and Sikkim (table 1). The details of explorations led by the station are follows.

16.1.1. Collection of scented rices of Manipur: A total of 41 accessions (Imphal and part of Senapati: 8; Thoubal (7), Chandel (4), Churachandpur and Tamenglong (11), Bishnupur and Imphal East (5), Ukhrul (6) of scented rice have been collected during the exploration tour which fairly represent the variability available in Manipur in respect to aromatic rice. Out of eight districts, four districts (Imphal West, Imphal East, Thoubal, Bishnupur) fall under valley and other districts are hilly. The altitude of the explored region ranged from 749-1656 m above sea level. All the rice accessions fall under glutinous/sticky type of rice. The local people generally called these rices as Chakhao (Chakhao amubi/ angangbi, poireiton), Buhman (Churachandpur district) and Ethebuw in Chandel district. The variation has been observed in respect to husk colour (black/red/yellow), seed coat colour (black/white/red), presence of awn (awned/awnless), level of aroma (strong/ medium/ mild), crop duration (135 – 150 days), lodging susceptibility and growing environment (valley-hills). Two other types of mild scented rice, Phouen mubi and Langphou have also been collected. These two types are cultivated in small scale in valleys. The farmers in the plains (valleys) are growing high yielding improved varieties in large scale and these traditional scented rices are grown in small plots for home consumption to be used in ceremonies or special occasions. The explored sites and diversity in the collected aromatic rice germplasm is presented in Fig 1.

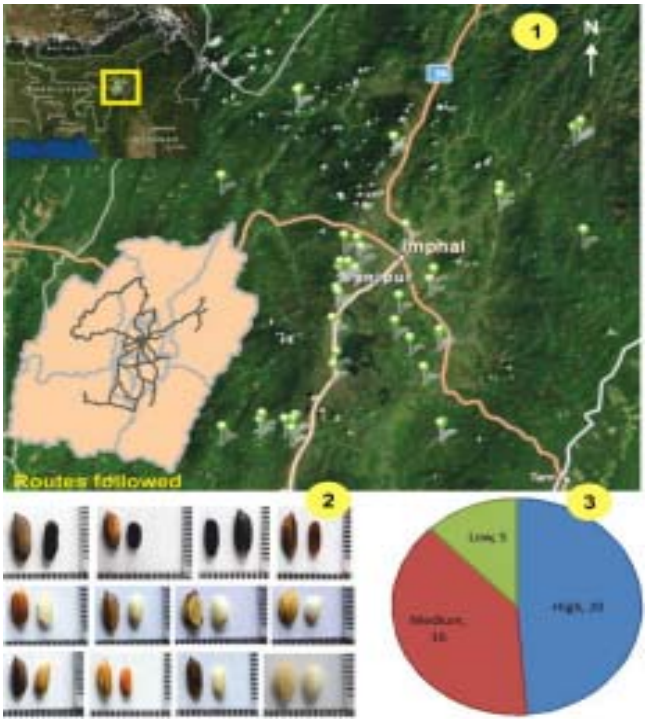


Figure 1: Collection of scented rices of Manipur. 1. Collection sites and routes followed; 2. Variability in grain characteristics of aromatic rices; 3. Variation in aroma level of collected rice germplasm

16.1.2 Multicrop (landraces of Indigenous crops) Germplasm collection from Mizoram: The explored region (Mamit, Aizawl and Champhai districts) has a very rich gene pool for Agri-horticutural crops. In general, crop growing area was confined to road side with river banks and bunds of farmer's fields. Among fruits star goose berry, *Citrus medica* (Atkora) , *C. sinensis*, *C. maxima*, banana and guava are common. In *jhum* cultivation, ginger and paddy are the main crops with

some vegetables. Chow-Chow is grown mainly in Aizwal. Considerable diversity is found in chilli and cherry chilly is a rare collection in this exploration. A total of 38 crop germplasm were collected during this exploration and notable among these were cherry chilli, Black coloured chilli, *Garcinia cowa*, *Parkia timoriana, Tinospora,* Rudraksh (having three lobes), etc. The explored sites and diversity in the collected aromatic rice germplasm is presented in Fig 2.

Figure 2: Variability collected from Mizoram. 1: Routes followed during exploration; 2. wild okra; 3: Ten-eyed colocasia; 4: *Parkia timoriana*; 5: variability in pumpkin

16.1.3 Exploration and collection of multicrop germplasm from parts of Sikkim: This exploration trip was planned for the collection of maize, rice buckwheat and *Vigna* spp. in East, West and South districts of Sikkim. This area is bordering to Bhutan & China in east, Bengal in South and Nepal and Tibet in West. The explored area falls under the mid to high altitude with an altitudinal range of 612m to above 2900m. A total of 122 germplasm accessions of maize, rice buckwheat and *Vigna spp*. etc. were collected.

A large extent of diversity observed in maize (*Zea mays*). Landraces of maize namely, *Payali Makai, Sewait Makai, Murli makai* were collected. Significant diversity was observed for seed colour (white, orange, dark red, yellow and creamy), seed size (small/ medium/ bold), and cob size (small, medium, big). Diversity in rice ranged from a coarse to a very fine grain, seed colour and some are scented also. Rice landraces such as *Bhangeri, Charaki, Chompay, Jamati, Kalo Dhan, Karki, Khimti, Krishna bhog, Mashina, Nunia* (black awaned and scented), *Phudungay, Tulsi, Tholo Attay* were collected. In buckwheat (*Fagopyrum esculentum* known as *meetha phafar* and *F. tataricum* as *teeta phafar*) were grown in this region for domestic consumption. In buckwheat variability was observed for seed shape (triangular/ conical/ sagitate), size (small/ medium/ big) and colour (brown/ black/ dull brown/ grayish-black). Farmers take two crops of buckwheat in during the year, first crop harvested in November-December and second in February- March. Rice bean (*Musum, Moto Musam, Local Dal*) which is the main pulse crop grown and consumed in the surveyed area, particularly in south and east Sikkim. Striking diversity was observed and collected for seed size (medium , bold and very bold), pod size (up to18cm), colour (brown/ brownish-cream / brownish-grey and mottled, chocolate-brown cream, dark brown, grayish, dark red / light yellow). There is not much variability observed in black gram (*Kalo Dal*), green gram (*Payali Dal*) and Adzukibean (*Rato Musam*) in this area. The Adzukibean which is locally called *Rato masum* earlier grown in the area which not common now-a-days. These pulses are generally grown as mixed crop with maize and rice but in Namachi area green gram and black gram grown as a sole crop during *kharif*. The explored sites and diversity in the collected aromatic rice germplasm is presented in Fig 3.

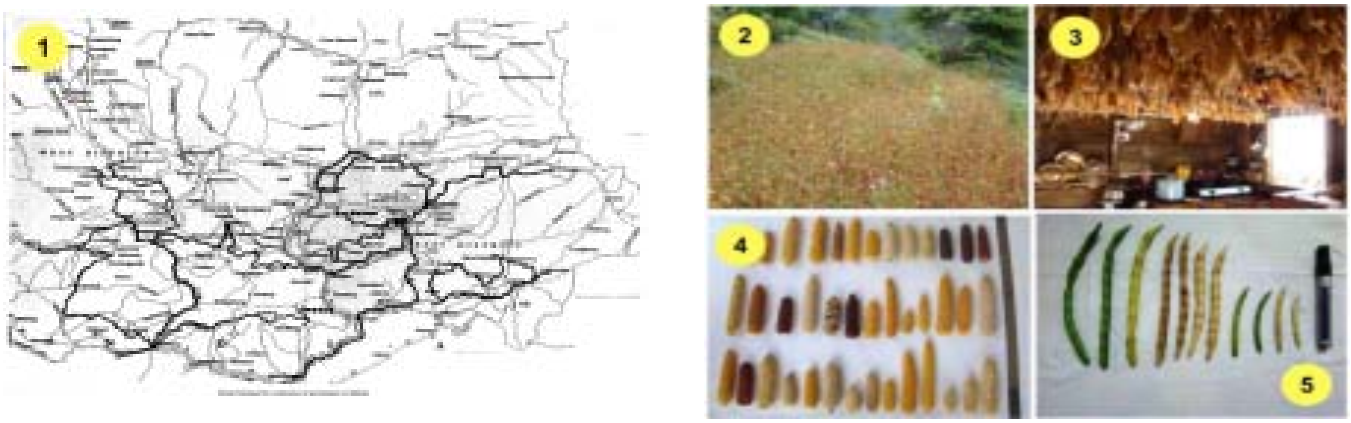


Figure 3: Exploration for collection of multicrop germplasm from Sikkim. 1: Route map; 2: Buckwheat field; 3: traditional method of maize storage; 4: variability in maize; 5: variability in pod characteristics of rice bean

Table1: Details of exploration and collection of germplasm

Explored Region	Crop Specific/ Traits Specific/ Multicrop	Total Collection	Crops Collected	Collaborator
Districts of Manipur	Scented rice	41	Scented ('chakhao')	ICAR RC for NEHR, Manipur rices of Manipu Centre, ImphalKVK, Churachandpur, Manipur
Mamit, Aizawl and Champhai districts of Mizoram	Multicrop	38	Vegetables (14), rhizomatous crops (6), fruits (4), cereals (4), others crops (10)	ICAR RC for NEHR, Sikkim Centre, Kolasib
East, West and South districts of Sikkim	Multicrop	122	Maize (46), rice (17), buck wheat [22: *Fagopyrum esculentum* (16) and *Fagopyrum tataricum* (6)], *Vigna* spp. [37: Rice bean (21), black gram (7), green gram (7), adzuki bean (1), cowpea (1)]	ICAR RC for NEHR, Sikkim Centre, Tadung

16.2 Characterization and Maintenance of Germplasm

The germplasm of different agri-horticultural crops collected from NEH region were grown in the experimental field for preliminary evaluation based on agro-morphological descriptors. After two-year characterization the germplasm were sent to National Gene Bank (NGB) for conservation. The germplasm of paddy, maize and chilli collected by ICAR RC for NEHR, Nagaland Centre were also evaluated to find out potential genotypes in terms of yield and yield-attributing traits. Brief results on the characterization of mandate crops are follows:

16.2.1. Paddy

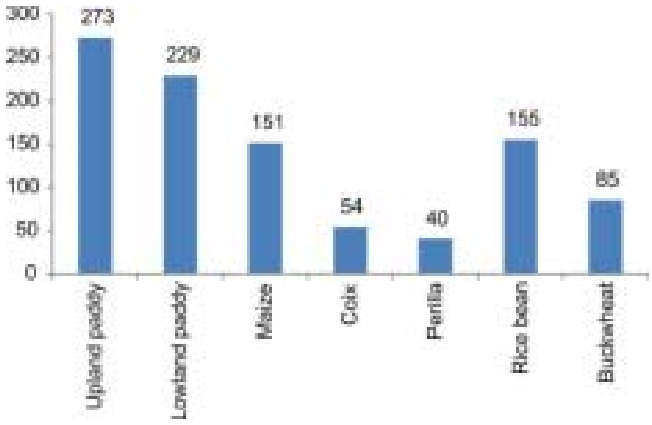
16.2.1.1. Upland paddy: A total of 273 accessions were characterized in augmented block design (ABD) with five checks viz. Local Manipuri, Prasad, Sarsha, Gnoba and Kala joha. Summary statistics for some of the quantitative traits are given in table 2.

16.2.1.2. Lowland paddy: A total of 229 lowland paddy germplasm were characterized for 43 agro-morphological traits during rain-fed season in augmented block design (ABD) using five local rice cultivars viz. Local Manipuri, Gnoba, Sarsa, Prasad and Kala joha. These rice germplasm were consisted of collected rices

Table 2: Mean, coefficient of variation and range of some quantitative traits in upland paddy germplasm

Traits	Mean	SD	CV%	Minimum	Maximum
Leaf length (cm)	64.7	12.0	18.5	30.0	94.0
Leaf width (cm)	1.8	0.3	17.5	1.0	2.8
Days to 50% flowering	110.8	14.7	13.3	72.0	152.0
Plant height (cm)	133.0	21.1	15.8	69.0	188.0
Panicle length (cm)	27.3	3.1	11.4	19.0	38.0
100-seed weight (g)	2.2	0.5	22.3	1.1	3.6
Days to maturity	139.4	13.6	9.8	124.0	192.0
Yield/ plant (g)	70.2	26.2	37.3	12.0	191.4

from Nagaland and Arunachal Pradesh. Considerable amount of variation was observed for most of the traits studied especially for panicle number, panicle weight, grains/panicle, grain L/B and grain yield/plant (Table 3). Categorization of 229 rice genotypes based on grain aroma level resulted in 117 non-aromatic, 22 medium aromatic and 30 highly aromatic rices. The rice germplasm of Nagaland (124 accessions) were evaluated for different traits (Fig 4) as well as for occurrence of leaf blast disease. The field screening for leaf blast disease reaction was performed and Potential Disease Incidence (PDI %) was worked out based on five independent visual scores against each accessions under both low land and upland ecosystem. PDI% ranged from 4.4 to 77.8 and rice cultivars were marked as resistant, moderately resistant, moderately susceptible and susceptible to leaf blast disease.



16.2.2 Maize: A total of 151 maize accessions were characterized for a number of qualitative and quantitative traits along with six checks such as RCM-1-1, Navjot, Local red, Local yellow, local white and Delhi check. Germplasm were evaluated in ABD. Summary statistics for some of the quantitative traits are presented in table 4.

A maize line (MCM-11/01) with multiple cobs (3-5) was selected from trial plot of an indigenous collection (IC524594) in 2009. The parent accession was collected from Zubja village (latitude 25°42.6"N, longitude 94°02.4"E, altitude 983 m), Kohima (Nagaland). Selected plants were grown in isolation for two consecutive years (2010 and 2011) at NBPGR Regional Station, Umiam. Data were recorded on a number of agro-morphological traits. It recorded a higher (3.4) number of ears/plant, as all checks had single ear/ plant. This is a unique trait as it has not been observed in the existing germplasm of NEH region. Though the selection had higher number of ears/plant, but the grain yield/plant was not significantly higher than the checks, mainly due to its small grain size. Besides higher number of ears (cobs), MCM-11/01 had dark brown coloured husk and cream coloured kernel.

16.2.3. *Coix:* A total of 54 coix accessions and four checks viz. IC089382, Pollin, IC524631 and Mayeun were evaluated in ABD. The mean values and range of some quantitative traits are given in table 5.

16.2.4 Perilla: The mean values and range of variation in 40 Perilla accessions for some quantitative agro-morphological traits are presented in table 6. Germplasm were evaluated along with four checks (Shillong local, Jayantia local, IC521292 and IC526643) in ABD.

16.2.5 Rice bean: A total of 144 rice bean germplasm were evaluated in ABD along with four checks (RBL6, RBL-1, PRR1 and PRR4) and the summary statistics are given in table 7.

16.2.6 Buckwheat: Summary statistics (table 8)for 85 buckwheat germplasm characterized in ABD along with six checks viz.Akabra, Kuppa, Sabrosh, Phesru, Reshuwat and Kulugang.

Table 3: Mean, coefficient of variation and range of quantitative traits in lowland rice germplasm

Traits	Mean	SD	CV%	Minimum	Maximum
Days to 50% flowering	113.90	13.37	11.74	85.00	174.00
Days to 85% maturity	151.93	13.61	8.96	127.00	189.00
Plant height (cm)	119.78	16.73	13.97	72.00	167.00
tiller number	10.37	4.30	41.51	3.33	26.33
Panicle number	9.71	4.21	43.37	3.33	24.67
Panicle length (cm)	26.01	2.93	11.26	17.87	35.00
Panicle weight (g)	4.21	1.36	32.29	1.30	8.25
Grains/panicle	184.95	51.29	27.73	61.50	341.00
Grain length (mm)	7.77	1.06	13.59	4.70	10.85
Grain breadth (mm)	3.22	0.46	14.21	2.10	4.30
Grain L/B	2.46	0.50	20.50	1.59	4.52
Brown rice length (mm)	5.78	0.79	13.72	3.60	7.89
Brown rice breadth (mm)	2.72	0.35	12.89	2.02	3.51
Brown rice L/B	2.16	0.41	19.11	1.32	3.49
1000-grain weight (g)	24.76	5.97	24.12	11.20	41.30
Grain yield/plant (g)	29.14	9.40	32.26	11.08	55.12
Harvest index	0.28	0.05	16.60	0.14	0.50

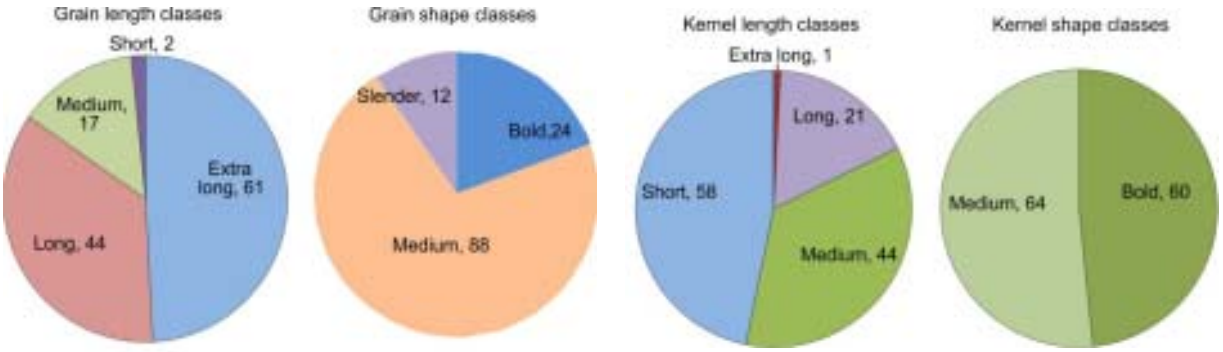


Figure 4: Classification of 124 rice germplasm of Nagaland based on grain and kernel length and shape classes

Table 4: Mean, coefficient of variation and range of quantitative traits in maize germplasm

Traits	Mean	SD	CV%	Minimum	Maximum
Days to tasseling	72.6	10.6	14.6	61.0	108.0
Days to silking	77.0	11.5	14.9	52.0	115.0
Days to maturity	123.0	13.1	10.7	80.0	180.0
Plant height (cm)	298.6	56.0	18.7	138.8	424.0
Ear/plant	1.2	0.4	32.7	1.0	3.0
Ear width (cm)	4.4	0.7	15.8	2.3	6.7
Ear height (cm)	172.5	36.5	21.2	76.0	271.0
Rows/cob	13.2	2.2	16.4	8.0	19.8
Kernels/row	24.3	7.1	29.4	7.0	65.2
Grain yield/plant (g)	82.6	30.6	37.1	15.0	220.0

Table 5: Mean and range of variation in quantitative traits of *Coix* germplasm

Traits	Mean	SD	CV%	Minimum	Maximum
Days to 50% flowering	104.2	4.1	4.0	93.0	111.0
Plant height (cm)	364.7	30.5	8.3	300.0	426.7
Leaf length(cm)	78.8	7.2	9.1	52.7	91.0
Leaf width (cm)	5.4	0.4	8.0	4.6	6.3
No. of tillers/hill	1.8	0.8	42.4	1.0	4.3
No. of nodes/tiller	14.8	1.4	9.5	12.0	18.7
Days to 80% maturity	160.1	5.3	3.3	150.0	168.0
Yield/plant (g)	94.6	34.4	36.4	32.9	188.4
100-seed weight (g)	9.6	1.3	13.1	6.5	13.0

Table 6: Mean, coefficient of variation and range of some quantitative traits in *Perilla*

Traits	Mean	SD	CV%	Minimum	Maximum
Days to 50% Flowering	136.9	9.1	6.6	112	161
Leaf length (cm)	11.9	0.9	8.2	8.8	13.8
Leaf width (cm)	9.6	0.9	8.7	8	11.4
No. of primary branches	13.2	2.2	16.9	7.8	17
Inflorescence length (cm)	10.4	1.7	16.3	7	13.8
Petiole length (cm)	5.7	0.7	11.7	4.4	8
No. of Inflorescence/plant	97.1	20.2	20.8	51.4	139
Plant height (cm)	157.6	18.0	11.4	114.8	203.6
Days to 80% maturity	185.7	9.7	5.2	166	205
100-seed weight (g)	1.60	0.4	22.9	1.1	2.8
Yield/plant (g)	16.5	6.2	37.4	3.76	29.02

Table 7: Mean, coefficient of variation and range of quantitative traits of rice bean accessions

Traits	Mean	SD	CV%	Minimum	Maximum
Days to 50% flowering	64.0	6.8	10.6	50.0	81.0
Plant height (cm)	85.9	24.2	28.2	39.0	148.0
Stem thickness (cm)	0.7	0.3	38.2	0.3	2.2
Pod length (cm)	9.1	0.9	10.4	7.4	13.4
No. of seed/pod	8.2	0.7	9.1	6.2	10.6
100-seed weight (g)	8.1	3.4	41.9	3.7	33.1
No. of pod/cluster	3.8	0.6	17.0	2.6	7.0
No. of pod/plant	44.9	15.3	34.1	8.0	99.8
Days to 80% maturity	117.5	10.7	9.1	98.0	143.0
Seed yield/plant (g)	246.7	127.6	51.7	20.0	700.0

Table 8: Mean, coefficient of variation and range of quantitative traits in buckwheat accessions

Traits	Mean	SD	CV%	Minimum	Maximum
Days to 50% flowering	30.2	4.9	16.2	24.0	48.0
Leaf width (cm)	5.0	0.6	12.6	3.0	6.6
Leaf length (cm)	5.8	0.8	14.6	3.5	8.1
No of primary branches	3.4	0.7	21.3	2.0	5.3

Days to maturity	69.6	4.8	7.0	60.0	78.0
100-seed weight (g)	2.6	0.5	17.3	1.3	3.5
Yield/plant (g)	41.3	13.1	31.7	12.4	68.4

16.2.7 AICRP trials: Following AICRP trials were conducted during 2011:

Crop	Trial
Perilla	25 perilla accessions were evaluated in randomized block design (RBD) with 2 checks (Shillong local and Jayantia local) as per the programme.
Coix	25 coix accessions along with two checks (Mayeun and Pollin) were evaluated in RBD as per programme.
Rice bean	11 rice bean and four checks (RBL6, RBL-1, PRR1 and PRR4) were evaluated in RBD as per programme.

16.2.8 Chilli: A total of 95 chilli accessions comprising 86 king chilli (*Capsicum chinense*), 09 bird-eye chilli (*C. frutescens*) germplasm were regenerated.

16.3 Regeneration and Maintenance of Horticultural Germplasm in FGB

The germplasm of rhizomatous crops, such as ginger (152), turmeric (186), taro (20) and yam (46), and fruit crops viz. banana (60), citrus (29), guava (8), other fruits (9) and M&APs (100) have been multiplied/ maintained in the FGB.

16.4 Germplasm Supply

Following germplasm were supplied to the indentors under MTA.

- *Alpinia zerumbet* (01), *Kaempferia galanga* (01) Center of Advanced Study, Department of Botany, Kolkata.
- *Alpinia officianarum* (01) to AMPRS, Kerala Agricultural University, Ernakulum, Kerala.
- *Oryza sativa* (30), CPGS, CAU, Umiam, Shillong.
- *Oryza sativa* (40), NEHU, Department of Botany, School of Life Sciences, Shillong.

16.5 Germplasm Conservation

A total of 434 germplasm of lowland paddy (157), upland paddy (125), maize (95), *Perilla* (34) and *Coix* (25) were sent to NGB for long term conservation.

Research Programme (Programme Code: Title, Leader)

PGR/PGC-SHL-01.00: Augmentation, characterization, evaluation, maintenance, regeneration, conservation, documentation and distribution of plant genetic resources in north-eastern India. (SK Verma (till December 13), **AK Misra** (w,e,f December 13)

Research Projects (Code, Title, PI, CoPIs and Associates)

PGR/BUR-SHL-01.01: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources of agricultural field crops (paddy- low land/upland, Maize and mustard) and their wild relatives. (**AK Misra** (w,e,f December 13), SK Verma (till December 13), RS Rathi and S Roy)

PGR/BUR-SHL-01.02: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources of horticultural crops (chilli, ginger, turmeric, yams, taros, *Citrus*, banana and passion fruit) and their wild relatives. (SK Verma (till December 13), **AK Misra** (w,e,f December 13), RS Rathi and S Roy).

PGR/BUR-SHL-01.03: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources of UU & UEP crops (rice bean, *Coix*, perilla and buck wheat) and their wild relatives. (**RS Rathi**, SK Verma (till December 13), AK Misra and S Roy).

17. REGIONAL STATION, SHIMLA

Summary: Three explorations were conducted and diversity collected representing maize (51), kidney bean (27), rice (14), wheat (17), buckwheat (25), barley (11), mustard (15), amaranth (32) and others (26). Significant collections include landraces of red rice, traditional maize, kidney bean and grain amaranth. A total of 2,013 germplasm accessions were grown for characterization, evaluation and multiplication. Genetic variability for seed and pod colour, shape and size was recorded in pea germplasm and also for other traits in different crops. Sixty-four accessions of field pea were screened against 4 isolates, *viz*., *Rangway*, *Trilokinath*, *Stingri*, *Kangra* of powdery mildew (*Erysiphe pisi*). Among fruits, 202 accessions of apple (41), pear (24), plum (41), apricot (22), peach (33), and walnut (41) were characterized and evaluated. Wide range of variability was recorded for traits like fruit colour, shape and size. In peach EC038736, EC312408, EC552643, EC552644 and EC387511were found superior for multiple traits while 'Silver King' of nectarine was found promising for fruit size and colour. A total of 330 accessions were supplied for LTS (Long-Term Storage) while 10,377 accessions of seed crops and 1,185 of perennial crops were conserved in the MTS and FGB, respectively. Germplasm comprising 2,215 seed samples of agricultural crops and 815 rooted plants and 967 bud sticks of fruit crops were supplied to researchers across the country.

17.1 Germplasm Collection

Three explorations were conducted and diversity collected represent maize (51), kidney bean (27), rice (14), wheat (17), buckwheat (25), barley (11), mustard (15), amaranth (32) and others (26). Significant collections include landraces of red rice, traditional maize, kidney bean and grain amaranth. Genetic variability was observed for cob size, shape, seed colour, seed size in maize while it was less in case of red rice and rajmash due to wide spread cultivation of only three landraces of red rice and red small capsule type rajmash. During surveys, it was observed that traditional varieties of maize are getting eroded due to hybrid varieties being pumped into cultivation by the state functionaries. Nevertheless, the area under red rice and rajmash has become stable because farmers are getting better price for these rare and popular genetic resources of Western Himalaya.

Genetic variability for cob size and shape, seed colour, seed type and seed size in maize

17.2 Germplasm Characterization and Evaluation

17.2.1 Agricultural crops: A total of 2,013 germplasm accessions were grown during the year for characterization, evaluation and multiplication (Table 1). The germplasm was characterized in augmented block design and also in randomized blocked design along with standard checks.

The data were recorded as per the standard descriptors and analyzed for mean and range and promising accessions identified for important traits (Table 2).

The most prevalent landraces of red rice collected from Chamba district of Himachal Pradesh

Genetic variability for seed and pod colour, shape and size was recorded in pea germplasm. Germplasm accessions, *viz*., EC598556, EC598558, EC5985711, EC598573 and EC598731 showed superiority for multiple traits like for pod length, pods/plant, seeds/pod, seed weight. Besides, 64 accessions of field pea were screened against four isolates, *viz*., *Rangway*,

Table 1: Crop-wise details of the germplasm grown

Crop	Accessions	Check
Kidney bean	468	Triloki, Vaspa, Jawala, PLB-10-1, Kentucky-wonder, PLB-14-1, Kailash
Adzuki bean	44	HPU-51, Totru local
Amaranth	461	Annapurna, PRA-2, PRA-3, Durga
Buckwheat	56	Himgiri, Himpriya, VL-7, Sangla B1
Chenopod	55	PRC-9801, EC507741, IC22503
Rice bean	101	PRR-1, PRR-2, RBL-1, RBL-6
Cowpea	103	Cowpea No.1, Cowpea No.2
Pea	222	DMR-7, DMR-11, Azad pea, Super Lincoln, Rachna, HFP-4
Finger millet	78	Multiplication
Foxtail millet	100	Multiplication
Proso-millet	41	Multiplication
Urd bean	30	Multiplication
Soybean	152	Multiplication
Kulthi	102	Multiplication

Variability in pod length, colour and shape in pea

IC26973 of rice bean identified for high number of pods / plant

Trilokinath, *Stingri*, *Kangra* of powdery mildews (*Erysiphe pisi*) prevalent in Western Himalaya under laboratory conditions. Accessions IC208366, IC208378, IC218988, IC267142, IC278261, IC381866 and EC598814 showed resistance against all the four isolates. In rice bean, IC26973, IC18465 and IC18183 were found promising for number of pods and seed yield/plant.

17.2.2 Fruit crops: A total of 202 accessions of various temperate fruit crops, *viz*., apple (41), pear (24), plum (41), apricot (22), peach (33), walnut (41) were characterized and evaluated for various qualitative and quantitative characters as per descriptor and promising accessions were identified (Table 3). Wide range of variability was recorded for traits like fruit colour, shape and size. In peach EC038736, EC312408, EC552643, EC552644 and EC387511were found superior for multiple traits while 'Silver King' of nectarine was found promising for fruit size and colour. In plum, IC558082, IC552682, IC552685 and EC034050 were found superior for multiple traits while IC552693 matured late in the 3rd week of August. These varieties can ensure the

Table 2: Promising accessions identified for various important agronomic traits

Character	Range	Mean	Promising accessions
Amaranth			
Plant height (cm)	101.30-351.25	226.27	IC42273-2, IC42281-11, IC38665, IC38618
Inflorescence length (cm)	35.42-111.60	73.50	EC32889-1, EC239363, EC239381, IC42279
Days to maturity	129.00-177.00	153.00	EC151543, EC151544, EC146547,EC146539

1000-seed weight (g)	0.50-0.95	0.72	EC12336, EC28940, EC35940, IC42315, IC42277
Grain yield/plant (g)	8.30-183.71	96.42	IC42271, IC42008, IC42001, IC42268, IC42665
Buckwheat			
Plant height (cm)	65.75-259.00	162.37	IC109716, IC18045, IC17371, IC109717, IC258239
No. of cyme/plant	7.50-32.55	20.02	IC18045, IC109718, IC109722, IC243186, IC17371
Days to maturity	72.00-132.00	102.50	IC329193, IC329495, IC313129, IC329107
1000-seed weight (g)	12.30-29.10	20.70	IC258241, IC274437, IC329190, IC274432
Seed yield/plant (g)	3.68-23.50	13.59	IC42426, IC274425, IC310047, IC310044, IC17371
Adzuki bean			
Plant height (cm)	42.0-94.85	68.82	IC485396, SMLAB-8, IC485388, IC485382
No. of cluster/plant	6.20-16.5	11.25	IC108856, IC16771, IC341937, IC00294, IC341940
No. of pods/cluster	1.55-4.50	3.50	IC341958, HPAB-51, IC485382, IC469174
No. of pods/plant	14.50-44.55	29.52	IC108856, IC341940, IC341937, IC00293, IC16761
Days to maturity	101.00-115.00	108.00	IC341940, IC16765, IC108855, IC108856
100-seed weight (g)	5.28-18.00	11.64	IC485382, IC341949, IC485385, SMLAB-8
Rice bean			
No. of branches/plant	3.50-5.50	4.25	EC14075, EC00262, EC16136, EC18222, EC18260
Pod length (cm)	9.70-14.20	11.95	EC114123, EC340284, EC48452, EC18771
Days to maturity	144.00-172.00	158.00	EC00262, EC15565, EC48452, EC87898, EC98453
No of seeds/pod	6.50-10.00	8.25	EC12436, EC14075, EC18184, EC18565, EC98452
100-seed weight (g)	5.08-8.96	6.58	IC19338, IC16342, IC15640, IC19781-2, IC18563
Seed yield/plant (g)	42.09-67.27	54.68	IC26973, EC98452, IC002074, IC18183, IC18465
Kidney bean			
Pod length (cm)	6.60-17.20	11.90	JCR1920, JCR1895, JCR1900, JCR1894, JCR1898
No. of seeds/pod	4.00-6.00	5.00	JCR1937, JCR1942, JCR1943, JCR1916, JCR1914
No. of pod/plant	5.50-28.0	16.75	JCR1915, SKY11, SKY74, JCR1893, JCR1895
Days to maturity	102.00-148.00	125.00	JCR1929, JCR1900, JCR1896, JCR1932, JCR1933
Pea			
Pod length (cm)	3.50-15.30	9.40	EC598646, EC598864, IC552772, EC598733
No. of pods/plant	6.00-70.00	38.00	EC598879, IC107452, EC598876, EC598883
No. of seeds/pod	3.00-7.00	5.25	EC598879, EC598853, EC598854, EC598858
100-seed weight (g)	2.29-34.96	18.62	EC598582, EC598643, EC598646, EC598811
Days to maturity	116.00-216.00	166.00	EC598608, EC598665, EC598666, EC598738
Seed yield/plant (g)	8.02-98.68	53.35	EC598770, EC598740, EC598838, IC107452
Cowpea			
Days to flowering	69.00-95.00	82.00	IC108744, IC107472, IC108437, IC328954
No of cluster/plant	2.00-10.50	6.25	IC556473, IC556475, IC106829, IC107470
Pod length (cm)	10.10-35.80	22.95	IC313296, IC328989, IC556467, IC556472
No of pods/plant	3.14-19.50	11.30	IC556475, IC328954, IC106822, C328967
Days to maturity	147.00-162.00	154.50	IC108746, IC108758, IC107472, IC106019
No of seeds/pod	7.00-18.00	12.50	IC106838, IC326602, IC321138, IC328967
100-seed weight (g)	6.44-19.54	12.99	IC108756, IC280012, IC107472, IC108437
Seed yield/plant (g)	2.90-23.10	13.00	IC107472, IC106822, IC108843, IC108437

availability of Plum till late August. In apricot, EC140315, EC140316, EC539003, EC558083 and IC584511 were showed superiority over check varieties. In walnut, IC20112, IC020115 were found promising for high kernel weight and nut-kernel ratio.

IC552693 of plum

Nectrin Silver King

EC539003 of apricot

Table 3: Characterization of temperate fruit crops for various economic characters

Crop	Character	Promising Accession
Apple		
	Early maturity (<90 days)	EC451318, EC492551, EC453642, EC552612, EC038735, EC036439
	Fruit weight (>125 g)	EC552613, EC538522, EC115746, EC162910, EC114117, EC034041,
	High TSS (>15%)	IC557999, EC153984, EC115669
	High productivity	EC492551, EC552613, EC552616, IC349911, EC115746
Pear		
	Early maturity (<125days)	EC552675, EC057511, EC432619, EC552669, EC552671, IC415344
	Fruit weight (>200 g)	EC212619, EC552671, EC552673, IC415449, IC558066
	High TSS (>13%)	EC513666, EC552669, EC552673, IC415449
	High productivity	EC552674, EC552676, EC027810, EC126286
Peach		
	Early maturity (<90days)	EC488324, EC552639, EC552644, EC552645, EC313953, EC280769
	Large fruit (>75 g)	EC038737, IC538537, EC552641, EC331812, EC280769
	TSS (>15%)	EC488324, EC552645, IC447934, IC548059, EC331812
	High productivity	EC552642, IC566147, EC552639, EC038736, EC038737, IC349928
Plum		
	Early maturity (<85 days)	IC558067, IC558069, IC558082, IC533626, EC393740, EC382626
	High fruit weight (>60 g)	IC558067, IC558068, EC393741, EC552670, EC349972, EC393741
	TSS (>15%)	EC552684, EC552692, EC552689, IC558003, IC558084, IC349972
	High productivity	EC539001, IC552693, IC552682, IC558082, EC393741, EC034050
Apricot		
	Early maturity (<75 days)	EC174901, IC349933, IC584510, IC584511
	Fruit weight (>50 g)	EC539003, EC552702
	High TSS (>18%)	IC349933, IC584511, IC584510
	High productivity	EC539003, EC140315, EC140316, IC220447, IC558083, IC584511
Walnut		
	Early maturity (>110 days)	EC024507, EC024562, EC031071, EC035719, EC036748
	High nut weight (>15 g)	IC019369, IC019371, IC019379, IC020070, IC020075, IC258417

Kernel weight (>5 g)	IC019369, IC019379, IC020067, IC020112, IC258417
Kernel ratio (>50)	IC020112, IC020115, IC258417
Soft shelled	EC024562, EC026891, EC038836, IC020065 EC038837, IC019369
High productivity	EC024507, EC024562, EC026891, EC036452, IC020075, IC538531

17.3 Germplasm Conservation

A total of 330 accessions comprised of pea (257), barnyard millet (20), prosomillet (19) and finger millet (34) were supplied to National Gene Bank for LTS while 10,377 accessions of seed crops and 1,185 of perennial crops (Table 4) were conserved in the MTS and FGB, respectively.

Table 4: Germplasm accessions being maintained in the MTS and FGB

a. Medium Term Storage

Crop	Accession	Crop	Accession	Crop	Accession	Crop	Accession
Amaranth	3086	Adzuki bean	155	Finger millet	410	Proso millet	160
Buckwheat	890	Cowpea	174	Foxtail millet	278	Horse gram	130
Chenopod	166	Pea	688	Barnyard millet	71	Cuphea	16
French bean	3784	Rice bean	327	Meetha karela	42		
Total							**10377**

b. Field Gene bank

Crop	Accession	Crop	Accession	Crop	Accession	Crop	Accession
Apple	259	*Pistacia*	3	*Viburnum*	3	Grape	14
Peach	52	Chinese ber	3	*Rubus* spp.	20	*Mespilus* spp.	4
Pear	97	Hops	6	*Ribes*	6	Mulberry	4
Plum	58	*Citrus*	4	Quince	10	Rose	39
Apricot	42	Pine-apple guava	2	Passion fruit	3	Pomegranate	106
Cherry	18	Fig	10	Crataeagus	3	M&AP	52
Walnut	165	Strawberry	4	Chestnut	2	Ornamentals	51
Hazelnut	20	Olive	6	Chestnut	2	Persimmon	12
Pecan nut	50	Almond	16	Kiwifruit	8	Others	33
Total							**1,185**

c. Conservation of crops wild relatives (CWR): Wild relatives of various agri-horticultural crops species have been maintained both in the MTS facility for seed crops and in the FGB for perennial and vegetative propagated crops.

Crop	Wild relatives
Amaranth	*Amaranthus hybridus, A. retroflexus, A. lividus, A. viridis, A. graecizans, A. dubius, A. spinosus, A. tricolor*
Buckwheat	*Fagopyrum emarginatum, F. cymosum, F. tataricum* var. *Himalaicum, F. giganteum*
Chenopod	*Chenopodium amaranticolor, C. botrys, C. mural, C. ambrosioides*
French bean	*Phaseolus lunatus, P. coccineus*
Faba bean	*Vicia hirsuta, V. tetrasperma, V. villosa*
Apple	*Malus baccata, M. spectabilis, M. micromalus, M. zumi, M. sargentii, M. sikkimensis, M. mandshurica, Malus* x *scheideckeri, M. sieversii, M. orientalis , M. drangensis, M. prunifolia*
Pear	*Pyrus pyrifolia, P. pashia* var. *kumaoni, P. jacquemontiana, P. pashia*
Prunus spp.	*Prunus nepaulensis, P. armeniaca, P. cerasoides, P. mira, P. mume, P.* x *pseudocerasus, P. cerasus, P. cornuta*

Walnut	*Juglans nigra, J. mandshurica, J. ailantifolia, J. cordiformis*
Kiwifruit	*Actinidia arguta, A. callosa*
Grapes	*Vitis ficifolia, V. arizonica, V. riparia, V. barlandierii, V. acerifolia, V. gerdiana, V. aestivalis, V. amurensis, V. cinerea, Parthenocissus quinquefolia, P. himalayana*
Pistachio nut	*Pista atlantica, P. terebinthus, P. chinensis* ssp. *integerrima*
Olive	*Olea grandulifera*
Rubus spp.	*Rubus ellipticus, R. niveus, R. paniculatus, R. lasiocarpus, R. fruticosus, R. macilentus, R. mollucanus, R. assamensis, R. nutans, R. calycinus*
Minor fruits	*Punica granatum, Cotoneaster. bacillaris, C. salicifolia, C. zabelli, C. franchettii, Crataegus wendlandii, C. melanocarpa, C. oxycantha, Feijoa sellowiana, Cydonia oblonga, Docynia indica, Viburnum cotinifolium, Elaeagnus umbellata, Castanea crenata, Olea cuspidata, Ziziphus jujuba, Diospyros lotus, Ficus palmata, F. carica, Corylus jacquemontii*
Allium spp.	*Allium fistulosum, A. carolinianum, A. tuberosum, A. schoenoprasum, A. auriculatum, A. griffithianum, A. consanguneum, A. sativa* var. *ophioscordon, A. ampeloprasum*

17.4 Germplasm Supply

Germplasm comprising 2,215 seed samples of agricultural crops and 815 rooted plants and 967 bud sticks of fruit crops were supplied to researchers across the country.

- **Seed crops**: Pea (30), maize (49), paddy (109), amaranth (991), buckwheat (168), finger millet (65), adzuki bean (117), rice bean (90), chenopod (83), barley (17), wheat (37), kidney bean (360), cowpea (20), barnyard millet (20), prosomillet (25) and foxtail millet (34).
- **Rooted plants:** Apple (26), kiwifruit (60), peach (24), pear (98), pepino (57), persimmon (82), apricot (05), *Stevia* (45), pecan nut (06), *Rubus* (25), pineapple-guava (302), almond (04), Rose (10) Chinese ber (14), hazelnut (08), fig (16), walnut (20) and quince (13).
- **Bud sticks:** Apple (50), peach (30), plum (22), pear (85), apricot (35), pecan nut (92), kiwifruit (75), persimmon (164), quince (16), walnut (269), wild peach (40), wild apricot (60), pomegranate (05) and others (24).

Research Projects (Project Code, Title, PI and Co-PI)

PGR/GEV/BUR/SHM-01.01: Augmentation, characterization, evaluation, maintenance, regeneration, conservation, documentation, and distribution of genetic resources of pseudo cereals, pulses, and other lesser known hill crops (**JC Rana a**nd VD Verma)

PGR/GEV/BUR/SHM-01.02: Augmentation, characterization, evaluation, maintenance, regeneration, conservation, documentation, and distribution of genetic resources of temperate fruits, vegetables and medicinal and aromatic plants. (**VD Verma,** JC Rana and Sandhya Gupta)

Externally funded Ad-hoc research projects

- On farm conservation and promotion of cultivation of small millets and pseudo-cereals in participatory mode in Himachal Pradesh (**JC Rana,** completed in December, 2011)
- Mass multiplication of quality planting material of some new fruits as an alternative to diversity fruit cultivation in HP (**JC Rana,** completed in September, 2011)
- Impact of climate change on plant species composition: analyzing with a few typical plant species in Shimla and Kinnaur Districts of Himachal Pradesh (JC Rana, DST) Snout monitoring, mapping, mass and energy balance and assessment of biophysical environment of Nardu glacier, Baspa basin, District Kinnaur, Himachal Pradesh (**JC Rana**)
- To understand the impact of retrieving snowline on the agri-diversity, other flora and societies in Spiti basin-A joint programmed of MOEF and DOS on the monitoring Snow and Glaciers of Himalayan Region (**JC Rana**)
- Evaluation of genetic diversity of Kidney bean, Field pea for agronomic, quality and processing traits (**JC Rana**)

18. REGIONAL STATION, SRINAGAR

Summary: The 478 accessions of wheat (240), barley (114) and mustard (124) were evaluated for their morphological characters during *rabi* 2010-11 under rainfed conditions. The 723 accessions of wheat (335) , barley (280) and sarson (108) were sown in *rabi* 2011-12 for characterization and evaluation under rainfed condition of Himalayan. The 39 accessions comprising *Dioscorea deltoidea* (23), strawberry (5), pran (onion) (5), mint (3) and *Iris* spp. were maintained as a live plants in the field.

18.1Germplasm Evaluation

A total of 478 accessions comprising of wheat (240), barley (114) and mustard (124) were evaluated for their morphological characters in Augmented Block Design during *rabi* 2010-11 under rainfed conditions. The723 accessions of wheat (335) barley (280) and mustard (108) have been sown in the field during *rabi* 2011-12 for characterization and evaluation under rainfed conditions.

18.1.1. Identification of promising genotypes:

Wheat: The 240 accessions of wheat were sown in the augmented block design for evaluation for morphological characters. The standard agronomical practices were followed to raise good crop under rainfed condition. The observation were recorded for seed yield per plant and its contributing characters i.e. number of seeds per spike, number of spikelets per spike, spike length and 100 seed weight, days to 50% flowering and days to maturity. Higher seed yield per plant than the best performing check Gw-322(15.65gm) was recorded for accessions IC335953 (24.17gm) followed by IC279881 (22.37gm), IC279314 (22.11gm), IC279875 (20.71gm), and IC279334 (20.70 gm). Higher number of grains per spike were recorded for accessions IC266978 (56.81), IC118779 (53), IC310069 (52.60), IC335981 (52.6), IC260923 (51.40) than the best performing check HD2333 (42.14) for the character. The spikelets per spike were recorded more in number for genotypes IC335953 (21), IC279314 (21), IC279881(21), IC279318(20), IC335920 (19.6) than the best performing check GW 322 (18.58). The test weight was observed to be higher for the genotypes IC279230 (5.67gm), IC279315 (5.35gm), IC301584 (5.28gm), IC335947(5.19gm), IC310076 (5.12gm) than the best performing check C-306 (4.13gm).

18.1.2. Barley: The 114 accessions of barley were sown in the augmented block design for evaluation for morphological characters at the Research Farm of Regional Station of National Bureau of Plant Genetic Resources, K.D. Farm, Rangreth, Old Air Field, Srinagar. The standard agronomical practices were followed to raise good crop under rain fed condition. The observation were recorded for seed yield per plant and its contributing characters i.e. number of seeds per spike, number of spikelets per spike and 100 seed weight. Higher seed yield per plant than best performing check DI (13.31gm) was recorded for accessions IC278986 (22.60 gm), IC278959 (22.5gm), IC279132 (22.15 gm), IC279167 (20.08gm) and IC311040 (19.51gm). Higher number of grains per spike were recorded for accessions IC397985 (57.5), IC279167(57), IC31147 (56.75), IC310089 (56), IC279212 (55.8) than the best performing check DI (51.67) for the character. The spikeletes per spike were recorded more in number for genotypes IC310087 (20.6), IC278986 (20.5), IC382702 (20.5), IC279271(20.4), IC397985(20) than the best performing check DI (18.06). The test weight was observed to be higher for the genotypes IC279279 (4.95gm), IC311057 (4.89gm), IC397985 (4.85gm), IC311040 (4.85gm), IC279130 (4.80gm) than the best performing check DI (3.80gm).

18.1.3. Sarson: The 124 accessions of sarson (mustard) were sown in the augmented block design for evaluation for morphological characters. The standard agronomical practices were followed to raise good crop under rain fed condition. The observation were recorded for seed yield per plant and its contributing characters i.e. number of seeds per siliqua, siliqua length (cm), total number of siliquae on primary branches, total number of siliquae on main stem, total number of siliquae per plant, and test weight. Higher seed yield per plant than best performing check Bhawani (17.99 gm) was recorded for accessions IC399859 (29.96 gm), IC399858 (27.61gm), IC553083 (26.86 gm), EC 191597 (26.4gm). The number of seeds per siliquawere recorded for accessions IC399886 (24.2), IC553083 (22.4), IC399859 (21), as compare to best performing check Bhawani (17.30) for the character. The total number of siliquae per plant were observed for accessions IC399855 (202.2),IEC 553083 (198), IC399843 (195) as compare to Bhawani (183). Higher number of siliquae on main stem was recorded for EC 399858 (87), IC399859 (68),

IC553083 (58), than the best performing check Bhawani (39). The observed test weight for accessions IC491094 (0.95gm), IC399856 (0.95gm), IC30974 (0.84gm) as compare to check Bhawani (0.72gm).

18.2 Maintenance of Germplasm

The 39 accessions comprising *Dioscoreadeltoidea*(23) strawberry (5), pran (onion) (5), mint (3) and *Iris spp.* were maintained as a live plants in the field.

18.3 Germplasm Supplied

The 17 accessions of *Dioscoreadeltoidea* were supplied to Department of Botany of Haryana Agricultural University Hisar and Jamia Hamdard University Delhi.

Research Project (Code: Title, PI, Co-PI)

PGR/PGC-BUR-SRI-01: Augmentation, characterization, evaluation, maintenance, regeneration, conservation, documentation and distribution of germplasm resources of various crops from Jammu and Kashmir regions (**Om Vir**, Sheikh M. Sultan)

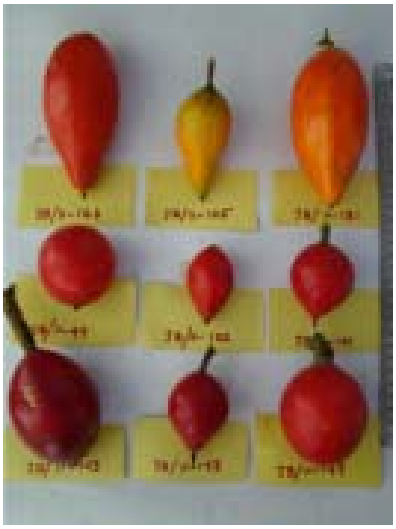
19. REGIONAL STATION, THRISSUR

Summary: Four exploration/ collection missions were conducted in two districts of Goa, four districts of Mizoram, three districts of Tripura and six districts of Assam and a total of 365 samples of germplasm were collected from Goa (54), Mizoram (150), Tripura (96) and Assam (65). Out of the collected germplasm, two samples of unique chillies landraces and 61 of landraces of deep-water rice from Assam were sent for long-term storage at Germplasm Conservation Division, NBPGR, New Delhi. During *rabi* 2010-11, 170 accessions of rice (*Oryza sativa*), 3 of wild bittergourd (*Momordica charantia* var. *muricata*), 22 of pumpkin (*Cucurbita moschata*), 5 of cushaw (*C. argyrosperma*), 5 of *Solanum insanum*, 17 of *Kaempferia galanga* and 380 of horsegram (*Macrotyloma uniflorum*) were evaluated. During *kharif* 2011, 34 accessions of upland landraces and 85 of lowland rice, 43 of *Sesamum* species and 36 of Malabar tamarind (*Garcinia cambogia*) were characterised/ evaluated. Seeds of 67 accessions mostly of forage crops and pumpkin were multiplied and sent for long-term storage. For cryopreservation, five multiplied accessions of recalcitrant seed bearing germplasm, three of black pepper and one each of *Phyllanthus emblica* and *Pourteria campechiana* were sent. Seeds of 229 accessions of rice and 380 of horsegram were added to the MTS facility of the Station. Based on material transfer agreement, 307 accessions mostly of bittergourd, okra, mango and snakegourd were supplied to nine user agencies mostly state agricultural universities. Various accessions were transferred to respective NAGS, *viz.*, mango (18) to CISH, Lucknow; lesser yam (7), greater yam (35) and wild *Dioscorea* (36 in 11 species) to CTCRI, Thiruvananathapuram; turmeric (55) to IISR, Kozhikode; and gooseberry (1) to CIAH, Bikaner. A total of 55 accessions in five crops (cassava–5, ginger–8, lesser galangal-1, greater galangal-6 and brahmi-22) and 10 wild related species (*Dioscorea pubera*-1, *D. pentaphylla*-3, *D. intermedia*-1, *D. belophylla*-1, *D. bulbifera*-2, *D. tomentosa*-1, *D. wallichii*-1, *D. oppositifolia*-1, *Curcuma raktakanta*-1 and *C. aeruginosa*-1) were maintained in *in vitro* conservation media. A set of 100 accessions of horsegram was sent to two institutions for multi-location evaluation under the National Network Project on Arid Legumes and a set of 200 accessions of okra to nine centres of multi-location evaluation through Germplasm Evaluation Division, NBPGR, New Delhi.

19.1 Exploration and Collection

Four exploration and collection missions were conducted as presented below:

19.1.1 Goa: Goa state was explored in collaboration with scientists of Indian Council of Agricultural Research Complex for Goa for vegetables, tuber crops and ornamentals. A total of 54 samples from 14 sites comprising of 13 samples in tuber crops (4 in greater yam, 4 in sweet potato and one each in lesser yam, potato yam, elephant foot yam, cocoyam and taro), 1 in horsegram, 11 samples in Chinese spinach (10 red and 1 green), two in spleen amaranth, 3 in okra (local types), 4 in chillies, 4 in drumstick and 3 in vegetable cowpea were collected. All the tuber crops are from indigenous tribes Gowli and Kulmi who practice subsistence agriculture. JAT/11-41- *Colocasia esculenta* "madi" is unique to Goa and neighbouring Uttar Kannad District of Karnataka and is cultivated for its petiole and mother corm, both used extensively as vegetable. Among ornamentals, three types in *Crossandra* (orange-red fully opening, orange-red half opening (preferred by growers) and yellow), orange and yellow forms in marigold and one each in *Barleria* and cockscomb were collected. Chinese spinach collections are all red broad leaved forms (farmer selections) barring one green form. Extremely high variability in chillies was observed including 3 named types for specific purposes.



Species diversity in *Trichosanthes* collected from Mizoram

19.1.2 Mizoram: In a collaborative exploration and collection mission with Central Horticultural Experimental Station, Indian Institute of Horticultural Research, Bhuvaneswar and in association with Krishi Vigyan Kendras in Aizwal, Kolasib, Mamit and Champai districts of Mizoram State, a total of 150 samples of cucurbits were collected from 62 sites. The collections included 30 of teasle gourd (cultivated and wild), 22 of cucumber, nineteen of pumpkin, twelve of ash gourd, eleven each of bitter gourd and *Momordica charantia* var. m*uricata* (both wild and semi-domesticated), nine of snake gourd, two of *Trichosanthes lepiniana*, three of *T. tricuspidata*, four of *T wallichiana*, seven of *Cucumis*

hystrix, six of bottle gourd, four each of ridge gourd, snap melon and sponge gourd, one each of *Solena amplexicaulis* and water melon. Best time for collection of *C. hystrix* is early November and for cucumber it is September and for all other cucurbits it is October. *C hystrix* is a wild edible vegetable comparable to gerkin and has direct domestication potential. Landraces and primitive cultivars abound in cucurbits as improved varieties are yet to reach the area. Good variability for fruit characters in teasle gourd, ash gourd, pumpkin, cucumber, wild *Trichosanthes* and *C. hystrix* was collected.

Aanakkodan – saline tolerant deep water rice landrace

IC582471 resistant to drought

19.1.3 Tripura: In a collaborative exploration and collection mission with Central Horticultural Experimental Station, Indian Institute of Horticultural Research, Bhuvaneswar and in association with Krishi Vigyan Kendras in South Tripura and West Tripura Districts of Tripura State, a total of 96 samples of cucurbits and Asiatic *Vigna* were collected from 36 sites. The collections included 32 of teasle gourd, eight of cucumber, nine of pumpkin, ten of ash gourd, one of pointed gourd,

***Kaempferia galanga* – IC373588 superior for fresh rhizome yield, dry rhizome yield and dry leaf yield**

Diversity in *Cucurbita* species

five of bottle gourd, nine of ridge gourd, four of snap melon, seven of sponge gourd, one of water melon, one of Chinese lardfruit (*Hodgsonia macrocarpa* -wild, spotted in three forest pockets), one of black gram (primitive form) and two of *Vigna umbellata*. Good variability for fruit characters in teasle gourd (including six unique high yielding farmer selections), ash gourd, pumpkin, cucumber, smooth gourd and ridge gourd was collected. Efforts were made to visit maximum *jhum* lands (shifting cultivation) for collection of land races and the agrarian tribes "Deb burman'', "Jamathiya", "Tripura" and the most primitive "Mog" and "Riang" communities were visited, besides Manipuri and Bengali farmers in plains. For the purpose of collection of unique germplasm of west Tripura (reported by Krishi Vigyan Kendra, Chebri), farmers' fields were visited and collected germplasm and associated information of trait-specific germplasm of rice (3 accessions), chillies (2) and spine gourd (1). These 2 chillies were named landraces (*Balujhuri* and *Baramaria*) and as they are unique, enough quantity of seeds collected and sent for long-term storage at GCD, NBPGR, New Delhi.

19.1.4 Assam: One exploration and collection mission was undertaken to six districts of Assam namely

Diversity of tuber crops, chillies, etc. maintained in farm store of Gowli tribe of South Goa

Kamrup, Nalbari, Lakhimpur, Dhemaji, Jorhat and Sonitpur, for the collection of germplasm of trait-specific deep-water rice in collaboration with the Regional Rain-fed Lowland Rice Research Station, Central Rice Research Institute, Gerua, Hajo, Kamrup District; the Regional Agricultural Research Station, Assam Agricultural University, Garimoria, North Lakhimpur, Lakhimpur District; and Krishi Vigyan Kendra at Nalbari, Assam. In all, collected 65 samples of germplasm from six districts of Assam in 27 sites where deep-water rice is traditionally grown. The area under deep-water rice cultivation is fast decreasing and it was timely that this mission could be planned and undertaken now. Forty-eight named and distinct landraces in 59 samples of deep-water rice were collected from farmers' field or threshing yard and two aromatic rice varieties were collected from Regional Agricultural Research Station, Assam Agricultural University, North Lakhimpur. Two accessions of *Alpinia* species and one each of *Acorus calamus* and *Capsicum frutescens* (perennial tall plant) were also collected. A duplicate set of 59 samples of deep-water rice was shared with the scientist of the collaborating Institute, namely, Dr Narayan Bhakta, Scientist (Senior Scale), Regional Rainfed Lowland Rice Research Station, Gerua, Kamrup District, Assam of CRRI, Cuttack. Dr Dhiren Chawdhury, Senior Scientist, Regional Agricultural Research Station, North Lakhimpur took the unrepresented samples of varieties while collecting itself. The Head, RRLRRS CRRI, Gerua was requested to extend all assistance for the multiplication, characterization, evaluation and utilization of these samples of deep-water rice at Gerua during the coming *kharif* season itself and deposit of freshly harvested and characterized and evaluated germplasm in the National Genebank, NBPGR, New Delhi. A duplicate set is with NBPGR RS, Thrissur for arranging multiplication at NBPGR Base Centre, Cuttack or NBPGR RS, Thrissur. All the 61 accessions of collected rice samples have been sent for long-term storage by Germplasm Conservation Division, NBPGR, New Delhi.

JAT/11-34 – Drumstick – prolific bearing from Kulmi tribe of South Goa

JAT/11-52 –JAT/11-32 Yellow and Orange Howered

19.1.5 Unique collections

- Among the samples collected from Mizoram, unique collections included first time collection of fruit variability in *C. hystrix* (7 samples), 60 cm long ash gourd (JB/11-93), scented ash gourd cultivated in *jhum* lands (10 samples), 30 cm long ridge gourd (JB/11-32 and 42), deep yellow fleshed (carotenoid rich) and 32 cm long cucumber (JB/11-112), easy to transport small snake gourd (15 cm long, 600 g-JB/11-14) and extra long (30 cm) pepoid pumpkin (JB/11-159).

- From Tripura, unique collections included first time collection of Chinese lardfruit (*Hodgsonia macrocarpa*, JB/11-253- a wild cucurbit with edible kernels/oil seed), semi-domesticate sweet gourd JB/11-225 (750 g/fruit), JB/11-254 - scented smooth gourd with unique shape, JB/11-247-extra long ridge gourd

(45 cm), JB/11–197, small round cucumber and 8 accessions of scented ash gourd cultivated in *Jhum* lands. The teasle gourd samples, JB/11- 179 (120 g/ fruit), JB/11-193 (150 g/fruit), JB/11- 266 (200g/ fruit), JB/11- 236 – Australian kakrol - (250 g/fruit), JB/11- 200 – Sunder kakrol - (120 g/ fruit) and JB/ 11- 234 – Narayan kakrol - (100 g/ fruit) are claimed to be high yielders.

- The lone collection of bird chilli (*Capsicum frutescens*)–ZA&DC/2011-58, collected from Assam was a robust herb or bushy shrub with upright fruit, initially green, turning to pale yellow, yellow to red, up to 5 cm long.

Ashgourd (JB/11-93), extra long (60 cm) collected from Mizoram

Variability in scented ashgourd cultivated in jhum lands of Mizoram

Descriptor	Descriptor states	No. of accessions
Coleoptile colour	Green	166
	Purple	4
Basal leaf sheath colour	Green	168
	Purple lines	2
Apiculus colour	White	126
	Purple	44
Panicle type	Compact	1
	Intermediate	168
	Open	1
Awning	Short and partly awned	4
	Short and fully awned	2
	Long and partly awned	2
	Long and fully awned	16
	Absent	146
Seed coat colour	White	75
	Light brown	4
	Brown	16
	Red	75
Hull colour	Straw	113
	Golden	7
	Golden brown	6
	Brown furrows on straw	30
	Purple	1
	Brown (Tawny)	4
	Black	9

19.2 Characterisation and Evaluation

19.2.1 Cereals

Rice (*Oryza sativa*) *rabi* 2010-11: One-hundred and seventy accessions of rice were evaluated in an augmented block design for 12 qualitative and 10 quantitative characters along with four check varieties namely Ahalya, Jaya, Jyoti and Thulasi. No variability was found in five qualitative characters namely early seedling vigour, leaf pubescence, leaf blade colour, panicle exertion and threshability. Variability observed in other qualitative characters is detailed below:

***Cucumis setosus* - a valid and distinct biological species different from *C. sativus* which is endemic to Maharashtra, established at NBPGR Regional Station, Vellanikkara, Thrissur, Kerala**

Carotenoid rich cucumber (JB/11-153) collected from Mizoram

Rice (*Oryza sativa*) (Upland *kharif* 2011): A total of 34 accessions of upland rice landraces collected over the years during past from southern Western Ghat region were evaluated in a randomized block design for 12 qualitative and 10 quantitative characters along with three check varieties namely Harsha, Vaishak and Jyoti. With respect to 3 qualitative characters, no variability was found in leaf pubescence, panicle exertion and threshability. The range of variations observed in other qualitative characters is detailed below:

Rice (*Oryza sativa*) (Lowland *kharif* 2011): Eighty five accessions of lowland rice which were identified superior during previous years of evaluation were

The variability observed in 10 quantitative characters is presented below:

Characters	Range	Mean	SD	CV (%)
Leaf length (cm)	28.80-56.20	36.40	4.88	13.42
Leaf width (cm)	0.33-1.08	0.75	0.12	15.33
No. of effective tillers	4.60-37.00	11.52	4.23	36.73
Days to 50% flowering	32.00-66.00	41.83	7.12	17.01
Plant height (cm)	57.60-112.00	85.03	12.98	15.26
Panicle length (cm)	11.00-24.60	18.14	1.96	10.80
Grain length (mm)	6.28-10.89	8.33	0.69	8.31
Grain width (mm)	2.07-3.60	2.69	0.21	7.81
100-grain weight (g)	1.65-3.40	2.33	0.25	10.85
Grain yield/ plant (g)	2.08-38.35	10.72	4.24	39.54

The promising accessions identified compared to the respective best check varieties for yield and yield attributing traits are detailed below:

No. of effective tillers	
IC567748	28.4
IC086361	27.8
IC086351	21.8
IC145176	22.4
IC199588	37.0
Ahalya (Check)	18.2

Panicle length (cm)	
IC086369	24.6
IC350755	22.0
IC350705	22.0
IC251469A	22.4
IC145173	22.0
IC212007	23.8
Jaya (Check)	20.2

100-grain weight	
IC086374	2.81
EC204997	2.85
EC205114	3.4
IC086450	2.92
IC145175	2.93
IC251493	2.86
IC251489	2.83
Jyoti (Check)	2.76

Grain yield	
IC567748	38.35
IC199589	22.46
Jyoti (Check)	15.92

evaluated in an augmented block design for 12 qualitative and 10 quantitative characters along with four check varieties namely Ahalya, Jaya, Jyoti and Thulasi. When the qualitative characters were observed, no variability was found in four characters namely, leaf pubescence, leaf blade colour, panicle exertion and threshability. The variability observed in other qualitative characters is detailed below:

Eleven accessions were found superior for number of effective tillers (>12), 20 for panicle length (>24 cm), 11 for 100-grain weight (>3.0 g) and eleven accessions for grain yield/ hill (>23g). IC536532, IC536568 and IC536559 were superior for combination of traits namely number of effective tillers (17.6, 15.8, 16.4), panicle length (25 cm, 24.6 cm, 25.6 cm) and grain yield/ hill (42.6, 39.8, 39) compared to the bset check Jaya for number of effective tillers (12.2) and panicle length (23.4 cm) and Ahalya for grain yield/ hill (22.08 g). Similarly, IC413628, IC413633 and IC413645 were superior for panicle length (25, 26.8, 24.6 cm) and 100-grain weight (3.52, 3.34, 3.31) compared to the best check Jaya (Panicle length–23.4 cm; 100-grain weight–2.98 g).

Characters	Descriptor states	No. of Accessions
Early plant vigour	Good	3
	Very good	31
Coleoptile colour	Green	30
	Purple	4
Basal leaf sheath colour	Green	31
	Purple lines	3
Leaf Blade colour	Light green	2
	Green	32
Apiculus colour	White	30
	Purple	4
Panicle type	Intermediate	30
	Open	1
	Both	2
Awning	Short and partly wned	2
	Long and fully awned	1
	Absent	31
Seed coat colour	White	2
	Light brown	3
	Red	29
Hull colour	Straw	9
	Golden	1
	Golden brown	2
	Brown furrows on straw	12
	Brown (Tawny)	9
	Black	1

The range of variation observed in 10 quantitative characters are given below:

Characters	Range	Mean	SD	CV (%)
Leaf length (cm)	40.1-76.6	57.9	10.2	17.7
Leaf width (cm)	0.65-4.4	1.5	0.7	45.1
Days to 50% flowering	58.0- 101.0	74.0	13.0	17.5
No. of effective tillers	7.6-20.1	13.1	2.8	21.5
Plant height (cm)	52.9- 170.5	127.7	29.4	23.1
Panicle length (cm)	17.2- 73.9	23.6	9.2	39.1
Grain length (mm)	7.7 - 9.5	8.6	0.5	6.0
Grain width (mm)	1.9 - 2.5	2.1	0.1	5.1
100-grain weight (g)	2.0- 2.9	2.5	0.2	9.5
Grain yield/ Plant (g)	10.0- 31.0	19.8	6.0	30.5

Eleven accessions were found superior for grain yield compared to the best check Vaishag as detailed below:

TCR No.	Accession no.	Local name	Grain yield/ Plant (g)
4735	IC324565	*Chennelu*	24.0
6279	IC203767	*Velutha navara*	29.5
6281	IC203769	*Palkaima*	29.0
6283	IC203771	*Karutha navara*	26.5
6288	IC203776	*Mundodan*	27.0
6304	IC203792	*Veluthadichan*	23.0
6328	IC203820	*Karutha choman*	31.0

6331	IC203823	*Keeripoothadan*	29.0
6279A	IC203767A	*Pularikaru*	24.0
6329A	IC203821A	*Kara kozhivalan*	29.01
	Best check	Vaishag	21.0

All these accessions were early maturing type with 90-100 days duration on par with the check.

Characters	Descriptor states	No. of accessions
Early plant vigour	Good	4
	Very good	81
Coleoptile colour	Green	74
	Purple	10
Basal leaf sheath colour	Green	74
	Purple lines	10
Apiculus colour	White	49
	Purple	19
	Both	17
Panicle type	Intermediate	1
	Open	78
	Both	6
Awning	Short and partly awned	6
	Long and fully awned	6
	Absent	73
Seed coat colour	White	33
	Light brown	18
	Brown	4
	Red	30
Hull colour	Straw	55
	Brown furrows on straw	20
	Brown (Tawny)	9
	Others	1

check entries, five checks were repeated thrice in three blocks) sown in Federer's augmented design being a centre under multi-location evaluation location for a project by NRC DNAFP, NBPGR, New Delhi, 380 entries survived. These were harvested in two spells in January and February 2011 (335 accessions and 45 check entries). Twenty qualitative and 13 quantitative pod and seed characters were studied. The variability noticed in qualitative characters is detailed below:

Promising accessions

- Six superior accessions identified for number of pods per plant above the check value of 163.2 were IC15735 (237), IC121640 (350), IC561032 (186.5), IC71814 (166.6), IC26132-1 (195.4) and IC344193 (190.4). The 7 accessions with 100-seed weight above the check value of 3.8 g were IC139547 (3.9 g), IC243504 (3.9 g), IC717335 (3.9 g); IC47461, IC139522 (4 g); IC139545 (4.2 g) and IC139520 (4.4 g).

The variability observed in the quantitative characters are given in the following table

Characters	Range	Average	SD	CV (%)
Leaf length (cm)	44.8-82.6	63.3	7.3	11.5
Leaf width (cm)	0.92-1.9	1.3	0.2	14.6
Days to 50% flowering	56-144	73.0	18.0	24.7
No. of effective tillers	5.2-22.2	9.8	3.1	31.7
Plant height (cm)	63-180	138.3	22.0	15.9
Panicle length (cm)	16.6-35.0	22.6	2.8	12.3
Grain length (mm)	5.8-11.9	8.6	1.0	11.7
Grain width (mm)	1.52-3.1	2.1	0.3	14.4
100-grain weight (g)	1.42-3.7	2.5	0.4	18.1
Grain yield/ plant (g)	2.0-42.6	15.4	7.8	50.5

19.2.2 Grain legumes

Horsegram (*Macrotyloma uniflorum*) *rabi* 2010-11: Out of 390 entries of horsegram (345 accessions and 45

- Eight accessions identified superior for seed yield per five plants above the check value 16.5 g were IC121640 (15.7 g), IC22794 (18.9 g), IC71814 (16.4 g), IC321300 (16.5 g), IC26132-1 (18.2 g), IC15775 (16.6 g), IC344193 (22.1 g) and IC277687 (18.1 g).

Fruit variability in chillies of South Goa

***Cucumis callosus* – IC550203 – tolerant to drought, downy mildew, alternaria fruit rot, *Cucumber mosaic virus* and aphid**

A field view of upland rice landraces grown during *kharif* 2011 at NBPGR Regional Station, Vellanikkara, Thrissur, Kerala.

Soft wood grafting of Himalayan entity *Abelmoschus crinitus* on *A. moschatus* (in the middle).

- Four accessions, *viz*., IC561040, IC139553, IC139413 and IC47132 showed early maturity with less than 73 days compared to the best check (73 days).

19.2.3 Vegetables

Wild bitter gourd *(Momordica charantia* var. *muricata)* (*rabi* 2010-11): Three accessions (IC582471, IC582420 and IC582449) were found to be highly resistant to drought, flowering, fruiting and growing without any water supply in dry summer months. These materials were also found to possess field resistance to powdery mildew.

Pumpkin *(Cucurbita moschata)* (*rabi* 2010-11): A total of 22 accessions of pumpkin was characterized. Pumpkin germplasm showed variability for fruit characters both qualitative and quantitative. Highest single fruit weight of 7.00 kg was observed in IC330938 and smallest fruits were observed in IC284894 (2.40 kg), IC332091 (2.00 kg) and IC345749 (2.06 kg). IC332091 had uniformly small round fruits desired by growers.

***Cushaw (Cucurbita argyrosperma)* (*rabi* 2010-11):** Fruit variability was restricted to mature fruit colour either orange red or creamish white in the five accessions studied.

***Cucurbita* species (*rabi* 2010-11):** Six accessions of *Cucurbita* species received from Germaplsm Excahnge Unit, NBPGR, New Delhi were taxonomically classified in to *C. moschata* (IC567366, IC567375, IC567389 and

Character	Character states	No. of accessions
Growth habit	Erect	51
	Viny	208
	Very viny	76
Leafiness	Intermediate	211
	Abundant	124
Leaf pubescence	Moderately pubescent	229
	Densely pubescent	106
Date of emergence	3 days	298
	4 days	33
	5 days	4
Yellow mosaic incidence	Low incidence	180
	Medium incidence	128
	High incidence	52
Sclerotia wilt	Low incidence	180
	Medium incidence	128
	High incidence	27
Branching	High	48
	Medium	272
	Low	15
Twining tendency	Slight	51
	Intermediate	202
	Pronounced	82
Branching pattern of primary branches	Middle	9
	Base	326
Stem base colour	Purple	47
	Green	288
Stem top colour	Purple	190
	Green	145
Stem pubescence	Puberulent	3
	Moderately pubescent	256
	Highly pubescent	76
Stem hair colour	Greenish white hairs was noticed invariably in all the accessions	335
Nodulation	Poor nodulation not prominent was noticed in all the accessions	335
Flowering period	Synchronous	245
	Asynchronous	55
	Intermediate	35
Mature pod colour	Straw	2
	White	3
	Cream	129
	Light brown	200
	Brown	1
Pod curvature	Almost linear	132
	Less curved	196
	More curved	7
Purple pigmentation on pod	Nil	298
	Less	36
	More	1
Pod pubescence	Glabrous	38
	Puberulent	94
	Moderately pubescent	176
	Densely pubescent	27
Seed colour	Cream	8
	Light brown	111
	Intermediate brown	25
	Dark brown	27
	Grey	4
	Chocolate	6
	Black	24
	Red Brown	2
	Mottled black	2
	Mottled brown	18
	Mottled grey	39
	Mottled light brown	58
	Mottled dark brown	9
	Mottled chocolate	2

The range of variation observed in quantitative characters along with best check value are given below:

Characters	Range	Mean	SD	CV%	Best check value (Check)
Days to flowering	35-86	43.47	12.42	28.58	35 (C-2, AK-26; C-3, AK-38)
No. of primary branches	3.0-10.67	6.58	1.29	19.53	9.4 (C-1, AK-21)
Plant height (cm)	26.75-170.6	91.53	22.12	24.17	154.2 (C-4, HGGP)
Days to 50% flowering	41-98	52.92	14.34	27.1	42 (C-2, C-3)

Pod length (cm)	2.8-6.6	4.7	0.65	13.86	6.1 (C-4)
Pod width (cm)	0.4-0.9	0.63	0.08	12.71	0.8 (C-4)
No. of pods/plant	2.56-350	60.03	36.97	61.58	163.2 (C-4)
No. of seeds/pod	2.36-8	5.97	0.77	2.89	6.8 (C-4)
Seed length (mm)	4.82-6.84	5.72	0.37	6.47	6.7 (C-3)
Seed width (mm)	0.26-2.68	2.22	0.19	8.79	2.6 (C-2)
100-seed weight (g)	1.95-4.35	2.87	0.41	14.3	3.8 (C-3)
Seed yield/5 plants (g)	0.99-163.68	30.76	19.55	63.56	82 (C-1)
Days to maturity	65-115	82.32	8.48	10.3	73 (C-4)

Deep-water rice collections from Kamrup Dt., Assam

Deep-water rice collections from Lakhimpur Dt., Assam

IC567437), *C. maxima* (IC567377) and *C. argyrosperma* (IC567366).

***Solanum insanum* (*rabi* 2010-11):** *S. insanum* is a wild/ weedy species related to brinjal. Five accessions were studied for 16 quantitative and 11 qualitative characters. No variability was found in the qualitative characters studied except for the tender stem colour which ranged from light violet to green. Among the quantitative characters studied, variation was more in fruit pedicel prickle number (0 to 4.6), fruit calyx prickle number (0 to 17.4), stem prickle number (0 to 8.0), upper lamina prickle number (0 to 9.0) and lower lamina prickle number (0 to 8.8).

19.2.4 Oilseeds

***Sesamum* species (*Kharif* 2011):** Forty-three accessions in three wild/ weedy species of *Sesamum*, namely *S. mulayanum* (26 accessions), *S. malabaricum* (4) and *S. radiatum* (13) were characterized for six quantitative characters namely plant height (cm), internode length (cm), number of capsules/ plant, capsule length (cm), number of seeds/ capsule and 100-seed weight (g) in two replications. The range and mean observed for each of these characters were as follows respectively for each species:

19.2.5 Spices- Malabar tamarind (*Garcinia cambogia*) (*kharif* 2011): Forty-six trees in 36 accessions were characterised for 21 fruit and 11 seed characters. IC244093-1 and IC244101-3 were superior for multiple traits namely fresh fruit weight (183 g) and (159 g), fresh fruit length (68.2 mm) and (67.0 mm), fresh fruit diameter (76.1 mm) and (72.9 mm), fresh rind weight (131.3 g) and (124.5 g) and fresh rind thickness (10.9 mm) and (11.7 mm), respectively. In 50 trees in 38 accessions of Malabar tamarind, two fruit yield characters were studied. Among them, IC244100-2 (Check-1) yielded the maximum number of fruits (7698)

and IC244110 yielded the maximum fresh weight of 639 kg of fruits. Eleven grafts in four accessions were characterised for 21 fruit, 11 seed and two yield traits during. Compared to the checks, for number of fruits/ graft and total fresh yield of fruits/ graft, IC244081-2 (301 and 30.7 kg) and IC244083-1 (570 and 55.9 kg) were superior to the best check IC244100-2 (177 and 11.9 kg), respectively. Six accessions of grafted Malabar tamarind which were late bearing (8 years for first fruiting after transplanting) were characterised for 3 yield traits namely total number of fruits/ graft/year, total fresh weight of fruits/ graft/ year and mean fresh weight of individual fruit (g). The range of variation observed for each trait was 3 to 403 fruits, 250 to 8.773 kg and 21.5 to 88.3 g, respectively. None were found superior to the two checks.

19.2.6 Medicinal and Aromatic Plants

***Kacholam* (*Kaempferia galanga*) (*rabi* 2010-11):** Seventeen accessions were evaluated for 13 quantitative and seven qualitative characters. There was no variability with respect to qualitative traits observed such as nature of rhizome, aroma of rhizome and leaf, tuber colour and shape, and hairiness of leaf (upper and lower surfaces). Variability was observed with regard to rhizome height, thickness and fresh weight, leaf length, breadth and fresh weight, leaf sheath length, and root length, thickness and fresh weight. In terms of fresh rhizome yield, which is the most significant trait, IC373594 (119.8 g), IC373588 (117.48 g), IC550152 (116.3 g), IC373589 (105.8 g) and IC373590 (104.6 g) were superior to the better check 'Rajani' (102.8 g).

19.3 Germplasm Conservation

19.3.1 Medium-term Storage at Thrissur: During the period, 289 accessions of rice and 380 of horsegram were added to the MTS facility after regeneration and multiplication.

19.3.2 Long-Term Storage at GCD, NBPGR, New Delhi: From the regenerated germplasm, 43 accessions of forage crops (*Sehima nervosum*-25, *Iseilema laxum*-11, *Chloris gayana*-2 and 1 each of *Cenchrus setigerus, Chrysopogon zeylanicus, Eshne dispar, Perotis indica*

Extra long ridge gourd (JB/11-32) collected from Mizoram

Variability in smooth gourd collected from tribal pockets/Jhum lands of Tripura

Chinese lardfruit - Hodgsonia macrocarpa (JB/11-253) – a wild cucurbit with edible kernel/oilseed collected from Tripura

***Momordica cochinchinensis* (JB/11-225) – sweet gourd, semi-domesticate from Jamathiya tribe, Tripura**

Characters	*S. mulayanum*		*S. malabaricum*		*S. radiatum*	
	Range	Mean	Range	Mean	Range	Mean
Plant height	87.0-188.0	138.1	113.8-178.0	148.7	166.5-209.1	185
Internode length	2.5-4.9	3.3	2.6-7.5	5.0	5.1-6.7	5.8
No. of capsules/ plant	32.6-194.8	89.0	49.1-149.1	100.2	14.5-169.0	95.5
Capsule length	2.1-2.7	2.4	1.9-2.7	2.3	2.5-3.0	2.8
No. of seeds/ capsule	47.9-74.4	60.7	53.7-65.3	59.8	73.0-107.6	93.8
100-seed weight	0.16-0.29	0.2	0.1-0.23	0.2	0.16-0.22	0.2

and Themeda sp.), 15 of pumpkin, 3 medicinal plants (*Caesalpinia bonduc, Mimusops elenji* and *Adenanthera pavonina*), 3 of sweet gourd (*Momordica cochinchinensis*) and 1 accession each of aonla (*Phyllanthus emblica*), cushaw (*Cucurbita argyrosperma*), rice bean (*Vigna umbellata*) were deposited for long-term storage at National Genebank, Germplasm Conservation Division, NBPGR, New Delhi.

19.3.3 *In vitro* conservation at Thrissur: The following number of accessions of germplasm in five crops and 10 wild related species are being maintained in *in vitro*:

19.4 Germplasm Supply

19.4.1 Germplasm transfer to NAGS: A total 78 accessions of tuber crops comprising lesser yam (7) and wild *Dioscorea* spp. (36 in 11 species), greater yam (35) to CTCRI, Thiruvananathapuram; one of goose berry to CIAH, Bikaner, 18 of mango to CISH, Lucknow and 55 of turmeric to IISR, Kozhikode were transferred.

19.4.2 Germplasm supply for multi-location evaluation: A set each of 100 accessions of horsegram was supplied to two centres, namely, UAS, Bangalore and RARS, KAU, Pattambi for multi-location evaluation under the National Network Research Programme on Arid Legumes. A set each of 200 accessions of okra for supply to nine centres were sent to Germplasm Evaluation Division, NBPGR, New Delhi for multi-location evaluation.

19.4.3 Germplasm supply under MTA to user agencies: A total of 307 accessions were supplied to nine user agencies under MTA. Details are as below:

19.4.4 Germplasm supply to NBPGR: In all, 17 accessions of *Kaempferia galanga*, one each of *Mimusops elengi*, *Adenanthera pavonina* and *Calophyllum inophyllum* and five of *Alpinia galanga* were supplied to Germplasm Evaluation Division for biochemical evaluation; 335 accessions of horsegram sent for molecular characterisation to NRC for DNAFP, NBPGR, New Delhi. Three accessions of black pepper, one each of *Phyllanthus emblica* and *Pourteria campechiana* were sent for cryopreservation.

Crop/ wild species	No. of accessions conserved
Cassava	5
Ginger	8
Alpinia calcarata	1
A. galanga	6
Bacopa monnieri	22*
Dioscorea pubera	1
D. pentaphylla	3
D. intermedia	1

Crop / wild species	No. of accessions conserved
D. tomentosa	1
D. wallichi	1
D. oppositifolia	1
D. bulbifera	2
D. belophylla	1
Curcuma raktakanta	1
C. aeruginosa	1
Total	**55**

Research Programme (Code, Title and Programme Leader)

PGR/GEV-BUR-THR-01.00): Augmentation, Characterisation, Evaluation, Maintenance, Regeneration, Conservation, Documentation and Distribution of Plant Genetic Resources in Southern India including Goa and Andaman & Nicobar Islands (**Z Abraham**)

Research Projects (Code: Title, PI, Co-PI and Associates)

PGR/GEV-BUR-THR-01.01: Augmentation, characterization, evaluation, maintenance, regeneration, conservation, documentation and distribution of genetic resources of field crops and their wild relatives (**M Latha,** Z Abraham, KI Asha, S Mani)

PGR/GEV-BUR-THR-01.02: Augmentation, characterization, evaluation, maintenance, regeneration, conservation, documentation and distribution of genetic resources of tuber and fruit crops and their wild relatives (**KI Asha,** K Joseph John, R Asokan Nair)

PGR/GEV-BUR-THR-01.03: Augmentation, characterisation, evaluation, maintenance, regeneration, conservation, documentation and distribution of genetic resources of spices, their wild relatives and medicinal & aromatic plants (**Z Abraham**, M Latha, K Joseph John, S Mani)

PGR/GEV-BUR-THR-01.04: Augmentation, characterisation, evaluation, maintenance, regeneration, conservation, documentation and distribution of genetic resources of tropical vegetables and their wild relatives (**K Joseph John**, M Latha, R Asokan Nair)

PGR/GEV-BUR-THR-02.00: Use of *in vitro* technology for mass propagation and conservation of clonally/ vegetatively propagated crops and their wild relatives (**Z Abraham**, KI Asha,A Indira Devi)

Externally Funded Research Projects

- NAIP Project on Biosystematics of the Genera *Vigna*, *Cucumis* and *Abelmoschus* (Joseph John K and Latha M) (Code: 044-NAIP-KVB-08).
- NOVOD Board Project on Multiplication, Conservation and Biochemical Profiling of Kokum (*Garcinia indica*), a Potential Source of Edible Oil found in Southern Western Ghats (**Z Abraham**, Sangita Yadav and M Latha,) (Code: 049-NOVODB-TSR-ZA-08).

20. GENERAL INFORMATION

20.1 Institute Management Committee (IMC)

Director NBPGR, Pusa Campus, New Delhi-110012	Chairman
Assistant Director General (Seed) ICAR, Krishi Bhawan, New Delhi – 110001	Member
Sh. Rakesh Poria Directorate of Agriculture, Haryana	Member
Dr. R. Saikumar Project Director, Directorate of Maize Research, New Delhi - 110012	Member
Dr. S.K. Jain Principal Scientist, IARI, New Delhi - 110012	Member
Dr. T.V. Ananth Narayan Head (PGR), IIHR, Hassaraghatta Lake Post, Bangalore- 560 089	Member
Dr. Pritam Kalia Head , Division of Vegetable Sciences, IARI, New Delhi - 110012	Member
Sh. Avesh Yadav FAO, IARI, New Delhi - 110012	Member
Chief F & A O IARI, New Delhi-110012.	Member
Senior Admn. Officer NBPGR, New Delhi-110012	Member Secretary

20.2 Research Advisory Committee (RAC)

Dr. R.S. Rana Ex-Director, NBPGR; D-43, Indra Prastha Apartment, Sector-14, Rohini, New Delhi-110085	Chairman
Dr. Akhilesh Kumar Tyagi Director, National Institute of Plant Genomic Research, Aruna Asaf Ali Marg; P.O. Box No. 10531, New Delhi-110 067	Member
Dr. P.N. Mathur Coordinator for South Asia Sub-Regional Office, Bioversity International, NASC, DPS Marg, Pusa Campus, New Delhi-110 012	Member
Dr. Ranjini Warrier Director, GOI, Ministry of Environment & Forests, CS Division, Paryavaran Bhawan, CGO Complex, Lodi Road, New Delhi-110003	Member
Dr. K.D. Srivastava Ex-Professor, IARI, House No. 23, Block No. 7, Sector 30-31, Springfield Colony, Faridabad-1211003, Haryana	Member
Dr. V.A. Parthasarthy Narmada Nilaya, Santhi Nagar, Chelavoor P.O., Calicut-673571	Member
Dr. K.C. Bansal Director, NBPGR (NBPGR), Pusa Campus, New Delhi-110012	Member
Dr. J.S. Sandhu Assistant Director General (Seed), Indian Council of Agricultural Research (ICAR), Krishi Bhavan, New Delhi – 110114	Member
Dr. R. Sai Kumar Project Director, Directorate of Maize Research, Pusa Campus, New Delhi-110 012	Member
Dr. Pritam Kalia Head, Division of Vegetable Sciences, IARI, New Delhi-110012	Member
Dr. I.S. Bisht Principal Scientist & I/C Technical Cell, NBPGR, New Delhi-110 012	Member Secretary

The XIII meeting of the RAC, NBPGR was held in New Delhi on 24-25 September, 2011 under the Chairmanship of Dr. R S Rana. RAC members, all heads of Divisions, Officers-in-Charge of Regional Stations, Units and Cells and other scientists attended the meeting. One member, Dr. V.A. Parthasarthy, had sought leave of absence.

Based on the presentations made during the RAC meeting and the discussions held, the following important recommendations emerged:

- Identifying suitable sites for *in-situ* on-farm conservation of agro-bioresources
- Adoption of an integrated approach to conservation of plant genetic resources
- Gap analysis of germplasm collected and conserved in the National Genebank
- Validation of trait specific unique accessions for use of plant breeders
- Adopting user-friendly database software enabling on-line access
- Need for computerisation of all data on pests intercepted by the PQ Division
- Accelerating the pace of developing National Permafrost Conservation Facility
- Strengthening partnership with NAG Sites
- Upgrading status of two Base Centres, namely, Ranchi and Cuttack
- Urgent attention to the needs of Regional Station at Srinagar

20.3 Institute Research Council (IRC)

Chairman- Director, NBPGR
Member Secretary- Dr. KK Gangopadhyay
The First Institute Research Council (IRC) Meeting for the year 2011 was held under the Chairmanship of Prof. K.C. Bansal, Director, NBPGR during June 17-21 to discuss the progress of institute projects during 2010-11 and finalize the technical programme of 2011-12. More than 125 scientists and technical officers from both headquarter as well as regional stations attended the meeting. Dr. Bansal made a presentation on achievements and future strategies in respect of mandate of NBPGR during a special session held on June 17 followed by external invited experts namely Dr. J.S. Sandhu, ADG (Seed), ICAR; Drs A.K. Singh, N.K. Singh, K.V. Prabhu, V.S. Ramamurthy, V.G. Malathi from IARI, Delhi; Dr. P.N. Mathur, Bioversity International, Delhi; and Dr. Kuldeep Singh, Punjab Agricultural University, Ludhiana.

20.4 Institute Joint Staff Council (IJSC)

Chairman- Director, NBPGR

Members Staff Side	Members Office Side
Sh. R.K. Sharma Secretary (Staff Side),	Dr. S.K. Malik. Senior Scientist, Secretary (Office Side)
Sh. R.C. Yadav	Dr. Rekha Chaudhary, Principal Scientist
Sh. Subhash Chandra	Dr. Sushil Pandey, Senior Scientist
Sh. Yogesh Kumar Gupta	Sh. S.K. Sinha, Sr. Admn. Officer
Sh. Suresh Ram, Sh. Y.K. Yadav	Sh. B.K. Bansal, F&AO

20.5 Personnel

(i) Scientific Staff

S.No.	Name	Designation	Discipline
1.	Dr. K C Bansal	Director	Plant Physiology
Division of Germplasm Evaluation			
1.	Dr. Manoranjan Dutta	Head	Genetics & Cytogenetics
2.	Dr. Ranbir Singh	Principal Scientist	Economic Botany
3.	Dr. I S Bisht	Pr Scientist & Professor, PGR	Plant Pathology
4.	Dr. Ashok Kumar	Principal Scientist	Plant Breeding
5.	Dr. K K Gangopadhyay	Senior Scientist	Horticulture
6.	Sh. N K Gautam	Scientist (Sel. Grade)	Economic Botany
7.	Dr. (Ms) Archana Raina	Senior Scientist	Plant Biochemistry

8.	Dr. (Ms) Sangita Yadav	Senior Scientist	Plant Biochemistry
9.	Dr. T V Prasad	Senior Scientist	Agricultural Entomology
10.	Dr. Mohar Singh	Senior Scientist	Plant Breeding
11.	Dr. Anirban Roy	Senior Scientist	Plant Pathology
12.	Dr. Tej Pal Singh	Senior Scientist	Plant Physiology
13.	Dr. Manas Kumar Bag	Senior Scientist	Plant Pathology
14.	Dr. Rakesh Bhardwaj	Senior Scientist	Biochemistry
15.	Dr. Sandeep Kumar	Senior Scientist	Biochemistry
16.	Dr. (Mrs) Pragya	Senior Scientist	Horticulture/ Floriculture
17.	Dr. (Mrs) Jyoti Kumari	Senior Scientist	Plant Breeding
18.	Dr. Arivalgan M	Scientist	Plant Biochemistry
Division of Plant Exploration and Germplasm Collection			
1.	Dr. D C Bhandari	Principal Scientist & Head	Economic Botany
2.	Dr. E Roshini Nayar	Principal Scientist	Economic Botany
3.	Dr. Anjula Pandey	Principal Scientist	Economic Botany
4.	Dr. Rakesh Srivastava	Senior Scientist	Horticulture
5.	Dr. KC Bhatt	Senior Scientist	Economic Botany
6.	Dr. K Pradheep	Senior Scientist	Economic Botany
7.	Dr. D P Semwal	Senior Scientist	Economic Botany
Division of Germplasm Conservation			
1.	Dr. R K Tyagi	Principal Scientist & Head	Plant Breeding
2.	Dr. (Mrs) Kalyani Srinivasan	Principal Scientist	Plant Physiology
3.	Dr. (Mrs) Veena Gupta	Principal Scientist	Economic Botany
4.	Dr. (Mrs) Neeta Singh	Principal Scientist	Plant Physiology
5.	Dr. (Mrs) J Radhamani	Senior Scientist	Plant Physiology
6.	Dr. (Mrs) Anjali Kak	Senior Scientist	Economic Botany
7.	Dr. (Mrs) Chitra Pandey	Senior Scientist	Seed Technology
8.	Dr. Sushil Pandey	Senior Scientist	Seed Technology
9.	Dr. (Mrs) Sherry Racheal Jacob	Scientist	Seed Technology
Division of Plant Quarantine			
1.	Dr. PC Agarwal	Principal Scientist & Head	Plant Pathology
2.	Dr. (Mrs) Usha Dev	Principal Scientist	Plant Pathology
3.	Dr. (Mrs) Manju Lata Kapur	Principal Scientist	Agricultural Entomology
4.	Dr. DB Parakh	Principal Scientist	Plant Pathology
5.	Dr. Baleshwar Singh	Principal Scientist	Plant Pathology
6.	Dr. (Mrs) Shashi Bhalla	Principal Scientist	Agricultural Entomology
7.	Dr. (Mrs) Celia Chalam V	Senior Scientist	Plant Pathology
8.	Dr. (Mrs) Kavita Gupta	Senior Scientist	Agricultural Entomology
9.	Dr. Mool Chand Singh	Senior Scientist	Agronomy
10.	Dr. Zakaullah Khan	Senior Scientist	Nematology
11.	Dr. Jameel Akhtar	Senior Scientist	Plant Pathology
12.	Dr. A Kandan	Senior Scientist	Plant Pathology

Germplasm Exchange Unit			
1.	Dr. Arjun Lal	Principal Scientist & OIC	Nematology
2.	Dr. (Mrs) Vandana Tyagi	Senior Scientist	Economic Botany
3.	Dr. (Mrs) Nidhi Verma	Senior Scientist	Economic Botany
4.	Dr. S K Yadav	Senior Scientist	Horticulture
5.	Ms Anitha Pedapati (on study leave)	Scientist	Horticulture
PGR Policy Planning			
1.	Dr. (Mrs) Pratibha Brahmi	Senior Scientist & OIC	Economic Botany
Tissue Culture & Cryopreservation Unit			
1.	Dr. (Mrs) Rekha Chaudhary	Principal Scientist & OIC	Economic Botany
2.	Dr. (Mrs) Ruchira Pandey	Principal Scientist	Economic Botany
3.	Dr. (Mrs) Neelam Sharma	Principal Scientist	Economic Botany
4.	Dr. (Ms) Anuradha Agarwal	Senior Scientist	Economic Botany
5.	Dr. (Mrs) Sandhya Gupta	Senior Scientist	Economic Botany
6.	Dr. S K Malik	Senior Scientist	Economic Botany
7.	Dr. Zakir Hussain	Senior Scientist	Genetics
8.	Dr. (Ms) Anju Jain	Senior Scientist	Economic Botany
All India Coordinated Research Network on UUC			
1.	Dr.D C Bhandari	Project Coordinator	Economic Botany
2.	Dr. BS Phogat	Principal Scientist	Agronomy
3.	Dr. Hanuman Lal Raigar	Senior Scientist	Agricultural Statistics
4.	Dr. (Mrs) Rashmi Yadav	Senior Scientist	Agronomy
DNA Fingerprinting			
1.	Dr. KV Bhat	Principal Scientist	Plant Breeding
2.	Dr. (Mrs) Gurinderjit Randhawa	Principal Scientist	Plant Physiology
3.	Dr. Soma Sundar Marla	Principal Scientist	Biotechnology
4.	Dr. M C Yadav	Principal Scientist	Biotechnology
5.	Dr. Mukesh Kumar Rana	Senior Scientist	Plant Breeding
6.	Dr. (Mrs) Lalit Arya	Senior Scientist	Biochemistry
7.	Dr. (Mrs) Ambika Baldev	Senior Scientist	Biotechnology
8.	Dr. Rakesh Singh	Senior Scientist	Biotechnology
9.	Dr. S. Rajkumar	Senior Scientist	Biotecnology
10.	Dr. Sundeep Kumar	Senior Scientist	Biotecnology
11.	Dr. Tapan Kumar Mandal	Senior Scientist	Biotecnology
12.	Dr. Monendra Grover	Senior Scientist	Biotecnology
13.	Dr. Deep Narain Saha	Senior Scientsit	Biotecnology
14.	Dr. Rajesh Kumar	Senior Scientist	Biotecnology
15.	Dr. Manjusha Verma	Senior Scientist	Biotechnology
16.	Sh. R Parimalan	Scientist	Biotechnology
17.	Sh. Chet Ram (on study leave)	Scientist	Biotechnology
18.	Sh. Amit Kumar Singh	Scientist	Biotechnology
19.	Dr. (Ms) Yesin K Jeshima	Scientist	Genetics and Plant Breeding
AKM Cell			
1.	Dr. Sunil Archak	Senior Scientist & OIC	Biotechnology
2.	Dr. (Mrs) Madhubala Priyadarshini	Scientist (Senior Scale)	Computer Applications in Agriculture

Regional Station, Akola			
1.	Dr. Nilamani Dikshit	Senior Scientist & In-charge	Economic Botany
2.	Sh. Abdul Nizar	Scientist (Senior Scale)	Economic Botany
Regional Station, Bhowali			
1.	Dr. S K Verma	Principal Scientist & OIC	Economic Botany
2.	Dr. K S Negi	Principal Scientist	Economic Botany
3.	Dr. A K Trivedi	Senior Scientist	Plant Physiology
Base Center, Cuttack			
1.	Sh. Diptiranjan Pani	Scientist & In-Charge	Economic Botany
2.	Dr. R.C Mishra	Senior Scientist	Economic Botany
3	Sh. S.D. Barik	Scientist (Senior Scale)	Economic Botany
Regional Station, Jodhpur			
1.	Dr. Omvir Singh	Principal Scientist & OIC	Economic Botany
2.	Dr. A K Singh	Senior Scientist	Economic Botany
Regional Station, Hyderabad			
1.	Dr. SK Chakraborty	Principal Scientist & OIC	Plant Pathology
2.	Dr. B Sarath Babu	Principal Scientist	Agricultural Entomology
3.	Dr. SR Pandrawada	Senior Scientist	Economic Botany
4.	Dr. (Ms) Kamla Venkateshwaran	Senior Scientist	Economic Botany
5.	Dr. Natrajan Sivaraj	Senior Scientist	Economic Botany
6.	Dr. (Mrs) Anitha Kodaru	Principal Scientist	Plant Pathology
7.	Sh.Sunil Neelam	Scientist (Senior Scale)	Economic Botany
8.	Dr. K Rameash	Senior Scientist	Entomology
Regional Station, Ranchi			
1.	Dr. J B Tomar	Principal Scientist & OIC	Economic Botany
2.	Sh. Santosh Kumar	Senior Scientist	Economic Botany
Regional Station, Shillong			
1.	Dr. A K Misra	Principal Scientist & OIC	Economic Botany
2.	Dr. R S Rathi	Senior Scientist	Plant Breeding
3.	Dr. Somnath Rai	Scientist	Economic Botany
Regional Station, Shimla			
1.	Dr. J C Rana	Principal Scientist & OIC	Economic Botany
Regional Station, Srinagar (J & K)			
1.	Dr. Sheikh Mohd. Sultan	Senior Scientist & OIC	Economic Botany
Regional Station, Thrissur			
1.	Dr. N K Dwivedi	Principal Scientist & OIC	Economic Botany
2.	Dr. Z Abraham	Principal Scientist	Economic Botany
3.	Dr. Joseph John K	Senior Scientist	Economic Botany
4.	Dr. (Mrs) Asha KI	Senior Scientist	Economic Botany
5.	Dr. (Mrs) M Latha	Senior Scientist	Plant Breeding
6.	Dr. (Mrs) Suma A	Scientist	Economic Botany

(ii) Technical Staff at NBPGR Headquarters and its Regional Stations/ Base Centres

S.No	NAME	DESIGNATION
NBPGR Headquarters' at New Delhi		
1.	Sh. B.P Dahiya	T-9 (Elect. Engineer)
2.	Dr. Om Prakash	T-7-8 (Tech. Officer)
3.	Sh. Abhay Sharma	T-5 (Tech. Officer)
4.	Ms. Rita Rani	T-6 (Tech. Officer)
5.	Sh. Charan Singh	T-7-8 (Tech. Officer)
6.	Sh. Rajiv Mathur	T-7-8 (Tech. Officer)
7.	Dr. C S Raghav	T-7-8 (Tech. Officer)
8.	Sh. S P Singh	T-7-8 (Tech. Officer)
9.	Sh. Ram Prasad Yadav	T-7-8 (Tech. Officer)
10.	Ms Poonam Suneja	T-7-8 (Tech. Officer)
11.	Sh. Rakesh Singh	T-6 (Tech. Officer)
12.	Sh. Mahabir Singh Rathore	T-6 (Tech. Officer)
13.	Sh. Harinder Singh	T-6 (Tech. Officer)
14.	Sh. Ram Singh	T-6 (Tech. Officer)
15.	Sh. K D Joshi	T-7-8 (Tech. Officer)
16.	Sh. Daya Shankar	T-6 (Tech. Officer)
17.	Dr. Rajiv Gambir	T-7-8 (Tech. Officer)
18.	Dr. Dinesh Chand	T-7-8 (Tech. Officer)
19.	Sh. Ashok Kumar Maurya	T-7-8 (Tech. Officer)
20.	Sh. Surender Singh Ranga	T-7-8 (Tech. Officer)
21.	Sh. Axma Dutt Sharma	T-6 (Tech. Officer)
22.	Sh. Bharat Lal Meena	T-6 (Tech. Officer)
23.	Sh. Dinesh Chand Mishra	T-4 (Tech. Officer)
24.	Ms. Rita Gupta	T-5 (Tech. Officer)
25.	Sh. Rajiv Singh	T-6 (Tech. Officer)
26.	Sh. Dinesh Kumar Pokhrial	T-2 (Lab. Asstt.)
27.	Sh. Rohtash Singh	T-2 (Lab. Asstt.)
28.	Sh. Babu Ram	T-6 (Tech. Officer)
29.	Mrs Sangeeta Tanwar	T-6 (Tech. Officer)
30.	Dr. Narendra Singh Panwar	T-6 (Tech. Officer)
31.	Sh. R S Yadav	T-5 (Tech. Officer)
32.	Sh. Devendra Kumar Nerwal	T-6 (Tech. Officer)
33.	Smt Gurvinder Khera	T-4 (Telephone Operator)
34.	Sh. Bhopal Singh Panwar	T-6 (Tech. Officer)
35.	Sh. Y S Rathi	T-6 (Tech. Officer)
36.	Sh. Ombir Singh Ahlawat	T-6 (Fieldman)
37.	Sh. Om Prakash (Library)	T-5 (Lab. Tech.)
38.	Sh. Satya Prakash	T-5 (Elec./Mech.)
39.	Sh. Surender Singh Bhoj	T-4 (Lab. Tech.)
40.	Sh. Narendra Pal	T-5 (Tech. Asstt.)
41.	Sh. Parmesh Kumar	T-5 (Tech. Asstt.)
42.	Sh. Anang Pal	T-5 (Tech. Asstt.)
43.	Sh. Ram Chander Yadav	T-5 (Fieldman)
44.	Sh. Bhawnesh Kumar	T-4 (Fieldman)
45.	Sh. Gopi Chand	T-4 (Fieldman)
46.	Sh. Ramesh Chander	T-5 (Lab. Asstt.)
47.	Sh. Ram Kumar Sharma	T-5 (Fieldman)
48.	Sh. Arun Kumar Sharma	T-4 (Lab. Asstt.)
49.	Sh. Dharam Pal Singh Meena	T-5 (Fieldman)
50.	Sh. Ram Kuwar (till 31 August, 2011)	T-2 (Fieldman)
51.	Sh. Om Prakash	T-3 (Fieldman)
52.	Sh. Dilawar Singh	T-2 (Lab. Tech.)
53.	Sh. Lal Singh	T-3 (Electrician)
54.	Mrs Nirmala Dabral	T-4
55.	Sh Punam Chand Binda	T-3
56.	Sh. Shashi Kant Sharma	T-3
57.	Sh. Ram Milan	T-1
58.	Sh. Vijay kumar Mandal	T-2
59.	Sh. Ram Nandan	T-2
60.	Sh. Harideo Prasad	T-2
61.	Sh. Naresh Kumar	T-2
62.	Sh. Sunil Kumar	T-3
63.	Mrs Smita Jain	T-5
64.	Sh. S K Ojha	T-2
Drivers (Headquarter/Reg. Station/ Base Centre)		
65	Sh. Kishan Nath	T-5, New Delhi
66	Sh. Govardhan Singh	T-4, Jodhpur
67	Sh. Balwant Singh	T-3, New Delhi
68	Sh. Braham Prakash	T-4, New Delhi
69	Sh. E N Prabhakaran	T-2, Thrissur
70	Sh. Joginder Singh	T-3, Shimla
71	Sh. Khushvinder Kumar	T-2, New Delhi
72	Sh. L T Dabekar	T-2, Akola
73	Sh. Mohd. Abas Ali Khan	T-2, Hyderabad
74	Sh. Mohan Ram	T-2, Bhowali
75	Sh. Narendra Ram	T-3, Ranchi
76	Sh. Ram Balak Rai	T-2, New Delhi
77	Sh. Ravinder Kumar	T-2, New Delhi
78	Sh. Dev Sunder	T-2, (Tractor Driver)
79	Sh. Wazir Singh	T-2, New Delhi
80	Sh. Ranjit Singh	T-2, New Delhi

81	Sh. Gopal Singh	T- 1, New Delhi
NBPGR Regional Station, Akola		
82	Sh. J K Ingle	T-6 (Tech. Officer)
NBPGR, Regional Station, Bhowali		
83	Sh. A S Rana	T-5 (Tech. Officer)
84	Sh. Rattan Ram Arya	T-5 (Tech. Officer)
85	Sh. Ramit Joshi	T-3 (Fieldman)
86	Sh. P S Mehta	T-6 (Tech. Officer)
NBPGR, Regional Station, Hyderabad		
87	Sh. Babu Abraham	T-5 (Tech. Officer)
88	Sh. R Gunasekharan	T-5 (Tech. Officer)
NBPGR, Regional Station, Jodhpur		
89	Sh. B C Bachhawandia	T-6 (Tech. Officer)
90	Sh. Bhatta Ram	T-4 (Expl. Asstt.)
NBPGR, Regional Station, Ranchi		
91	Sh. Ashok Kumar Gupta	T-5 (Tech Officer)

NBPGR, Regional Station, Shillong		
92	Sh. M Goswami	T-4 (Expl. Asstt.)
93	Sh. S N Sharma	T-3 (Fieldman)
94	Sh. Sanjeev Kumar Singh	T-4
NBPGR, Regional Station, Shimla		
95	Sh. Brij Pal Singh	T-6 (Tech. Officer)
96	Sh. Prakash Chand	T-3 (Fieldman)
97	Sh. Ram Chander	T-2
NBPGR, Regional Station, Thrissur		
98	Sh. R Ashokan Nair	T-6 (Tech. Officer)
99	Sh. S Mani	T-6 (Tech. Officer)
100	Sh. T T Vellaudhan	T-4 (Fieldman)
101	Mrs. Indira Devi	T-6
NBPGR, Regional Station, Srinagar		
102	Sh Diksha Gautham	T-4

(iii) Administrative Staff at HQs and Regional Stations

S.No.	Name	Designation
1.	Ms. Sunita Sharma	Sr.A O
2.	Sh.S K Sinha (w.e.f August 27, 2011)	Sr A O
3.	Sh. B K Bansal	F & AO
4.	Sh. Girish Chandra Chandola	A. A. O.
5.	Mrs. Archna Raghav, Delhi	A.D. (OL)
6.	Sh. Umesh Chandra Sati	Security Officer
7.	Sh. M. K. Ahuja	A F&AO
8.	Sh Madan Lal Malik, Delhi	DDO
9.	Sh. Kulwant Singh, Delhi	AAO
10.	Mrs. Vijay Laxmi Gulati, Delhi	AAO
11.	Sh. Nandan Singh Patwal, Bhowali	AAO
12.	Sh. Din Dayal, Delhi	AAO
13.	Sh. S.S. Wange, Akola	AAO
14.	Mrs. Vinay Bala Sharma, Delhi	Assistant
15.	Mrs Kuljeet Kaur, Delhi	Assistant
16.	Ms. Pratibha, Shimla	Assistant
17.	Mrs. Yashoda Rani, Delhi	Assistant
18.	Sh. Dinesh Prasad, Delhi	Assistant
19.	Ms Sangeeta Gambhir, Delhi	Assistant
20.	Mrs. Surinder Kaur, Delhi	Assistant
21.	Sh. Surender Kumar, Delhi	Assistant
22.	Mrs. Bharti Sharma, Delhi	Assistant
23.	Mrs. Savitri Devi, Delhi	Assistant
24.	Mrs Vijay Laxmi Sharma, Delhi	Assistant
25.	Sh. Mahabir Singh Yadav, Delhi	Assistant
26.	Mrs. Leela Sharma, Jodhpur	Assistant
27.	Mrs. Radha Rani, Hyderabad	Assistant
28.	Sh. Yogesh Kumar, Delhi	Assistant
29.	Sh. Purushottam Dhoke, Akola	Assistant
30.	Mrs Satvinder Kaur, Delhi	Assistant
31.	Mrs Madhu Bala, Delhi	Assistant
32.	Sh. Prabal Dasgupta, Delhi	Assistant
33.	Sh. Dinesh Sharma, Delhi	Assistant
34.	Mr. M. Srinivasa Rao, Hyderabad	Assistant
35.	Sh. Avdhesh Kumar, Delhi	Assistant
36.	Sh. Sanjay Kumar Lal, Delhi	Sr. Clerk
37.	Sh. Benny Mathew, Thrissur	Sr. Clerk
38.	Mrs. Lakshmilian Kharnary, Shillong	Sr. Clerk
39.	Sh. J.K. Singh, Delhi	Sr. Clerk
40.	Sh. Sanjay Dangwal, Delhi	Sr. Clerk
41.	Sh. Arvind Kumar, Delhi	Sr. Clerk
42.	Sh. K. C. Kundu, Delhi	Sr. Clerk
43.	Sh. P. Suleman, Hyderabad	Sr. Clerk
44.	Sh. T.V. Govindon (Thrissur)	Stenographer
45.	Ms. R.S. Latha Devdas, Delhi	Stenographer
46.	Ms. Graciously Dkhar (Shillong)	Stenographer

47.	Ms. Kanchan Khurana, Delhi	Stenographer
48.	Ms. V. Vijayalaxmi, Delhi	Stenographer
49.	Sh. Ganga Nand, Delhi	Stenographer
50.	Mrs. Urmila, Delhi	Stenographer

51.	Mrs. Neelam Khatri, Delhi	Stenographer
52.	Mrs. Poonam Batra, Delhi	Stenographer
53.	Sh. Rameshwar Dayal, Delhi	Jr. Clerk
54.	Sh. Dev Kumar, Delhi	Jr. Clerk

20.6 Staff Reservations

Category	Total number of Employees	Total number of Scheduled Caste (SC) Employees	Total number of Scheduled Tribe (ST) Employees	Total number of OBC Employees
Scientist	117	10	-	8
Technical	89	14	3	6
Administrative	57	12	3	1
Supporting	86	31	4	11

20.7 Staff Transferred/ Retired/ New Appointments

20.7.1 Transfers

- Dr. Rajan, Principal Scientist, Division of Plant Quarantine, NBPGR, New Delhi transferred to ICAR HQ w.e.f January 7
- Dr. Gunjeet Kumar, Senior Scientist, Division of Evaluation, NBPGR, New Delhi transferred to IARI, New Delhi w.e.f March 22.
- Dr. K S Varaprasad was relieved as OIC, NBPGR RS Hyderabad to new post as Director, Directorate of Oilseeds Research, w.e.f. of April 30
- Sh. S.K. Sinha, joined as Senior Administrative Officer, NBPGR, New Delhi on transfer from CRRI, Cuttack on August 27.
- Sh. Dharam Singh Meena, Technical Officer, T-6 joined NBPGR, New Delhi on transfer from CRRI, Cuttack on September 1.
- Sh. Goverdhan Singh (T-4), Driver, transferred from NBPGR, New Delhi to NBPGR R/S Jodhpur w.e.f October 31.
- Sh. Gopal Singh, Driver, transferred from NBPGR R/S Shillong to NBPGR, New Delhi to w.e.f November 8.

20.7.2 Retirements

- Dr. Sidheshwar Prasad, Senior Scientist, Division of Conservation, Sh. Gopi Chand, T-4, and Sh. Ram Milon, T-2, Division of Germplasm Evaluation, NBPGR, New Delhi retired on January 31.
- Sh. Sher Singh, SSGR-III retired on January 31.
- Sh. A.S. Rana, Techncial Officer (T-5) retired on February 28.
- Sh. I.V. Ramachandran, SSS, NBPGR, R/S Thrissur, retired on April 30.
- Sh. K.C. Muneem, Principal Scientist (Plant Pathology), NBPGR, R/S Bhowali, retired on June 30.
- Dr. Manju Upreti, Technical Officer (T-7-8), NBPGR, New Delhi, retired on June 30.
- Dr. V D Verma, Principal Scientist took voluntary retirement on July 27.
- Dr. S.K. Pareek, Principal Scientist (Agronomy), Division of Germplasm Evaluation, NBPGR, New Delhi, retired on July 30.
- Dr. Beche Lal, Principal Scientist (Entomology), Division of Plant Quarantine, NBPGR, New Delhi, retired on July 30.
- Sh. Ram Kunwar, T-2, retired on August 31.
- Sh. Mahavir Singh Rana, SSS, took volutary retirement w.e.f. August 2.
- Sh. S.K. Gupta, Administrative Officer, NBPGR, New Delhi retired on December 31.

20.7.3 New Appointments

- Dr. Manas Kumar Bag joined as Senior Scientist in the Division of Germplasm Evaluation, NBPGR, New Delhi w e.f January 11.
- Dr. Arvindaram Kandan, joined as Senior Scientist in the Division of Plant Quarantine, NBPGR, New Delhi w.e.f. February 26.
- Dr. (Ms) Rashmi Yadav joined Division of Germplasm Evaluation, NBPGR, New Delhi, as Senior Scientist (Agronomy) w.e.f. October 21.
- Dr. (Ms) Suma A. joined NBPGR, New Delhi, as Scientist (Economic Botany) w.e.f. December 23.
- Ms Sheel Yadav joined NBPGR, New Delhi, as Scientist (Plant Biotechnology) w.e.f. December 24.

20.8 Promotions of Staff

- Sh. Rakesh Singh promoted as T 7-8 w.e.f. January 1, 2010.
- Sh. Devender Kumar Narwal, Nirmala Dabral, Om Prakash and Sunil Kumar from NBPGR, New Delhi promoted to the next higher grade in the Laboratory Technician Category I functional group.
- Sh. Gopal Singh, R/S Shillong, M. Venkata Ramana Reddy, R/S Hyderabad, Satya Prakash, NBPGR, New Delhi and Joginder Singh, R/S Shimla promoted to the next higher grade in the Workshop functional group.
- Sh, Ram Kumar Sharma and Ram Chander Yadav Division of Germpasm Evaluation, NBPGR New Delhi; Bhopal Singh Panwar and Narendra Pal, Issapur Farm; Dharampal Singh Meena and Anang Pal, Tissue Culture and Cryopreservation Unit, NBPGR New Delhi promoted to the next higher grade in the Field/ Farm Technicians functional group.
- Dr. S.K. Chakrabarty, Principal Scientist (Plant Pathology) has taken over as Officer-in-Charge, NBPGR R/S Hyderabad w.e.f. afternoon of April 30.
- Sh. S.S. Wange, Assistant, NBPGR, R/S Akola, promoted as Assistant Administrative Officer w.e.f. March 31, 2011.
- Sh. P.L. Dhoke, Senior Clerk, NBPGR, R/S Akola, promoted as Assistant w.e.f. March 31, 2011
- Ms. Radha Rani, UDC, NBPGR R/S Hyderabad was promoted to Assistant w.e.f March 30, 2011
- Dr. J.C. Rana, Principal Scientist, became Officer-in-Charge, NBPGR R/S Shimla w.e.f. June 6.
- Dr. S.K. Verma, Principal Scientist, became Officer-in-Charge, NBPGR R/S Bhowali w.e.f. December 29.
- Dr. A.K. Mishra, Principal Scientist, became Officer-in-Charge, NBPGR R/S Shillong w.e.f. December 29.
- Dr. (Ms) M. Latha, NBPGR R.S Thrissur, promoted from Scientist (Selection Grade) to Senior Scientist w.e.f. August 31, 2010.
- Dr. (Ms) Lalit Arya, NBPGR, New Delhi, promoted from Scientist (Selection Grade) to Senior Scientist w.e.f. April 20, 2010.
- Dr. N. Dixit, NBPGR R/S Akola promoted from Scientist (Selection Grade) to Senior Scientist.
- Sh. Y.S. Rathi, NBPGR, New Delhi; promoted from T-5 to T-6.
- Sh. Ramesh Chandra, Bhuvnesh Kumar, Gopi Chand, NBPGR, New Delhi; Bhatta Ram, NBPGR R/S Jodhpur, promoted from T-4 to T-5.
- Sh. Om Prakash, Brahm Prakash, NBPGR, New Delhi; Dev Sunder, NBPGR, Issapur Farm; Gordhan Singh, NBPGR R/ S Jodhpur, promoted from T-3 to T-4.
- Sh. Ranjit Singh Mehra, NBPGR, New Delhi; Ram Kumar, Dilawar Singh, NBPGR, Issapur Farm; Prakash Chand, NBPGR R/S Shimla; promoted from T-2 to T-3.
- Sh. S.K. Ojha, NBPGR, New Delhi, promoted from T-1 to T-2.

20.9 Awards/ Honours/ Prizes

- Prof. K.C. Bansal, Director, NBPGR, received the Recognition Award by NAAS for his outstanding contribution in Crop Sciences, during in the Inaugural

Session of X Agricultural Science Congress, held on 10-12th February at NBFGR, Lucknow.

- Dr. Anirban Roy, Senior Scientist, Division of Germpasm Evaluation, NBPGR New Delhi, received NAAS Young Scientist Award for his outstanding contribution in the field of Plant Protection in the Inaugural Session of X Agricultural Science Congress held on 10-12th February at NBFGR, Lucknow.

- Dr. Anirban Roy, Senior Scientist, (Plant Pathology) was selected as Associate of National Academy of Agricultural Sciences, New Delhi for the period 2012-16.

- Dr. T V Prasad, Senior Scientist, (Entomology) was awarded Young Scientist Award for the Year 2010 for his significant contribution in the field of Plant Protection by the Applied Zoological Researchers Association, Cuttack , Odisha.

- Dr. Vandana Tyagi received Scientist of the Year Award - 2011 from Scientific and Applied Research Centre (SARC), Meerut UP in the National Symposium on 14.9.2011.

- Dr. SK Yadav received Distinguished Scientist Award - 2011 for outstanding contribution in the field of Vegetable Science from Scientific and Applied Research Centre (SARC), Meerut UP in the National Symposium on 14.9.2011

- Dr. Monendra Grover received the Distinguished Bioinformatician Award by the Society of Applied Biotechnology.

- Dr. N Sivaraj was awarded the "Talented Scientist Award' during the 2nd International Seminar on Medicinal Plants and Herbal Products 2010 held at S.V. University, Tirupati

- Dr. Rakesh Singh, Senior Scientist, NBPGR, New Delhi was awarded the prestigious competitive DBT-CREST Fellowship for 2010-2011 by Department of Biotechnology, Govt. of India, to undergo training

NBPGR receives 'Krishi Sansthan Samman' Award

NBPGR (NBPGR) has won the first 'Krishi Sansthan Samman' (Public Sector Organization of the Year) Award as part of Mahindra Samriddhi India Agri Awards 2011 instituted by Farm Equipment Sector of Mahindra & Mahindra, Ltd. in partnership with Zee News. The Mahindra Samriddhi India Agri Awards is a platform to recognize purposeful contributions, made by individuals and institutions, in the field of agriculture. This honour is bestowed upon farmers and institutions to recognize their noteworthy and purposeful contributions to the field of agriculture, the backbone of the Indian economy. The idea is to share best practices in agriculture for a larger community benefit towards the development of Indian agriculture, thereby enhancing rural prosperity.

The first Mahindra Samriddhi India Agri leadership awards were presented in six categories - Farmer of the Year Award (Male), Farmer of the Year Award (Lady), 'Krishi Sansthan Samman', 'Krishi Shiksha Samman', 'Krishi Sahyog Samman' and 'Krishi Shiromani Samman'. NBPGR won the national level award in the 'Krishi Sansthan Samman' category, which is recognition for public sector organization committed to a broad policy on agriculture that has become instrumental in changing the lives of hundreds of farmers. The criteria for selection comprised impact of technology/ policy in formulation of innovative farming, sustainability and scalability. The awards were judged by an eminent jury chaired by Mr. P.K. Basu, Secretary, DAC, Ministry of Agriculture.

Hon'ble Minister of Agriculture, Mr Sharad Pawar was the Chief Guest at the awards ceremony held on February 21 at Ashoka Hotel, New Delhi. Professor K.C. Bansal, Director, NBPGR received the award on behalf of NBPGR, which comprised a citation, a trophy and cash prize of Rs 2,11,000. The award is a salute and recognition to the service rendered by all the past and present staff of NBPGR in management of PGR.

NBPGR received the 'Krishi Sanasthan Award' during the award function of Mahindra Samriddhi India Agri Awards 2011 along with Dr. M.S. Swaminathan


Prof. K.C. Bansal and Dr. Anirban Roy receiving award from Mr B.L. Joshi, Hon'ble Governor of Uttar Pradesh and Mr Harish Rawat, Hon'ble Union Minister of State for Agriculture

in the emerging area of biotechnology aimed at crop improvement. Additionally, he also has been conferred 'Young Scientist Award' by Society for Plant Research, S.V.P. University of Agriculture and Technology, Meerut, for his significant contributions in the field of Crop Biotechnology.

20.10 Deputations Abroad

1. Dr. Gurinder Jit Randhawa participated in Third Regional Workshop to exchange of information on GMO detection practices and techniques and their progressive harmonization at regional level, at Beirut, Lebanon, sponsored by FAO, Rome and two presentations were made on Harmonization of GMO Detection Strategies at Regional and Global Level and Biosafety Clearing House in India, and also chaired the plenary session from January 24-27.

2. Prof. K.C. Bansal, Director, NBPGR, participated in the Governing Body Meeting of the ITPGRFA, Philippinnes, March 12-18.

3. Dr. Sushil Pandey was deputed as International Seed Expert by Food and Agriculture Organization of the United Nations for participation in 'Expert Consultation Workshop on Seed Policy Formulation in INRAN/ENSA' held in Milan, Italy and delivered invited lecture on "Seed Policy Implementation in India" during March 28-30.

4. Dr. Gurinder Jit Randhawa participated in 15th European networking on GM detection Laboratories (ENGL) and also participated in the discussion on Low Level of Presence of transgenes at Ispra, Italy, sponsored by European Commission, Brussels, Belgium in May.

5. Prof. K.C. Bansal, Director, NBPGR, visited ICARDA, Syria to discuss and prepare a concept note on 'Centre of Excellence for Dryland Production Systems', May 21-26.

6. Dr. Tapan Kumar Mondal, Senior Scientist of NRC DNA Fingerprinting was deputed at Department of Crop Science, University of Illinois, Urbana-Champaign, USA under NAIP sponsored international training on, "Analysis of nitrogen use efficiency gene of Maize by next generation sequencing technology" from June 1- September 30.

7. Prof. K.C. Bansal Director, NBPGR, visited Bioversity International, Rome, Italy to participate in a series of meetings regarding future collaboration between Bioversity International and the Indian Council of Agricultural Research, June 26-27.

8. Dr. Sandhya Gupta, Chaired a session on 'Technique Development' and made an oral presentation on 'Cryopreservation of Apricot Dormant Bud using Droplet Freezing Method' in the 'First International Symposium on Cryopreservation of Horticultural Crops in China' held in Yangling, China, from 28-30 June.

9. Dr. Sandhya Gupta, delivered a lecture on 'Cryopreservation of Plant Genetic Resources at NBPGR' and presented a poster on 'Cryopreservation of Apple Genetic Resources using Dormant Buds' in 48th Annual Meeting of the Society for Cryobiology (CRYO 2011) held at Corvallis, USA during July 24-27.

10. Dr. Gurinder Jit Randhawa under exchange visit to National Institute of Biology (NIB) Ljubljana, under Indo-Slovenian Inter Governmental Programme of Cooperation in Science and Technology, Department of Science and Technology (DST) for bilateral project Novel cost-effective methods for GMO detection from September1-30.

11. Dr. Archana P. Raina, Senior Scientist attended training on "GC/MS Maintenance and Troubleshooting" at Agilent Technologies Life Sciences and Chemical Division at Singapore from September 19-21.

12. Dr. K.C. Bansal, Director, NBPGR, visited Tsukuba, Japan to participate in the National Focal Points meeting of Project GCP/RAS/240/JPN, FAO-NIAS International Symposium on 'Plant Genetic Resources in Asia and the Pacific Impacts and Future Directions' and study tour related to plant genetic resources from October 16-20.

13. Dr. Kavita Gupta was deputed to participate in the Expert Consultation on Biotechnology, Biosafety and Biosecurity organized by APAARI and Ministry of Agriculture and Cooperation, Chinese Taipei held at Taiwan Agricultural Research Institute (TARI), Taichung, Chinese Taipei on October 27– 28.

14. Dr. V. Celia Chalam was deputed for training at National Institute for Microbial Forensics & Food and Agricultural Biosecurity, Department of Entomology and Plant Pathology, Oklahoma State University, Stilwater, USA in the area of Biosecurity (recent techniques for detection of plant viruses in quarantine) from October 31, 2011 to January 28, 2012.

15. Dr. M. Dutta, Head, Germplasm Evaluation Division participated in the Workshop on the Implementation of the SUWON Agro-Biodiversity Framework Through Strengthened Regional Collaboration at Kuala Lumpur, Malaysia during November 2-6.

16. Dr. R K Tyagi participated in Genebank Managers' Meeting on consultation on GENESYS portal system organized by Bioversity International, GCDT and CIMMYT at CIMMYT El Batan, Mexico to discuss and provide inputs for application and functionality of the portal for information management from December 6-9.

20.11 Library and Documentation Services

NBPGR library is a special library on plant genetic resource management. Scientists, technical staff, research associates, students and trainees were regular users of the library. Library maintained its designated services and activities of acquisition of books and journals, exchange of literature, development of library collection database, circulation, reference services and documentation. NBPGR Library is one of the members of ICAR Cera Consortium, so all scientists and technical have facilities of accessing the on-line journals. Library also subscribed "Oxford University Press" on-line journals for life science for their members. Newspaper clipping services related to PGR and its related subjects were provided to readers regularly. During the year, 563 books related to various aspects of PGR management and Hindi literature was added to Headquarter and Regional station libraries through purchase and exchange basis. Library procured 70 journals including 34 international journals and 36 Indian through subscription/ gift and exchange for the use at the Headquarter and different regional stations. Five new journals have been started for 2011. Library possesses AGRIS, AGRICOLA, CABSAC, CAB-CD and Plant GENE database. Bureau's publications were provided to over 242 different organization in India and abroad and in return 250 publications as gratis received from various organizations. NBPGR Annual reports, Newsletter, Crop Catalogues, Brochures and other publications were distributed to various trainees and visitors from India and abroad.

20.12 Field Days & Biodiversity Fair Organized

20.12.1 Germplasm Field Day on *Rabi* Oilseeds: A Germplasm Field Day on *Brassica* (Rapeseed-Mustard) was organized at NBPGR Experimental Farm, Issapur and IARI New Area Farm, New Delhi on 28 Febraury

Field Day on *Rabi* Pulses

Field Day on *Rabi* Oilseeds

Farm Innovators' Meet

Felicitating innovative farmers during the "Farm Innovators' Meet" held at Issapur (From L to R, Progressi . Malhotra, Dr. J.S. Sandhu, Dr. K.C. Bansal, Prof. Swapan K. Datta, Mr Bharat Singh and Dr. M. Dutta)

A "Farm Innovators' Meet" was organized on 28 February, 2011 on National Science Day at NBPGR, Experimental Farm, Issapur, New Delhi to commemorate a decade of innovation in the Indian Council of Agricultural Research (ICAR) by recognizing Indian farmers for their genius and innovative ideas that have ultimately led to the significant progress of Indian Agriculture. More than 200 farmers, scientists and representatives of development agencies participated in this function. A total of 39 farmers from Rajasthan, Uttarakhand, Himachal Pradesh, Haryana and Delhi were felicitated for maintaining and promoting the use of landraces of different crops/ animals/ fish genetic resources and associated technologies related to conservation of agriculture. The farmers shared their experiences on development of new technologies/innovations made by them like conservation and utilization of neglected and underutilized species, organic farming, water conservation, fruit and vegetable cultivation and processing, beekeeping, Emu farming etc. as a source of their livelihood and income. Professor Swapan K. Datta, Deputy Director General (Crop Sciences) was the Chief Guest of the function in which local farmers and their leaders were also present.

2011 and 1 March 2011 respectively. A total of 29 scientists from different ICAR institutes, State Agricultural Universities and other institutions participated. During field visit, scientists selected promising germplasm for different traits to utilize in rapeseed mustard improvement programme.

20.12.2 Germplasm Field Day on *Rabi* Pulse Crops: A Germplasm Field Day on Rabi Pulse Crops was organized on 15 March, 2011 to promote germplasm utilization by the breeders. A total number of 25 participants from different parts of the country belonging to ICAR institutes, State Agricultural Universities, Govt. Departments, NGOs and private organizations participated in the germplasm field day. The scientists/ research workers selected the material of their choice and placed indents.

20.12.3 Germplasm Field Day on Wheat, Barley and *Triticale:* A Germplasm Field Day on wheat, barley and triticale was organized on 29 March, 2011 for on the spot assessment of diversity and selection of exotic germplasm for using in the breeding programme. A total of 105 scientists from different SAUs, ICAR institutes and Private Seed Companies participated in the field day. A total of 38 indents were received for seed supply.

20.12.4 Germplasm Field Day on Wheat organized at IARI Regional Station, Wellington : More than 16,000 accessions of wheat conserved in the National Gene Bank were multiplied during offseason at IARI Regional Station, Wellington. A Germplasm Field Day was organized on 21 August, 2011 with the objective to show the genetic variability in wheat genetic resources. Dr. J S Sandhu, ADG (Seeds) and Dr. Indu Sharma,

Field Day on Wheat, Barley and *Triticale*

Field Day on Wheat at Wellington

Project Director, DWR, Karnal participated in the event along with HoDs of NBPGR. About 100 participants including policy makers, breeders and farmers from 30 organizations attended the field day. It was a unique opportunity for wheat workers to observe the variability in large number of indigenous and exotic accessions of wheat and further to select germplasm of their interest.

20.12.5 Germplasm Field Day on Maize and Okra: A Germplasm Field Day on maize and okra was organized on 14 September, 2011 at IARI New Area Farm, New Delhi. Thirty five participants from different parts of the country belonging to ICAR institutes, State Agricultural Universities and private organizations participated in the germplasm field day. Besides, the senior officers of NBPGR; Dr. J S Sandhu, ADG (Seeds).

20.12.6 Germplasm Field Day on Pulses: A Pulses germplasm field day was organized at NBPGR, RS, Hyderabad on 25 August, 2011. Six participants from various research stations of Acharya N.G.Ranga Agricultural University participated in the field day. Germplasm displayed in the field were 185 accessions of Greengram, 113 accessions of Black gram and 45 accessions of cowpea. Priorities for selecting germplasm: Green gram (resistance to yellow vein mosaic, early maturing, synchronous flowering, Plant type suitable for mechanical harvesting, pre-harvest sprouting and bold and shiny seeded types), black gram (Resistance to yellow vein mosaic, podding on the main branch, bold and shiny seeded types and determinate types), cowpea (bushy type, medium bold seed, brown and white colour seeds and early duration upto 90 days).

20.12.7 Germplasm Field Day at Jodhpur: A germplasm field day was organized on 12 October, 2011 at Jodhpur. A total of 61 participants from ICAR institutes and organizations CAZRI (11), KVK (02), AICPMIP Mandor (1), Zonal Coordinator (02), JNVU, University (04), PG Mahila College (02), SADU Gujarat (01), M.Sc. students (03) and Farmers from nearby villages (37). In all, 15 Fields/ 4,907 accessions of various crops, namely, mung (800), moth (603), bajra (2312), cowpea (267), guar (627), Til (211) & NAIP-maize (68), sorghum (08), urd (04) and horsegram (01) + *Aloe vera* were screened by the participants.

20.12.8 Grass-root level training: To conserve and promote the cultivation of traditional crops and landraces of rice, maize, rajmash, and mash a grass-root level training was organized at Chamba.

PGR exhibition: Two PGR exhibitions were organized at Shimla from 1-4 June, 2011 in the SAGES Biodiversity Awareness programme and at Una from 23-27 November, 2011 in the Children Science Congress.

Discussion with Farmers - Bajra Crop

20.12.9 Trainings by RS Bhowali: One day training programme on Kiwi fruit production was organized at village Talwadi Estate, Block Tharali, Distt. Chamoli, UK under HMNEH MM-I on dated 15/12/2011. In this training programme, scientists, technicals of NBPGR, R/S Bhowali imparted a training programme on various aspects of kiwi production. In this programme the state government personnel viz., Block Head (02), Block Development Officer (01), In-Charge Horticulture Mobile Team (02), Block Panchayat Members (02), including 05 Gram pradhan and more than 135 farmers from 21 villages (ladies – 10 nos.and gents – 125 nos.) of Block Tharali, Distt. Chamoli, Uttarakhand have participated with great zeal and enthusiasm. A total of 300 grafted plants (2 each, male and female) were distributed free of cost for demonstration to the participated farmers and state government personnel.

Another two days training programme conducted on various aspects of vegetable production i.e., vegetable seed production, IPM management, vegetables seed production in nursery management, low cost method for vegetable production in hills and vegetable production in poly house and in natural condition as requested by District Project Manger, Almora under ULIPH Programme at NBPGR, R/S Bhowali w.e.f. May 27-28, 2011. A total of 21 farmers (female-12 + male-09) from 08 villages of District, Almora were participated in the said training programme.

Participants of the One day Kiwi training programme at Village Talwadi Estate, Chamoli, Uttarakhand

20.12.10 Biodiversity Fair cum Grassroot Level Awareness Programme on Plant Genetic Resources Conservation: It was organized by NBPGR Regional Station, Hyderabad in collaboration with Sanjeevini –an NGO, which has been working since 1998 among the tribal community of the region on the issues related to environment, food security and livelihood security, on 23rd January, 2011 at Arakuvalley, Visakhapatnam district of Andhra Pradesh. The programme was organized with the financial assistance from Tribal Support Project.A quiz programme on the agri-biodiversity wealth was organized which highlighted the various landraces and associated ITK.The winners in the quiz programme, the best agri-biodiversity conservers and grassroot ambassadors from Sanjeevani were felicitated towards the end of the programme. A total of 130 tribal farmers/members from local NGOs/ local line departments participated in the programme.

Biodiversity fair organised by RS Hyderabad at Arakuvalley

Breeders making selections during pulses field day at RS Hyderabad

20.12.11 International Day for Biological Diversity Celebrated

NBPGR, New Delhi, celebrated this year's International Day for Biological Diversity (IDB) on May 21, by holding an open day for school students with the aim to generate awareness amongst the youth about biodiversity. The theme for celebration was in line with this year's IDB theme, '*Forest Biodiversity: Earth's Living Treasure'.* The theme was a collaboration between the *Secretariat of the Convention of Biological Diversity (CBD)* and *the United Nations'* proclamation of 'Forest 2011: Forest for People' to raise awareness on sustainable management, conservation and sustainable development of all types of forests. The IDB 2011 theme lays emphasis on the importance of biodiversity in contributing to resilient forest ecosystems; and man's central role in management and conservation of forest biodiversity. The CBD Secretariat promoted all parties to the Convention to organize activities and events to celebrate the IDBD and to take advantage of it to showcase their work on biodiversity and forests, to raise public awareness and increase practical action.

About 115 students from 36 schools of Delhi participated in the IDB celebrations at NBPGR this year. The students were shown the activites being carried out by NBPGR. On this occasion, quiz and drawing competitions were organized which evoked great response from the students.

Prize winning painting

Children participating in a painting competition on the theme entitled 'Forests - The Living Treasure'

35th NBPGR Foundation Day Celebrated

On 1st August, the 35th Foundation Day of NBPGR was celebrated in a function attended by all its present and some former staff members. Dr. C.D. Mayee, Ex-Chairman (ASRB) was the Chief Guest and Prof. J.P. Khurana, Professor, Department of Molecular Biology, South Campus and Dr. P.L. Gautam, Chairman, PPVFRA, were the Guests of Honour. Prof. K.C. Bansal, Director, NBPGR, in his welcome address highlighted the major achievements of the Bureau during the last one year. He also described briefly the important plans for future activities at the Bureau. To encourage and motivate the staff, Dr. C.D. Mayee presented the Best Worker Awards to four employees, namely, Mr Bhawnesh Kumar (T-4), Mr Brahm Prakash (Driver, T-3) and Mr Brahm Dev Paswan (SSS) from headquarters and Mrs Pratibha Bhatt (Assistant, NBPGR, Shimla). Certificates of appreciation were given to eight employees by Dr. P.L. Gautam. These include Mr Arvind Kumar (LDC), Mr Dev Kumar (LDC), Mr Dilawar Singh (T-3, Issapur Farm), Mr Om Prakash (SSS, Issapur Farm) from headquarters, Mr R.R. Arya (T-5, NBPGR, Bhowali), Mr Gopal Singh (T-2, NBPGR, Shillong), Mr L.T. Dabekar (Driver, T-2) and Mr K.M. Premkumaran (SSS, NBPGR, Thrissur). Another category of special awards (certificates of appreciation instituted by the Director, NBPGR) were given to six employees by Prof. J.P. Khurana. These include Mr Rajiv Mathur (Technical Officer), Mr S.S. Ranga (Technical Officer), Mr Arun Sharma (Technical Assistant), Mrs Kanchan Khurana (Stenographer), Mr S.K. Ojha (T-2) and Mr Ranjeet Singh (Driver) from the headquarters. Dr. P.L. Gautam and Prof. J.P. Khurana, the Guests of Honour in their address emphasised the need to remain focussed and concentrate more on utilization of PGR. The Chief Guest released a CD entitled 'Digital Library on Bruchids' prepared by the Bureau and congratulated all the staff for their commendable contribution in making NBPGR visible at the global level. In his address he emphasised on the need to focus on enhancing national networking on acquisition, conservation, evaluation and utilization of crop germplasm, strengthening database on PGR information and monitoring national and international regulations in PGR policy to ensure efficient PGR management.

Prof K.C. Bansal, Director, NBPGR, presenting a memento to the Chief Guest, Dr. C.D. Mayee, in the presence of Guests of Honour, Dr. P.L.Gautam and Prof. J.P. Khurana and DDG (CS), Prof. S.K. Datta during the 35th Foundation Day of NBPGR

20.13 Workshops/ Group Meetings/ Trainings Organized during 2011

Title of the programme	Duration	Venue
Crop Gene Expression Data Analysis and Structural Bioinformatics	1-11 March, 2011	NBPGR, New Delhi
Germplasm Advisory Committee meeting on Forage Grasses and Range Legumes	19 April, 2011	NBPGR, New Delhi
Germplasm Advisory Committee meeting on Pulses and Arid Legumes	9 May, 2011	NBPGR, New Delhi
Training Course on Diagnostic Methods for Detection and Identification of Pests of Seed and Other Planting Material and their Management	18-28 May, 2011	NBPGR, New Delhi
Training on Vegetable Seed Production	27-28 May, 2011	NBPGR, R/S Bhowali
Germplasm Advisory Committee meeting on Oilseed Crops	3 June, 2011	NBPGR, New Delhi
Germplasm Advisory Committee meeting on Rice, Wheat and Barley	22 June, 2011	NBPGR, New Delhi
Forest Biotechnology	11 to 20 July, 2011	NBPGR, New Delhi
Delhi Zone Meeting and Symposium on "Recent Advances in Diagnostics of Plant Pathogens and Certification Procedures for Planting Material" of the Indian Phytopathological Society	9 September, 2011	NBPGR, New Delhi
International training course on '*In Vitro* and Cryopreservation Techniques for Conservation of Plant Genetic Resources'	14- 26 November, 2011	NBPGR, New Delhi
Molecular Diagnostics for Risk Assessment and Management of Genetically Modified Crops	8 to 21 November, 2011	NBPGR, New Delhi

GAC on Oilseed Crops Chaired by Dr. S. P. Tiwari

Participants and faculty of 'Forest Biotechnology' training programme

Director addressing the Trainees during the Inaugural Session of the Training on Diagnostic Methods for Detection and Identification of Pests of Seed and Other Planting Material and their Management

Participants of the Training Diagnostic Methods for Detection and Identification of Pests of Seed and Other Planting Material and their Management with the Faculty

Prof. S.K. Datta distributing certificate and e-manual to a trainee during the Training Course on Molecular Diagnostics for Risk Assessment and Management of Genetically Modified Crops

Trainees during a practical session of the training '*In Vitro* and Cryopreservation Techniques for Conservation of Plant Genetic Resources'

Participation in Pusa 'Krishi Vigyan Mela'

The annual 'Krishi Vigyan Mela' 2011 of Indian Agricultural Research Institute, New Delhi was held from 3-5 March. NBPGR actively participated in this event by displaying the activities at thematic pandal and also in the general display pandal. Handouts of all relevant literature like NBPGR brochure, Farmers' Rights, registration of germplasm, biodiversity day etc. were distributed. Scientists also participated in the 'Kisan Goshti'. A biodiversity kit comprising the varieties/ cultivars of cowpea, ricebean, amaranth, kankoda, guar, winged bean, foxtail millet, wheat etc. were distributed to 19 awardee farmers for use and demonstration at their farm since these varieties are fast disappearing from NARS. A competition was conducted for school children for identifying the various underutilized fruits of India to generate awareness about PGR. NBPGR stall was adjudged as the 'Best Display' which comprised of a medal and a certificate.

A view of the NBPGR stall

Prof. K.C. Bansal showing the display to Dr. P.L. Gautam, Chairperson, PPV&FRA Authority

20.14 Participation of Staff in Seminars/ Symposia/ Conferences/ Workshops/ Training Programmes

Name	Title of Seminar/ Symposium/ Conference/ Workshop/ Training programmes	Place and period
KS Varaprasad	Consultation Meet on role of NAARM in Changing R&D Perspectives	NAARM, Hyderabad, 6 January
DC Bhandari	98th Indian Science Congress -Agrobiodiversity Conservation and Sustainable Agricultural Development,	SRM University, Chennai, 7 January
KK Gangopadhyay	Training Programme on Data Analysis using SAS	IASRI, New Delhi, 10-15 January
SK Malik	Workshop on Awareness on Conservation of Biodiversity	College of Agriculture, Rewa, MP 18 January
N Dikshit	8th International Safflower Conference	Hyderabad, 19-23 January
N Sivaraj, SR Pandravada, Kamala V.,	Awareness Programme on Maintenance Breeding in Crop Improvement, DUS	ANGRAU, Hyderabad, 27-29 January
Babu Abraham, G Suresh Kumar	Testing for Registration and Protection of Varieties under PPV&FR Act and Geographical Indications: Identification and Process of Registration	
KK Gangopadhyay, SK Yadav	Annual Group Meet on AICRP on Vegetable Crops	JAU, Junagadh, 27-30 January
Kamala V.	Training Programme on Data analysis using SAS	IASRI, New Delhi, 31 January-5 February
V Celia Chalam	X Agricultural Science	NBFGR, Lucknow, 10-12 February
AK Trivedi	Congress on Soil Plant and Animal Health for Enhanced and Sustained Agricultural Productivity	
Rakesh Srivastava	Biotechnological Approach for the Enhanced Production of Nutraceuticals in Fruits and Vegetables	CIAH, Bikaner, 14-27 February
DP Semwal	Remote Sensing Applications in Agriculture with Special Emphasis on Enhanced Input Use Efficiency	IARI, New Delhi, 15 February - 11 March
Vandana Tyagi, S P Singh	Interactive Session Cum Workshop on Plant Quarantine Activities at India India Habitat Centre, New Delhi18	February 2011
Rekha Chaudhury	International Symposium on Genomics and Biodiversity	CCMB, Hyderabad, 22-27 February
Vandana Tyagi Rakesh Singh	Training Course on Creative Writing in Agriculture for Officers of ICAR	Indian Institute of Mass Communication, New Delhi, 28 February- 4 March
AK Trivedi, PS Mehta, RR Arya, SS Koranga, SN Ojha	One Day Sensitization and Awareness Programme of Protection of Plant Varieties and Farmers' Right Act	GBPUA&T, Pantnagar, 5 March
KS Negi, PS Mehta	III Thematic Annual Workshop of NAIP-IV	IIHR Bangalore, 7-8 March
N Sivaraj	Consultative Workshop on Strategies for Formulation of Forest Genetic Resources Management Network (FGRMN)	Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore 9-10 March
SR Pandravada, R Jairam	Sixth monthly interaction Workshop of NAIP Biodiversity Project on Harmonizing Biodiversity Conservation and Agricultural Intensification through Integration of Plant, Animal and Fish Genetic Resources for Livelihood Security in Fragile Ecosystems	ANGRAU, KVK, Adilabad, 9-10 March
Archana Raina	Workshop on Innovative Solutions to Production of Nutraceuticals and Functional Foods	IARI, New Delhi, 22-26 March

SK Yadav, R Jairam	2nd National Workshop of NAIP Project on Harmonizing Biodiversity Conservation and Agricultural Intensification through Integration of Plant, Animal and Fish Genetic Resources for Livelihood Security in Fragile Ecosystems	MPUAT, Udaipur, 23-24 March
M Abdul Nizar	Annual Group Meeting on Sunflower and Sesame & Niger	Dr. Panjabrao, Deshmukh Krishi Vidyapeeth, Akola, 24-26 March
KS Negi	Herbal Plant Workshop organized by ULIPHS, Aajivika	Almora, 28 March
KS Negi	Workshop on Mountain Agriculture in Himalayan Region: Status, Constraints and Potential	CSWCRTI, Dehradun, 2-3 April
Ashok Kumar	54th Workshop of AICRP on Maize	TNAU, Coimbatore, 2-4 April
M Dutta	National Training Course on New Frontiers in Jute and Allied Fibre Research and Technology Development	CRIJAF, Barrackpore, 6-17 April
NK Gautam	Annual Rice Research Workers' Group Meeting	DRR, Hyderabad, 9-11 April
M Abdul Nizar	Group Meet of AICRP on Underutilized Crops	CSK HPKV, Palampur, 27 April - 4 May
BS Phogat	Group Meet on AICRP on Underutilized Crops	CSK HPKV, Palampur, 1-2 May
M Dutta	Launching Workshop on III Phase of IFAD funded Research Project on On-farm Conservation on NUS	MSSRF, Chennai, 5-6 May
RK Bhardwaj	Training on Rapid and Non-destructive Evaluation of Food Quality and Safety Factors using Spectroscopy and Biosensing Methods	CIPHET, Ludhiana, 6-19 May
DR Pani	National Group Meet, *Kharif*-2011, AICRP on Forage Crops	OUAT, Bhubaneswar, 7-9 May
NK Dwivedi	Annual Workshop of NRP Arid Legumes	SD University, SK Nagar, Palanpur 20-21May
SK Chakrabarty, N Sivaraj, Kamala V.,	International Biodiversity Day celebrations organized by the Andhra Pradesh State	
B Abraham	Biodiversity Board	Hyderabad, 22 May
NK Dwivedi, AK Singh, Pancha Ram	One Day Workshop on Intellectual Property Rights (DST)	AFRI, Jodhpur, 25 May
SR Pandravada	Annual Group Meeting of AICRP on Castor	DOR, Hyderabad, 26-28 May
Kamala V.	Group Meet on Kharif Pulses (Pigeon Pea)	ANGRAU, Hyderabad, 31 May-2 June
N Sivaraj	Thematic Group Meeting on Evaluation of major Food and Horticultural Crops to Climatic Stresses and Genetic Enhancement of Tolerance	CRIDA, Hyderabad, 6 June
M Dutta, Mohar Singh	DAC-ICARDA-ICAR Annual Workshop on DAC Funded Projects under National Food Security Mission-Pre-breeding on Lentil and Chickpea	NASC Complex, New Delhi, 17-18 June
AK Singh	XXII National Workshop of AICRP on Spices	RAU, Jaipur Campus, Durgapura, 18-19 June
TV Prasad, M Arivalagan	Training Programme on Data Analysis of Natural Resource Management Research Using SAS under NAIP Consortium on Strengthening Statistical Computing for NARS	IASRI, New Delhi, 20-25 June
Kavita Gupta, Dinesh Chand	Interactive Session-cum-workshop on Plant Quarantine activities	NASC Complex, New Delhi, 24 June
M Abdul Nizar, N Sivaraj, NK Dwivedi, Z Abraham	National Workshop on NBPGR-NAGs Partnership for Efficient Management and Use of Plant Genetic Resources	NBPGR, New Delhi, 29-30 July

SK Chakrabarty, B Sarath Babu	Innovative Rice Farmers' Meet	DRR, Hyderabad,2 August
Ranbir Singh	XVIII Annual Research Workers Group Meeting on Rapeseed- Mustard	Assam Agricultural University, Guwahati, 5-7 August
AK Tirvedi	Brainstorming Session on Prioritization of Plant Physiological Research for 12th Five Year Plan	Division of Plant Physiology, IARI, New Delhi, 5-6 August
Shashi Bhalla, GJ Randhawa, V Celia Chalam, Kavita Gupta	Consultative Workshop to Strengthen Compliance to BCH Requirements by MoEF	India International Centre, New Delhi, 17 August
N Sivaraj	Training Programme on Data Analysis using SAS	NAARM, Hyderabad, 17-23 August
Mohar Singh	Annual Chickpea Group Meet	Bengaluru,20-22 August
B Sarath Babu	National Conference on Sustainable Agriculture and Climate Change	CRIDA, Hyderabad, 23-24 August
Manju Lata Kapur, Shashi Bhalla, Kavita Gupta, TV Prasad, B Sarath Babu	Seminar on Agricultural Entomology for the 21 Century: The Way Forward	NBAII, Bengaluru, 25-26 August
JC Rana	National Consultation on Pomegranate: Strategies to Combat Bacterial Blight	IIHR, Bangalore, 27 August
N Sivaraj	Annual Group Meeting on Linseed and Safflower	DOR, Hyderabad, 27-29 August
M Dutta, BS Phogat	Annual Workshop on All India Coordinated Wheat and Barley Improvement	NASC Complex, New Delhi, 1-4 September
MK Bag, Anirban Roy, TV Prasad	Annual Zonal Chapter Meeting of Indian Phytopathological Society (Delhi Chapter) and Workshop on Recent Advances in Diagnostic of Plant Pathogens and Certification Procedures for Planting Materials	NBPGR, New Delhi, 9 September
Shashi Bhalla, V Celia Chalam, Kavita Gupta	Workshop on Understanding of BCH for Effective Enforcement of Regulation for Transboundary Movement of LMOs/ GMOs	NACEN, Faridabad, 12 September
Vandana Tyagi	National Symposium on Advances in Biotechnological Research in Agri-horticultural Crops for Sustaining Productivity, Quality Improvement and Food Security	SVBPUAT, Meerut, 14-16 September
NK Gautam	Annual Group Meeting on Rabi MULLaRP Crops	SKRAU, Durgapura, 17-18 September
M Dutta	National Workshop on NICRA	CRIDA, Hyderabad,19-20 September
Jyoti Kumari	SAS Training on Genetics/ Genomics Data Analysis	IASRI, New Delhi, 19 - 24 September
Ashok Kumar	Group Meet of AICRP on Medicinal and Aromatic Plants and Betel vine	YSP UHF, Solan, 21-24 September
AK Singh	All India Coordinated Pearl Millet Improvement Project Meeting and Field Day	AICPMIP, Mandore Jodhpur, 23 September
SK Verma, AK Misra, RS Rathi, S Roy, SK Singh	Round Table Conference on New Frontiers on Climate Resilient Farming Systems for Livelihood Security	ICAR RC for NEHR, Umiam, 30 September-1 October
Nidhi Verma	International Conference on Issues for Climate Change, Land Use Diversification and Biotechnological Tools for Livelihood Security (ICLDBT-2011)	Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, 8-10 October

MK Bag	Advanced Training on Monitoring and Forecasting of Plant Disease Epidemic under Climate Change Scenario	IARI, New Delhi, 10 October-1 November
M Dutta	Consultation on Climate Change Adaptation organized by FARMS (USAID-INDIA)	NASC, New Delhi, 18-19 October
SK Malik	International Symposium on Knowledge System of Societies for Adaptation and Mitigation of Impacts of Climate Change	ISEC, Bangalore, 19-21 October
DC Bhandari	International Humboldt Kolleg on Adaptive Management of Ecosystems: The Knowledge Systems of Societies for Adaptation and Mitigation of Impacts of Climate Change	Institute for Social and Economic Change, Bengaluru, 19-21 October
DR. Pani	Workshop on Protected areas of Odisha: Issues and Prospects	Orissa Environmental Society,Bhubaneswar, 25 October
Sunil Archak	Workshop-cum-Installation Training Programme of the Software	IASRI, New Delhi, 2-3 November
MC Singh	World Cotton Research Conference	Mumbai, 7-11 November
Anitha Kodaru	CIC and CAC Meetings of NAIP (Virology)	Advanced Centre for Plant Virology, IARI, New Delhi, 18-19 November
KS Negi, PS Mehta	6th Uttarakhand State Science and Technology Congress	SSJ Campus, Almora Kumaon University, 14 November
M Dutta	International Workshop on Cactus Crop to Improve the Rural Livelihoods and to Adapt to Climatic Change in the Arid and Semi-arid Regions of India	NBPGR, New Delhi, 25-26 November
Anirban Roy	INSA-IARI Workshop on Plant Virology	IARI, New Delhi, 7-8 December
Sunil Archak, Rajiv Gambhir	12th Esri India User Conference	Noida, 7-8 December
Kavita Gupta	Consultative Workshop to discuss the 2nd National Report on the Implementation of the Cartagena Protocol on Biosafety	NASC, New Delhi, 8 December
NK Gautam	National Symposium on Biodiversity and Food Security: Challenges and Devising Strategies	IIPR, Kanpur, 10-11 December
NK Dwivedi, Pancha Ram	National Symposium on Resources Utilization through Integrated Farming System and Biodiversity Conservation	RRS, CAZRI, Kukma, Bhuj, 20-22 December in Dry lands
Anjula Pandey, ER Nayar	National Training Course cum Seminar on Identification, Documentation and Conservation of Medicinal and Threatened Plant Species and Related Ethnobiological Aspects	Jiwaji University, Gwalior, MP, 20-24 December
GJ Randhawa, Manju Lata Kapur, Shashi Bhalla, Kavita Gupta, MC Singh, J Akhtar	Asia-pacific Regional Training of Trainers Workshop on the Identification and Documentation of Living Modified Organism	New Delhi, 21-25 December
M Dutta, Jyoti Kumari	Consultation Workshops on Global Strategy for the Ex-situ Conservation of Pearl millet and Finger millet and their Wild Relatives	NBPGR, New Delhi, 22-23 December
NK Dwivedi, Pancha Ram	National Seminar on Intellectual Prosperity and Innovation management in Knowledge Era	Vyas Engineering College for Girls, Jodhpur, 27 December

Dr Arjun Lal, Principal Scientist from ARS batch of 1976 at the age of 61 years participated in the Airtel Delhi Half Marathon held in New Delhi on 27 November 2011 and Standard Chartered Mumbai Marathon held in Mumbai on 15 January, 2012. He finished the half marathon (21.097 kms) in 2 hour :09 minutes: 35 seconds. He is source of inspiration to all ICAR employees.

Asia Sub-regional Training of 'Trainers Workshop on the Identification and Documentation of LMOs'

NBPGR, New Delhi co-hosted the Asia Sub-regional Training of 'Trainers Workshop on the Identification and Documentation of LMOs' for custom officials along with the International Centre for Genetic Engineering and Biotechnology (ICGEB), New Delhi. The training programme was sponsored by the Ministry of Environment and Forests, Govt. of India and held from November 21-25. Senior level participants representing 13 countries from the region were imparted hands on training on DNA based living modified organisms (LMO) detection at NBPGR. Three resource persons of CBD Secretariat, involved with biosafety issues and Biosafety Clearing House, of Cartagena Protocol on Biosafety at Secretariat of Convention on Biological Diversity (SCBD), Montreal, Canada were also part of the delegates at the workshop.

20.15 Publications

20.15.1 Research Papers

1 Adhikari B, Bag MK and RD Tripathi (2011) Effect of arsenate on phosphorus accumulation in rice under simulated condition. *J. Crop and Weed.* **7(1):** 8 - 11.

2 Agrawal A, RK Tyagi, R Goswami, S Uma, MS Saraswathi and P Durai (2011) Cryobanking of banana (*Musa* sp.) germplasm in India: Evaluation of agronomic and molecular traits of cryopreserved plants. *Acta Hort.* **908**: 129-138.

3 Anitha K, Kamala Venkateswaran, S K Chakrabarty, G Suresh Kumar, B Sarath Babu and K S Varaprasad (2011) Onion genetic

resources and pest resistance: The Indian Scenario. *Indian J. Plant Prot.* **39 (2)**: 81-92.

4 Arif Mohd, DR. Pani, NW Zaidi and US Singh (2011) PCR based identification and characterization of Fusarium species associated with mango malformation. *Biotechnol. Res. Intl.* doi:10.4061/2011/141649.

5 Awasthi CP, Meenakshi Thakur and JC Rana (2010) Biochemical evaluation of some promising genotypes of chenopod (*Chenopodium album* L.) *Indian J. Agric. Biochem.* **23 (2)**:133-136.

6 Bag MK (2011) Performance of a new generation fungicide Metominostrobin 20SC against sheath blight disease of rice. *J. Mycopathol. Res.,* **49(1):** 110-113.

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15 Chakrabarty SK, K Anitha, G Suresh Kumar, B Sarath Babu, RDVJ Prasada Rao, Babu Abraham and KS Varaprasad (2011) Exotic pathogen entry with crop germplasm into India- risks and significance. *Indian J. Plant Prot.* **39 (1)**: 23-28.

16 Chakrabarty SK, GA Girish, K Anitha and RP Thakur (2011) Eliminating smut (*Moesziomyces penicillariae*) from pearl millet seeds under transboundary movement. *Indian J. Plant Genet. Resour.* **24 (3)**: 340-342.

17 Chaudhury R, SK Malik, J Joshi and KR Shivanna (2010) Cryoconservation of pollen for germplasm storage and for utilization in breeding programmes. *J Palynology* **46**: 205-218.

18 Choudary H, DK Singh, SS Marla and VBS Chauhan (2011) Genetic diversity among cultivated and wild germplasm of cucumber based on RAPD analysis. *Indian J. Hort.* **68 (2):** 197-200.

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20.15.4 Plant Germplasm Reporter

1. Bhatt KC, Anjula Pandey, E Roshini Nayar, Rakesh Srivastava, DC Bhandari, Shashi Kant Sharma, NS Panwar, Rakesh Singh, Rita Gupta and OP Dhariwal (2011) *Plant Germplasm Reporter* (*Indigenous Collections*). NBPGR, New Delhi.

20.15.5 Crop Catalogue

1. Phogat BS, Dinesh Kumar, HL Raiger, YS Rathi, Sushila Kundu, AK Sharma, RK Gupta and M Dutta (2011) Catalogue on Multi-location Evaluation of Wheat Germplasm, Vol. I (2004-05). NBPGR, New Delhi, India. 495p.

2. Phogat BS, Ambrish K Sharma, HL Raiger, YS Rathi, Sushila Kundu, AK Sharma, RK Gupta and M Dutta (2011) Catalogue on Multi-location Evaluation of Wheat Germplasm, Vol. II (2005-06). NBPGR, New Delhi, India. 500p.

20.15.6 Books/ Manuals/ Annual Report/ Teaching aids

1. Arjun Lal, Kavita Gupta, Vandana Tyagi and Sangita Yadav (Eds.) NBPGR Annual report (2010). NBPGR Publication. New Delhi.199p

2. Chalam VC, S Bhalla, B Singh and Rajan (eds). 2011. Potential Quarantine Pests for India in Grain Legumes. NBPGR, New Delhi, India. 323 p. + xi.

3. Gupta Kavita, Chalam VC, Usha Dev, S Bhalla, Z Khan and PC Agarwal (eds). 2011. *Training Manual on Diagnostic Methods for Detection and Identification of Pests of Seed and Other Planting Material and their Management*. NBPGR, New Delhi, India. 165p.

4. Mehta PS and Negi KS (2011). Uttarakhand ki Bhojya Padap Prajatiya wa Paramparik Vyanjan. Bishan Singh and Mahendra Pal Singh, Dehradun. 126p

5. Raiger HL and Dutta M (2011) Germplasm characterization and evaluation of field crops (Kharif 2010), NBPGR, New Delhi.

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20.15.7 Web-enabled Digital Library and CD developed

1. Gupta Kavita, Ruquaeya Bano, CS Gupta, Shashi Bhalla, Manju Lata Kapur and B Lal (2011) *Digital Library on Bruchids*. Available at http://202.141.12.150/bruchid-library/ and CD Rom.

20.15.9 GeneBank Submissions

1. Saha D, AK Sureja, M Verma, L Arya, and AD Munshi (2012) Isolation and phylogenetic analysis of NBS-LRR encoding resistance gene analogues in Tomato leaf curl New Delhi virus resistant genotype of *Luffa cylindrica*. Accession numbers JQ432525 -JQ432540.

20.15.10 Radio/ TV talks

1. Dr. A. K. Trivedi delivered a radio talk entitled "*Utpadan Bridhdhi Mein Unnat Beijon Ki Upyogita*." at AIR, Almora on December 23, .

2. Dr. KS Negi delivered a radio talk entitled "*Parvatiya Kshetro Mein Sagandhiya Podho Ki Vaigyanik Tatha Vyavasayik Kheti*" at AIR, Almora on August 24, 2011.

3. Dr. PS Mehta delivered a radio talk on "*Chataki dhan ki paramparik aur viksit kismon tatha unki safal kheti*" at Kisan Vani, AIR, Almora, UK on March 14, 2011.

20.16 Patents Granted

Two patents were granted by the Indian Patent Office to NBPGR/ICAR on technologies developed by the staff of NBPGR. The technologies are given below:

1. Process enabling simultaneous detection of transgene Cp4 *epsps* and CaMV35S promoter in maize utilizing novel primers in multiplex PCR

2. An improved process for enrichment of babchi drug from the seeds of babchi *(Psoralea corylifolia* L.)

20.17 Registration of Germplasm

French bean (*Phaseolus vulgaris* L.) (INGR 10026/ IC280837/JJK-200-220) for long and broad pod french bean (Pole type) used as dual purpose i.e. tender vegetable and pulse. Pods large in size, smooth and broad, pod length 23-25 cm, pod width 2.2 -2.5 cm; pod shape

flat; flower colour white; seed colour bright white, 100 seed weight 33-36 gram and number of grains per pod 9; plant height 185-280 cm, number of pods/plat 80-120. Pods smooth, long, broad and flat much preferred by buyers for using them as vegetable or in preparation of Pizza/Sambhar.

20.18 Distinguished Visitors

Dr. S Ayyappan, Secretary, DARE and Director General, ICAR visited NBPGR, Regional Station, Shimla on 03 June 2011

Dr. S Ayyappan, DG, ICAR & Secretary, DARE and Dr. T P Rajendran, ADG (PP) visiting the RS Shillong with Dr. K C Bansal, Director, NBPGR, Dr. S V Ngachan, Director, ICAR RC for NEHR, Umiam and the staff of the station

Annexure 1: Meteorological data (temperature in degrees Celsius and rainfall in mm) at NBPGR Regional Stations

Station	Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Akola	Max temp	28.6	32.1	37.2	39.3	42.0	36.5	31.7	30.2	30.8	35.0	32.8	30.1
	Min temp	9.9	15.0	18.9	23.5	28.0	25.8	24.2	23.5	23.0	19.2	14.6	12.0
	Rainfall	—	3.7	3.8	28.8	15.2	81.2	166.2	126.6	88.6	1.7	—	—
Bhowali	Max temp	16.2	17.8	20.0	26.5	30.6	25.8	25.0	24.7	26.0	26.6	19.4	18.0
	Min temp	-0.5	1.5	6.1	10.2	14.1	15.8	18.5	18.1	14.9	11.0	5.6	2.2
	Rainfall	—	73.2	10.0	32.2	54.0	459.0	251.4	515.0	146.0	—	—	—
Cuttack	Max temp	26.9	29.8	33.3	34.2	35.6	33.2	31.6	30.6	30.5	31.8	30.31	27.4
	Min temp	13.9	18.3	22.5	24.3	26.3	26.0	26.1	26.2	25.8	24.1	9.1	17.5
	Rainfall	—	63.6	0.6	15.3	172.8	314.0	321.5	377.8	370.4	30.0	—	—
Hyderabad	Max temp	29.5	31.2	35.6	36.7	39.2	35.0	31.2	30.2	30.7	32.1	30.1	29.9
	Min temp	10.4	15.0	17.7	21.9	25.4	24.4	22.7	22.7	22.0	20.3	15.4	12.6
	Rainfall	—	6.0	—	3.0	7.5	40.7	191.0	147.3	68.1	47.9	27.5	0.0
Jodhpur	Max temp	24.5	27.5	35.0	38.7	41.4	41.0	37.1	34.0	32.9	36.0	33.2	27.5
	Min temp	09.1	13.6	18.4	22.8	28.2	29.8	27.6	26.4	24.0	19.3	16.7	11.8
	Rainfall	—	14.8	—	—	0.3	—	92.3	118.8	93.8	0.3	—	—
Shillong	Max temp	18.8	29.3	27.7	27.8	28.8	28.9	28.9	29.1	29.4	28.5	24.2	22.0
	Min temp	5.0	8.4	12.6	14.5	17.0	19.5	19.7	19.5	18.8	15.5	9.2	6.9
	Rainfall	—	—	44.3	110.9	207.8	586.6	419.7	389.1	344.3	408.3	22.3	4.7
Shimla	Max temp	12.8	14.4	19.9	21.7	26.8	24.7	23.8	23.7	23.5	19.5	20.2	15.1
	Min temp	2.6	4.6	8.7	7.2	14.8	15.6	17.5	17.4	16.0	13.2	11.5	6.8
	Rainfall	14.7	55.9	37.6	19.0	80.0	198.9	163.2	159.2	92.3	0.8	—	0.4
Thrissur	Max temp	32.7	33.7	34.8	34.3	33.0	29.3	29.1	29.4	30.0	31.1	31.4	31.9
	Min temp	22.2	22.0	23.9	24.5	24.9	23.6	22.9	22.9	23.1	23.5	22.9	21.9
	Rainfall	00.0	77.5	10.0	207.1	198.5	799.6	588.2	713.8	435.2	193.0	240.0	2.4

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