



# वार्षिक प्रतिवेदन ANNUAL REPORT 2008-2009



राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो

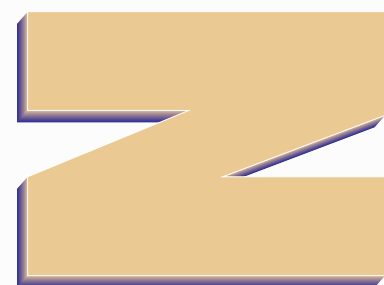
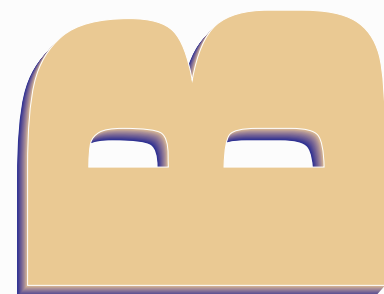
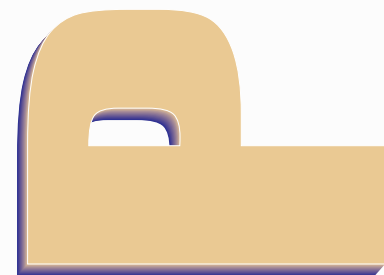
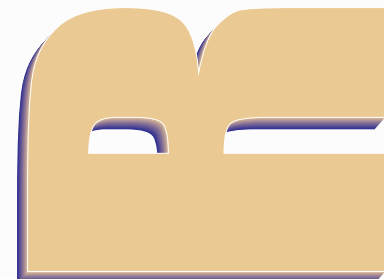
( भारतीय कृषि अनुसंधान परिषद )

पूसा परिसर, नई दिल्ली-110012

**NATIONAL BUREAU OF PLANT GENETIC RESOURCES**

(Indian Council of Agricultural Research)

Pusa Campus, New Delhi - 110 012





# NBPGR

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**ANNUAL REPORT**  
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Compiled and Edited by : Dr. Arjun Lal, Principal Scientist  
Dr. (Mrs.) Kavita Gupta, Senior Scientist  
Dr. (Mrs.) Vandana Tyagi, Senior Scientist

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

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## ACRONYMS

AFLP	Amplified Fragment Length Polymorphism	IARI	Indian Agricultural Research Institute
AICRP	All India Coordinated Research Project	IC	Indigenous Collection
ARIS	Agricultural Research Information System	ICAR	Indian Council of Agricultural Research
AVRDC	Asian Vegetable Research and Development Center	ICARDA	International Center for Agricultural Research in the Dry Areas
AVT	Advance Varietal Trial	ICRISAT	International Crops Research Institute for Semi-Arid Tropics
BARC	Bhabha Atomic Research Center	IFPGR	International Fund for Plant Genetic Resources
BPH	Brown Plant Hopper	INIBAP	International Network for the Improvement of Banana and Plantain
CBD	Convention on Biological Diversity	INPGRS	Indian National Plant Genetic Resources System
CGIAR	Consultative Group on International Agricultural Research	IPR	Intellectual Property Rights
CGRFA	Commission on Genetic Resources for Food and Agriculture	IRRI	International Rice Research Institute
CIAT	International Center for Tropical Agriculture	ISPGR	Indian Society of Plant Genetic Resources
CIMMYT	International Maize and Wheat Improvement Center	ITK	Indigenous Traditional Knowledge
CIP	International Potato Center	IUPGR	International Undertaking on Plant Genetic Resources
CMS	Cytoplasmic Male Sterility	LTS	Long Term Storage
CPGR	Commission on Plant Genetic Resources	MoU	Memorandum of Understanding
CSCNRVC	Central Sub-Committee on Crop Standards, Notification and Release of Varieties of Agricultural Crops	MTA	Material Transfer Agreement
CSIR	Council of Scientific and Industrial Research	MTS	Medium Term Storage
DAC	Department of Agriculture and Cooperation	NAAS	National Academy of Agricultural Sciences
DARE	Department of Agricultural Research and Education	NAGS	National Active Germplasm Sites
DBT	Department of Biotechnology	NARS	National Agricultural Research System
DFID	Departmental Fund for International Development	NATP	National Agricultural Technology Project
DPPQS	Directorate of Plant Protection, Quarantine & Storage	NBPGR	National Bureau of Plant Genetic Resources
DRDO	Defense Research and Development Organization	NGO	Non-Governmental Organization
DST	Department of Science and Technology	NHCP	National Herbarium of Cultivated Plants
DWR	Directorate of Wheat Research	NRC	National Research Center
EC	Exotic Collection	NRCWA	National Research Centre for Women in Agriculture
ELISA	Enzyme Linked Immuno Sorbent Assay	PAGE	Polyacrylamide Gel Electrophoresis
FAO	Food and Agricultural Organization	PEQN	Post-Entry Quarantine Nursery
GATT	General Agreement on Tariffs and Trade	PGRFA	Plant Genetic Resources for Food and Agriculture
GHU	Germplasm Handling Unit (of NBPGR)	RFLP	Restricted Fragment Length Polymorphism
GIS	Geographical Information System	SAU	State Agricultural University
GPA	Global Plan of Action	STMS	Sequence Tagged Microsatellite Site
HYV	High Yielding Variety	TGMS	Temperature-sensitive Genic Male Sterile
IARC	International Agricultural Research Center	TRIPS	Trade Related Intellectual Property Rights



## PREFACE

It gives me immense pleasure to place before you the Annual Report (2008-09) 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.

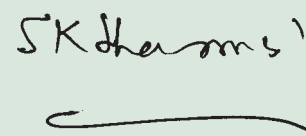
Considering the suggestions of the Germplasm Advisory Committees (GACs) on the various crop groups, plant explorations were undertaken to collect the trait specific germplasm and wild relatives of crop plants, which constituted 40% of the total collections made during the period under report. Similarly, trait specific germplasm for quality, biotic and abiotic stresses, etc., was introduced from abroad and made available to indentors/ researchers after quarantine clearance. A large number of accessions of agri-horticultural crops were grown for characterization, evaluation, regeneration and maintenance at New Delhi and various regional stations of Bureau located in different agro-climatic zones of the country. Besides, multi-location evaluation of rice, wheat, chickpea and pigeonpea involving AICRP/ ICAR crop-based institutes/ SAUs resulted in the identification of promising accessions for yield, quality attributes and tolerance to biotic stresses.

A total of 13,720 accessions of orthodox seeds were added to the base collection raising the total germplasm holding to 3,67,419 accessions in the National Genebank. A total of 2,011 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. More than 2500 varieties in different crops were fingerprinted and included in the database on DNA fingerprinting. Three M.Sc and one Ph.D students were awarded degrees in PGR during the year.

I take this opportunity to place on record my sincere thanks and gratitude to Dr Mangala Rai, Director General ICAR and Secretary DARE, Govt. of India, to Dr PL Gautam, Deputy Director General (Crop Sciences), and to Dr S P Tiwari, Deputy Director General (Education), ICAR for their continued guidance, encouragement and support in executing the mandate of NBPGR.

I thank all the scientists, technical, administrative and supporting staff of NBPGR for their teamwork, efficiency and dedication.

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



29 April 2009  
New Delhi

SK Sharma  
Director

## प्रतिवेदन सारांश

वर्ष 2008-2009 के दौरान ब्यूरो ने पादप आनुवंशिक संसाधनों के प्रबन्धन से सम्बंधित सभी क्षेत्रों में अच्छी उन्नति की तथा नये कीर्तिमान स्थापित किए। पादप ब्यूरो के मुख्यालय तथा इसके अधीन क्षेत्रीय केन्द्रों क्रमशः अकोला, भोवाली, कटक, हैदराबाद, जोधपुर, राँची, शिमला, शिलांग तथा त्रिशूर पर पादप आनुवंशिक संसाधनों के प्रबन्धन में प्रमुख उपलब्धियाँ इस प्रकार रही।

### पादप अन्वेषण एवं जननद्रव्य संग्रहण

वर्ष 2008-2009 के दौरान देश के विविध भौगोलिक क्षेत्रों में किए गए 36 पादप अन्वेषणों के माध्यम से 2954 प्राप्तियाँ (कृषि औद्योगिकी फसलों की 2106 प्राप्तियाँ, वन्य उपजातियों की 848 प्राप्तियाँ) संग्रहित की गई। जननद्रव्य संग्रहण का कार्य पादप ब्यूरो के वैज्ञानिकों द्वारा स्वतंत्र रूप से तथा राष्ट्रीय संस्थाओं के सहयोग से पूरा किया गया। पादप अन्वेषण तथा जननद्रव्य संग्रहण देश के विभिन्न राज्यों क्रमशः अरुणाचल प्रदेश, छत्तीसगढ़, हरियाणा, हिमाचल प्रदेश, जम्मू-कश्मीर, कर्नाटक, केरल, मध्य प्रदेश, महाराष्ट्र, मिज़ोरम, उड़ीसा, पाण्डीचेरी, पंजाब, राजस्थान, तामिलनाडू तथा उत्तराखण्ड में किए गए। संग्रहित पादप प्रजातियों को संग्रहण स्थल के निकट (पादप ब्यूरो के क्षेत्रीय केन्द्र) उगाया गया एवं उचित मात्रा में एकत्रित बीज को राष्ट्रीय जीन बैंक में दीर्घावधि भण्डारण हेतु संग्रहित किया गया। राष्ट्रीय वनस्पति संग्रहालय कृष्ट पादप में कुल 320 नमूने और शामिल किए गए।

**वन्य प्रासंगिक पादप प्रजातियों का संग्रहण :** वन्य प्रासंगिक पादप प्रजातियों के संग्रहण पर विशेष ध्यान देते हुए एक अन्वेषण के दौरान राजस्थान से 51 प्राप्तियाँ संग्रहित की गई। एक अन्य अन्वेषण में पूर्वी गोदावरी विसाखापट्टनम तथा श्रीकाकुलम जिलों से 82 प्राप्तियाँ एकत्रित की गई। कुछ फसल विशेष अन्वेषण इस प्रकार किए गए:

**राजस्थान एवं हरियाणा से ब्रैसिका टोरनेफोर्टाई जननद्रव्यों का संग्रह:** एशियन, अफ्रीकन या सहारा सरसों के नाम से प्रचलित जंगली सरसों की प्रजातियों के जननद्रव्यों का राजस्थान व हरियाणा राज्यों से संग्रह किया गया। इन प्रजातियों में एफीडस, आल्टरनेरिया ब्लाइट, सफेद फफूंदी तथा सूखा प्रतिरोधिता के गुण पाए जाते हैं। इसका प्रजनन कार्यक्रम में बहुतायत से इस्तेमाल हो रहा है। कुल 12 जननद्रव्यों का संग्रह राजस्थान के झुंझनू, सीकर तथा बीकानेर एवं हरियाणा के महेन्द्रगढ़ एवं भिवानी जिलों से किया गया।

आंध्रप्रदेश के खम्मन जिले से शाकीय सब्जियों के 125 जननद्रव्य संग्रहीत किए गए जो 20 विभिन्न प्रजातियों से हैं। इनमें चौलाई, बथुआ, मेथी, धनिया, मोरिंगा तथा सरसों प्रमुख हैं।

क्षेत्रीय केन्द्र त्रिशूर ने राष्ट्रीय केला अनुसंधान केन्द्र तिरुचिरापल्ली के साथ मिलकर पश्चिमी घाट के कल्लाकाडू मुण्डान्थूरई टाईगर रिजर्व से जंगली केले, मूसा एक्वमिनाटा तथा अन्य प्रजातियों के 16 जननद्रव्य एकत्रित किए। केरल के कानी आदिवासियों द्वारा इस्तेमाल होने वाली 'आरोग्यपाच्य' नामक औषधि के जननद्रव्य भी संग्रहीत किए गए। दुर्लभ तथा स्थानीय औषधीय पौधों के जननद्रव्य संग्रह हेतु कोल्हापुर, जिला महाराष्ट्र में अम्बा रिजर्व फॉरेस्ट,

हिरण्याकेशी वन, अम्बोली गिरिस्थान, सांवतवाडी तथा सतगुडी क्षेत्र से विभिन्न प्रजातियों के 54 जननद्रव्य एकत्रित किए गए जिनमें बारलेरिया, जायफल, डायोस्पाइरम, चन्दन, काली मिर्च तथा नोनी प्रजाति प्रमुख हैं। एक अन्य अन्वेषण दौरे में एरणाकुलम, कोजीकोडे तथा अलापूज्जा जिले (केरल) से नोनी के पांच जननद्रव्य एकत्रित किए गए।

कद्दू जननद्रव्यों के प्रजातीय वर्गीकरण हेतु क्षेत्रीय केन्द्र त्रिशूर द्वारा एक वर्गीकरण कार्यक्रम तैयार किया गया है।

**तटीय आंध्र प्रदेश तथा निकटवर्ती क्षेत्रों से संग्रहीत जननद्रव्य संग्रह:** रा. पा. आ. सं. ब्यूरो, क्षेत्रीय केन्द्र हैदराबाद द्वारा आंध्र प्रदेश एवं उसके निकटवर्ती क्षेत्रों से सब्जियाँ, तिलहन और कपास के संग्रह किए गए जिनमें प्याज-23, छोटा प्याज-14, वन्य दलहन-40, कल्टीवेटेड दलहन-11, औषधीय पौधे-8, कंदीय फसलें-119, मिर्च-27, अन्य-26, तिलहन-85, गौसिपियम आर्बोरेटम-30, गौसिपियम आर्बोरेटम-2, हर्बेसियम-35, पोंगामिया-16 सम्मिलित थे।

**अल्प-उपयोगी वृक्ष प्रजातियों का पादप अन्वेषण, जननद्रव्य एवं बीज भंडारण अध्ययन:** पश्चिमी भारत के शुष्क क्षेत्रों एवं पाकिस्तान से "मीठाजल" अथवा "पीलू" (सैल्वाडोरा ऑलीओयडीज़) का संग्रह किया गया जो कि बहुप्रयोगी झाड़ीनुमा पेड़ है। रा. पा. आ. सं. ब्यूरो, नई दिल्ली एवं जोधपुर के संयुक्त अन्वेषण दौरे के दौरान पश्चिमी राजस्थान के भागों से 21 पादप प्राप्तियाँ संग्रहीत की गई। इनके फलों के रंग और आकार में विविधता पाई गई। इनके फल अंगूर के गुच्छों जैसे लगते हैं। ताजे फल खाए जाते हैं और फलों को कई महीनों तक सुरक्षित रखने के लिए पेड़ पर गूदे के साथ ही सुखाए जाते हैं।

रा. पा. आ. सं. ब्यूरो, नई दिल्ली एवं केन्द्रीय शुष्क बागवानी संस्थान, बीकानेर के सहयोग से हिमाचल प्रदेश के जिलों ऊना, कांगड़ा, हमीरपुर और बिलासपुर की पहाड़ियों से लसूड़ा जननद्रव्य के संग्रह किए गए जिनमें पाला सहिष्णुता पाई गई। 18 पादप प्राप्तियाँ से फलों एवं कलमों के संग्रह किए गए।

ब्यूरो के ऊतक संवर्धन एवं हिमपरिरक्षण इकाई में 'पीलू' एवं 'लसूड़ा' के बीज भंडारित किए गए। संग्रहीत पादप प्राप्तियाँ में से 10 पादप प्राप्तियाँ में अंकुरण नहीं निकले। कार्डिया मिक्सा के गूदा रहित फल में "कार्डिया घुन" का संक्रमण पाया गया। ब्यूरो नई दिल्ली के पादप संगरोध विभाग में जननद्रव्य एक्स-रे विश्लेषण करने से ज्ञात हुआ कि घुन संक्रमण से 90 प्रतिशत से ज्यादा बीज पूर्ण रूप से क्षतिग्रस्त हो गए थे।

**हिमाचल प्रदेश से रोज़ा प्रजातियों के जननद्रव्य संग्रह:** रा. पा. आ. सं. ब्यूरो, क्षेत्रीय केन्द्र, शिमला में भारतीय बागवानी अनुसंधान संस्थान, बंगलौर और हिमालयन जैव संसाधन प्रौद्योगिकी संस्थान, पालमपुर के सहयोग से रोज़ा प्रजातियों हेतु अन्वेषण किया और 16 प्रजातियों की 42 पादप प्राप्तियाँ संग्रहीत की गई।

**अंडमान और निकोबार द्वीपसमूह से संग्रहीत जननद्रव्य:** रा. पा. आ. सं. ब्यूरो, क्षेत्रीय केन्द्र, त्रिशूर द्वारा अंडमान एवं निकोबार द्वीपसमूह में फसलों की जंगली प्रजातियाँ एवं सापेक्षता

औषधीय पौधों के संग्रह हेतु अन्वेषण दौरा किया गया। 48 पादप प्राप्तियां संग्रहीत की गईं जिनमें जंगली करेला, दाल, काली मिर्च, चचींडा, रत्ती, चावल, नोनी, जिमिकंद अरबी, सुतरी, नींबू, रतालू एवं सरकंडा की प्रजातियों का संग्रह किया गया। इस दौरान करमाटंग क्षेत्र के सदाबहार वनों से धान की 2 भूप्रजातियां 'खुशबुई' (जे ए एस/08-32) और 'बर्मा' (जे ए एस/08-33) संग्रहीत की गईं।

**राजस्थान से अन्वेषण एवं जननद्रव्य संग्रह:** रा. पा. आ. सं. ब्यूरो, क्षेत्रीय केन्द्र, जोधपुर द्वारा राजस्थान के राजसमन्द और उदयपुर जिलों से विंगना की वन्य प्रजातियों एवं सब्जियों के संग्रह किए गए। कुल 51 जननद्रव्य संग्रह किए गए जिनमें पेठा (1), करेला (2), लौकी (9), कुंदरू (3), *कुकुमिस प्रोफेटस* (1), *कु. सेटाइवस किस्म हार्डविकाई* (4), *कुकुरबिटा आर्गिरोस्पर्मा* (1), खीराककड़ी (6), कनकोडा (1), लूफा *एक्युटेंगुला* किस्म अमारा (1), लूफा *सिलिण्ड्रिका* (1), लूफा *हमोफ्रोडिता* (1), *मोमोर्डिका बल्सामिना* (3), कद्दू (4), तोरी (3), *विंगना रेडिएटा* किस्म *सबलोबेटा* (7) और *विंगना ट्राईलोबेटा* प्रजातियां सम्मिलित थीं।

### जननद्रव्य विनिमय

**आयातित जननद्रव्य :** इस वर्ष विभिन्न फसलों की कुल 33130 प्राप्तियां (81112 नमूने) 43 देशों से आयात की गईं। विभिन्न फसलों में विशिष्ट गुणों वाले जननद्रव्यों का आयात किया गया जो इस प्रकार हैं।

**गेहूं:** (ईसी 631734, संयुक्त राज्य अमरीका)-सॉफ्टनैस जीन्स पिन ए और पिन बी सहित क्रोमोसोम 5 ए एन के समगमेंटयुक्त ट्रांसलोकेशन किस्म। ईसी 631967-986, संयुक्त राज्य अमरीका-दानों की कठोरता नियंत्रण करने वाली प्यूरोइनडोलाईन एलीस्स में विभिन्नता वाली आईसोजनिक हार्ड स्प्रिंग किस्में। ईसी 633777, कनाडा-शुष्क क्षेत्रों के लिए अनुकूलनशील, कंडवा रोग प्रजातियों की प्रतिरोधितायुक्त किस्में। ईसी 633778-784, इकार्डा-पी बी डब्ल्यू 343 नई किस्मों में यू जी 99 एवं यैलो रस्ट प्रतिरोधिता युक्त किस्में।

**चावल:** ईसी 634219-20, संयुक्त राज्य अमरीका-म्यूटेंट जननद्रव्य शीथ ब्लाइट, बैक्टीरियल पैनेकल ब्लाइट तथा नैरो ब्राऊन लीफ स्पॉट प्रतिरोधिता युक्त।

**मक्का:** ईसी 634221-237, संयुक्त राज्य अमरीका-वैस्टर्न कोर्न रूटवर्म प्रतिरोधी किस्म।

**जौ:** किस्म क्लीयरवाटर ईसी 631731, संयुक्त राज्य अमरीका-अधिक उपजाऊ, हरा चारा के लिए प्रयोग की जाने वाली किस्म। किस्म टिटोनिया ईसी 631736, संयुक्त राज्य अमरीका-अधिक उपजाऊ, स्पॉट ब्लॉच एवं नेट ब्लॉच प्रतिरोधी किस्म। ईसी 634221-237, संयुक्त राज्य अमरीका-रशियन गेहूं एफिड प्रतिरोधी, माल्टिंग गुण आधारित जौ की प्रत्येक लाइन में विभिन्न प्रकार की प्रतिरोधिता।

**सूरजमुखी:** ईसी 634078-80, संयुक्त राज्य अमरीका-कंडुवा रोग प्रजातियों हेतु प्रतिरोधी किस्में।

**टमाटर:** ईसी 632003-021, ताईवान-बैक्टीरियल ब्लाइट

(टी एम 2 ए एलेल), फयूजेरियम ब्लाइट, ग्रे लीफ स्पॉट हेतु प्रतिरोधी किस्में।

**मसूर:** अधिक पैदावार तथा ठंड प्रतिरोधी किस्म इसी 631332 तुर्की से आयात की गई।

**मिर्च:** एफिड रोधी ईसी 611331-611364 ताईवान से, अत्यधिक तेज, 55-60 दिन में पकने वाली, फाईटोफ्थोरा रोग प्रतिरोधी तथा भूलसा (जीवाणु) रोधी किस्म इसी 612322 वियतनाम से तथा विभिन्न विषाणु रोग प्रतिरोधी इसी 628891-628920, 631683-631687 सभी ताईवान से आयात की गईं।

**खरबूजा:** संकर किस्म अरकंगा ईसी 612132 जालीदार बाहरी सतह, हल्का हरा गुदा, तथा फयूजेरियम भूलसा रोग प्रतिरोधी वियतनाम से, संकर किस्म ऐलियन-40-45 दिन में पकने वाली, 1.2 -1.3 कि.ग्रा. प्रति फल वजन, हरा मीठा तथा जूसी ईसी 612133 वियतनाम से तथा पीली सतह, अण्डाकार फल, क्रीम रंग का गुदा तथा प्रति फल वजन 2.5 कि.ग्रा. ईसी 612134 वियतनाम से आयात किए गए।

**स्ट्रबेरी:** लेमूर किस्म इसी 619154-619156 अच्छी गुणवत्ता वाले खूशबूदार फल अमेरिका से।

**सेब:** फायर ब्लाइट प्रतिरोधी ईसी 612824-825 तथा स्केब प्रतिरोधी किस्म इसी 612822-823 के पौधे अमेरिका से आयात किए गए।

**अवाकेडो:** पोलोक किस्म इसी 632072 कम तेल युक्त, जल्दी पकने वाली तथा बड़े आकार के फल (750 ग्राम प्रति फल) तथा किस्म पिकरटोन इसी 632073 लम्बे आकार वाले फल-दोनों अमेरिका से आयात किए गए।

**जननद्रव्य निर्यात:** विदेशों में अनुसंधानकर्ताओं की मांग की आपूर्ति हेतु कुल 19359 नमूने (811 नई दिल्ली से तथा, 18548 नमूने इकरीसेट फसलों के हैदराबाद से) विभिन्न देशों को भेजे गए। इसके अलावा 20950 नमूने इकरीसेट फसलों के नार्वे के स्वालवार्ड ग्लोबल सीड वाल्ट' में लम्बी अवधि के लिए संरक्षण हेतु भेजे गए। इन सभी नमूनों को जैवविविधता अधिनियम 2002 के प्रावधानों का पालन करते हुए सचिव, डेयर, भारत सरकार एवं अध्यक्ष, राष्ट्रीय जैवविविधता प्राधिकरण की अनुमति के बाद निर्यात किया गया।

**गेहूँ की किस्मों का निर्यात:** वर्ष 1999 में यूगांडा में स्टेम रस्ट की एक और पोटेट प्रजाति यू जी 99 का पता लगाया गया जो कि गेहूँ की किस्मों के लिए बड़ा खतरा है। यू जी 99 केन्या, इथियोपिया एवं ईरान में फैली हुई है। यू जी 99 के तीव्रता से बढ़ने पर विश्व स्तर पर स्टेम रस्ट के जोखिम से निपटने के लिए भारत ने कोर मैम्बर के रूप में पहल की है। भा. कृ. अनु. परिषद इस बीमारी को दूर करने के लिए सक्रिय भूमिका निभा रहा है। भा. कृ. अ. प., सिम्मिट, और मैक्सिको के बीच समझौता ज्ञापन के अन्तर्गत ब्यूरो द्वारा 253 गेहूँ की किस्में केन्या को निर्यात की गईं जिनका मूल्यांकन यू जी 99 एवं नई प्रजातियों के लिए किया जाएगा।

**राष्ट्रीय आपूर्ति:** देशभर के अनुसंधानकर्ताओं की मांग के



आधार पर विभिन्न फसलों के कुल 9681 नमूने मटेरियल ट्रांसफर एग्रीमेंट के तहत फसल सुधार कार्यक्रमों हेतु आपूर्ति किए गए।

### पादप संगरोध जांच

अनुसंधान कार्यों के लिए विनिमय (आयात+निर्यात) होने वाले जननद्रव्यों की संगरोध जांच एवं उपचार पादप ब्यूरो के मुख्यालय, नई दिल्ली तथा क्षेत्रीय केन्द्र, हैदराबाद में की जाती है। जांच एवं परीक्षणों के आधार पर स्वस्थ पाई गई पौध सामग्री एवं बीज ही मांगकर्ताओं को भेजी जाती है।

मुख्यालय नई दिल्ली के पौध संगरोध विभाग में कुल 33,130 प्राप्तियां संगरोध जांच हेतु प्राप्त हुई जिनमें 25450 प्राप्तियां (26929 नमूने) आयात किए गए तथा 493 प्राप्तियां विदेशों को निर्यात की गई। ट्रायल मटेरियल की कुल 7680 प्राप्तियां (54183 नमूने) आयात की गई। पौध संगरोधालयों में विस्तृत जांच करने पर 4325 नमूने विभिन्न नाशीजीवों से ग्रसित पाये गये। इसमें से 491 नमूने कीटों द्वारा, 346 नमूने सूत्रकृमियों द्वारा, 297 नमूने फफूंद एवं जीवाणु से एवं 81 नमूने विषाणुओं द्वारा ग्रसित पाये गये। कुल 4325 ग्रसित संक्रमित नमूनों में से 4316 नमूनों को विभिन्न विधियों जैसे धूमन, एक्सरे रेडियोग्राफी, उष्ण जल उपचार, फफूंद एवं कीटनाशक रसायनों द्वारा उपचारित कर स्वस्थ बीज/पौध सामग्री को ही मांगकर्ताओं को भेजा गया।

निर्यात के लिए 493 प्राप्तियों को स्वस्थ पाये जाने पर “स्वस्थता प्रमाण पत्र” जारी कर निर्यात किया गया।

क्षेत्रीय केन्द्र, हैदराबाद द्वारा कुल 12660 नमूने आयातित सामग्री के तथा 18548 नमूने निर्यात हेतु प्राप्त हुए जिनका विस्तृत निरीक्षण किया गया। कुल 1909 आयातित नमूने ग्रसित पाये गये जिनमें से 1655 के रोग कीट मुक्त कर मांगकर्ताओं को भेजा गया। निर्यात के लिए 1854 नमूने स्वस्थ पाये गये जिन्हें स्वस्थता प्रमाण पत्र के साथ विदेशों को भेजा गया।

### जननद्रव्य लक्षण वर्णन, मूल्यांकन तथा अनुरक्षण

पादप ब्यूरो के मुख्यालय तथा ईसापुर फार्म तथा विभिन्न क्षेत्रीय केन्द्रों एवं भारतीय कृषि अनुसंधान परिषद की विभिन्न संस्थाओं के साथ तैयार साझा कार्यक्रम के अन्तर्गत विभिन्न फसलों के जननद्रव्यों को लक्षण वर्णन, मूल्यांकन एवं अनुरक्षण/पुनरूत्पादन हेतु उगाया गया जो इस प्रकार है:

ईसापुर फार्म तथा मुख्यालय (पूसा फार्म) में 7661 प्राप्तियां लक्षण वर्णन एवं मूल्यांकन हेतु तथा 4141 प्राप्तियां अन्तर्राष्ट्रीय नर्सरी ट्रायल हेतु उगाई गई। सरसों (721 प्राप्तियां), सूरजमुखी (36), कुसुम (352), अलसी (85) को तेल की मात्रा (प्रतिशत) एवं गुणवत्ता के लिए मूल्यांकित किया गया। इसी प्रकार औषधीय एवं संगंधीय फसलों के 402 नमूनों को विभिन्न गुणों के लिए आंकलन किया गया।

क्षेत्रीय केन्द्रों क्रमशः अकोला पर 2997 प्राप्तियों का रबी में तथा 4250 प्राप्तियों का खरीफ में मूल्यांकन किया गया, भुवाली में 404 प्राप्तियां लक्षणवर्णन, मूल्यांकन अनुरक्षण के लिए, जोधपुर में 2239 प्राप्तियां मूल्यांकन हेतु, शिलांग में 2184 प्राप्तियां लक्षणवर्णन एवं मूल्यांकन हेतु तथा 142 प्राप्तियां अनुरक्षण हेतु, शिमला में 1816 प्राप्तियां अनुरक्षण हेतु, श्रीनगर में 605 प्राप्तियां लक्षणवर्णन

एवं मूल्यांकन हेतु तथा त्रिशूर में धान (113 प्राप्तियां) तथा अन्य फसलों की 497 प्राप्तियां लक्षण वर्णन, मूल्यांकन अथवा पुनरूत्पादन हेतु उगाई गई।

विभिन्न फसलों के मूल्यांकन से आंकी गई आशाजनक प्राप्तियां इस प्रकार रही:-

ब्यूरो के क्षेत्रीय केन्द्र त्रिशूर एवं उमियाम में जननद्रव्य के लक्षणवर्णन एवं मूल्यांकन के पश्चात कुछ आशाजनक जीनप्रारूपों की पहचान की गई।

**करेला (मोमोर्डिका चरशिया किस्म म्यूरिकेटा)** में आईसी 467670, 467682 550113, 467645, 441250, 541248 467680 एवं 467644 प्रजातियां सूखा प्रतिरोधी, निरंतर बढ़ोतरी वाली तथा कम आर्द्रता एवं नमी परिस्थितियों में फलने वाली पाई गई।

**जंगली हल्दी प्रजाति** में तीन पादप प्राप्तियों, आईसी 313104, 273580, 313115 को अरारोट उपज के लिए आशाजनक पाया गया।

**मिर्च** में आईसी 255943 को शीघ्र परिपक्वता (105 दिन) के लिए लक्षित पाया गया जबकि चेक किस्म (सी ए -960) 126 दिन में तैयार होती है।

**डॉलिकस बीन:** अर्का जय की तरह आईसी 546370, 63 दिन में सबसे जल्दी पकने वाली पाई गई।

**धान्य एवं स्यूडोधान्य:** उच्चभूमि के धानों में आईसी 540249 की उत्तम जीन प्रारूप के रूप में पहचान की गई, निम्नभूमि के धानों में आईसी-527250, मक्का में आईसी-419593, राइसबीन में एल आर बी -290, पेरिल्ला में आर एस 66/99 तथा कुटू में आईसी 394880 एवं जॉब्स टीयर्स में आईसी 203985 प्रजाती आशाजनक पाई गई।

**मसाले एवं कंदीय फसलें:** अदरक में आईसी 319569, हल्दी में आईसी 420565, कोलोकेसिया एस्क्यूलेटा में आईसी 527237, मिर्च में एफ डी आई-ए के पी-21 तथा डायोस्कोरिया में ए ए यू डी ए-10 में उच्चकोटि के जीनप्रारूपों की पहचान की गई।

**राजमां जननद्रव्य मूल्यांकन:** ब्यूरो के शिमला केन्द्र में राजमां की 345 जननद्रव्य पादप प्राप्तियों में एग्रोनोमिक गुणों एवं एन्थ्रेक्नोज बीमारी का पता लगाने हेतु मूल्यांकन किया गया। ईसी 530965 पादप प्राप्ति अत्यधिक उपजाऊ एवं एन्थ्रेक्नोज बीमारी के प्रतिरोधि तायुक्त पाई गई और 21 पादप प्राप्तियां (जैसे आईसी 039081, आईसी 329154, आईसी 415417, ईसी 500367, ईसी 500716, ईसी 530965 एवं ईसी 530866) खेत में एन्थ्रेक्नोज बीमारी के प्रति पूर्ण रूप से रोधितायुक्त पाई गई।

**चाईनीज़ पालक के जननद्रव्यों का मूल्यांकन:** ब्यूरो के क्षेत्रीय केन्द्र त्रिशूर में चाईनीज़ पालक के जननद्रव्यों का मूल्यांकन किया गया। आशाजनक पादप प्राप्तियों (आईसी 550142, आईसी 550145 और आईसी 469564) की पहचान की गई।

### जननद्रव्य संरक्षण

**बीज जननद्रव्य संरक्षण:** राष्ट्रीय जीन बैंक में दीर्घ कालीन संरक्षण हेतु विभिन्न फसलों की कुल 13720 प्राप्तियां प्राप्त हुई। सभी प्राप्तियों को जीन बैंक द्वारा निर्धारित मापदण्डों के अनुसार

संशोधित किया गया। इनमें से 13542 प्राप्तियों को आधार संग्रहों में शामिल किया जिसके फलस्वरूप राष्ट्रीय जीन बैंक के आधार संग्रहों की कुल संख्या बढ़कर 367419 हो गयी है। इस दौरान जननद्रव्य संचालन यूनिट ने 852 प्राप्तियां प्राप्त की जिनको मध्यावधि भण्डार गृह में संदर्भ सामग्री के रूप में रखा गया। जीन बैंक में संरक्षित 2121 प्राप्तियों का निरीक्षण किया गया तथा 2225 प्राप्तियों की पासपोर्ट सूचना को पूर्ण किया गया। कुल 5873 प्राप्तियों को मूल्यांकन/पुनरुत्पादन हेतु भेजा गया।

**पादप उत्तक कल्चर संरक्षण:** वानस्पतिक संवर्धन वाली पादप प्रजातियां जिनमें बीज नहीं बनते जैसे बागवानी, प्रकन्दीय, औषधीय तथा संकटापन्न पौधों एवं नई औद्योगिक फसलों की 2011 प्राप्तियों का उत्तक संवर्धन विधियों द्वारा कमरे के तापमान अथवा निम्न तापक्रम (4° से.) पर संरक्षित किया गया। प्रजातियों के अनुसार उप-संवर्धन का अंतराल 4 से 24 माह रहा। विभिन्न प्रजातियों के लिए अनुकूल 'प्राटोकाल' विकसित करने तथा उप-संवर्धन का अंतराल बढ़ाने के लिए अनुसंधान किए गए। कुल 4 प्राप्तियां (ऐलियम-2, ए ग्लेडिमोलस-2) के उत्तक कल्चर मांगकर्ताओं को भेजे गए।

**तरल नाईट्रोजन में हिम-परिक्षण :** विभिन्न पौधों की 345 प्राप्तियां (आर्थोडोक्ष तथा रिकेल्सीटेंट बीज, पराग कण, सुषुप्त कोमल सम्मिलित थे) को तरल नाईट्रोजन में -160° से. - 180° से. पर परिरक्षण किया गया। क्रायो बैंक में हिम परिरक्षित प्राप्तियों की संख्या 8804 हो गई।

### डी.एन.ए.फिंगरप्रिंटिंग

राष्ट्रीय महत्व की 33 फसलों की विभिन्न किस्मों को पहचान कर उन्हें पृथक् करने के लिए कई विधियों द्वारा डी. एन. ए. फिंगर प्रिंट्स विकसित किए गए। फसल डी. एन. ए. फिंगर प्रिंट डेटा बेस को अपडेट किया गया। आयातित ट्रांसजेनिक बीजों में विद्यमान ट्रांसजीन की पहचान के लिए प्राइमर्स का रूपांकन किया गया तथा पी.सी.आर आधारित प्राटोकाल विकसित किए गए।

### अन्य गतिविधियां

**राष्ट्रीय जैवसुरक्षा कार्यशाला:** एन बी पी जी आर द्वारा 25 मार्च 2008 को एन ए एस सी परिसर में जैव सुरक्षा पर कृषि संबंधित विषयों पर एक दिवसीय कार्यशाला का आयोजन किया गया जिसका उद्देश्य जैवसुरक्षा पर राष्ट्रीय कार्ययोजना विकसित करना था। वर्तमान में कृषि में जैवसुरक्षा से संबंधित मुद्दों का महत्व बढ़ रहा है जिन्हें 19-20 जनवरी 2008 को आयोजित उपकुलपतियों के सम्मेलन में प्रकाश में लाया गया था। कार्यक्रम में जननद्रव्य की स्थिति, राष्ट्रीय कार्यप्रणाली, अवसंरचना, कार्यकुशलता, अन्तर्राष्ट्रीय सहमति, पौधों के अनुसंधान योग्य पहलू, जी एम ओ सहित पशुधन, कुक्कुटपालन, मत्स्य एवं आक्रामक खरपतवार सम्मिलित हैं।

**'जैवविविधता भारत' पर राष्ट्रीय शिक्षा विज्ञान प्रदर्शनी:** एन बी पी जी आर क्षेत्रीय केन्द्र त्रिशूर ने 'जैवविविधता भारत' राष्ट्रीय शिक्षा विज्ञान, प्रदर्शनी में भाग लिया। प्रदर्शनी को केरल राज्य विज्ञान प्रौद्योगिकी एवं पर्यावरण परिषद् ने प्रायोजित किया तथा केरल जैवविविधता बोर्ड ने मालाबार बोटैनिकल गार्डन कोजीकोडे में आयोजित किया। 48000 से अधिक विद्यार्थी प्रदर्शनी में आए

तथा ब्यूरो पेंविलियन में जैवविविधता संरक्षण कार्य को उत्सुकतापूर्वक देखा।

**जननद्रव्य सलाहकार समिति की बैठक:** जननद्रव्य सलाहकार समिति की तीन बैठकों का आयोजन किया गया। पहली बैठक मक्का, ज्वार और बाजरा पर 22 फरवरी को डॉ. एन. सीताराम निदेशक, राष्ट्रीय ज्वार अनुसंधान केन्द्र, हैदराबाद की अध्यक्षता में आयोजित की गई। दूसरी बैठक औषधीय एवं सगंधीय पौधों पर डॉ. सुशील कुमार, पूर्व निदेशक, केन्द्रीय औषधीय एवं सगंधीय अनुसंधान केन्द्र की अध्यक्षता में आयोजित की गई। तीसरी बैठक 15 मार्च को सब्जी तथा बागवानी फसलों पर डॉ. जी. एल. कौल पूर्व उपकुलपति, आसाम कृषि विश्वविद्यालय की अध्यक्षता में आयोजित की गई।

**अन्तर्राष्ट्रीय जैव विविधता दिवस का आयोजन:** कृषि के टिकाऊ विकास हेतु जैव विविधता के महत्व के प्रति आम जनता में जागरूकता लाने के लिए रा.पा.आ.सं. ब्यूरो एवं इसके सभी क्षेत्रों में 22 मई को अन्तर्राष्ट्रीय जैव विविधता दिवस का आयोजन किया गया। इसमें दिल्ली में 45 स्कूलों के बच्चों ने भाग लिया, बच्चों को ब्यूरो के जीन बैंक और वानस्पतिक उद्यान के बारे में जानकारी दी गई। इस विषय पर बच्चों के लिए प्रतियोगिता का आयोजन भी किया गया और विजेता बच्चों को डॉ. पी.एल. गौतम, उप महानिदेशक (फसल विज्ञान) द्वारा पुरस्कार भी प्रदान किए गए। डॉ. के.एस. वाराप्रसाद, प्रमुख वैज्ञानिक एवं केन्द्र प्रभारी को भी डॉ. वाई.एस. राजशेखर रेड्डी, माननीय मुख्य मंत्री आंध्र प्रदेश द्वारा सम्मानित किया गया।

**रा. पा. आ. सं. ब्यूरो की पंचवर्षीय समीक्षा दल (क्यू आर टी) की बैठक:** ब्यूरो की 2002-2007 की अवधि की पंचवर्षीय समीक्षा दल की बैठक 9, 10 मई को नई दिल्ली में डॉ. एस. के. वासल की अध्यक्षता में आयोजित की गई। समीक्षा दल में डॉ. आर. जे. सैनी, आर. के. सिंह, पी. पुष्पांगदन और ए. एन. मुखोपाध्याय भी शामिल थे। ब्यूरो के निदेशक ने ब्यूरो की गतिविधियों के बारे में जानकारी प्रदान की। विभागाध्यक्षों और प्रभारी अधिकारियों ने अपने-अपने विषयों पर संक्षिप्त जानकारी प्रदान की। डॉ. डी. एस. राठौर की अध्यक्षता में 21 मई को आधे दिन की बैठक आयोजित की गई जिसमें मुख्यालय की गतिविधियों को प्रदर्शित किया गया। ब्यूरो की प्रगति के आधार पर सदस्यों ने अनेक सिफारिशें और सुझाव दिए।

**नोडल अधिकारियों की परामर्श बैठक:** रा. पा. आ. सं. ब्यूरो, नई दिल्ली में 28 मई को राज्य कृषि विश्वविद्यालयों द्वारा नोडल अधिकारियों की परामर्श बैठक का आयोजन किया गया। बैठक में नोडल अधिकारी, राज्य कृषि विश्वविद्यालयों के प्रतिनिधि, परियोजना समन्वयक, भा. कृ. अनु. परिषद् एवं ब्यूरो के अधिकारियों ने भाग लिया। बैठक की अध्यक्षता डॉ. पी. एल. गौतम, उप महानिदेशक (फसल विज्ञान), द्वारा की गई। बैठक में पादप किस्मों की सुरक्षा और किसानों के अधिकार अधिनियम पर चर्चा की गई।

**भारत में जननद्रव्य विनिमय नीतियों एवं प्रक्रियाओं पर प्रशिक्षण पाठ्यक्रम:** रा.पा.आ.सं. ब्यूरो, नई दिल्ली के जननद्रव्य विनिमय विभाग द्वारा 17 से 26 नवम्बर, 2008 को जननद्रव्य विनिमय-नीतियों एवं प्रक्रियाओं पर लघु अवधि पाठ्यक्रम का

आयोजन किया गया। पाठ्यक्रम प्रतिभागियों को अनुसंधान उद्देश्यों के लिए जननद्रव्य आयात एवं निर्यात के विभिन्न नियमों, अधि नियमों एवं प्रक्रियाओं के बारे में जानकारी प्रदान कराना था। इसका उद्देश्य राष्ट्रीय स्तर पर समीक्षक जनसमूह तैयार करना था जो जननद्रव्य विनिमय से संबंधित मुद्दों को समझ सकें एवं उनमें भाग ले सकें। इसमें भा.कृ.अनु. परिषद्, राज्य कृषि विश्वविद्यालयों एवं विभागों से कुल 19 प्रतिभागियों ने भाग लिया।

**सी बी डी के अन्तर्गत उपलब्धता एवं लाभ के बंटवारे के मुद्दों के संदर्भ में ब्रेन स्टॉर्मिंग सत्र:** उपलब्धता एवं लाभ के बंटवारे (ए बी एस) के मुद्दे पर रा.पा.आ.सं. ब्यूरो में ब्रेन स्टॉर्मिंग सत्र 4 अक्टूबर को आयोजित किया गया। बैठक उपमहानिदेशक (फसल विज्ञान) भा. कृ. अनु. परिषद् की अध्यक्षता में आयोजित की गई। उन्होंने इस बैठक में सी बी डी के तत्वाधान में प्रस्तावित अन्तर्राष्ट्रीय उपलब्धता एवं लाभ के बंटवारे के संदर्भ में अन्तर्राष्ट्रीय स्तर पर किये गये मुद्दों के महत्व पर प्रकाश डाला। उन्होंने कहा कि सी बी डी की धारा 15 और 8 (जे) को ध्यान में रखते हुए देशों (कान्ट्रेक्टिंग पार्टियां) को समान अधिकार तथा लाभ का बंटवारा प्रदान करने के लिए वचनबद्ध रहना चाहिए।

सत्र के दौरान भारत के जैव विविधता अधिनियम 2002 के संदर्भ में ए बी एस से संबंधित विभिन्न मुद्दों पर विचार किया गया। ए बी एस विषय पर अन्तर्राष्ट्रीय स्तर पर भारत की तैयारी के लिए कई कार्य बिन्दु निर्धारित किए गए।

**पादप आनुवंशिक संसाधनों के संरक्षण के लिए इन विट्रो संरक्षण तकनीकों पर अन्तर्राष्ट्रीय प्रशिक्षण पाठ्यक्रम:** रा. पा. आ. सं. ब्यूरो एवं भारतीय कृषि अनुसंधान परिषद् के सेन्टर फॉर एक्सेलेंस कार्यक्रम के अन्तर्गत बायोवर्सिटी इंटरनेशनल साउथ एशिया कार्यालय, नई दिल्ली के सहयोग से 17-29 नवम्बर तक पादप आनुवंशिक संसाधनों के संरक्षण हेतु इन विट्रो एवं क्रायो संरक्षण तकनीकों पर अन्तर्राष्ट्रीय प्रशिक्षण का आयोजन किया गया। इस प्रशिक्षण पाठ्यक्रम में ए पी सी ओ ए बी का भी सहयोग रहा। इसमें 12 देशों के 16 प्रशिक्षार्थियों ने भाग लिया जिनमें मलेशिया, साउदी अरेबिया, साउथ अफ्रीका, फिलीपींस, फिजी आइसलैंड, चेक रिपब्लिक, श्रीलंका, नाइजीरिया, मिश्र, मारीशस, ताइवान तथा भारत में भा.कृ.अनु. परिषद् के तीन संस्थानों, सी. टी. सी. आर. आई त्रिवेन्द्रम, सी. आई. टी. एच., श्रीनगर तथा एन. आर. सी. केला, त्रिचुरापल्ली से थे। पाठ्यक्रम में लेक्चर एवं प्रैक्टिकल कराया गया, इसका संचालन फैकल्टी के 16 सदस्यों ने किया जो कि रा. पा. आ. सं. ब्यूरो के टिशू कल्चर एवं क्रायोप्रिजर्वेशन इकाई, राष्ट्रीय डी. एन. ए. छायाचित्रण, बायोवर्सिटी इंटरनेशनल ए पी सी ओ ए बी, यूनिवर्सिटी ऑफ लूवेन, बेल्जियम तथा ए पी ए ए आर आई के कार्यकारी सचिव से संबंधित थे। इस प्रशिक्षण की मुख्य बात यह रही कि प्रशिक्षणार्थियों को “हैंडस आन ट्रेनिंग” प्रदान की गई।

**हिन्दी दिवस समारोह का आयोजन:** रा.पा.आ. सं. ब्यूरो, पूसा कैम्पस नई दिल्ली में दिनांक 14 सितम्बर, 08 को हिन्दी दिवस समारोह के अवसर पर शब्दार्थ, हिन्दी टंकण, अनुवाद, प्रश्न मंच, निबंध, टिप्पण एवं प्रारूप लेखन और भाषा एवं सामान्य ज्ञान प्रतियोगिता का आयोजन किया गया। 50 विजेता अधिकारियों एवं कर्मचारियों को प्रथम, द्वितीय, तृतीय और सराहना पुरस्कार प्रदान

किए गए। इस अवसर पर डॉ. एस.के. यादव, वरिष्ठ वैज्ञानिक, जननद्रव्य विनिमय विभाग को राजभाषा हिंदी में सर्वाधिक वैज्ञानिक प्रकाशन करने पर पुरस्कृत किया गया।

दिनांक 15 सितम्बर 08 को तकनीकी अधिकारियों के लिए “केन्द्र सरकार के कार्यालयों के साथ हिन्दी में मूल पत्राचार को बढ़ावा देने के उपाय” के सन्दर्भ में कार्यशाला का आयोजन भी किया गया। ब्यूरो के अधिकारियों एवं कर्मचारियों को हिन्दी में अधिक कार्य करने के लिए प्रोत्साहित किया गया और प्रशासनिक वर्ग का अधिकांश टिप्पण और लेखन का कार्य भी हिन्दी में किया गया।

## नई परियोजनाएं

राष्ट्रीय कृषि नवीन प्रक्रिया परियोजना द्वारा “एग्रोवेब-डिजिटल डिस्सेमिनेशन सिस्टम फॉर इंडियन एग्रीकल्चरल रिसर्च (ए डी डी एस आई ए आर)” विषय पर परियोजना की स्वीकृति प्रदान की गई। परियोजना के लिए रा. पा. आ. सं. ब्यूरो, नई दिल्ली प्रमुख केन्द्र होगा और इसमें 8 सहकारी केन्द्र भी शामिल होंगे। जून 2008 से दो वर्ष की अवधि के लिए इस परियोजना का खर्च रुपए 526.87 लाख होगा। डॉ. आर. सी. अग्रवाल, प्रमुख वैज्ञानिक परियोजना शोधकर्ता होंगे।

अप्रैल 2008 से तीन वर्ष की अवधि के लिए जैव प्रौद्योगिकी विभाग द्वारा “बायोटेक्नोलॉजिकल एप्रोच फॉर क्रायो प्रिजर्वेशन ऑफ एप्पल जर्मप्लास्म यूसिंग विंटर बड्स” विषय पर अनुसंधान परियोजना स्वीकृत की गई। डॉ. संध्या गुप्ता इसकी प्रमुख शोधकर्ता होंगी।

**एन.ए.आई.पी. के अन्तर्गत नई परियोजनाएं:** एन.ए.आई.पी. के अन्तर्गत दो नई परियोजनाएं प्रदान की गई। एक परियोजना ब्यूरो के क्षेत्रीय केन्द्र, हैदराबाद को “नावल स्ट्रेटेजीज़ फॉर मोलेक्यूलर डॉयग्नोसिस ऑफ प्लांट वॉयरसिस” विषय पर प्रदान की गई जिसका बजट रुपए 36.832 लाख होगा। परियोजना का नेतृत्व भारतीय कृषि अनुसंधान संस्थान, नई दिल्ली द्वारा किया जाएगा। इस परियोजना की अवधि 9 जुलाई 2008 से 31 मार्च 2012 तक होगी। दूसरी परियोजना क्षेत्रीय केन्द्र भोवाली को “स्टडीज़ ऑन रिलेशनशिप बिटवीन इकोजियोग्राफी ऑफ दे कैमोटार्डिपिक वेंरिएशन ऑफ नाईन एम्पोटेन्ट बट् हाईली थ्रेंटेड मेडिसिनल प्लांट स्पीशीज एंड प्रोस्पैक्ट्स ऑफ देयरकल्टीवेशन” विषय पर प्रदान की गई जिसका बजट रुपए 415.98 लाख होगा। इस परियोजना का नेतृत्व राष्ट्रीय वानस्पतिक अनुसंधान संस्थान, लखनऊ द्वारा किया जाएगा। इस परियोजना की अवधि अगस्त 2008 से चार वर्ष की होगी।

**पी जी आर में पी.एच.डी. एवं स्नातकोत्तर डिग्री:** भारतीय कृषि अनुसंधान परिषद् का 46 वां दीक्षांत समारोह अत्यंत महत्वपूर्ण था। इसमें पहली बार पादप जननद्रव्य पाठ्यक्रम के अन्तर्गत सुश्री निधि वर्मा, एवं श्री शैलेश तिवारी को पी एच डी डिग्री प्रदान की गई। कुमारी पी. रमैया को स्नातकोत्तर डिग्री के लिए स्वर्णपदक दिया गया। श्री अविनाश पाण्डे तथा कुमारी अधिनी पंजाहिनी को भी स्नातकोत्तर डिग्री प्रदान की गई। पी जी आर कोर्स के प्रोफेसर डॉ. बी. बी. मण्डल की जनवरी में सेवानिवृत्ति होने पर डॉ. सत्यवीर सिंह मलिक को पी. जी. आर. पाठ्यक्रम का नया प्रोफेसर बनाया गया। डॉ. मलिक के सेवानिवृत्ति होने पर 1 अगस्त 2008 से डॉ. आई. एस. बिष्ट को नया प्रोफेसर बनाया गया।



## 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 2008-09 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 36 explorations were undertaken and 2,954 accessions of different agri-horticultural crops comprising 2,106 accessions of cultivated and 848 of wild species including wild relatives of crop plants were collected from parts of Andaman and Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Chhattisgarh, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Mizoram, Orissa, Pondicherry, Punjab, Rajasthan, Tamil Nadu and Uttarakhand. These explorations were undertaken by the NBPGR headquarters, New Delhi and its Regional Stations namely, Akola, Bhowali, Cuttack, Hyderabad, Jodhpur, Ranchi, Shillong, Shimla and Srinagar in collaboration with ICAR Institutes/SAUs. A total of 320 herbarium specimens, 117 seed samples and 21 economic products were processed and added to the National Herbarium of Cultivated Plants (NHCP) maintained at headquarters.

**Wild relatives of crop plants collected:** Major emphasis was given for collection of wild species including wild relatives of crops. One exploration and collection trip was undertaken and 51 germplasm collections of different crops and their wild relatives were made from various parts of Rajasthan. Another survey was conducted in tribal pockets of Khammam, East Godavari, Visakhapatnam and Srikakulam districts. A total of 82 accs. were collected including Wild legumes: 40 accs. (*Bauhinia* spp., *Canavalia* spp., *Cassia* spp., *Mucuna* spp., *Sesbania* spp. and others); Cultivated legumes: 21 accs. (cowpea, French bean, lima bean, pigeon pea, rice bean and others); Medicinal: 11 accs. (*Aristolochia*, *Gloriosa*, *Hemidesmus*, *Plumbago* and others); Miscellaneous: 2; and Wild

relatives: 6 accs. (*Dioscorea*, *Luffa*, *Solanum*, *Trichosanthes*).

**Specific explorations:** A total of 171 germplasm accessions were collected through two crop-specific explorations. Under the first exploration, the crops viz., wheat, barley, fenugreek and coriander were collected from district of Pauri with collaboration of NRC on Seed Spices, Ajmer, Rajasthan and VPKAS, Almora. The second specific exploration was undertaken for cold tolerant paddy from district Pithoragarh, Champawat and U.S. Nagar. The collected germplasm comprised cereals (90), spices (30), pulses (13), vegetables (6), oil seeds (5), M & AP (17), Wild relatives (9) and ornamental (1).

A total of 189 accessions was collected in five exploration and collection missions carried out in six districts of Kerala, 13 districts of Tamil Nadu, one district of Puducherry and three districts of Andaman & Nicobar (A & N) Islands. This resulted in the collection of 77 accessions from Tamil Nadu, 63 from Kerala, 48 from A & N Islands and one from Puducherry. The collected germplasm included two landraces of rice ('khusbui' and 'Burma') from A & N Islands. Profusely bearing heavier bunches in karanj, physicnut which bears fruit throughout the year, a wild relative of drumstick, leafy amaranth with robust habit and thick stem were the unique and interesting collections made. Another collaborative exploration and collection mission to the tribal pockets of Madhya Pradesh was undertaken and a total of 216 accessions of germplasm comprising cereals (2), pseudo-cereal (1), minor millets (34), oilseeds (130), vegetables (11), pulses (9), medicinal plants (5), fibre crop (1) and wild relatives of crop plants (23) were collected.

One survey was undertaken in West Godavari, East Godavari, Visakhapatnam, Vizianagaram and Srikakulam districts of South and North Coastal region of Andhra Pradesh in collaboration with ANGRAU. A total of 172 accs. of germplasm which include 119 accs. of tuber crops, 27 accs. of chillies and *Capsicum frutescens* and 26 accs. of other crops / wild relatives including *Alpinia* sp., *Amorphophallus paeoniifolius* var. *campanulatus*, *Capsicum frutescens*, *Caryota urens*, *Colocasia esculenta* var. *aquaticilis*, *Cucumis hardwickii*, *Curcuma angustifolia*, *C. aromatica*, *Lycopersicon pimpinellifolium*, *Melothria* sp.,



*Mucuna monosperma*, *Piper* sp., *Solanum indicum* and *Stemona tuberosa*.

**Landraces collected:** The important landraces collected under tuber crops include: **Greater Yam-** *Cheda dumpa*, *Pendalamu*; **Dioscorea spp.-** *Adavi tega*, *Arika pendalamu*, *Cheda dumpa*, *Konda teega*, *Kunda dumpa*, *Nagali dumpa*, *Nagalimatam dumpa*, *Saapu tega*, *Siragadi dumpa*, *Tega*, *Wyma dumpa*; **Taro-** *Chema*, *Chinna chema*, *Peer chema*; **Elephant foot yam-** *Dula gandha*, *Durada kanda*, *Gandha*, *Kanda*, *Teepi kanda*; **Tannia/ Cocoyam-** *Arati chema*, *Chema*, *Chema dumpa*, *Durada saara*, *Pala chema*, *Pedda chema*, *Rangam saara*, *Saara dumpa*, *Saara kanda*, *Sanku chema*, *Teepi sara*; **Sweet potato-** *Chilakada dumpa*, *Kandamula dumpa*, *Tiyya dumpa*; **Cassava-** *Karra pendalamu*, *Pendalam dumpa*; **Queensland Arrowroot-** *Tamara dumpa* and under **Chillies** Agency, *Anakapalli potti*, *Bongu mirchi*, *Deshawali*, *Laavulu*, *Pachcha mirapa*, *Pottikaya* and *Rasagulla*.

## EXCHANGE OF GERMPLASM

**Introduction of germplasm:** During the period under report 33,130 accessions (81,112 samples) were imported from 43 countries, which included 25,450 germplasm accessions (26,929 samples) as well as trial material 7,680 entries (54,183 samples) of different agricultural and horticultural crops. Requirements for germplasm from abroad were met by arranging material from different Indian sources and 493 samples of different crops were exported to six countries with phytosanitary certificate issue by Plant Quarantine Division, NBPGR, New Delhi while 18,548 samples of ICRISAT mandated crops were exported to different countries with phytosanitary certificate issued by NBPGR regional station, Hyderabad. In all, 154 phytosanitary certificates were issued during the reporting period. A total of 9,681 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).

### Promising trait specific germplasm introduced:

**Triticum aestivum:** Adapted to drier regions, source of resistance to races of loose smut (EC633777) from Canada; PBW343 new version lines carrying genes resistant to Ug 99 and yellow rust (EC633778-784) from ICARDA, Syria; Resistance to wheat *Soil borne mosaic virus* and *Spindle streak mosaic virus*

(EC634055) from USA; Translocation line carrying a segment of chromosome 5, including softness genes *Pin a* & *Pin b* (EC631734) from USA; Isogenic hard wheat lines differing for the presence of high grain protein gene *Gpc-B1* (EC631987-002) from USA; Germplasm resistant to biotypes 1 & 2 of Russian wheat aphid, semi dwarf, early maturing (EC632017) from USA; near isogenic hard spring lines differing in puroindoline alleles, controlling grain hardness, useful to study the basis for texture & quality differences in hard wheat (EC631967-986) from USA and isogenic lines differing for presence of high grain protein gene *Gpc B1* to serve as a source of increased grain protein for hard red, white spring wheat breeding program and provide material to investigate the effect of *Gpc B1* in high protein background (EC631987-632002) from USA.

**Hordeum vulgare:** Variety Lentah-superior yield & test weight, most widely used as green feed (EC631731) from USA; Variety Clearwater-hull less, low phytate and high available (CV 335) phosphorus concentrations in the grain, superior feed quality (EC631732) from USA; Variety Tetonia-high yielding, resistance to spot blotch & net blotch (EC631946) from USA; Lines resistance to Russian wheat aphid, each line has a different source of resistance in malting barley cultivar backgrounds (EC634221-27) from USA.

**Oryza sativa:** Mutant germplasm lines having improved resistance to sheath blight, bacterial panicle blight & narrow brown leaf spot (EC634219-20) from USA.

**Zea mays:** Resistance to western corn rootworm (EC633803) from USA.

**Helianthus annuus:** Source of resistance to races of loose smut (EC634078-80) from USA.

**Lens culinaris:** High yielding and high level of winter hardness (EC631332) from Turkey.

**Capsicum annum:** Tolerant to aphids (EC611331-611364) from Taiwan, very hot, 55-60 days maturity, extremely prolific, tolerant to *Phytophthora*, TMV & bacterial wilt (EC612322) from Vietnam; Lines resistant to *Chili veinal mottled virus*, *Poty virus Y* and bacterial wilt (EC628891-920, EC631683-687) from Taiwan.

**Cucumis melo:** Arkanga hybrid melon variety, fruits have a Netted skin, light green crispy flesh, strong tolerance to *Fusarium* blight strains 0 & 1 (EC612132) from Vietnam; Very vigorous hybrid variety Alien tolerant to both powdery and downy mildew. Prolific, medium early, can be harvested within 40-45 days

weighing about 1.2-1.3 kg/ fruit. Green flesh, juicy and sweet (EC612133) from Vietnam; Yellow skinned with oblong shape and cream colored flesh, weight approximately 2.5 kg/ fruit (EC612134) from Vietnam.

***Lactuca sativa*:** Variety Minetto, crisp headed, iceberg type medium small size, black seeded variety, resistant to heat and humidity, tolerant to tip burn (EC612126) from Vietnam; fast fall a mid early variety, black seeded, loose leaf type (EC612127) from Vietnam; butter head type major variety for heavy lettuce production. Recommended for winter and autumn production in temperate areas and tolerant to *Bremia* (EC612128) from Vietnam.

***Lycopersicon esculentum*:** Resistant to root knot nematode (EC631955-963); Lines tolerant to bacterial wilt, *Tomato mosaic virus*, fusarium wilt and gray leaf spot (EC632003-21); Resistance to *Tomato leaf curl virus* (EC635523-27); Resistant to Bacterial wilt (EC635528-33) Taiwan; Lines resistant to bacterial wilt, *Tomato mosaic virus*, fusarium wilt and gray leaf spot (EC612858-869); Resistant to whitefly transmitted geminivirus, bacterial wilt, *Tomato mosaic virus* (EC614997-615029); Heat tolerant lines (EC611883-891) from Taiwan.

***Fragaria vesca*:** Varieties Lamour, Clancy, Seneca with excellent fruit quality and flavour, firm flesh and good texture (EC619154-56) from USA.

***Malus domestica*:** Resistant to fire blight (EC612824-25) and resistant to apple scab (EC612822-23) from USA.

***Persea americana*:** Variety Pollock with low oil, early type, very large fruits weighing 750gms (EC632072); variety Pinkerton with long pear shaped fruits, excellent peeling characteristics (EC632073) from USA.

***Deschampsia antarctica*:** Antarctic hair grass a New crop, native to Antarctica (EC631954) from Chile.

***Chicorium intybus*:** Variety Scarole giant voluminous heads with white compact heart, slow bolting and good tolerance to tip burn & bolting (EC612129), Variety Frisee green suitable for spring production, performs well both in open fields and protected cropping and tolerant to bolting (EC612130), Variety Grosse bouclee large broad leaves, escarole endive tight and very well filled with curled heart, suitable for spring and summer production in temperate areas, used for both fresh markets and salad packs, good resistance to bolting (EC612131) from Vietnam.

**Export of Germplasm:** The plant material intended for export was procured from known Indian sources through correspondence and the same was forwarded to the indentors in foreign countries along with phytosanitary certificates issued by the Plant Quarantine Division of the Bureau and import permit, if any after approval from ICAR/DARE and clearance from National Biodiversity Authority of India. A total of 19,359 samples (811 from New Delhi and 18,548 from Hyderabad of ICRISAT mandate crops) were exported to several countries for research and 20,950 samples of ICRISAT mandate crops germplasm was sent to Norway for conservation in the Svalbard Global Seed Vault under Material Transfer Agreement (MTA).

**National Supply:** A total of 9,681 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 MTA.

## QUARANTINE OF GERmplasm

**At New Delhi,** a total of 33,130 accessions (81,112 samples) comprising germplasm accessions as well as trial material entries of various crops and 493 accessions (891 samples) under export were processed for quarantine clearance. These samples included true seeds, rooted plants, cuttings, rhizomes, suckers, bulbs, nuts and tissue culture plantlets. The detailed quarantine examinations revealed that 4,325 samples were infested/infected contaminated with various pests viz., insects/mites - 491 samples including 82 with hidden infestation; nematodes-3,456; fungi/ bacteria- 297 and viruses (81). Of the 4,325 infested/ infected/ contaminated samples, 4,316 were salvaged through fumigation, hot water treatment (HWT), X-ray radiography, pesticidal dip, mechanical cleaning and growing-on test. Nine samples were rejected including one sample of *Glycine max* from USA due to the presence of downy mildew fungus (*Peronospora manshurica*), a pest not yet reported from India. In addition, 260 accessions of Indian origin collected during explorations were processed for pest-free conservation. Of these 201 samples were subjected to X ray radiography of which 55 samples found infected were salvaged. Two samples were rejected due to severe infestation. Fourteen Phytosanitary Certificates were issued for consignments meant for export. In addition, 305 samples of transgenic crops viz., *Brassica oleracea* var. *capitata* (cabbage), *B. oleracea* var. *botrytis* (cauliflower), *Gossypium* spp., *Oryza sativa* and *Zea mays* were processed for quarantine clearance.

**At Hyderabad,** a total number of 31,208 samples [12,660-imports & 18,548-exports] were received for quarantine processing during the period under report. 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 and several pests of quarantine significance were intercepted. A total of 1,909 imported samples were found infested/ infected with pathogens (1,714), insects (81) and nematodes (114). A total of 1,655 samples were salvaged, 249 detained and 5 samples were rejected. A total of 18,548 samples were processed for export to different countries. In all, 154 phytosanitary certificates were issued.

## GERMPLASM CHARACTERIZATION, EVALUATION AND MULTIPLICATION

A total of 7,661 accessions of various agri-horticultural crops comprising cereals (3,203), millets & forages (447), pulses (2,390), oilseeds (668), vegetables (390), underutilized crops (438), medicinal and aromatic plants (125) were grown for characterization and evaluation. In addition, 4,141 accessions of international nurseries comprising of wheat, Barley and *triticale* were also grown in Post Entry Quarantine Nursery (PEQN). The germplasm of the oilseeds namely, rapeseed mustard (721), sunflower (36), safflower (352), linseed (85) was analysed for oil content and quality parameters. Similarly the germplasm of walnut (17), almond (39) and *S. oleoides* (20) was analyzed for quality traits. In phytochemical evaluation, 402 samples of medicinal and aromatic plants were analyzed and evaluated for their active compounds. Collaborative evaluation of germplasm was also undertaken for specific traits involving AICRP/ ICAR/ SAUs. The details of germplasm characterized and evaluated at the various regional stations are as follows:

**Akola:** During *Rabi* 2007-08, 2,997 accessions comprising Amaranth (1,158), Chick pea (1,010), Grass pea (119), Linseed (193) and Safflower (517) and during *Kharif* 2008, 4,250 accessions of germplasm comprising millets (599), pulses (991), oilseeds (1,419), vegetables (619) and wild relatives of crop plants (622) were regenerated and multiplied. A total of 1,387 accessions of linseed (193), safflower (538) and chick pea (656) and 726 accessions comprising *Sesamum* spp. (132), *Abelmoschus tuberculatus* (84), *A. manihot* var. *tetraphyllus* (132), *A. ficulneus* (86) and castor (292) were characterized during *Rabi* (2007-08) and *Kharif*

2008, respectively.

**Bhowali:** A total of 404 accessions were received 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): Rose- Geranium (24,336 Nos.), *Ginkgo biloba* (44 nos.), Lavender (75,864 nos.), *Rosa damascena* (554 nos.), *Rosmarinus officinalis* cv. French – 27,204, *Rosmarinus officinalis* cv. Italian – 5554 nos.; Horticultural Plants: Kiwi (2324 nos.), Kagzi nimbu (251 nos.); Agricultural Crops: Wheat – HB-208 (8 kg) were supplied to different farmers/ indentors.

**Hyderabad:** A total of 879 accs of different agri-horticultural crops consisting of black gram (60), horse gram (150), sorghum (210), brinjal (115) and chillies (125), cowpea (80), dolichos bean (78) and leafy vegetables (61) were grown for characterization/ evaluation/ multiplication during *Rabi* 2007-08. A total of 1,063 accessions of small millets, black gram, sesame, brinjal, chillies, cowpea, field bean and wild legumes were grown in the field along with appropriate checks for characterization/ evaluation/ multiplication in *Kharif* 2008.

**Jodhpur:** Observations were recorded on morpho-agronomic traits of 174 and 2,065 accessions raised during *Summer* and *Kharif* 2008, respectively. Genetic stocks with unique traits such as determinate habit with early maturity; and branched as well as all node cluster bearing ability in guar were identified and characterized during *Kharif* 2008. Blocks of horticultural plants and plants of economic importance were maintained and data were recored in *Aloe barbadensis*, anola, bael, *Capparis decidua*, jamun, mulberry, *Salvadora* spp., *Jatropha curcas* and jojoba germplasm.

**Shillong:** For characterization of crops, a total 2,184 accs. covering 12 crops were sown of which 1,824 accs. were harvested. Promising accs. were identified in each crop, based on the yield data. A total of 462 accs. of Buckwheat, Job's tear, Maize, Ricebean, Rice, Taro, Yam in addition to *Momordica cochinchinensis*, *Mucuna pruriens* and medicinal plants were supplied to 15 indentors. A total of 142 accs. comprising rice and maize were sent for LTS to National Gene Bank and one accession of rare bamboo germplasm species was sent for cryo-storage at NBPGR, New Delhi.

**Shimla:** A total of 1,816 accessions of agri-horticultural crops were characterized and multiplied for



conservation. 474 accessions of various grain crops were submitted for long term storage. One thousand one hundred fifty three accessions of fruit crops, their wild relatives, medicinal plants and ornamentals were conserved and maintained in field gene bank at Shimla and 9,788 accessions of various crops were conserved in MTS at Shimla. Germplasm accessions of agricultural crops (782) and horticultural crops (612 rooted plants and 1,137 bud sticks) were supplied to various indenters under MTA.

**Srinagar:** The 605 accessions of wheat (330), barley (164) and mustard (111) were characterized and evaluated during *Rabi* 2007-08 and 576 accessions of wheat (303), barley (145) and sarson (128) were sown in *Rabi* 2008-09 for characterization and evaluation.

**Thrissur:** During *Rabi* 2007-08, 113 accessions of rice (*Oryza sativa*) and 117 of horsegram (*Macrotyloma uniflorum*) were evaluated. In summer 2008, 24 accessions of Chinese spinach (*Amaranthus tricolor*), 10 of spleen amaranth (*A. dubius*), 18 of mango (*Mangifera indica*) and 9 of kokum (*Garcinia indica*) were characterised/ evaluated. During *Kharif* 2008, 100 accessions of okra (*Abelmoschus esculentus*), 174 of brinjal core set (*Solanum melongena*), 10 of Chinese potato (*Solenostemon rotundifolius*), 21 of lesser yam (*Dioscorea esculenta*) and 34 of Malabar tamarind (*Garcinia cambogia*) were characterised/ evaluated. Based on material transfer agreement, 599 accessions comprising 8 crops and 39 wild related species were supplied to 18 user agencies.

## GERMPLASM CONSERVATION

**Conservation in Seed Genebank:** A total of 13,720 germplasm accessions of various crops were received for long-term conservation in the National Genebank. These were processed following the genebank standards adding another 13,542 accessions to the base collection raising the total germplasm holding to 3,67,419. A total of 852 accessions received at the Germplasm Handling Unit were stored in the medium-term storage module as reference material. Monitoring of stored germplasm (2,121 accessions) and updating of passport data (2,225 accessions) was carried out. A total of 5,873 accessions were supplied from the genebank for evaluation/ regeneration or research. Longevity of castor, groundnut, sesame, niger and cotton at ambient temperatures was found to be more when seeds were dried to ultra low moisture contents (i.e. < 5 per cent moisture content). Methods for breaking seed dormancy were developed

in some medicinal plants and wild species viz. *Dodonea viscosa*, *Ariesema caudate*, *Cucumis setosus*, *C. callosus*, *Tecoma stans*, *Catunera spinosa*.

**In vitro/ Tissue Culture Conservation:** A total of 2,011 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. Research work continued on aspects related to *in vitro* slow growth and cryopreservation in aforementioned group of crops. Employing several slow growth strategies, subculture duration could be extended to varying periods in *Dahlia* and *Pyrus* sp. Cost-effective conservation experiments yielded encouraging results in *Gladiolus* cv. and *Kaempferia rotundata*. Experiments to test the potential of synseeds in *Zingiber officinale* yielded encouraging results. Cryopreservation experiments led to varying degree of pre-and post-freezing success in *Cicer microphyllum*, *Gentiana kurroo*, *Musa* sp. and *Zingiber officinale*. Genetic stability studies employing various morphological or molecular marker (RAPD, SSR) in *Colocasia esculenta* revealed that there were no significant differences between *in vitro*-conserved accessions and their respective mother plants. A total of 4 accessions comprising *Allium sativum* (1), *A. tuberosum* (1) and *Gladiolus* (2) were supplied as *in vitro* cultures to various indenters.

**Cryopreservation:** A total of 345 accessions comprising orthodox, intermediate and recalcitrant seed species, dormant buds and pollen were cryopreserved during the year totaling 8,804 accessions in the cryogenebank. Successful cryopreservation was achieved in seeds, embryos and embryonic axes of *Salvadora* sp., *Prunus armeniaca*, *P. dulcis* and *Juglans regia*.

## DNA FINGERPRINTING

NRC on DNA Fingerprinting has so far developed protocols for cultivar identifications in 33 crops of national importance using the molecular marker techniques like STMS, AFLP and ISSR. The crops include cereals (rice, wheat, barley), millets (finger millet, sorghum, pearl millet), pulses (chickpea, French bean, horsegram, lentil, peas, pigeonpea, mungbean, ricebean, urdbean, soybean), oilseeds (mustard, safflower, sesame, niger), fibres (cotton, jute), vegetables (tomato, chillies,



cucurbits) fruits and nuts (banana, mango, cashew, citrus) and medicinal plants (chlorophytum, neem, vetiver). More than 2,500 varieties in different crops were fingerprinted till December 2008. The analysis of diversity in molecular markers of important crops like rice, mungbean, oilseed brassicas and tomato have provided insight into the genetic base of Indian crop varieties. Such information will form the basis for developing efficient strategies for their breeding and genetic resources management.

PCR-based detection protocols have been developed for the several genes in transgenic planting materials some using multiplex PCR for simultaneous detection of promoter, terminator and marker gene along with endogenous genes in duplex, triplex, tetraplex formats in genetically modified crops. Developed protocol for simultaneous amplification of six commonly used marker genes, viz., *nptII*, *aadA*, *hpt*, *bar*, *pat* and *uidA* for detection of GM crops.

Genetic diversity analyses and DNA profiling was conducted in mungbean, finger millet, pearl millet, sesame, water melon using STMS, ISSR and RAPD markers. The analyses helped in the estimation of available genetic diversity in the collections and also in generating DNA fingerprints of these indigenous cultivars.

## OTHER ACTIVITIES

- Meetings of the Quinquennial Review Team, 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. Five scientists were sent abroad to participate in foreign meetings. Details of these participations are given in chapter 19 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:**

- o National Workshop on “Agricultural Biosecurity” on March 25, 2008 at National Agricultural Science Complex, New Delhi
- o One day Training and Field Visit Programme on “Agricultural and Horticultural Crop Plant Genetic Resources” on June 28, September 8, and December 12, 2008 at NBPGR, Bhowali
- o Indo-US SPS 2<sup>nd</sup> Workshop on “Agricultural Knowledge Initiative” (AKI) from July 22-23, 2008 at National Agricultural Science Complex, New Delhi
- o Brain Storming Session on “Issues of Access and Benefit Sharing on Genetic Resources” on October 4, 2008 at NBPGR, New Delhi
- o Brainstorming Session on “Plant Quarantine including Internal Quarantine Strategies in view of Onslaught of Diseases and Insect Pests” on November 4, 2008 at National Agricultural Science Complex, New Delhi
- o A Short Training Course on “Germplasm Exchange: Policies and Procedures in India” from November 17-26, 2008 at NBPGR, New Delhi
- o An International Training Course on “*In vitro* and Cryopreservation Techniques for Conservation of Plant Genetic Resources” from November 17-29, 2008 at NBPGR, New Delhi
- o Brain-storming Session on “Plant Taxonomy and Biodiversity” on December 16, 2008 at NBPGR, New Delhi
- o One day Training Programme on “Kiwi Production” on December 19, 2008 at NBPGR, Bhowali
- **Field days organized:** At Issapur Experimental Farm and IARI, New Delhi, Four Germplasm Field Days for various crops (*Rabi* pulses, wheat, barley and triticale, maize and pearl millet, *Kharif* pulses,

medicinal & aromatic plants and vegetables) were organized to promote germplasm utilization by the plant breeders/ user scientists. The meetings of Germplasm Advisory Committee constituted for different crops/ crop groups were also organized. Field days were also conducted at Regional Stations, Hyderabad, Jodhpur and Thrissur for the benefit of breeders.

- **Release of PCR-based Diagnostic Kits:** PCR-based diagnostic kits have been developed for detection of endogenous genes, specific transgenes and 35S promoter sequence in five genetically modified crops viz., cotton (*cry1Ac*, *cry2Ab* genes), brinjal (*cry1Ac* gene), cauliflower (*cry1Ac* gene), mustard (*barnase* and *barstar* genes) and tomato (*osmotin* gene). These kits were released by Shri Kapil Sibal, Hon'ble Union Minister for Science and Technology and Earth Sciences on 7 April 2008.
- **Publications:** NBPGR Annual Report and quarterly Newsletter were published and distributed to all concerned with PGR management. Besides, research papers (85) on various subjects were published in national and international journals; book chapters (58) in various edited books; proceedings/ annual review/ books (6); plant germplasm reporter (5); crop catalogues (1); information bulletins/ brochures/ advisory leaflets on plant quarantine pests (3); and popular articles in Hindi/ English (26) were published by the scientists of the NBPGR (details are given in chapter 19).
- **Germplasm Registered:** A total of 117 proposals belonging to 14 crop groups were approved for registration in the Plant Germplasm Registration Committee meeting.

# 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 purposes.

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 centres that provide access to representative agro-ecological situations in the country. It has strong linkages with leading crop-based Institutes, National Research Centers, All India Coordinated Crop Improvement Projects, State Agricultural Universities and other stakeholders. NBPGR also works in close collaboration with several international institutes/ organizations through memoranda/ workplans developed under bilateral/ multilateral agreements. The Bureau not only provides genetic resources to on-going crop improvement programmes to sustain continued advances in agricultural productivity and stabilize production, but also conserves them safely to meet needs of future generations.

## Organizational Set-up

The Director, NBPGR is overall in-charge of administration, research management and coordination. The Institute Management Committee, Research Advisory Committee, 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 504 comprising 128 scientific, 127 technical, 78 administrative and 171 supporting staff.

## National Genebank

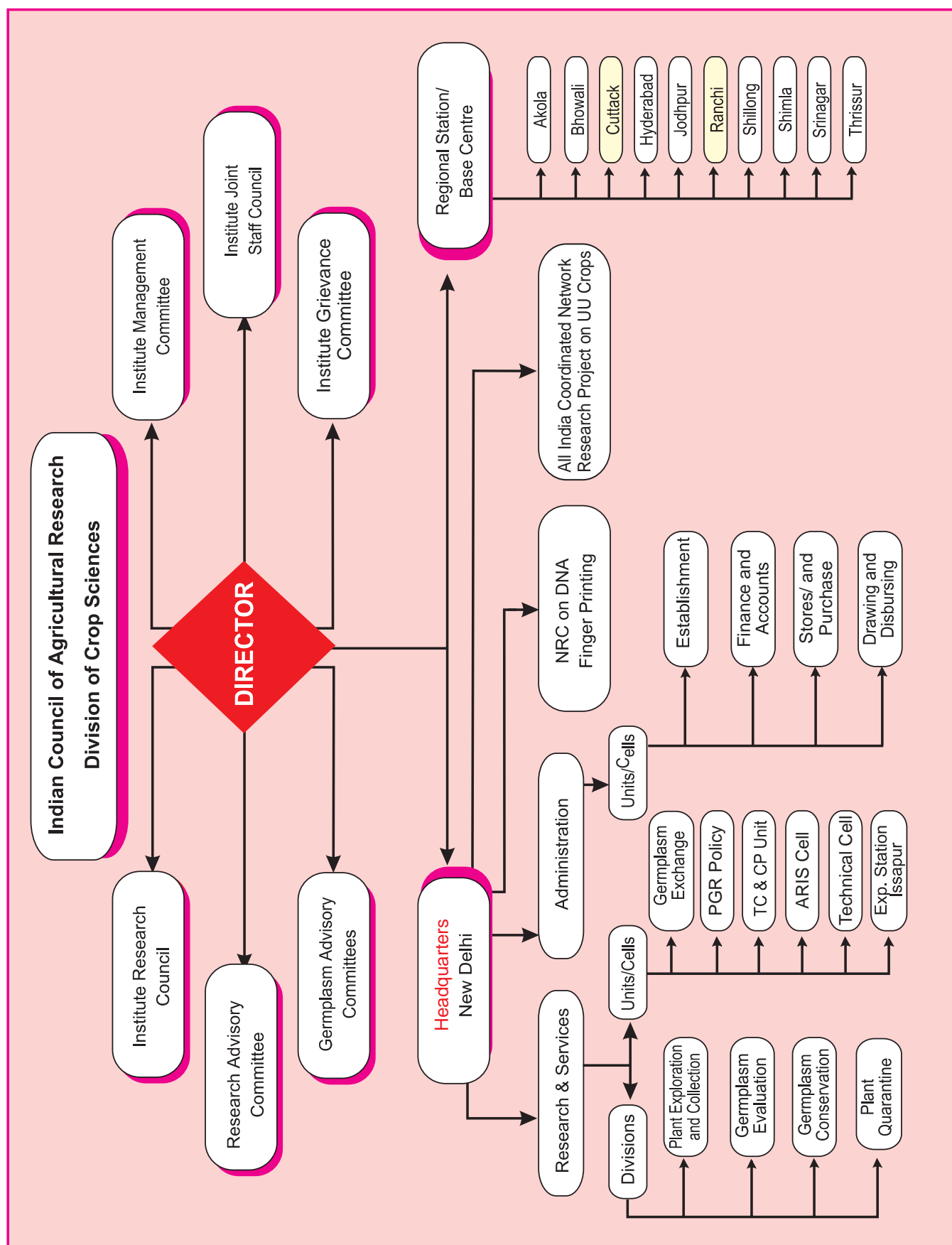
The Indian National Genebank was established by the council at NBPGR to conserve national heritage of germplasm collections in the form of seeds, vegetative

### MANDATE

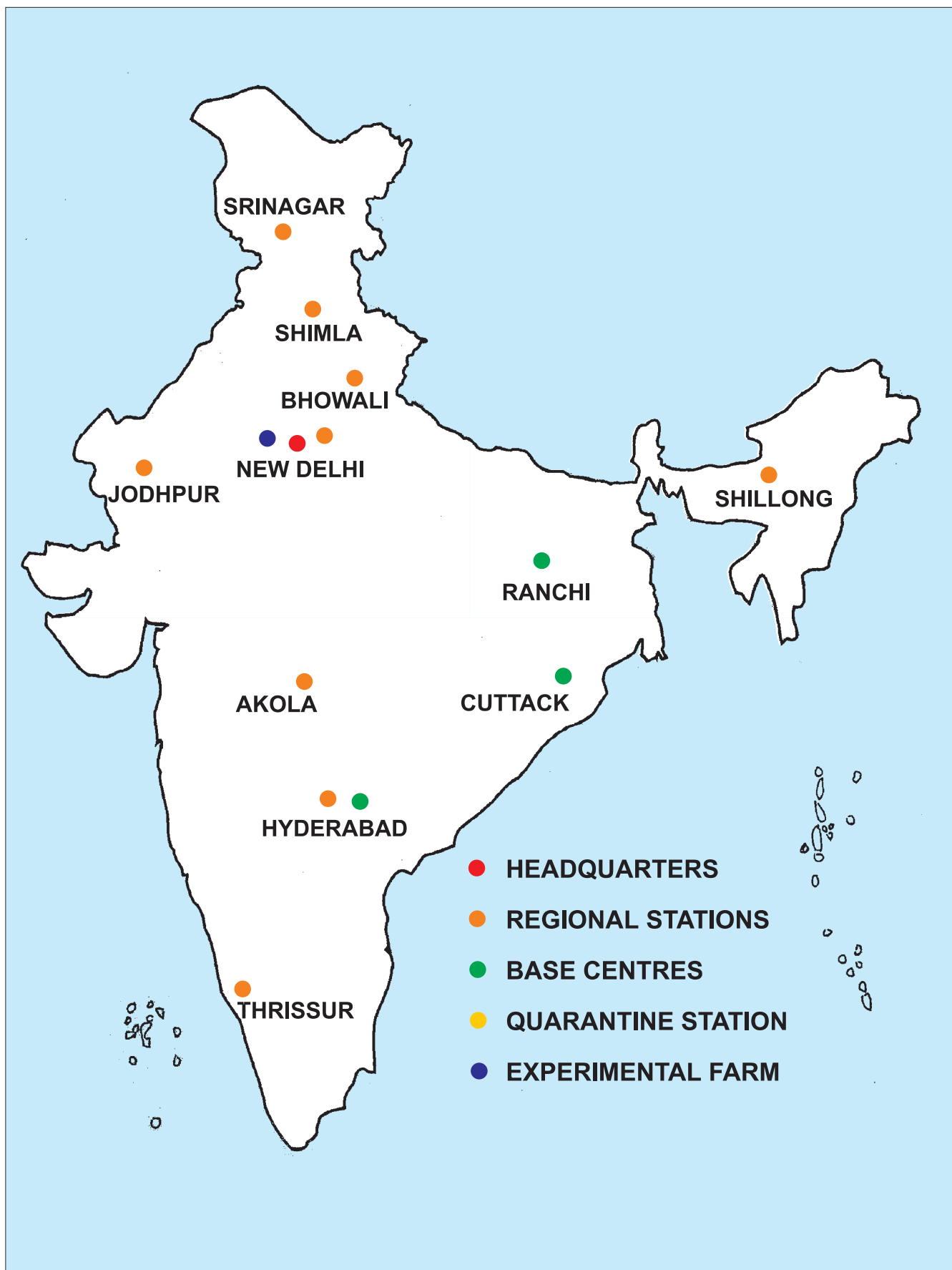
To act as the nodal institute at national level for acquisition and management of indigenous and exotic plant genetic resources (PGR) for agriculture, and to carry out related research and human resource development for sustainable growth of agriculture.

### OBJECTIVES

- To plan, organize, conduct and coordinate exploration and collection of indigenous and exotic plant genetic resources.
- To undertake introduction, exchange and quarantine of plant genetic resources.
- To characterize, evaluate, document and conserve crop genetic resources and promote their use in collaboration with other national organizations.
- To develop information network on plant genetic resources.
- To conduct research, undertake teaching and training, develop guidelines and create public awareness on plant genetic resources.







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<sup>3</sup> and two of 176 m<sup>3</sup> capacity) were installed for long-term storage of seeds of orthodox species kept in laminated aluminium foils at -20°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 Genebanks in the world.

### **Indian National Plant Genetic Resources System (INPGRS)**

NBPGR is gradually developing and strengthening the national plant genetic resources system by linking up the National Base Collection (kept under long-term storage at NBPGR) with 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 workplans developed under MoU between Government of India and other countries, and 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, 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 specializes 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 alongwith 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.

# 1. DIVISION OF PLANT EXPLORATION AND GERMPLASM COLLECTION

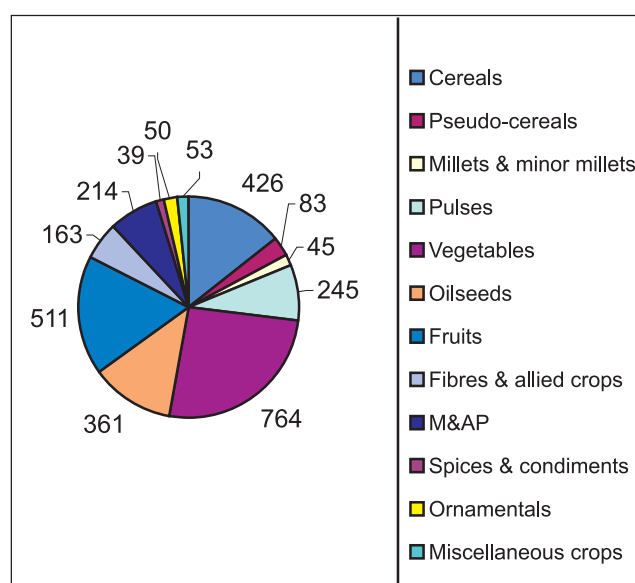
**Summary:** Thirty six explorations were undertaken across the country in collaboration with various ICAR institutes/SAUs and 2,954 accessions of various agri-horticultural crops, wild relatives and other economic plants were collected. Of these, 673 accessions were collected by NBPGR Headquarters through 11 explorations from parts of Haryana, Himachal Pradesh, Maharashtra, Mizoram, Orissa, Punjab and Rajasthan. A total of 320 herbarium specimens, 117 seed samples and 21 economic products were processed and added to the National Herbarium of Cultivated Plants (NHCP).

## 1.1 Plant Exploration and Germplasm Collection

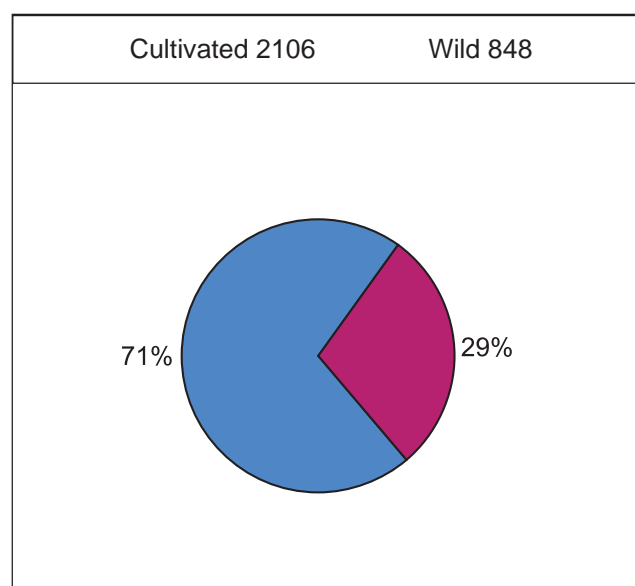
A total of 36 explorations were undertaken and 2,954 accessions of different agri-horticultural crops comprising 2,106 accessions of cultivated and 848 of wild species including wild relatives of crop plants were collected from parts of Andaman and Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Chhattisgarh, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Mizoram, Orissa, Pondicherry, Punjab, Rajasthan, Tamil Nadu and Uttarakhand (Table 1 and 2).

**Table 1: Explorations undertaken and germplasm collected during 2008**

Region	Explorations undertaken (No.)	Accessions collected (No.)
Jodhpur (Arid region)	1	51
Thrissur (South west coastal region)	4	184
Cuttack (Humid/ moist tropical east coastal region)	2	225
Shillong (North east hill region)	-	-
Bhowali (Central Himalayan region)	2	171
Shimla (North west Himalayas and high altitude region)	4	266
Srinagar (North west Himalayas and high altitude region)	2	401
New Delhi (North west plains)	11	673
Ranchi (Sub-tropical humid region)	-	-
Akola (Central Indian region)	1	216
Hyderabad (South east coastal region)	9	767
<b>Total</b>	<b>36</b>	<b>2,954</b>



**Germplasm collected in different crop groups**



**Germplasm (%) collected in cultivated and wild species including wild relatives**

**Table 2: Details of crop diversity collected during 2008**

Crop group(s)	Crop(s)/ Species	Accs. (No.)
Cereals	Barley (30), maize (46), paddy (308) and other wild <i>Oryza</i> spp. (7), wheat (35)	426
Pseudo-cereals	<i>Amaranthus caudatus</i> (9), <i>A. dubius</i> (12), <i>A. spinosus</i> (5), <i>A. tricolor</i> (33), <i>Chenopodium album</i> (10), <i>C. hybridum</i> (5), others (9)	83
Millets and minor millets	Finger millet (6), kodo millet (21), little millet (11), others (7)	45
Pulses	Black gram (59), cowpea (5), French bean (34), green gram (42), horse gram (24), khesari (22), lentil (7), pea (7), pigeonpea (7), soybean (10), <i>Vigna radiata</i> var. <i>sublobata</i> (7), others (21)	245
Vegetables	<i>Abelmoschus manihot</i> var. <i>pungens</i> (5), <i>Allium cepa</i> var. <i>aggregatum</i> (14), <i>Amorphophallus campanulatus</i> (6), <i>Basella alba</i> (7), bitter gourd (7), bottle gourd (64), brinjal (57), <i>Canavalia cathartica</i> (5), cassava (12), chilli (45), colocasia (84), cucumber (23), <i>Cucumis melo</i> var. <i>conomon</i> (5), <i>C. sativus</i> var. <i>hardwickii</i> (13), <i>Dioscorea alata</i> (26), elephant foot yam (12), fenugreek (7), field bean (6), jack bean (7), lablab bean (16), <i>Luffa acutangula</i> var. <i>amara</i> (8), <i>L. tuberosa</i> (14), <i>Lycopersicon pimpinellifolium</i> (9), <i>Momordica charantia</i> var. <i>muricata</i> (6), <i>M. cochinchinensis</i> (16), <i>M. subangulata</i> (6), onion (28), pumpkin (55), ridged gourd (46), smooth gourd (27), sweet potato (12), <i>Xanthosoma sagittifolium</i> (30), others (86)	764
Oilseeds	<i>Brassica juncea</i> (11), <i>B. nigra</i> (13), <i>B. tournefortii</i> (12), <i>Calophyllum calaba</i> (5), <i>Jatropha curcas</i> (30), linseed (94), niger (118), <i>Pongamia pinnata</i> (38), sesame (11), <i>Sesamum mulayanum</i> (5), others (24)	361
Fruits	<i>Capparis decidua</i> (6), <i>Citrus grandis</i> (15), <i>C. limon</i> (8), <i>C. macroptera</i> (13), <i>Citrus</i> hybrid (9), <i>Cordia myxa</i> (17), <i>Hippophae rhamnoides</i> (148), <i>Malus pumila</i> (17), <i>Morinda citrifolia</i> (19), <i>Prunus armeniaca</i> (101), <i>P. pashia</i> (8), <i>Salvadora oleoides</i> (21), <i>Ziziphus nummularia</i> (65), <i>Z. rotundifolia</i> (5), others (59)	511
Fibre and allied crops	<i>Corchorus</i> spp. (29), <i>Crotalaria</i> spp. (8), <i>Gossypium arboreum</i> (32), <i>G. herbaceum</i> (35), kenaf (29), <i>Sesbania grandiflora</i> (5), sunnhemp (21), others (4)	163
Medicinal and aromatic plants	<i>Abrus precatorius</i> (10), <i>Alpinia calcarata</i> (8), <i>A. galanga</i> (8), <i>Amomum dealbatum</i> (6), <i>Costus speciosus</i> (6), <i>Hedychium spicatum</i> (8), <i>Homalomena aromatica</i> (7), <i>Indigofera tinctoria</i> (5), <i>Mucuna pruriens</i> (11), <i>Tinospora cordifolia</i> (26), <i>Withania somnifera</i> (21), <i>Valeriana jatamansi</i> (5), others (93)	214
Spices and condiments	Coriander (25), others (14)	39
Ornamentals	<i>Rosa brunonii</i> (14), <i>R. multiflora</i> (7), others (29)	50
Miscellaneous crops	<i>Borassus flabellifer</i> (9), <i>Cassia</i> spp. (13), <i>C. tora</i> (15), others (16)	53
<b>Total</b>		<b>2,954</b>

## 1.2 Explorations undertaken by the Headquarters, New Delhi

A total of 673 accessions were collected through 11 explorations covering parts of Haryana, Himachal Pradesh, Maharashtra, Mizoram, Orissa, Punjab and Rajasthan. The areas explored and germplasm collected during these missions are given in Table 3.

### 1.2.1 Exploration for collection of *Brassica* spp. in Haryana, Punjab and Rajasthan

A total of 42 accessions comprising *Brassica nigra* (13), *B. tournefortii* (12), *B. juncea* (9), *B. campestris* var. *yellow sarson* (2), *B. napus* (1), *Eruca sativa* (3) and *Lepidium sativum* (2) were collected from parts of

Alwar, Jhunjhunu, Sikar, Nagour, Bikaner and Sri Ganganagar districts in Rajasthan; Bhiwani, Hisar, Mahendragarh and Rewari districts of Haryana and Bathinda district of Punjab. *B. tournefortii*, a species under sporadic cultivation and cross compatible with oleiferous Brassicas was collected with variability in plant type (dwarf and tall) and seed colour (brown, yellow and light brown). Bold seeded and highly branched types in *B. juncea* were collected from Rewari and Alwar. Variables in *Eruca sativa* for flower colour (creamy and yellow) were also collected from Bikaner. Introduction of high yielding varieties of oilseed Brassicas in the areas of cultivation has resulted in vanishing of diversity in *B. tournefortii*. Presently, this species is under cultivation as oilseed and forage crop in very limited areas.



**Table 3: Explorations undertaken by Headquarters during 2008**

S. No.	Collector(s)/ Collaborator(s)	Region explored (Duration)	Diversity collected	No. of accessions		
				Cult.	Wild	Total
1.	NBPGR (HQ)	Haryana, Punjab & Rajasthan (March 5-10)	<i>Brassica</i> spp. (37) and others (5)	42	-	42
2.	NBPGR (HQ) and NBPGR, Jodhpur	Rajasthan (May 12 -17)	<i>Salvadora oleoides</i> (21), <i>Capparis decidua</i> (6) and others (2)	-	29	29
3.	NBPGR (HQ) and CIAH, Bikaner	Himachal Pradesh (June 2-7)	<i>Cordia</i> spp. (18) and others (4)	2	20	22
4.	NBPGR (HQ) and CRIJ&AF	Haryana & Punjab (October 15-23)	Sunnhemp (20), <i>Corchorus</i> spp. (18)	20	18	38
5.	NBPGR (HQ)	Haryana (October 13-18)	Giloe (26) & asgandh (18)	-	44	44
6.	Veena Gupta (under externally-funded project)	Maharashtra (November 7-10)	M&AP and other economic plants (39)	-	39	39
7.	NBPGR (HQ) and CIAH, Bikaner	Haryana & Rajasthan (November 14-25)	<i>Ziziphus nummularia</i> (65) & <i>Z. rotundifolia</i> (5)	-	70	70
8.	NBPGR (HQ)	Mizoram (November 17-28)	M&AP (42) and other economic plants (10)	22	30	52
9.	NBPGR (HQ) CRRI and CTCRI (Special Mission)	Orissa (December 1-10)	Paddy (90), Colocasia (25) and others (23)	134	4	138
10.	NBPGR (HQ) and CRRI, CTCRI (Special Mission)	Orissa (December 1-10)	Paddy (60) and other crops (65)	121	4	125
11.	NBPGR (HQ)	Mizoram (December 3-20)	Citrus (67) and others (7)	61	13	74
<b>Total</b>				<b>402</b>	<b>271</b>	<b>673</b>



*Brassica tournefortii* collected from farmer's field in Rajasthan



### 1.2.2 Exploration for minor horticultural crops in parts of Rajasthan

This exploration was undertaken in collaboration with NBPGR Regional Station, Jodhpur and a total of 29 accessions of minor horticultural crops comprising *Salvadora oleoides* (21), *Capparis decidua* (6), *Grewia subinaequalis* (1) and *Citrullus colocynthis* (1) were collected from parts of Bikaner, Churu, Jaisalmer, Jhunjhunu and Jodhpur districts. Variability was collected for fruit colour (orange and red) in *S. oleoides*. Fruits of *S. oleoides* are plucked from wild by children and women. Fruits are eaten fresh or dried with pulp for consumption in off-season.



*Cordia myxa*, a heavy bearing type collected from Una in HP



*Capparis decidua*: a minor fruit crop in Rajasthan

### 1.2.3. Exploration for minor fruit crops in parts of Himachal Pradesh

This exploration was undertaken in collaboration with Central Institute of Arid Horticulture (CIAH), Bikaner, Rajasthan and a total of 22 accessions were collected from Bilaspur, Hamirpur, Kangra and Una districts. The diversity collected included *Cordia myxa* (17), *C. vestita* (1), *Ficus palmata* (2), *F. roxburghii* (1) and *Morus alba* (1). Variability in *C. myxa* for tree habit, trait type and taste was prevalent.

### 1.2.4. Exploration for collection of sunnhemp and *Corchorus* spp. in Haryana and Punjab

This trip was undertaken in collaboration with Central Research Institute for Jute and Allied Fibres (CRIJ&AF), Barrackpore, West Bengal and Sunnhemp Research Station, Pratapgarh, Uttar Pradesh and a total of 38 accessions were collected from parts of Bhiwani, Jhajjar, Jind, Hisar, Mahendragarh, Mewat, Rohtak, Sirsa, Sonapat districts of Haryana and Abohar, Bathinda and Mansa districts of Punjab. The diversity collected included *Crotalaria juncea* (20), *Corchorus tridens* (7), *C. aestuens* (5), *C. olitorius* (3), *C. trilobularis* (2) and *C. pseudo-olitorius* (1). In Haryana, the population of *C. tridens* was high in comparison to other species. It was observed that the farmers were not much interested in cultivation of sunnhemp in Haryana mainly due to availability of alternatives like plastic rope. This led to poor cultivation of the crop in the area. Local indigenous knowledge on processing and use of different fibre species was also documented through interaction with local inhabitants and farming communities.

### 1.2.5. Exploration for medicinal plants in parts of Haryana

A total of 44 accessions comprising of *Tinospora cordifolia* (25) and *Withania somnifera* (19) were collected from parts of Jind, Karnal, Kurukshetra, Panipat, Sonapat and Yamunanagar districts. Cuttings



Sunnhemp in farmer's field (Left) and its collection from farm store (Centre) and rope from sunnhemp fibre (Right)



of *T. cordifolia* were collected from different host plants such as neem, popular, *Prosopis* to work out host-based variation in active principles and other phytochemical traits. Samples were collected in *W. somnifera* from diverse habitats to study morphological variation in plant type from different habitats. Indigenous knowledge was recorded in these species.

### 1.2.6. Exploration for medicinal plants in Western Ghats of Maharashtra

An exploration was undertaken in collaboration with Shivaji University, Kolhapur and a total of 39 accessions of different medicinal and aromatic plants and other economic plants were collected from parts of Satara, Kolhapur and Pune districts of Maharashtra. The diversity collected included *Triumfetta rhomboidea*, *Arisaema caudatum*, *Celastrus paniculatus*, *Gymnosporia* sp., *Smithia cetolosa*, *Cassia tora*, *C. mimosoides*, *Morinda pubescence*, *Argyria cuneata*, *Tecoma stans*, *Thunbergia erecta*, *Eulophia nuda*, *Tridax* sp., *Cynoglossum* sp., *Chlorophytum glaucoides*, *C. nimmonii*, *Emblia officinalis*, *Ceropegia hirsuta*, *C. oculata*, *Arundinella spicata*, *A. tuberculata*, *Lavandula lawii*, *Vigna khandalensis*, *Vigna* spp., *Barleria cristata*, *Duranta* sp., *Crotalaria juncea*, *Bryonopsis laciniata*, *Cucumis setosus*, *C. callosus*, *Jatropha curcas*, *Cassia obtusifolia*, *C. siamia*, *Jacaranda mimosifolia* and *Anogeissus latifolia*.



### 1.2.7 Exploration for paddy, tuberous vegetables and other crops in flood-affected areas of Orissa

**1.2.7.1** One hundred thirty eight accessions comprising paddy (90), *Colocasia esculenta* (25), *Dioscorea alata* (8), *Oryza rufipogon* (5), *Amaranthus caudatus* (3), *Amorphophallus campanulatus* (1), *Coriandrum sativum* (1), *Cucurbita moschata* (1), *Ipomoea batatas* (1), *Luffa acutangula* (1), *Maranta arundinacea* (1) and *Phaseolus vulgaris* (1) were collected from flood affected parts of Bhadrak, Cuttack, Jagatsinghpur, Jajpur, Kendrapara, Khurda and Puri districts of Orissa in collaboration with CRRI, Cuttack and CTCRI, Bhubaneswar under special exploration mission.

**1.2.7.2** In another trip, 125 accessions comprising of paddy (60), *Colocasia esculenta* (8), *Amaranthus tricolor* (6), *Cajanus cajan* (6), *Capsicum annum* (5), *Vigna radiata* (5), *V. mungo* (3), *Macrotyloma uniflorum* (3), *Amorphophallus campanulatus* (2), *Dioscorea alata* (2), *Eleusine coracana* (2), *E. indica* (2), *Sesamum indicum* (2), *Vigna umbellata* (2), *Leonotis leonurus* (2), *Amaranthus viridis* (1), *Canna edulis* (1), *Cucurbita moschata* (1), *Ipomoea batatas* (1), *Luffa acutangula* (1), *Maranta arundinacea* (1), *Brassica napus* (1), *Linum usitatissimum* (1), *Ricinus*



***Homalomena aromatica* (anchi-ri): a promising aromatic plant used in cosmetics**



***Citrus grandis*: a highly variable species used as fruit in Mizoram**

*communis* (1), *Cicer arietinum* (1), *Phaseolus vulgaris* (1), *Curcuma longa* (1), *Pennisetum typhoides* (1), *Embllica officinalis* (1) and *Ocimum sanctum* (1) were collected from flood affected areas of Bolangir, Boudh, Gajapati, Kalahandi and Nayagarh districts of Orissa in collaboration with CRRI, Cuttack and CTCRI, Bhubaneswar under special exploration mission. In paddy, variability was observed in scented types, local types for grain colour and size.

### 1.2.8 Exploration for medicinal plants in parts of Mizoram

A total of 52 accessions of medicinal and aromatic plants were collected from Aizawl, Kolasib, Lunglei, Mamit and Serchip districts. The diversity included *Homalomena aromatica* (7), *Amomum dealbatum* (6), *Allium* spp. (5), *Alpinia bracteata* (5), *Costus speciosus* (4), *Hedychium coronarium* (3), *Curcuma* spp. (5), *Solanum anguivi* (2), *Clerodendron colebrookianum* (2), *Trichosanthes tricuspidata* (2), *Phyllanthus acidus* (2), *Chlorophytum nepalensis* (1), *Abelmoschus manihot* var. *pungens* (1), *Mesua ferrea* (1), *Solanum nigrum* (1), *Solanum khasianum* (1), *Eryngium foetidum* (1), *Polygonatum cirrhifolium* (1), *Zanthoxylum armatum* (1) and *Bruinsmia polysperma* (1). A tall type in *A. dealbatum* was observed in Mamit district. Diversity collected in *Homalomena aromatica* showed high plant types in Aizawl and Mamit districts. Indigenous knowledge was recorded on 18 plant species harvested from wild habitat which were reported to be consumed as vegetables, fruits and medicines and also under semi-domestication in this area.

### 1.2.9 Exploration for collection of *Citrus* spp. in parts of Mizoram

Parts of Aizawl, Kolasib, Lunglei, Mamit and Serchip districts were explored and a total of 74 accessions of horticultural crops belonging to *Citrus grandis* (15), *C. macroptera* (13), *Citrus* sp. (9), *C. limon* (8), *C. limetta* (4), *C. sinensis* (4), *C. jambhiri* (3), *C. reticulata* (3), *C. karna* (2), *C. medica* (2), *C. megaloxycarpa* (2), *C. pseudolimon* (1), *Garcinia cowa* (1), and wild relatives (7) which included *Crotalaria* spp. (2), *Melothria maderaspatana* (1), *Abelmoschus manihot* var. *pungens* (3) and *Vigna* sp. (1) were collected.

### 1.2.10 Exploration for fodder type of *Ziziphus* spp. in Haryana and Rajasthan

An exploration was undertaken in collaboration with

Central Institute of Arid Horticulture (CIAH), Bikaner, Rajasthan, and a total of 70 accessions were collected from the drier areas of Hisar, Rewari and Sirsa districts in Haryana and Alwar, Churu, Jhunjhunu and Sikar districts in Rajasthan. The diversity included *Z. nummularia* (65) and *Z. rotundifolia* (5) representing variability in morphological characters of habit, stem, leaf and fruits. Variability was recorded in plant height, leaf size and type of thorns and fruit shape, size, pulp, taste and colour.

### 1.3 National Herbarium of Cultivated Plants (NHCP)

**1.3.1 Augmentation:** A total of 320 herbarium specimens, 117 seed samples and 21 economic products were processed and added to NHCP taking the existing collection to 19,799 herbarium specimens, 2,816 seed samples and 548 economic products.

Fifty five taxa previously not represented in the NHCP were also added: *Allium odorum* (= *A. ramosum*), *Cucurbita* sp., *Petroselinum crispum*, *Solanum tuberosum*, wild species of *Indigofera*, *Trigonella*, *Passiflora*, *Prunus* and *Rubus* and several wild economically important species (Table 4).

**Table 4: Some important taxa added to NHCP**

Botanical name	Family	State	Main use
<i>Abelia grandiflora</i> (Andr.) Rehd.	Caprifoliaceae	Himachal Pradesh	Wood for walking sticks
<i>Acer sterculiaceum</i> Wall.	Aceraceae	Himachal Pradesh	Wood
<i>Allium odorum</i> L.	Alliaceae	Arunachal Pradesh	Edible leaf
<i>Aralia cachemirica</i> Decne	Araliaceae	Himachal Pradesh	Forage value
<i>Chamaecyparis funebris</i> (Endl.) Franc.	Pinaceae	Meghalaya	Source of essential oil and wood
<i>Cornus rugosa</i> Lam.	Cornaceae	Himachal Pradesh	Source of wood
<i>Cotoneaster frigidus</i> Wall. ex Lindl.	Rosaceae	Arunachal Pradesh	Wood used for walking-sticks
<i>Cotula australis</i> Hk.f.	Asteraceae	Himachal Pradesh	Cover crop
<i>Cucurbita argyrosperma</i> C. Huber	Cucurbitaceae	Kerala	Vegetable
<i>Cucurbita maxima</i> Duch.	Cucurbitaceae	Kerala	Vegetable
<i>Cudrania tricuspidata</i> (Carriere) Bur.	Moraceae	Himachal Pradesh	Source of wood
<i>Dichroa febrifuga</i> Lour.	Hydrangeaceae	Meghalaya	Roots and leaf tips for medicinal value
<i>Ehretia aspera</i> Willd.	Ehretiaceae	Delhi	Multipurpose-fruits edible, leaves for fodder
<i>Erigeron multiradiatus</i> (DC.) Benth.	Asteraceae	Himachal Pradesh	Medicinal
<i>Euryale ferox</i> Salisb.	Nymphaeaceae	Delhi	Fruits (makhana)
<i>Hypericum choisianum</i> Wall.	Hypericaceae	Himachal Pradesh	Medicinal
<i>Hypoxis aurea</i> Lour.	Amarylilidaceae	Uttarakhand	Rootstock for medicinal value
<i>Indigofera dosua</i> Buch.-Ham.	Fabaceae	Himachal Pradesh	Fodder
<i>Iris germanica</i> L.	Iridaceae	Himachal Pradesh	Rhizomes source of aromatic orris root
<i>Juniperus recurva</i> Buch.-Ham.	Pinaceae	Himachal Pradesh	Source of wood and incense
<i>Jurinea macrocephala</i> (Royle) C. B. Clarke	Asteraceae	Himachal Pradesh	Aromatic roots as incense
<i>Maerua arenaria</i> Hk.f. & Thoms.	Capparidaceae	Delhi	Roots for medicinal value
<i>Magnolia grandiflora</i> L.	Magnoliaceae	Himachal Pradesh	Source of essential oil and medicinal value
<i>Oenothera biennis</i> L.	Onagraceae	Himachal Pradesh	Medicinal and cover crop
<i>Olea glandulifera</i> Wall. ex G. Don	Oleaceae	Himachal Pradesh	Source of wood and in agroforestry
<i>Parkinsonia aculeata</i> L.	Caesalpiniaceae	Delhi	Forage-yielding tree
<i>Passiflora caerulea</i> L.	Passifloraceae	Himachal Pradesh	Edible fruit
<i>Petroselinum crispum</i> (Mill.) Airy-Shaw	Apiaceae	Himachal Pradesh	Leaves as garnish
<i>Platanus orientalis</i> L.	Platanaceae	Himachal Pradesh	Source of chinara wood
<i>Polygonum bistorta</i> L. (= <i>Bistorta</i> (D. Don) Greene)	Polygonaceae	Himachal Pradesh	Medicinal value, Root-affinis stocks edible
<i>Populus nigra</i> L.	Salicaceae	Himachal Pradesh	Source of wood
<i>Rubus alpestris</i> Bl.	Rosaceae	Arunachal Pradesh	Fruits yield fibre
<i>Rubus macilentus</i> Cambess.	Rosaceae	Himachal Pradesh	Fruits edible
<i>Salix daphnoides</i> Vill.	Salicaceae	Himachal Pradesh	Branches and leaves for fodder, inner bark is edible
<i>Salvia coccinea</i> Juss.	Lamiaceae	Himachal Pradesh	Medicinal value
<i>Solanum tuberosum</i> L.	Solanaceae	Himachal Pradesh	Potato cultivars
<i>Solanum wendlandii</i> Hk. f.	Solanaceae	Himachal Pradesh	Ornamental climber
<i>Tragopogon gracilis</i> D. Don	Asteraceae	Himachal Pradesh	Edible leaves
<i>Trigonella emodi</i> Benth.	Fabaceae	Himachal Pradesh	Forage
<i>Vaccinium sprengelii</i> (G. Don) Sleum	Ericaceae	Meghalaya	Fruit edible, leaves as vegetable
Rehd. (= <i>V. donianum</i> Wight)			
<i>Viburnum sieboldii</i> Miq.	Caprifoliaceae	Himachal Pradesh	Edible fruit



### 1.3.2 Digitization of taxa represented in the NHCP:

Facilities for digitization were added and the work of preparing digital images of all taxa represented in the herbarium was initiated. During this period a total of 2,267 species belonging to 827 genera and 121 families were digitized.



Digital images of *Curcuma* spp. in NHCP

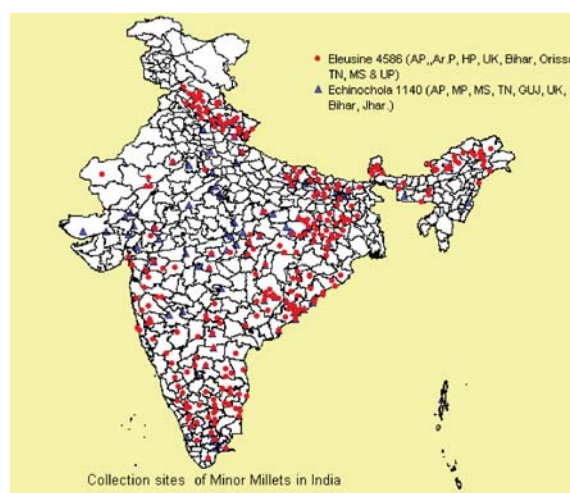
A total of 58 samples/species were identified, the significant ones being *Balanites aegyptiaca*, *Elephantopus scaber*, *Hemidesmus indicus*, *Phyllanthus murex* and *Zanthoxylum armatum*. Authentication certificates (11) were issued to students and researchers from different institutions and universities in India. Training on herbarium methods and procedures was organized for trainees/visitors from Delhi University and National Institute of Science Communication and Information Research (NISCAIR), New Delhi and students from Indian Agricultural Statistics Research Institute and Indian Agricultural Research Institute, New Delhi.

**1.3.3 Taxonomic studies:** Taxonomic studies were

taken up in (i) legume taxa- species identity and nomenclature of wild species related to *Atylosia-Cajanus* and *Flemingia-Moghania* were worked out and used to resolve the identity of ten species of *Cajanus* and six species of *Flemingia* represented in NHCP. (ii) Alliaceae/Liliaceae- *Allium* (3) from NEH region were identified on the basis of bulb, leaf and scape characters. (iii) An endemic species of *Chlorophytum*, *C. nepalense* was identified based on leaf and inflorescence characters and delineated from allied species, *C. borivillianum*.

### 1.4. Documentation of diversity in different agri-horticultural crops of India

Mapping was completed for Dr. Y Sundera Rao herbarium (459 belonging to 7 families and 16 genera). Maximum representation was from southern peninsular region (Tamil Nadu, Karnataka, Kerala and Orissa). GIS Maps were completed for analysis of diversity collected in minor millets from different parts of India.



#### Research Programme (Programme Code: Title, Leader)

PGR/PGC-BUR-00: Exploration for collection of germplasm of agri-horticultural crops, maintenance of herbarium and biosystematic and ethnobotanical studies (**DC Bhandari** w.e.f. 1.8.08; ER Nayar upto 31.7.08).

#### 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** w.e.f. 1.8.08, KC Bhatt up to 31.7.08, Rakesh Srivastava, Anjula Pandey 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, ER Nayar, Gunjeet Kumar and AK Singh)

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

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

#### Externally-funded project

New Millennium Indian Technology Leadership Initiative (NMITL) project on Genetic improvement of *Jatropha curcas* for adaptability and oil yield (**SK Sharma**, JB Tomar and KC Bhatt)

## 2. DIVISION OF GERmplasm EVALUATION

**Summary:** A total of 7,661 accessions of various agri-horticultural crops comprising cereals (3203), millets & forages (447), pulses (2,390), oilseeds (668), vegetables (390), underutilized crops (438), medicinal and aromatic plants (125) were grown for characterization and evaluation. In addition, 4,141 accessions of international nurseries comprising wheat, Barley and triticale were also grown in Post-entry Quarantine Nursery (PEQN). The germplasm of the oilseeds namely, rapeseed mustard (721), sunflower (36), safflower (352), linseed (85) was analysed for oil content and quality parameters. Similarly the germplasm of walnut (17), almond (39) and *S. oleoides* (20) was analyzed for quality traits. In phytochemical evaluation, 402 samples of medicinal and aromatic plants were analyzed and evaluated for their active compounds. Three Germplasm Filed Days for Brassica; wheat, barley, triticale and maize were organized to promote germplasm utilization by the plant breeders/ user scientists. A total of 4,997 accessions of different crops were supplied to 68 indentors belonging to different institutes for their use in crops improvement programmes. The meetings of Germplasm Advisory Committees constituted for different crops/ crop groups were also organized.

### 2.1 Germplasm Evaluation

#### 2.1.1 Characterization and preliminary evaluation for agro-morphological traits:

A total of 7,661 accessions of various agri-horticultural crops comprising cereals (3,203): wheat (2,285), barley (290), maize (628); millets & forages (447): pearl millet (234) and oat (213); pulses (2,390): cowpea (459), urdbean (325) and lentil (1,606); oilseeds (668): rapeseed-mustard (529), sunflower (50), linseed (89); vegetables (390): brinjal (60), bottle gourd (120), ridge gourd (60), ashgourd (150); underutilized crops (438): fababean (61), rice bean (246), amaranth (131) and medicinal and aromatic plants (125): aloe (42), mucuna (15), basil (46) and *Abrus* (22) were grown for characterization and evaluation.

Besides, 4,141 accessions of wheat (3,202), barley (776) and triticale (163) belonging to international nurseries were also grown in Post Entry Quarantine Nursery (PEQN). In addition, 353 accessions of medicinal and aromatic plants comprising vetiver (131), palmarosa (55), giloe (25), aloe (80), asparagus (22) and other M&AP (40) were also maintained in the field gene bank.

Wide range of variability was observed in the germplasm of different crops. Based on characterization and preliminary evaluation, promising accessions for various attributes, viz., earliness, pod length, pods per plant, seeds per pod and 100 seed weight, yield per plant etc. have been identified in different crops (Table 1).

**Table 1: Promising germplasm accessions identified in different crops for major traits**

Crop	Promising traits	Accession no.
<b>Cereals</b>		
Maize	Early maturing types (<80) days	IC369144, IC385844
	Late maturing types (>100) days	IC471870, IC395793
	Dwarf types (<80 cm)	IC385926, IC369144
<b>Millets and Forages</b>		
Pearlmillet	No. of basal tillers/plant (>15.2)	IC370524, IC285154, IC285152
	Stem thickness (>16 mm)	NIC17816, IC329074, IC329073
	Internode distance (>22.2 cm)	IC420358, IC285156, IC285164
	Leaf length (>83.0 cm)	IC420358, IC420361, IC537955
	Leaf width (>4.10 cm)	IC420362, IC333240, IC420357
	Green fodder yield/plant	IC285193, IC285199, IC537967, IC370524
	Dry fodder yield/plant	IC339043, IC370522, IC373561, IC369854
Oat	Peduncle length	IC411787
	Spikelet per panicle	IC411787, IC413424
	Green fodder yield/plant	IC372642, IC413424

<b>Pulses and legumes</b>		
Cowpea	Days to 50% flowering ( $\leq 40$ )	IC396755, EC517139, EC528392, EC5238395
	Pod length ( $\geq 38$ cm)	IC536636, IC536639
	Pods per plant ( $\geq 45$ )	IC249141, IC402175, IC402180, IC390242, IC202762
	Seeds per pod ( $\geq 22$ )	IC402172, EC472287, EC528420, IC371749
Lentil	Bold seeded ( $\geq 4.50$ )	IC560196, IC560225, IC560209, IC560176, IC560169, ET122547, ET122540, ET122551
	Pods per plant ( $\geq 261$ )	IC5600207, IC560046, IC560301, IC560051, IC560207, IC560153
	Days to 50% flowering ( $\leq 68$ Days)	IC560125, IC560331, IC560346, IC559753, IC560152
	Tall with high biomass ( $\geq 64$ cm)	ET123500, ET123583, ET123567, ET123578, ET123645
Urdbean	Days to 50% flowering ( $\leq 42$ )	IC61097, IC84206, IC212677
	Pod length ( $\geq 4.80$ cm)	IC73291, IC10703, IPU-99-22, STY-2801
	Pods per plant ( $\geq 107$ )	PGRU-85014, PGRU-9016, IPU-99-22, IPU-99-40
	Seeds per pod ( $\geq 7$ )	STY-2801, IPU-96-1, IPU-99-22, UH-218, PGRU-9016
<b>Oilseed crops</b>		
Indian mustard	Early flowering	IC417893, IC491559
	Long siliqua	IC491598, IC424424
Sunflower	Yield/plant	EC512672, EC512749, EC512751
Linseed	high capsules /plant	IC538797, IC526377
	Seed yield /plot	IC345460
<b>Vegetable crops</b>		
Brinjal	Plant spread ( $>86.0$ cm)	IC090915, IC398153
	Fruit weight ( $>228.5$ g)	IC249300
Bottlegourd	Internode length ( $>17.7$ cm)	IC342080, IC421941, IC382192
	Petiole length ( $>21.3$ cm)	IC398884, IC117715, IC342078
	Node no of 1 <sup>st</sup> Female flower ( $<83.0$ )	IC146386, IC322396, IC388188
	Days to 50% flowering ( $<38.0$ )	IC117715, IC339206, IC382188
	Peduncle length ( $>18.0$ cm)	IC276405, IC398546
	No of primary branches( $>22.0$ )	IC201155, IC536593, IC418558
	Fruit length ( $>66.8$ cm)	IC284949, IC322396, IC276353
	Fruit Width ( $>19.8$ cm)	IC342078, IC284876
	Yield/ plant ( $>702.0$ g)	IC342078, IC276353, IC322396
<b>M &amp; A plants</b>		
Aloe	Leaf length ( $> 45$ cm)	IC326744, IC265889
	Leaf width ( $>9$ cm)	IC326744, IC527343
	Leaf thickness ( $>2.0$ cm)	IC5276344, IC520365
	No. of leaves per plant ( $>25$ )	IC265889, IC326744
Basil	Plant height ( $>95$ cm)	IC326711, EC338785
	Herbage yield ( $>500$ g on FWB)	EC388893, EC112548
Mucuna	No. of pods cluster/ plant ( $>8$ )	IC369144, IC385844
	No. of pods per cluster ( $>6$ )	IC471870, IC395793
	No. of seeds per pod ( $>5$ )	IC385926, IC369144

**2.1.2 Germplasm enhancement in sesame:** Crossed progenies ( $F_4$ ) of superior enhanced germplasm and the trait specific exotic accessions with non-shattering habit and white seed colour were grown for evaluation and further progeny advancement.

**2.1.3 Core set validation in brinjal:** The developed brinjal core set (181 accs.) is being validated at 5

locations.

## 2.2 Biochemical evaluation of field crops

**2.2.1 Oil content in oilseeds :** One thousand one hundred ninety four (1,194) germplasm collections of oilseeds comprising of *B. juncea* (342), *B. rapa* var. yellow sarson (204), *B. rapa* var. brown sarson (88), *B.*

*rapa* var. *toria* (16), *B. napus* (31), *B. chinensis* (23), *B. rapa* (6), *Eruca sativa* (4), *B. nigra* (4), *B. carinata* (2), *L. sativa* (1), sunflower (36), safflower (352) and linseed (85) were analyzed for total oil content. Range of variation and mean values of oil percentage is given

in Table-2. Promising accessions of *Brassica* and safflower were further analysed for fatty acid profile and the results are given in Table 3. IC313380 and IC491586 were found superior in oil content for two years consecutively.

**Table 2: Range and mean value of oil content in oilseeds**

Crop/ Species (No. of Acc.)	Oil (%)		Promising accessions
	Range	Mean	
<i>B. juncea</i> (342)	25.13-44.66	36.68	IC491408 ,IC521380
<i>B. rapa</i> var. yellow sarson (204)	30.01-49.20	41.64	IC355343, IC520760
<i>B. rapa</i> var. brown sarson (88)	31.56-47.31	39.97	IC401469
<i>B. rapa</i> var <i>toria</i> (16)	33.01-43.72	39.93	IC343127
<i>B. napus</i> (31)	36.19-44.26	41.14	IC491586
<i>B. chinensis</i> (23)	19.55-46.97	41.09	IC313380 , EC386745
<i>B. rapa</i> (6)	36.28-43.33	41.04	IC191597
<i>Eruca sativa</i> (4)	28.42-31.66	29.71	-
<i>B. nigra</i> (4)	20.34-28.71	24.86	-
<i>B. carinata</i> (2)	22.49-33.63	28.06	-
<i>L. sativa</i> (1)	-	25.13	-
Sunflower (36)	33.14-49.6	40.98	-
Safflower (352)	24.53-36.63	30.58	-
Linseed (85)	33.09-47.09	42.22	IC426929

**Table 3: Fatty acid profile in Brassica and safflower accessions**

Fatty acid	Range (%)	Mean (%)	Promising accessions
<i>B. juncea</i> (342)	25.13-44.66	36.68	IC491408 ,IC521380
<b>Brassica</b>			
Palmitic acid	1.88-2.22	2.34	-
Stearic acid	0.64-1.45	1.10	-
Oleic acid	10.92-21.25	14.81	-
Linoleic acid	12.06-19.29	15.21	-
Linolenic acid	4.22-13.14	9.84	-
Ecocenoic acid	3.82-8.68	6.75	-
Erucic acid	34.10-51.83	49.97	-
<b>Safflower</b>			
Palmitic acid	2.76-7.40	6.16	IC500122, IC566018
Stearic acid	1.94-6.24	3.26	EC565894, IC500046
Oleic acid	13.90-37.80	17.94	IC500047, EC565997
Linoleic acid	54.60-77.49	72.64	EC565885, IC499881

### 2.2.2 Quality analysis of walnut, almond and *S. oleoides* accessions

Seed samples of walnut (17), almond (39) and *S. oleoides* were analysed to establish their quality traits. The range of variation with mean value of the quality traits are given below (Table-4).



**Table 4: Quality analysis of walnut, almond and *S. oleoides* germplasm**

Trait studied	Range (%)	Mean (%)	Promising accessions
<b>Walnut</b>			
Kernel oil (%)	65.93-75.26	72.05	IC561581, IC561568
Palmitic acid	4.76-7.63	6.11	IC561604, IC561596
Stearic acid	1.74-3.34	2.64	IC561561, IC561564
Oleic acid	14.77-28.29	20.19	IC561591, IC561562
Linoleic acid	47.07-66.00	57.97	IC561561, IC561583
Linolenic acid	8.13-19.90	13.11	IC561564, IC561598
<b>Almond</b>			
Kernel oil (%)	48.92-67.94	58.43	IC561519, IC561510
Palmitic acid	5.05-9.08	7.07	IC561499, IC561443
Stearic acid	0.66-3.61	2.14	IC561516, IC561443
Oleic acid	56.95-78.76	67.86	IC561463, IC561516
Linoleic acid	13.69-32.95	23.32	IC561524, IC561499
<b><i>S. oleoides</i></b>			
Oil (%)	43.25-57.74	50.97	IC561782, IC561791
Deoic acid	0.57-1.34	0.98	IC561783, IC561781
Lauric acid	20.13-29.64	23.95	IC561783, IC561776
Myristic acid	50.95-54.37	52.88	IC561798, IC561781
Palmitic acid	14.39-20.63	18.01	IC561797, IC561788
Oleic acid	3.30-6.71	4.16	IC561788, IC561787

## 2.3 Phytochemical evaluation of medicinal and aromatic plants

A total of 402 samples of various medicinal (159) and aromatic (243) plants were analyzed for active constituents.

### 2.3.1 Aromatic plants

**2.3.1.1 *Ocimum basilicum*:** *Ocimum basilicum* (42 accessions) were analyzed for essential oil content, physico-chemical constants and aroma constituents using gas chromatograph. The range of physico-

chemical constants was found to be 1.4720-1.4925, 1.71°-11.27°, 2.33-13.1 and 0.8502-0.8689 for refractive index, optical rotation, acid value and specific gravity respectively. The promising accessions identified for essential oil content were IC466168 (0.37%), IC436183 (0.34%) and IC328582 (0.32%). GC analysis showed presence of methyl chavicol, linalool and methyl cinnamate as the major constituents in *Ocimum* oil.

**2.3.1.2 Chemical studies of *Alpinia* species:** Three species of *Alpinia* were analyzed for essential oil content in rhizomes and aroma composition as given in Table 5.

**Table 5: Essential oil content and aroma constituents of *Alpinia* species**

Plant name	Range (%) DWB	Superior types	No. of components identified by GLC	Major aroma constituents (%)
<i>Alpinia galanga</i> (8 accs)	0.08-0.39	IC087883 (0.39%)	29	1, 8-Cineole, a-pinene, b-pinene, a-terpineole and terpinen-4-ol
<i>Alpinia calcarata</i> (6 accs)	0.47-0.71	IC373608 (0.71%) IC210421 (0.70%)	24	1,8-Cineole, -fenchyl acetate, camphor and a-terpineole
<i>Alpinia zerumbet</i> (2 accs)	1.49-2.56	-	-	Under study

*Alpinia galanga* accession IC349746 collected from Walayar village of district Palakkad in Thrissur, Kerala was found to contain high 1,8-cineole (72.49%) content and was registered for this trait.

**2.3.1.3 GLC analysis of aroma content:** GLC analysis was done for thirty samples of essential oils of commercially important aromatic plants to identify their aroma constituents (Table 6).

**Table 6: Chemical composition of volatile essential oils**

Plant species	Accessions	No. of components identified	Major compounds identified Major aroma constituents (%)
<i>Artemisia dracunculus</i>	1	15	Sabinene (61.03), myrcene, Terpinene-4-ol
<i>A. maritima</i>	1	15	$\alpha$ -Thujone(82.16), b- thujone
<i>A. nilagirica</i>	1	25	Artemisia ketone, 1,8-cineole, camphor, borneol, terpinene-4-ol, borneol
<i>A. annua</i>	1	27	Artemisia ketone , 1,8-cineole, camphor, borneol, terpinene-4-ol
<i>Rosmarinus officinalis</i>	2	24	a-pinene, camphene, 1,8-cineole, Camphor, Borneol
<i>Pogostemon cablin</i>	3	14	Patchouli alcohol
<i>Skimmia laureola</i>	2	18	Linalool, Linalyl acetate, Geranyl acetate, Geraniol
<i>Lavendula angustifolia</i>	4	25	Linalool, Linalyl acetate, myrcene, 1,8-cineole
<i>L. stoechas</i>	1	22	1,8-cineole, Camphor (52.12), Fenchone , linalool
<i>Pelargonium graveolens</i>	6	21	Citronellol (21.68-45.02) Geraniol (2.93-32.27), Isomenthone, linalool, citronellyl formate, geranyl formate
<i>Cymbopogon flexuosus</i>	4	14	Citral a, citral b
<i>Satureja montana</i>	1	19	Carvacrol (77.23), thymol
<i>Thymus serpyllum</i>	1	19	Thymol (39.70) , carvacrol
<i>Origanum vulgare</i>	2	18	Thymol (33.35), carvacrol

Based on GLC profile, promising chemotypes identified were *Artemisia dracunculus* (Sabinene (61.03%) rich chemotype), *Lavendula stoechas* (Camphor (52.12%) rich chemotype), *A. maritima* (Thujone (82.16%) rich type), *Satureja montana* (Carvacrol (77.23%) rich chemotype), *Thymus serpyllum* (Thymol (39.70%) rich chemotype) and *Origanum vulgare* (Thymol (33.35%) rich chemotypes).

**2.3.1.4 Studies on physico-chemical properties of essential oils:** Essential oils of twenty samples of various aromatic plants were analyzed for their physico-chemical constants (acid value, refractive index, specific gravity and optical rotation) to ascertain the oil quality (Table 7).

**Table 7: Physico-chemical properties of some essential oils**

Plan Name	Specific gravity	Refractive index	Acid Value	Ester Value	Saponification Value
Zanthoxylum ( <i>Zanthoxylum armatum</i> )	0.8495	1.6940	1.51	39.9	41.41
Skimmia ( <i>Skimmia laureola</i> )	0.9358	1.4845	1.87	13.70	15.57
Rosemary ( <i>Rosmarinus officinalis</i> )	0.8639	1.6915	6.51	38.9	15.41
Patchouli ( <i>Pogostemon cablin</i> )	0.9562	1.5020	2.10	21.1	23.20
Lavender ( <i>Lavendula angustifolia</i> )	0.9388	1.6905	3.33	26.7	30.03
Geranium ( <i>Pelargonium graveolens</i> )	0.8739	1.6880	9.87	43.4	65.27
Lemon Grass ( <i>Cymbopogon flexuosus</i> )	0.8763	1.4800	7.3	-	-
Greater galangal ( <i>Alpinia galanga</i> )	0.8817	1.4690	3.9	-	-
Lesser galangal ( <i>A. calcarata</i> )	0.8789	1.4710	7.8	-	-
Vetiver ( <i>Vetiveria zizanioides</i> )	0.9753	1.5125	7.12	7.12	15.39

**2.3.2 Chemical analysis of medicinal plants:** One hundred fifty nine samples of medicinal plants were analyzed for their active constituents (Table 8).

**Table 8: Chemical analysis of important medicinal plants**

Plant Name (Common name)	Accessions (Samples)	Active constituent	Range (%)	Promising Accessions
<i>Tinospora cordifolia</i> (Giloe)	21 accs	Total bitters	0.27-0.82	IC281972 (0.82%) IC281963 (0.77%)
<i>Aloe barbadensis</i> (Ghrit kumari)	36 accs (72)	Aloe gel (Inner leaf) (Outer leaf)	0.293-1.316 0.230-0.893	IC413045
<i>Andrographis paniculata</i> (Kalmegh)	22 accs (66 samples)	Andrographolide	1.01-1.53 (Herbage) (Ratoon crop)	IC471895 (1.53 %)

The results of above studies indicated that inner leaves of *Aloe barbadensis* contained high aloe gel content compared to outer leaves of the plant and andrographolide content in *Andrographis paniculata* was found to decline in ratoon crop compared to first year crop.

## 2.4 Documentation of Information of PGR

- Computerization and statistical analysis of data was completed for 7,538 accessions, 5,043 accessions and 1,879 accessions for *Kharif* (2007), *Rabi* (2007-08) and horticultural crops (2007) respectively.
- Annual Reports on Germplasm Characterization & evaluation of field crops for *Kharif* (2007), *Rabi* (2007-08) and horticultural crops 2007 were brought out.

## 2.5 Germplasm Field Days Organized

To promote germplasm utilization three Germplasm Field Days were organized for different crops. These were for Brassica (March 18, 2008), Wheat, Barley and *Triticale* (March 26, 2008), Maize (September 15, 2008), A large number of participants from different parts of country belonging to ICAR institutes, State Agricultural Universities, Govt. Departments, NGOs and private organizations participated in the Germplasm Field Days. The scientists/ research workers selected the material of their choice.

## 2.6 Germplasm Advisory Committee Meetings Organised

The Germplasm Advisory Committee meetings were organized for different crop/ crop groups at NBPGR Headquarters, N. Delhi (Table 9).

**Table 9: Germplasm Advisory committee meetings held**

Crop/ Crop group	Date
Maize, Pearl millet & Sorghum	22.02.08
Medicinal & Aromatic Plants	14.03.08
Vegetable & Horticultural Crops	15.03.08

## 2.7 Distribution of Germplasm for Utilization

Utilization of germplasm of various crops by breeders and other scientists in the country for crop improvement programmes is an important aspect in sustainability of crop production. During the period, a total of 4,997 seed samples of various crop groups namely, cereals (4,169), pulses (40), oilseeds (98), vegetables (528), forages (9), under utilized crops (2) and medicinal and aromatic plants (151) were supplied to 68 research workers of ICAR Institute, State Agricultural Universities and other research centers engaged in crop improvement programmes (Table 10).

**Table10: Distribution of germplasm of different crops**

Crop group/ crop	No. of samples
<b>Cereals</b>	<b>4,169 (28)</b>
Wheat	3,649 (20)
Barley	520 (8)
<b>Pulses</b>	<b>40 (4)</b>
Cowpea	34 (2)
Urd	1(1)
Chickpea	15(1)
<b>Oilseeds</b>	<b>98(4)</b>
Rapeseed mustard	98(4)
<b>Vegetables</b>	<b>528 (5)</b>
Brinjal	72 (2)
Tomato	414 (1)
Bottle gourd	40 (1)
Ash gourd	2 (1)
<b>Forages</b>	<b>9 (1)</b>
Oat	9 (1)
<b>Underutilized Crops</b>	<b>2 (1)</b>
<b>Medicinal and aromatic plants</b>	<b>151 (25)</b>
<b>Grand total</b>	<b>4,997 (68)</b>

Figures in parenthesis represent number of indentors

## 2.8 Germplasm holdings in medium term storage (MTS)

A total of 21,925 accessions of various filed crops comprising cereals (4,836), millets and forages (187), pulse (4,935), oilseeds (5,724), vegetables (4,953), underutilized crops (1,073) and medicinal and aromatic plants (217) were maintained in medium term storage during the period under report (Table 11).

**Table 11: Active Germplasm Holding in MTS as on 31.12.2008**

<b>Cereals</b>	<b>4,836</b>
Maize	1,750
Wheat	1,446
Barley	1,640
<b>Pulses</b>	<b>4,935</b>
Cowpea	1,465
Pea	775
Urd	500
Lentil	450
Mung	645
Chickpea	1,100
<b>Oilseeds</b>	<b>5,724</b>
Rapeseed mustard	4,468
Safflower	350
Sunflower	244
Sesame	550
Crambe	22
Linseed	75

Taramira	4
Lepidium	11
<b>Vegetables</b>	<b>4,953</b>
Brinjal	2,227
Tomato	1,050
Bottle gourd	350
Ridge gourd	300
Sponge gourd	320
Ash gourd	100
Onion	90
Fenugreek	360
Palak	50
Coriander	100
Pumpkin	6
<b>Forages</b>	<b>187</b>
Oat	187
<b>Underutilized crop</b>	<b>1,073</b>
Faba bean	300
Rice bean	103
Amaranthus	70
Sesbania	400
Crotolaria	200
<b>Medicinal &amp; Aromatic Plants</b>	<b>217</b>
Ocimum	50
Mucuna	55
Poppy	53
Andrographis	23
Psoralea	11
Ashwagandha	4
Hyocyamus	6
Catharanthus	15
<b>Total</b>	<b>21,925</b>

### Research Programme (Programme Code: Title and PI)

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

### 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**)

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

PGR/GEV-BUR-DEL-01.03: Characterization, evaluation, maintenance, regeneration and documentation of germplasm resources of pulses with special reference to cowpea and pea (**NK Gautam**, SK Mishra and Babu Ram)

PGR/GEV-BUR-DEL-01.04: Characterization, Evaluation, Maintenance, Regeneration and Documentation of Germplasm Resources of Oil Seeds with special reference to *Brassica*, Sunflower, safflower and linseed (**Ranbir Singh**, and Poonam Suneja)

PGR/GEV-BUR-DEL-01.05: Characterization, evaluation, maintenance, regeneration and documentation of germplasm resources of tomato, sponge gourd, ridge gourd, bottle gourd, onion and ornamentals (**Gunjeet Kumar**, KK Gangopadhyay and BL Meena)

PGR/GEV-BUR-DEL-01.06: Characterization, evaluation, maintenance, regeneration and documentation of germplasm resources of brinjal, radish, spinach, methi, coriander and fruit crops (**KK Gangopadhyay**, SK Yadav, BS Phogat, BL Meena and Gunjeet Kumar)

PGR/GEV-BUR-DEL-01.07: Characterization, Evaluation, Maintenance, Regeneration and Documentation of Germplasm Resources of Medicinal Plants (**Ashok Kumar**, SK Pareek, Archana Raina, Jitender Mohan and Poonam Suneja)

PGR/GEV-BUR-DEL-01.08: Characterization, Evaluation, Maintenance, Regeneration and Documentation of Germplasm Resources of Forages (**Ranbir Singh** and Poonam Suneja)



PGR/GEV-BUR-DEL-01.09: Biochemical Evaluation of Germplasm Resources of Various Field Crops (**S Mandal**, Sangita Yadav, SK Mishra and Poonam Suneja)

PGR/GEV-BUR-DEL-01.10: Characterization, Evaluation, Maintenance, Regeneration and Documentation of Germplasm Resources of Under-Utilized Crops (**BS Phogat**, RP Dua, Hanuman Lal and RS Rathi)

PGR/GEV-BUR-DEL-01.11: Studies on Statistical Techniques for Efficient Management of PGR (**Hanuman Lal** and RK Mahajan)

PGR/GEV-BUR-DEL-01.12: Genetic Resources Information Programme (**RK Mahajan**, RC Agarwal , Hanuman Lal and Madhu Bala)

PGR/GEV-BUR-DEL-01.13: Genetic Enhancement of Crop Species with Particular Reference to Pigeonpea and Mungbean (**SK Mishra** and IS Bisht)

PGR/GEV-BUR-DEL-01.14: Characterization, Evaluation, Maintenance, Regeneration and Documentation of Germplasm Resources of Chickpea and Pigeonpea (**RP Dua**, NK Gautam, S Mandal and OP Dahiya)

PGR/GEV-BUR-DEL-01.15: Characterization, Evaluation, Maintenance, Regeneration and Documentation of Germplasm Resources of Lentil and Urdbean. (**NK Gautam** and Babu Ram)

PGR/GEV-BUR-DEL-01.16: Characterization, Evaluation, Maintenance, Regeneration and Documentation of Germplasm Resources of Aromatic Plant (**Archana Raina**, SK Pareek, Ashoka Kumar, Jitendra Mohan, and Poonam Suneja)

PGR/GEV-BUR-DEL-01.19: Development of Core set in Brinjal (*Solanum melongena* L.). (**KK Gangopadhyay**, SK Yadav, RK Mahajan, IS Bisht and Gunjeet Kumar)

### 3. DIVISION OF GERMPLASM CONSERVATION

**Summary:** A total of 13,720 germplasm accessions of various crops were received for long-term conservation in the National Genebank. These were processed following the Genebank standards adding another 13,542 accessions to the base collection raising the total germplasm holding to 3,67,419. A total of 852 accessions received at the Germplasm Handling Unit were stored in the medium-term storage module as reference material. Monitoring of stored germplasm (2,121 accessions) and updating of passport data (2,225 accessions) was carried out. A total of 5,873 accessions were supplied from the Genebank for evaluation/regeneration or research. Longevity of castor, groundnut, sesame, niger and cotton at ambient temperatures was found to be more when seeds were dried to ultra low moisture contents (i.e. < 5 per cent moisture content). Methods for breaking seed dormancy were developed in some medicinal plants and wild species viz. *Ariesema caudate*, *Cucumis setosus*, *C. callosus*, *Catunera spinosa*, *Dodonea viscosa* and *Tecoma stans*.

The Division continued its efforts to support the national repository with long term storage of seeds of various agricultural and horticultural crops in the National Genebank (-18°C), and voucher samples of introduced and collected accessions in the medium-term storage at (7°C) for reference. In addition, the registration of potentially valuable germplasm and conservation of released varieties and genetic stocks identified under the National Agricultural Research System have been the other important activities. Supportive research directed towards understanding the storage behaviour of hitherto unexplored and under-explored species, identification and implementation of factors that prolong the storage life of seeds and maintain the genetic integrity of conserved germplasm in a cost effective manner continued.

#### 3.1 Germplasm Augmentation

The Germplasm Handling Unit (GHU) received a total of 1,729 seed accessions. Of these a total of 852 accessions were stored in medium-term storage module as reference material. Another 869 accessions with

sufficient quantity of seed were sent for long-term conservation.

A total of 13,720 germplasm accessions of various agricultural crops were received for long-term conservation at the National Genebank. A total of 13,542 accessions qualified for conservation as per the Genebank standards and were stored as base collections at -18°C. These include cereals (4,037), pseudocereals (228), millets and forages (2,227), legumes (1,109), oilseeds (3,723), fibers (696), vegetables (859), medicinal and aromatic plants and narcotics (400), spices and condiments (195), agro-forestry (68). These include released varieties (349) and genetic stocks (139) in various crops.

The crop-wise details of the various accessions added to the National Genebank are listed in Table 1. With this the total germplasm holdings in the National Genebank has increased to 3, 67,419 representing 1,516 species (Table 1). In addition, a total of 3,790 exotic accessions of different crops were kept as voucher specimen in the medium-term storage module.

**Table 1: Status of germplasm holdings in the National Genebank (-18 °C) (as on December 31, 2008)**

Crop Group	No. of Acc. stored (During 1.1.08 to 31.12.08)	No. of new species added	Present status Total
Paddy	3,444	1	86,210
Wheat	285	-	38,897
Maize	277	-	7,538
Others	31	-	11,185
<b>Cereals</b>	<b>4,037</b>	<b>1</b>	<b>1,43,830</b>
Sorghum	596	-	19,430
Pearl millet	437	-	7,989
Minor millet	742	1	20,458
Others	452	32	4,384

<b>Millets and Forages</b>	<b>2,227</b>	<b>33</b>	<b>52,261</b>
Amaranth	102	-	5,034
Buckwheat	121	-	801
Others	5	-	335
<b>Pseudo Cereals</b>	<b>228</b>	<b>-</b>	<b>6,170</b>
Chickpea	257	-	16,684
Pigeonpea	104	-	11,092
Mung bean	33	-	3,592
Others	715	1	24,731
<b>Grain Legumes</b>	<b>1,109</b>	<b>1</b>	<b>56,099</b>
Groundnut	827	5	14,276
<i>Brassica</i>	800	-	10,122
<i>Safflower</i>	81	-	7,366
Others	2,015	6	21,555
<b>Oilseeds</b>	<b>3,723</b>	<b>11</b>	<b>53,319</b>
Cotton	599	-	5,431
Jute	39	-	2,903
Others	58	6	2,168
<b>Fibre Crops</b>	<b>696</b>	<b>6</b>	<b>10,502</b>
Brinjal	80	-	3,948
Chilli	7	-	2,009
Others	772	4	17,728
<b>Vegetables</b>	<b>859</b>	<b>4</b>	<b>23,685</b>
Custard apple	-	-	59
Papaya	-	-	23
Others	-	-	300
<b>Fruits</b>	<b>-</b>	<b>14</b>	<b>382</b>
Opium poppy	-	-	350
Ocimum	23	-	399
Tobacco	-	-	1,461
Others	377	76	3,913
<b>Medicinal &amp; Aromatic Plants &amp; Narcotics</b>	<b>400</b>	<b>76</b>	<b>6,123</b>
Coriander	8	-	493
<i>Sowa</i>	-	-	59
Others	187	2	1,858
<b>Spices &amp; Condiments</b>	<b>195</b>	<b>2</b>	<b>2,410</b>
Pongam oil tree	-	-	395
<i>others</i>	68	50	2,008
<b>Agro-forestry</b>	<b>68</b>	<b>50</b>	<b>2,403</b>
Lentil	-	-	7,712
Pigeonpea	-	-	2,523
<b>Duplicate Safety Samples</b>	<b>-</b>	<b>-</b>	<b>10,235</b>
<b>Total</b>	<b>13,542**</b>	<b>198</b>	<b>3,67,419*</b>

\*The figure includes 3349 Released varieties and 1593 Genetic stocks

No. of crop species conserved - 1516

\*\* The figure includes 349 Released varieties and 139 Genetic stocks

No. of crop species conserved - 198

### 3.2 Germplasm Registration

A total of 228 proposals were received for germplasm registration and 117 proposals belonging to 14 crop groups were approved for registration in the Plant Germplasm Registration Committee meeting. The details of registered germplasm are given in Table-2.

**Table 2: Germplasm registered during 2008**

Crop group	No. of proposals received	No. registered
Cereals	65	32
Pseudo cereals	4	-
Millets	8	3
Grain legumes	60	17
Oilseeds	11	6
Fibre crops	26	18
Vegetable crops	10	6
Fruit crops	2	2
Spices	3	3
Ornamentals	17	16
M & A plants	7	5
Tuber crops	4	4
Sugar yielding plants	7	4
Agro- forestry	4	1
<b>Total</b>	<b>228</b>	<b>117</b>

### 3.3 Documentation and Database Management

Efforts were continued to update passport data on germplasm conserved. Passport data were updated for a total of 2,225 accessions comprising cereals (316), fibres (1,434), vegetables (255) and pulses (220).

### 3.4 Monitoring of Germplasm Viability

Germplasm stored in the long-term storage module for 10 years or more (2,121 accs.) were monitored for seed viability, seed quantity and seed health to identify accessions that may require regeneration as per the genebank standards. This included accessions of cereals (191), pseudocereals (606), oilseeds (235), medicinal plants (115), spices and condiments (294), fibres (234), pulses (240), and vegetables (106). Viability of all the accessions was maintained conforming to the gene bank standards.

### 3.5 Regeneration of Germplasm

A total of 5,873 germplasm samples of various crops were supplied for seed multiplication/ research/

evaluation. These include accessions of paddy (1,911) maize (300), wheat (2,669), cucumber (24), ash gourd (123), bottle gourd (24), sponge gourd (26), fenugreek (100) pigeonpea (250) and chickpea (327).

### 3.6 Supportive Research

#### 3.6.1 Seed dormancy and standardization of germination protocols

Methods for breaking seed dormancy and germination were developed in some wild species. Enhanced germination was observed in *Dodonea viscosa* and *Ariesema caudate* in sulphuric acid treatment (50% for 10 mins) whereas cutting the seed coat at distal end gave maximum germination in *Cucumis setosus* and *C.callosus*. *Tecoma stans* and *Catuneragum spinosus* gave best germination using TP method at 20°C in dark.

#### 3.6.2 Seed priming

Seed priming experiment was undertaken in *Cucumis sativus* and *Jatropha curcas*. The seeds of *Cucumis* showed a very low viability of 30-35%. Amongst different priming treatments viz. hydro, chemical, osmo, halo and sand priming tried, halo and osmo was the best treatment for *Cucumis* species which increased the germination to 80-90 per cent. The seeds of *Jatropha* always showed non-uniform germination with low viability rates. There was a significant increase in the germination percentage of all the accessions after priming. Amongst different priming treatments viz. hydro, chemical, osmo and sand priming tried sand priming was found to be the best in *Jatropha* seeds where there is almost an increase of 40-60% over the control followed by hydro priming (30-50% increase). Both seed vigour and rate of germination increased with priming.

#### 3.6.3 Effect of ultra desiccation

To develop protocols for cost effective conservation, observations on storability of seeds dried to low moisture contents were continued in castor, groundnut, sesame, chickpea, cotton and *Jatropha*. Significantly higher germination was observed in sesame, chickpea and cotton at lowest moisture studied (i.e. 2-3%) than in seeds at next higher level of 4.5-5.0 % moisture content after 12 years of storage at ambient temperature. Similarly longevity of castor, groundnut, pigeonpea was found to be more when seeds were dried to ultra low moisture contents (i.e. < 5 per cent moisture content)



than those stored at higher moistures at ambient temperature after more than 9 years of storage.

Seeds of *Jatropha curcas* received from 5 different states viz. Uttaranchal, Gujarat, Rajasthan, Tamil Nadu, Kerala were studied for the effect of ultra desiccation. The seed viability of the fresh sample was in the range of 82 to 100%. These seeds were equilibrated over saturated salt of LiCl<sub>2</sub> in sealed desiccators at 20 °C. These ultra dry seeds with 3.2 per cent moisture were

hermetically sealed in aluminum foil pouches and were kept at ambient temperature. The seed viability was assessed at an interval of 4 months upto the period of 14 months. The results depicted a steady decline in viability with storage time. A significant decline in few accessions started after 14 month of storage. The accessions obtained from southern humid tropic zone decreased to about 26-30% after 14 months of storage. (Table 3).

**Table 3: Effect of storage for different durations on viability of ultra desiccated *Jatropha* seeds**

Nat. ID	Storage period (months)				
	0	2	6	10	14
Seed Viability					
IC559360	100	100	98	95	95
IC422125	98	85	82	80	80
IC559370	80	75	80	76	76
IC559368	90	85	80	82	82
IC554538	80	75	80	80	75
IC555380	100	100	98	95	95
IC559358	80	78	78	75	72
IC555381	62	60	55	55	50

#### Research Program Research Projects (Institute Code: Title, PI, Co-PIs and Associate/s)

PGR/GCN-BUR-DEL-01.00: *Ex situ* conservation of Plant Genetic Resources of Agricultural and Horticultural Crops using conventional methods (AK Singh (upto July 2008) Kalyani Srinivasan)

PGR/GCN-BUR-DEL-01.01: Management of information and facilities of germplasm conserved in the national network (**RC Agrawal**; Anjali Kak & Rita Rani)

PGR/GCN-BUR-DEL-01.02: Conservation of legume germplasm using conventional seed storage methods (**Neeta Singh**; Chitra Pandey)

PGR/GCN-BUR-DEL-01.03: Conservation of paddy using conventional seed storage methods (**Kalyani Srinivasan**; AD Sharma)

PGR/GCN-BUR-DEL-01.04: Conservation of oilseed and fruit crops germplasm using conventional seed storage methods (**J Radhamani**)

PGR/GCN-BUR-DEL-01.05: Conservation of cereals excluding paddy and agro-forestry species, using conventional seed storage methods (**K Srinivasan**; 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 forage and fibre crop species germplasm using conventional seed storage methods (**Anjali Kak**; Veena Gupta)

PGR/GCN-BUR-DEL-01.08: Conservation of millets germplasm using conventional seed storage methods (AK Singh( upto July 2008); **J Radhamani**)

PGR/GCN-BUR-DEL-01.09: Conservation of vegetable germplasm using conventional seed storage methods (**Chitra Pandey**; Neeta Singh)

PGR/GCN-BUR-DEL-01.10: Investigating seed dormancy, seed storage behaviour, and physiological and biochemical changes during storage. (**Kalyani Srinivasan**; Neeta Singh, Veena Gupta, J Radhamani, Anjali Kak, Chitra Pandey, Manju Uprety, AD Sharma)

#### Externally funded projects

- "Biodiversity conservation of Targeted Rare and Endangered Medicinal Plants of Western Ghats" funded by "National Medicinal Plant Board" (**Veena Gupta**)
- "Collection, Assembly and Conservation of Genetic Resources of Physic nut (*Jatropha* Linn.)" DBT funded (**J Radhamani**)
- "National Plant Variety Repository" PPVFRA funded (**Anurudh K Singh**)

## 4. DIVISION OF PLANT QUARANTINE

**Summary:** A total of 33,130 accessions (81,112 samples) comprising germplasm accessions as well as trial material entries of various crops and 493 accessions (891 samples) under export were processed for quarantine clearance. These samples included true seeds, rooted plants, cuttings, rhizomes, suckers, bulbs, nuts and tissue culture plantlets. The detailed quarantine examinations revealed that 4,325 samples were infested/ infected contaminated with various pests viz., insects/ mites - 491 samples including 82 with hidden infestation; nematodes-3,456, fungi/ bacteria- 297 and viruses (81). Of the 4,325 infested/ infected/ contaminated samples, 4,316 were salvaged through fumigation, hot water treatment (HWT), X-ray radiography, pesticidal dip, mechanical cleaning and growing-on test. Nine samples were rejected including one sample of *Glycine max* from USA due to the presence of downy mildew fungus (*Peronospora manshurica*), a pest not yet reported from India. In addition, 260 accessions of Indian origin collected during explorations were processed for pest-free conservation. Of these 201 samples were subjected to X ray radiography of which 55 samples found infected were salvaged. Two samples were rejected due to severe infestation. Fourteen Phytosanitary Certificates were issued for consignments meant for export. In addition, 305 samples of transgenic crops viz., *Brassica oleracea* var. *capitata* (cabbage), *B. oleracea* var. *botrytis* (cauliflower), *Gossypium* spp., *Oryza sativa* and *Zea mays* were processed for quarantine clearance.

### 4.1 Import Quarantine

**4.1.1 Quarantine examination:** A total of 33,130 accessions (81,112 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, 1,454 samples were exposed to X-ray radiography for detection of hidden infestation of bruchids and chalcids. A total of 4,325 samples were found infested/ infected/ contaminated. Of these, 491 samples were found infested with insects/ mite including 82 with hidden infestation; 3,456 samples infected with nematodes, 297 found infected with fungi/ bacteria and 81 with viruses. A number of pests of major quarantine importance were intercepted (Table 1).

**4.1.2 Salvaging of infested/ infected/ contaminated germplasm:** Of the total 4,325 infested/ infected/ contaminated samples, 4,316 were salvaged by various disinfestation techniques/ treatments like mechanical cleaning to remove damaged/ abnormal seeds, soil clods (316), plant debris etc., fumigation with ethylene dichloride-carbon tetrachloride (EDCT) mixture @ 320 mg/ litre for 48 h at 30°C under normal air pressure against insect infestation and hot water treatment (HWT) at 52°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 (491) were salvaged through fumigation (153), X-ray radiography (82) and pesticidal dips (127); 2,407 samples

infected with nematodes were salvaged by hot water and 1,049 by nematicidal dip treatments; 297 samples infected with fungi/ bacteria were salvaged by fungicidal seed treatment (264) and HWT (8), ethyl alcohol wash (25); and samples infected with viruses were salvaged through grow-out test. One sample of soybean (from USA) infected with downy mildew fungus (*Peronospora manshurica*), a pest not yet reported from India; two and four samples of tomato due to infection with *Fusarium oxysporum* and *Xanthomonas vesicatoria*, respectively from Thailand, two culture tubes of *Solanum tuberosum* received in contaminated and decaying conditions were also rejected.

**Prophylactic treatments:** A total of 47,400 seed samples were subjected to fumigation, 684 samples of vegetative propagules were given pesticidal dip/ spray treatment and 10,539 samples of paddy were given mandatory hot water treatment. In order to prevent the introduction of new strains of tobamoviruses through seeds, all the introduced germplasm samples of chilli (181), and tomato (562) were subjected to prophylactic seed treatment with 10% tri-sodium orthophosphate.

**4.1.3 Grow-out test in post-entry quarantine nursery (PEQN)/ Greenhouses:** International nurseries trial material (3,155 entries) comprising wheat (1,828) from CIMMYT (Mexico) and ICARDA (Syria), barley (405) from ICARDA (Syria), and triticale (112) from CIMMYT (Mexico), exotic wheat (407) from CIMMYT (Mexico), ICARDA (Syria), Canada, France, registered germplasm of wheat (64) and *Vicia faba* (339) from ICARDA (Syria) were grown in PEQN at NBPGR. Besides these, 2,553 entries of wheat grown at Issapur farm were also observed under PEQ.

A total of 220 samples of exotic germplasm comprising *Glycine max* (80), *V. faba* (52), *Vigna radiata* (21), *V. umbellata* (7) and *V. unguiculata* (60) were grown in Post-entry Quarantine Greenhouses. The plants showing virus-like symptoms were tested by electron microscopy and using specific antiserum against various 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.

## 4.2 Export Quarantine

A total of 493 accessions (891 samples) of various crops intended for export to various countries were processed for detection of associated pests. Of these, 91 samples were found infected and all were salvaged. The fungi found associated were *Alternaria padwickii*, *Drechslera oryzae* and *Ustilaginoidea virens* on *Oryza sativa*, *Drechslera sorokiniana* and *Neovossia indica* on *Triticum aestivum*. Fourteen Phytosanitary Certificates were issued.

## 4.3 Detection of Viruses in In Vitro Cultures of Germplasm Meant for Conservation

A total of 23 *Allium* accessions *in vitro* conserved at TCCU were tested by ELISA against 6 commercially available *Allium* antisera (kits) including *Carnation latent virus* (CLV), *Garlic common latent virus* (GCLV), *Leek yellow stripe virus* (LYSV), *Onion yellow dwarf virus* (OYDV), *Shallot latent virus* (SLV) and *Shallot yellow stripe virus* (SYSV).

Results indicated that out of 23 *in vitro* cultures tested by ELISA, CLV was detected in 11 accessions, GCLV in 7 accessions and SYSV in 12 accessions. Electron microscopy revealed the presence of flexuous particles of different size belonging to *Carlavirus* and *Potyvirus* groups. Five samples viz., IC33295A, IC33295B, IC375074A, IC48786 and IC374978C were found to be free from any of the six viruses tested by ELISA.

## 4.4 Supportive Research

**4.4.1 Efficacy of microwave radiation treatment:** Paddy seeds infested with “white tip nematode” of rice were treated with microwave radiations at 1.35 kW and 2450 MHz frequencies in the domestic microwave. Seeds (50 gm in each packet) with 3 % moisture content in brown colored paper packets required an exposure of 60 seconds, while yellow packets required 80 seconds. Ten packets when placed in one go required 100 seconds, whereas seeds in open Petri dish required just 40 seconds to eradicate nematodes.

**4.4.2 Potential quarantine pests for India in grain legumes:** Information on pests of grain legumes (39 crops of 19 genera, 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. There are about 146 insects/ mites, 40 nematodes, 36 fungi, 12 bacteria and 42 viruses of quarantine significance in grain legumes not yet reported from India.

**Table 1: Pests Intercepted in the exotic germplasm during 2008**

Pest	Host	Source/ Country
<b>Insects and mites</b>		
<i>Aceria tulipae</i>	<i>Allium sativum</i>	Kazakhstan, USA
* <i>Bruchus dentipes</i>	<i>Vicia faba</i>	ICARDA (Syria)
<i>B. lentis</i>	<i>Lens culinaris</i>	ICARDA (Syria)
* <i>B. tristis</i>	<i>Lathyrus sativus</i>	ICARDA (Syria)
<i>Bruchidius</i> sp.	<i>Trifolium alexandrium</i>	Egypt
<i>Callosobruchus analis</i>	<i>L. sativus</i>	ICARDA (Syria)
<i>C. chinensis</i>	<i>Lens culinaris</i>	ICARDA (Syria)
* <i>C. subinnotatus</i>	<i>Vigna subterranea</i>	Ghana
<i>Hemiberlesia lataniae</i>	<i>Persia americana</i>	USA
<i>Oligonychus peruvianus</i>		
<i>Pectinophora gossypiella</i>	<i>Gossypium hirsutum</i>	Israel
<i>Rhizopertha dominica</i>	<i>Triticum aestivum</i>	Mexico
<i>Sitophilus zeamais</i>	<i>Zea mays</i>	Philippines

<i>Tribolium castaneum</i>	<i>Z. mays</i>	Thailand
<b>Nematodes</b>		
<i>Aphelenchoides besseyi</i>	<i>Oryza sativa</i>	Philippines
<i>Aphelenchoides</i> spp.	<i>Allium sativum</i>	Germany
<i>Helicotylenchus pseudorobustus</i>	<i>Prunus americana</i> , <i>Malus domestica</i>	USA
<i>Pratylenchus penetrans</i>	<i>Fragaria vesca</i> , <i>Olea europaea</i> , <i>P. americana</i> , <i>P. domestica</i> , <i>P. persica</i>	USA
<i>Xiphinema diversicaudatum</i>	<i>M. domestica</i> , <i>P. americana</i>	USA
<b>Fungi/ Bacteria</b>		
<i>Alternaria brassicicola</i>	<i>Brassica nigra</i> <i>B. oleracea</i> <i>B. juncea</i>	Australia, Canada Netherlands Korea
<i>A. brassicae</i>	<i>B. juncea</i> <i>B. oleracea</i>	Korea Netherlands
<i>A. helianthi</i>	<i>Helianthus annuus</i>	USA
<i>A. zinniae</i>	<i>H. annuus</i>	USA
<i>Botrytis cinerea</i>	<i>B. oleracea</i> <i>Prunus</i> spp. <i>Fragaria vesca</i>	Netherlands USA USA
<i>Colletotrichum dematium</i>	<i>Abelmoschus esculentus</i> <i>Capsicum annuum</i> <i>Eleusine</i> spp.	Taiwan Taiwan USA
<i>C. gloeosporioides</i>	<i>Solanum tuberosum</i> (TPS)	USA
<i>C. graminicola</i>	<i>Z. mays</i>	USA
<i>Drechslera oryzae</i>	<i>O. sativa</i>	USA
<i>D. sorokiniana</i>	<i>B. juncea</i> <i>T. aestivum</i> <i>Hordeum vulgare</i>	Korea Canada, CIMMYT (Mexico), USA USA
<i>Fusarium moniliforme</i>	<i>Abelmoschus esculentus</i> <i>Capsicum</i> spp. <i>Cucumis sativus</i> <i>Eleusine</i> spp. <i>Geranium</i> sp. <i>Glycine max</i> <i>Gossypium hirsutum</i> <i>Helianthus annuus</i> <i>Hordeum vulgare</i> <i>Hyocymus niger</i> <i>H. perforatum</i> <i>Oryza sativa</i> <i>Zea mays</i> <i>Indigofera tinctoria</i> <i>Lycopersicon esculentum</i> <i>Triticum aestivum</i> <i>T. turgidum</i> <i>Solanum tuberosum</i> (TPS)	Taiwan Taiwan Korea USA Denmark Taiwan Israel, Pakistan, USA USA Australia Denmark Denmark USA Indonesia, Italy, Philippines, Thailand, USA USA Taiwan, Thailand France, USA ICARDA (Syria) USA
<i>F. oxysporum</i>	<i>L. esculentum</i>	Thailand
<i>F. poae</i>	<i>Avena sativa</i> <i>Hordeum vulgare</i>	ICARDA (Syria) Australia
<i>F. solani</i>	<i>Prunus</i> spp. <i>Malus</i> spp. <i>Solanum tuberosum</i> (TPS) <i>Glycine max</i>	USA USA USA Taiwan
<i>*Peronospora manshurica</i>	<i>G. max</i>	USA
<i>Phoma lycopersci</i>	<i>L. esculentum</i>	Thailand
<i>Phomosis obscurans</i>	<i>Fragaria vesca</i>	USA



<i>Puccinia carthami</i>	<i>Carthamus</i> spp.	USA
<i>P. helianthi</i>	<i>Helianthus annuus</i>	France, USA
<i>Xanthomonas vesicatoria</i>	<i>Lycopersicon esculentum</i>	Thailand
<b>Viruses</b>		
<i>Alfalfa mosaic virus</i>	<i>Pisum sativum</i> *	USA
<i>Bean common mosaic virus</i>	<i>Vigna subterranea</i> *	Ghana
<i>Bean yellow mosaic virus</i>	<i>P. sativum</i>	USA
<i>Blackeye cowpea mosaic virus</i> strain of BCMV	<i>V. subterranea</i> *	Ghana
<i>Broad bean wilt virus</i>	<i>P. sativum</i>	USA
<i>Cowpea mild mottle virus</i>	<i>Glycine max</i>	AVRDC (Taiwan)
<i>Cowpea mosaic virus</i>	<i>G. max</i>	AVRDC (Taiwan)
* <i>Cowpea mottle virus</i>	<i>V. subterranea</i>	Ghana
<i>Cucumber mosaic virus</i>	<i>V. unguiculata</i>	Belgium
* <i>Cowpea severe mosaic virus</i>	<i>V. radiata</i> <i>V. unguiculata</i>	Australia Belgium
* <i>Pea enation mosaic virus</i>	<i>P. sativum</i>	USA
<i>Peanut stripe virus</i>	<i>P. sativum</i> *	USA
<i>Southern bean mosaic virus</i>	<i>V. unguiculata</i>	Belgium
<i>Soybean mosaic virus</i>	<i>G. max</i>	AVRDC (Taiwan)
<i>Tobacco necrosis virus</i>	<i>P. sativum</i> *	USA
<i>Tobacco ring spot virus</i>	<i>G. max</i>	AVRDC (Taiwan)
<i>Tobacco streak virus</i>	<i>G. max</i> *	USA, AVRDC (Taiwan)
	<i>P. sativum</i> *	USA
<i>Tomato black ring virus</i>	<i>G. max</i> *	USA, AVRDC (Taiwan)

\* Pest not yet reported from India

\* Pest present in India but not recorded on the host on which intercepted

## 4.6 Achievements in Externally- funded Projects

**4.6.1 National Containment/ Quarantine Facility for Transgenic Planting Material (DBT):** With the approval of RCGM, 305 samples of imported transgenic planting material comprising *Arabidopsis thaliana* (1) from USA for Indian Institute of Advanced Research, Gujarat; *Gossypium* sp. (154) viz., 4 for Bayer Bioscience Pvt. Ltd., Hyderabad, 50 for Emergent Genetics India Pvt. Ltd., Hyderabad and 100 for Monsanto India Ltd., Mumbai, all from USA; *Oryza sativa* (122) viz., 80 from Belgium for Bayer Bioscience Pvt. Ltd., Gurgaon, 3 from China for Pioneer Overseas Corporation, Hyderabad, 2 from the Philippines for Chinsurah Rice Research Station, West Bengal and 37 from USA for Dupont India Pvt. Ltd., Hyderabad; *Zea mays* (28) viz., 1 from the Philippines along with one corresponding non-transgenic sample for Syngenta India Pvt. Ltd., New Delhi; 4 for University of Agriculture Sciences, Bangalore, 5 along with five corresponding non-transgenic samples for Dow Agro Sciences India

Pvt. Ltd., Mumbai, 12 for Dupont India Pvt. Ltd., Hyderabad, 6 for Monsanto India Pvt. Ltd., Mumbai, all from USA, were received during the period for quarantine processing.

The transgenes present in these crops included, mutated *CAXI* gene in *Arabidopsis thaliana* for Cation-anion exchanger; *cry1Ab*, *cry1Ac*, *cry2Ab*, *cry2Ab2*, *cry2Ae* in *Gossypium* sp.; *cry1Ab*, *cry1Ac*, *cry1C*, *cry2A* in *Oryza sativa*; *cry1Ab*, *cry1Ac*, *cry1F* and *Bt Inbred lines* in *Zea mays* for insect resistance; *bar* in *Gossypium* sp. and *Oryza sativa* and *pat* in *Zea mays* for glufosinate amonium herbicide resistance; *cp4epsps*, *2mepsps* in *Gossypium* sp. and *cp4epsps*, *mepsps* in *Zea mays* for glyphosate herbicide tolerance; *α-amylase* and *Ferritin* gene in *Oryza sativa* for nutritional improvement; control element and *gus* reporter gene in *Zea mays*.

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, fungi: *Fusarium longipes*, *F. moniliforme*, *F. oxysporum*, *F. semitectum* in cotton from USA; *F. moniliforme* in maize from USA and in rice from China and the Philippines; and insects: *Cryptolestes* sp., *Rhizopertha dominica*, *Sitotroga cerealella*, *Tribolium castaneum* in rice from China.

One hundred and forty five samples comprising wheat leaves showing virus-like symptoms during PEQ inspection (64) and sap-inoculated maize leaves showing virus-like symptoms (81) were tested against five viruses using ELISA. The results revealed the presence of *Barley stripe mosaic virus* and *Wheat streak mosaic virus* not reported from India; *Maize dwarf mosaic virus* not reported on wheat in India. Electron microscopy revealed the presence of flexuous particles of 700-900 nm suggesting association of *Potyvirus*.

Rice samples were given mandatory hot water treatment at 52°C for 30 minutes against various seed-borne pests. Besides, infected samples of cotton and maize were salvaged by giving fungicidal treatment with bavistin and thiram.

DNA was extracted from the seedlings of all the transgenic lines received and were tested for the terminator gene using primers designed for *cry* recombinase gene. All these lines showed negative results for the terminator gene. The transgenic planting material was also tested for specific transgenes. Multiplex PCR protocols for simultaneous detection of two or more genes have also been standardized.

Post-entry quarantine inspection of cotton imported from the USA and grown in containment at Cotton Breeding Station, Kallalkal, Hyderabad; maize from the Philippines at Syngenta Research Station, Aurangabad, Maharashtra; maize from USA at Monsanto Research Station, Bangalore and Dupont Knowledge Centre, Hyderabad; rice from Belgium at Bayer Bioscience, Medak Dist., Andhra Pradesh and rice from China and USA at Dupont Knowledge Centre, Hyderabad was done and the crops were found to be free from exotic pests/ diseases.

**4.6.2 Classical biological control of *Mikania micrantha* with *Puccinia spegazzinii*: Implementation Phase (ICAR-CABI Collaborative Project):** Based on the permission from Plant Protection Adviser to Govt. of India for limited

field release of the Peruvian isolate of *P. spegazzinii* (W 2102) rust inoculum was supplied to Assam Agricultural University, Jorhat and Kerala Forest Research Institute, Peechi. The project was completed in June, 2008.

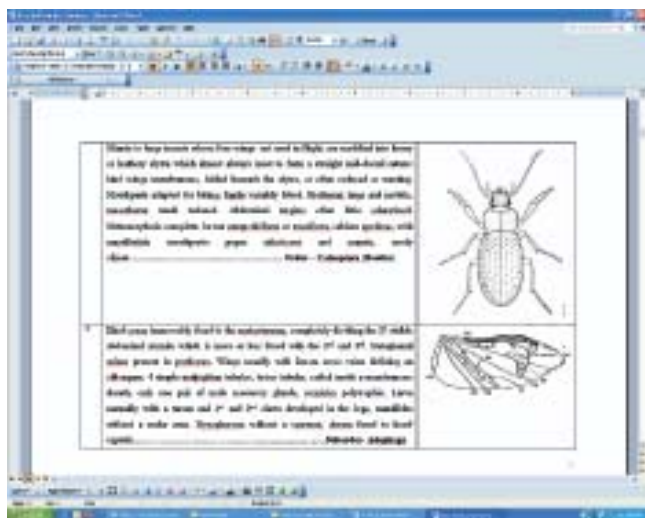
**4.6.3 Network project on diagnostics of emerging plant viruses (ICAR):** A total of 168 seed samples of French bean (104) and soybean (64) were subjected to growing-on test. Studies revealed a seed transmission rate of 1-82% of *Bean common mosaic virus* (BCMV) in French bean and 3-81% of *Soybean mosaic virus* (SMV) in soybean. Double Antibody Sandwich-ELISA and RT-PCR protocols developed for detection of BCMV and SMV were further tested and conformed that the protocols are reproducible.

**4.6.4 Development of technology for detecting presence of GMOs in an unknown sample and its utilization in dealing with bulk samples (DAC):** The recombinant protein of npt-II has been produced and immunization of rabbits is in progress. The validation of diagnostic kits developed for detection of npt II and uidA (B-D-Glucuronidase)-reporter is in progress.

**4.6.5 Studies on the potential of electron beam irradiation as quarantine disinfestation treatment against insect-pests in seeds (BRNS, DAE):** Experiments using Electron Beam (EB) irradiation as a disinfestation treatment against insect pests were conducted in seeds viz., paddy against *Rhizopertha dominica*, *Sitophilus oryzae* and *Sitotroga cerealella*; gram against *Callosobruchus chinensis*; soybean against *C. chinensis*/ *C. maculatus* and cotton against *Trogoderma granarium*. Irradiated infested seeds were observed for different parameters of insect growth and development of insect. Egg was found to be the most sensitive stage even at the lower doses. The seeds infested with the larval and pupal stages of the pest revealed declining trend in adult emergence with the increase in electron beam doses. Uninfested seeds were also irradiated at the same doses as infested seeds and tested for their germination and vigour as per ISTA rules. There was no significant difference in these parameters as compared to control.

**4.6.6 Preparation of digitized keys for quick and reliable identification of insect pests of Family Bruchidae of quarantine significance (DAC):** The annotated checklist of insect pests belonging to Family

Bruchidae of quarantine significance to India was updated with the information collected from various sources like databases and libraries in IARI, New Delhi, FRI Dehradun and the internet. Collected literature from various sources to develop the database on the Genera of quarantine significance viz., *Acanthoscelides*, *Bruchus*, *Bruchidius* and *Callosobruchus*. Compiled and collated the relevant information of bruchid of quarantine significance under the heads: scientific name – Genus and species, synonyms, host plants / species, morphology/ key characters, comparative notes-comparison with other known species, geographical distribution/ reported from, habitats, storage records and



biology - life cycles, generations per year, developmental phases, diapause etc., symptoms of damage, economic impacts, control measures, phytosanitary significance and References. A pictorial identification key has been developed for identification of fifty one bruchid genera.

#### 4.6.7 Development of quarantine disinfestation treatments (thermal/ modified atmosphere) against storage insect-pests infesting walnut (DAC):

The Walnut infested with different stages (egg, larva, pupa, adult) of *Ephestia (Cadra) cautella* and *Oryzaephilus mercator* were exposed to different temperatures for different durations. Based on the parameter of adult emergence, it was found that a temperature of 50°C for 120 min. was lethal to eggs, larvae and pupae of *E. cautella* infesting walnut with no adult emergence, while the adult mortality at this temperature occurred within 10 min. In *Oryzaephilus mercator* infesting walnut in the larval and pupal stage, there was no adult emergence at: 50°C at an exposure period of 120 min., 55°C at an exposure period of 60 min and 45°C at an exposure period of 360 min. The adult mortality at these temperatures occurred within 10-20 min.

#### 4.6.8 Development of farmer friendly diagnostic kits for transgenic event seed purity:

The validation of diagnostic kits developed for detection of *CryIF* is in progress.

#### Research Programme (Programme Code: Title, Leader)

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

#### 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, Shashi Bhalla, DB Parakh, Kavita Gupta, Charan Singh, Dinesh Chand, Ashok Maurya and KD Joshi)

PGR/PQR- BUR-DEL-01.02 Post-entry Quarantine Processing of Exotic Germplasm (**RK Khetarpal**, Arjun Lal, PC Agarwal, 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**, Rajan, Gurinder Jit Randhawa, Shashi Bhalla, Baleshwar Singh, V Celia Chalam 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, 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**, Rajan and KD Joshi)

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, Manju Lata Kapur, Kavita Gupta, Charan Singh)

PGR/PQR-BUR-DEL-01.09 Quarantine Treatments for Disinfection of Germplasm Under Exchange against Nematodes and Supportive Research (**Rajan**, Arjun Lal, KD Joshi)

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, KD Joshi)

PGR/PQR-BUR-DEL-01.11 Seed-health Testing for Conservation of Indigenous Germplasm Free from Pests (**B Lal**, Arjun Lal, Usha Dev, Manju Lata Kapur, Baleshwar Singh, Charan Singh, Dinesh Chand, Ashok Maurya and KD Joshi)

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)

### Externally funded projects

- National Containment/ Quarantine Facility for Transgenic Planting Material (DBT)(**RK Khetarpal**, Gurinder Jit Randhawa, Manju Lata Kapur, V Celia Chalam, Kavita Gupta)
- Classical biological control of *Mikania micrantha* with *Puccinia spegazzinii* (**DFID funded** ICAR-CABI Collaborative Project) (**Usha Dev** –Co-PI)
- Network Project on Diagnostics of Emerging Plant Viruses (**ICAR**) (**RK Khetarpal**, DB Parakh and V Celia Chalam)
- Development of Technology for Detecting Presence of GMOs in an Unknown Sample and its Utilization in dealing with Bulk Samples (**DAC**) (**RK Khetarpal**, 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**) (**Shashi Bhalla**, SK Sharma, B Lal and Kavita Gupta)
- Preparation of Digitized Keys for Quick and Reliable Identification of Insect Pests of Family Bruchidae of Quarantine Significance (**DAC**) (**Kavita Gupta**, B Lal, Manju Lata Kapur, Shashi Bhalla)
- Development of Quarantine Disinfestation Treatments (Thermal/ Modified Atmosphere) against Storage Insect-pests Infesting Walnut (**DAC**) (**Shashi Bhalla**, B Lal, Manju Lata Kapur and Kavita Gupta)
- Development of Farmer Friendly Diagnostic Kits for Transgenic Event Seed Purity (**ICAR**) (**RK Khetarpal** and V Celia Chalam)



## 5. GERMPLASM EXCHANGE UNIT

**Summary:** During the period under report 33,130 accessions (81,112 samples) were imported from 43 countries, which included germplasm 25,450 accessions (26,929 samples) as well as trial material 7,680 entries (54,183 samples) of different agricultural and horticultural crops. Requirements for germplasm from abroad were met by arranging material from different Indian sources and 811 samples were exported to six countries. A total of 9,681 samples of different crops were supplied to various users for utilization in the various crop improvement programmes in the country based on requests received from research workers in the country 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 introduction comprised material obtained on request from the scientists as well as collaborators for international trials to be conducted in India.

**Table 1: Introductions of seed/ plant propagules**

Accessions procured and processed	33,130 accessions (81,112 samples)
Germplasm	25,450 accessions (26,929) samples
Trial	7,680 accessions (54,183 samples)
Transgenic material imported (samples)	286
No. of countries involved	43
No. of Import Permit issued	666

**5.1.1 Cereals and Millets:** *Aegilops geniculata* (3), *A. kotschy* (4), *A. longissima* (4), *A. peregrina* (5), *A. tauschii* (4) all from USA; *Eleusine coracana* (5) from Kenya, *E. indica* (7), *E. jaegeri* (1), *E. tristachya* (5), *E. multiflora* (1) all from USA; *Hordeum vulgare* (61) from Australia, USA; *Oryza sativa* (5384) from China, Belgium, Kenya, Philippines and USA; *Pennisetum glaucum* (354) from Niger; *Setaria italica* (2) from Italy; *Sorghum bicolor* (137) from Australia, Kenya, Mali and USA; *Triticum aestivum* (2046) from Australia, France, Canada, Mexico, Syria, Turkey and USA; *T. dicoccum* (118), *T. durum* (3) from Canada, *T. sphaerococcum* (3) from France, *T. spelta* (1) from Mexico, *T. turgidum* (5) from USA, *T. turgidum* ssp. *dicoccum* (41) from Mexico and Syria; *Zea mays* (7460) from Brazil, Chile, China, Germany, Indonesia, Italy,

Mexico, Nigeria, Philippines, Spain, Thailand, USA and Zimbabwe. **Trials-** *Hordeum vulgare* (50 acc., 1985 samples) IBCSGP-09, IBLSGP-09, IBPMG, IBON-LRA-MO9, IBON-MRA-09, IBYT-LR-C-09, IBYT-LRA-M-09, BYT-MRA-M-09, INBYT-09, ISEBON-9, 15<sup>th</sup> EMBSN, 17<sup>th</sup> HBSN, 35<sup>th</sup> IBON, 30<sup>th</sup> IBYT, IBCB-S, IBCSGP-08, IBPMGP-08, ISEOBON; *Oryza sativa* (2801 acc., 6727 samples) -3<sup>rd</sup> IRHTN-08, 34<sup>th</sup> IIRON (Module 1), 34<sup>th</sup> IIRON (Module 2), 3<sup>rd</sup> INEVDSUT 08, 9<sup>th</sup> IRBON-08, 10<sup>th</sup> IRHTN, 31<sup>st</sup> IRLON (Module 1), 31<sup>st</sup> IRLON (Module 2), 32<sup>nd</sup> IRLON, 28<sup>th</sup> IRSSTN (Module 1- A) 21<sup>st</sup> IRSSTN, 34<sup>th</sup> IURON, 4<sup>th</sup> AERON, 27<sup>th</sup> IRBN, 9<sup>th</sup> IRTON; *Triticum aestivum* (2744 acc., 36,311 samples)- 29<sup>th</sup> ESWYT, 41<sup>st</sup> IBWSN, 16<sup>th</sup> SAWYT, 40<sup>th</sup> IDSN, 40<sup>th</sup> IDYN, 26<sup>th</sup> SAWSN, 29<sup>th</sup> ESWYT, 3<sup>rd</sup> ATEMRRSN, CWANA-31<sup>st</sup> DON, CWANA 31<sup>st</sup> DYT-LL-MIR, CWANA-31<sup>st</sup> DYT-MD; *Triticale* (753 acc., 1505 samples); *Zea mays* (816 acc. 2135 samples) ECA-EVT08, ECA-ILHT08, ECA-ILVT08, Early QPMOPV SO7, ECA-QHT08; Acid Soil 14 White, Acid soil 14 Yellow, Evaluation Hibridos Amarillos Mnedio, 08 CHTHEW14, 08 CHTTW35, CHTTY36, 08 CHTTY47, EVT1237, TTWCWL30, TTWCYL38, TTWCLWQN-13, TTWCYLQN-13, TSCLWQ-13, TSCLYQ-13, TSCLYN-13, Lines trial W(2), Y(2), 08 TTWCYL7, 8<sup>th</sup> Harvest Plus Line Early Trial-5 (08-HPLET5).

**5.1.2 Oilseeds:** *Arachis hypogaea* (44) from USA; *A. paraguariensis* (2) from USA; *Brassica napus* (97) from Australia; *B. juncea* (163) from Australia, South Korea; *Carthamus glaucus* (1), *C. lanatus* (10), *C. lanatus* ssp. *turkestanicus* (4), *C. oxycanthus* (13), *C. palesticus* (1), *C. tenuis* (1), *C. tinctorius* (134) all from USA; *Glycine max* (79) from Taiwan and USA; *Helianthus annuus* (343) from Australia, Chile, Egypt, France, Serbia, South Africa and USA; *H. anomalus* (3), *H. bolanderi* (1), *H. debilis silvestris* (1), *H. debilis cucumeri* (1), *H. deserticola* (3) *H. giganteus* (2) *H. hirsutus* (7), *H. neglectus* (1), *H. paradoxus*

(2), *H. praecox* ssp. *praecox* (2), *H. resinous* (2), *H. strumosus* (2), *H. tuberosus* (8) all from USA; *Ricinus communis* (27) from USA.

**5.1.3 Grain Legumes:** *Lens culinaris* (19) from Syria and Turkey, *L. ervoides* (16), *L. lamottei* (1), *L. nigricans* (8), all from Syria; *Vicia dasycarpa* (5), *V. faba* (52), *V. narbonensis* (10), *V. sativa* (9) all from Syria; *Vigna angularis* (1), *V. glabrescens* (1), *V. mungo* (2) all from Taiwan, *V. radiata* (48) from Taiwan and Thailand, *V. subterranea* (2) from Ghana (rejected due to seed borne virus infestation), *V. umbellata* (9) *V. unguiculata* both from Taiwan. **Trials-** *Cicer arietinum* (3401 samples) CILABN-09, CICNN-09, CICTN-09, CILMN-09, CIDTN-09, CIEN-SL209, CICTN-09, CIEM-SLI-09, CIEN-LA-08, CIFWN-LA-08, CIF4N-SL-09, FBSIPN-09, CIEN-LA-08, CIEN-LA-08; *Lathyrus sativus* (351 samples) ILAT-LS, IVAT-VN, IVAT-VS; *Lens culinaris* (1444 samples) LICTN-08, LIDTN-08, LIENE-08, LIEN-GLO-8, LIEN-L08, LIENMNR-08, LIEN-S-08, LIFWN-08, LIFWN08, LIF<sub>3</sub>N-08, LIRN-08, LIF<sub>3</sub>N-E-08; *Vicia faba* (324 samples) FBIABN, FBICSN.

**5.1.4 Fibres:** *Gossypium barbadense* (30) from USA, *G. hirsutum* (908) from Israel and USA; *Hibiscus sabdariffa* (75) from Australia and USA.

**5.1.5 Vegetables:** *Abelmoschus esculentus* (6) from Taiwan; *Allium cepa* (9), *A. cepa* var. *cepa* (2), *A. fistulosum* (23), *A. longicuspis* (2) all from USA; *A. sativum* (254) from Germany, Taiwan and USA; *Brassica oleracea* var. *capitata* (169) from Netherlands; *Capsicum annuum* (223) from Taiwan and Vietnam, *C. baccatum* (4), *C. chacoense* (10), *C. chinense* (19) *C. frutescens* (19), *C. pratermissum* (3), *C. pubescens* (5), *Capsicum* sp. (17) all from Taiwan; *Citrullus lanatus* (443) from Indonesia and USA; *C. lanatus* var. *citroides* (833) from USA, *Citrullus* sp. (12) from Vietnam; *Cucumis melo* (15) from Italy and Vietnam, *C. sativa* (147) from Korea, Taiwan and Thailand; *Cucurbita pepo* (53) from Egypt and Taiwan, *C. moschata* (2) from Taiwan, *C. pepo* (2) from Taiwan; *Lagenaria siceraria* (1) from Taiwan; *Lactuca sativa* (3) from Vietnam; *Luffa cylindrica* (1) from Taiwan; *Lycopersicon chilense* (10), *L. hirsutum* (1) both from Taiwan, *L. esculentum* (498) from Italy, Taiwan, Thailand and USA; *Momordica charantia* (11) from Taiwan; *Praecitrullus fistulosus* (5) from USA; *Solanum lycopersicum* (3)

from Taiwan, *S. melongena* (1) from Taiwan and *S. phureja* (30) from USA.

**5.1.6 Fruit plants:** *Carica papaya* (1) from USA; *Carya illinoensis* (13) from USA; *Ficus carica* (10) from USA; *Fragaria vesca* (3) from USA; *Jacaratia spinosa* (1) from USA; *Malus domestica* (13), *M. orientalis* (2), *M. sieversii* (2) all from USA; *Olea europea* (14) from Egypt; *Persea americana* (2) from USA; *Prunus armeniaca* (98) from USA; *Pyrus* sp. (10) from USA; *Vitis mustangensis* (7) from USA.



Variety Clancy (EC619155) of strawberry from Geneva Experimental Station, Cornell University, USA



Variety Fuerte (EC605810) of Avocado from California, USA

**5.1.7 Forages:** *Avena sativa* (100) from Syria; *Medicago sativa* (3) from Japan.

**5.1.8 Agroforestry crops:** *Acacia ampliceps* (1), *A. salicina* (1), *A. stenophylla* (1); *Casuarina glauca* (1); *Eucalyptus camaldulensis* (9) *E. longirostrata* (1), *E. moluccana* (1), *E. tereticornis* (1) all from Australia.

**5.1.9 Tubers:** *Solanum quitoense* (2) from Spain; *S. microdonton* (2) from USA; *S. stenotomum* (1) from

USA; *S. tuberosum* (72) from Peru, Scotland, Spain and USA; *S. tuberosum* ssp. *andigenum* (20), *S. tuberosum* ssp. *tuberosum* (2), *S. vernei* (1) all from USA; *Ipomoea batatas* (47) from Peru.

**5.1.10 Medicinal and Aromatic Plants:** *Chicorium intybus* (3) from Vietnam; *Geranium cinereum* (1), *G. platopetalum* (1); *Hypericum niger* (3), *H. perforatum* (2) all from Denmark; *Indigofera tinctorius* (7) from USA.

**5.1.11 Narcotics:** *Nicotiana africana* (1), *N. alba* (3), *N. longiflora* (4), *N. suaveolens* (9), *N. tabacum* (63) all from USA.

**5.1.12 Plantation Crops:** *Theobroma cacao* (104) from UK.

**5.1.13 Under Utilized Crops:** *Citrullus colocynthis* (1) from USA; *Simmondsia chinensis* (9) from USA; *Vasconcellea goudotiana* (1), *V. microcarpa* (1), *V. parviflora* (1), *V. pubescens* (1), *V. quercifolia* (1), *V. stipulata* (1) all from USA.

**5.1.14 New Crop:** *Deschampsia antarctica* (2) from Chile.

#### For National accessioning

*Arachis hypogaea* (419); *Helianthus argophyllus* (3), *H. debilis* (2), *H. divaricatus* (1), *H. laevigatus* (1), *H. resinous* (1), and *Theobroma cacao* (59) were received for national accessioning.

**Table 2: Trait specific germplasm introduced during 2008**

Crop/EC No./Country	Specific Traits	Distribution
<i>Triticum aestivum</i> EC633777 Canada	Adapted to drier regions, source of resistance to races of loose smut	DWR, Karnal, Haryana
<i>Triticum aestivum</i> EC633778-784 ICARDA, Syria	PBW343 new version lines carrying genes resistant to Ug 99 and yellow rust	DWR, Karnal, Haryana
<i>Triticum aestivum</i> EC634055 USA	Resistance to wheat Soil borne mosaic virus and Spindle streak mosaic virus	DWR, Karnal, Haryana
<i>Triticum aestivum</i> EC631734 USA	Translocation line carrying a segment of chromosome 5, including softness genes <i>Pin a</i> & <i>Pin b</i>	DWR, Karnal, Haryana
<i>Triticum aestivum</i> EC631987-002 USA	Isogenic hard wheat lines differing for the presence of high grain protein gene GPC-B1	DWR, Karnal, Haryana
<i>Triticum aestivum</i> EC632017 USA	Germplasm resistant to biotypes 1 & 2 of Russian wheat aphid, semi dwarf, early maturing	DWR, Karnal, Haryana
<i>Triticum turgidum</i> EC631967-986 USA	Near isogenic hard spring lines differing in puroindoline alleles, controlling grain hardness, useful to study the basis for texture & quality differences in hard wheat	DWR, Karnal, Haryana
<i>Triticum turgidum</i> EC631987-632002 USA	Isogenic lines differing for presence of high grain protein gene Gpc B 1. May serve as a source of increased grain protein for hard red, white spring wheat breeding program and provide material to investigate the effect of Gpc B1 in high protein background.	DWR, Karnal, Haryana
<i>Hordeum vulgare</i> EC631731 USA	Variety Lentah-superior yield & test weight, most widely used as green feed	IGFRI, Jhansi, UP
<i>Hordeum vulgare</i> EC631732 USA	Variety Clearwater-hull less, low phytate and high available (CV 335) phosphorus concentrations in the grain, superior feed quality	IGFRI, Jhansi, UP
<i>Hordeum vulgare</i> EC631946 USA	Variety Tetonia-high yielding, resistance to spot blotch & net blotch	DWR, Karnal, Haryana
<i>Hordeum vulgare</i> EC634221-27 USA	Lines resistance to Russian wheat aphid, each line has a different source of resistance in malting barley cultivar backgrounds	DWR, Karnal, Haryana

<i>Oryza sativa</i> EC634219-20 USA	Mutant germplasm lines having improved resistance to sheath blight, bacterial panicle blight & narrow brown leaf spot	DRR, Hyderabad, AP
<i>Zea mays</i> EC633803 USA	Resistance to western corn rootworm	DMR, New Delhi
<i>Helianthus annuus</i> EC634078-80 USA	Source of resistance to races of loose smut	DOR, Hyderabad, AP
<i>Lens culinaris</i> EC631332 Turkey	High yielding and high level of winter hardiness	IIPR, Kanpur, UP
<i>Capsicum annuum</i> EC611331-611364 Taiwan	Tolerant to aphids	IIHR, Bangalore, Karnataka
<i>Capsicum annuum</i> EC612322 Vietnam	Very hot, 55-60 days maturity, extremely prolific, tolerant to <i>Phytophthora</i> , TMV & bacterial wilt	IIVR, Varanasi, UP
<i>Capsicum annuum</i> EC628891-920 EC631683-687 Taiwan	Lines resistant to <i>Chili veinal mottled virus</i> , <i>Poty virus Y</i> and bacterial wilt	BCKV, Kalyani, WB
<i>Cucumis melo</i> EC612132 Vietnam	Arkanga hybrid melon variety, fruits have a Netted skin, light green crispy flesh, strong tolerance to fusarium blight strains 0 & 1	IARI, New Delhi; IIVR, Varanasi, UP
<i>Cucumis melo</i> EC612133 Vietnam	Very vigorous hybrid variety Alien tolerant to both powdery and downy mildew. Prolific, medium early, can be harvested within 40-45 days weighing about 1.2-1.3 kg/fruit. Green flesh, juicy and sweet	IARI, New Delhi; IIVR, Varanasi, UP
<i>Cucumis melo</i> EC612134 Vietnam	Yellow skinned with oblong shape and cream colored flesh, weight approximately 2.5 kg/fruit	IARI, New Delhi; IIVR, Varanasi, UP
<i>Lactuca sativa</i> EC612126 Vietnam	Variety Minetto, crisp headed, iceberg type medium small size, black seeded variety, resistant to heat and humidity, tolerant to tip burn	IARI, New Delhi; IIVR, Varanasi, UP
<i>Lactuca sativa</i> EC612127 Vietnam	Fast fall a mid early variety, black seeded, loose leaf type	IARI, New Delhi; IIVR, Varanasi, UP
<i>Lactuca sativa</i> EC612128 Vietnam	Butter head type major variety for heavy lettuce production. Recommended for winter and autumn production in temperate areas and tolerant to <i>Bremia</i>	IARI, New Delhi; IIVR, Varanasi, UP
<i>Lycopersicon esculentum</i> EC631955-963 Taiwan	Resistant to root knot nematode	PAU, Ludhiana, Punjab
<i>Lycopersicon esculentum</i> EC632003-21 Taiwan	Lines tolerant to bacterial wilt, <i>Tomato mosaic virus</i> , fusarium wilt and gray leaf spot	College of Agriculture, Dharwad, Karnataka
<i>Lycopersicon esculentum</i> EC635523-27 Taiwan	Resistance to <i>Tomato leaf curl virus</i>	College of Horticulture, KAU Kerala
<i>Lycopersicon esculentum</i> EC635528-33 Taiwan	Resistant to Bacterial wilt	College of Horticulture, KAU, Kerala
<i>Lycopersicon esculentum</i> EC612858-869 Taiwan	Lines resistant to bacterial wilt, <i>Tomato mosaic virus</i> , fusarium wilt and gray leaf spot	M/S Metahelix Life Sciences, Bangalore, Karnataka
<i>Lycopersicon esculentum</i> EC614997-615029 Taiwan	Resistant to whitefly transmitted geminivirus, bacterial wilt, <i>Tomato mosaic virus</i>	M/S Krishi Dhan, Vegetable seeds, Pune, MS
<i>Lycopersicon esculentum</i> EC611883-891 Taiwan	Heat tolerant lines	TNAU, Periyakulam, TN



<i>Fragaria vesca</i> EC619154-56 USA	Varieties Lamour, Clancy, Seneca excellent fruit quality and flavour, firm flesh and good texture	M/s MAHYCO, N Delhi
<i>Malus domestica</i> EC612824-25 USA	Resistant to fire blight	NBPGR, RS Shimla, HP
<i>Malus sieversii</i> EC612822-23 USA	Resistant to apple scab	NBPGR, RS Shimla, HP
<i>Persea americana</i> EC632072, USA	Variety Pollock with low oil, early type, very large fruits weighing 750gms	CHES, Chettalli
<i>Persea americana</i> EC632073 USA	Variety Pinkerton with long pear shaped fruits, excellent peeling characteristics	CHES, Chettalli
<i>Deschampsia antarctica</i> EC631954, Chile	Antartic hair grass New crop, native to Antarctica	M/S Avesthagen Limited, Bangalore, Karnataka
<i>Chicorium intybus</i> EC612129 Vietnam	Variety Scarole giant voluminous heads with white compact heart. Slow bolting and good tolerance to tip burn & bolting	IARI, New Delhi; IIVR, Varanasi, UP
<i>Chicorium intybus</i> EC612130 Vietnam	Variety Frisee green suitable for spring production, performs well both in open fields and protected cropping and tolerant to bolting	IARI, New Delhi; IIVR, Varanasi, UP
<i>Chicorium intybus</i> EC612131 Vietnam	Variety Grosse bouclee large broad leaves, escarole endive tight and very well filled with curled heart. Suitable for spring and summer production in temperate areas, used for both fresh markets and salad packs. Good resistance to bolting	IARI, New Delhi; IIVR, Varanasi, UP

**Table 3: Details of transgenic seed material introduced**

Crop/EC No./Country	Specific Traits	Distribution
<i>Oryza sativa</i> EC 611943-612003 Belgium	Transgenic rice containing <i>Cry Ab</i> , <i>Cry 1c</i> and <i>BAR</i> genes	M/s Bayer Biosciences Pvt. Ltd., New Delhi
<i>Oryza sativa</i> EC 626367-398 Belgium	Containing <i>Cry 1 Ab</i> , <i>Cry 1Ac</i> and <i>BAR</i> genes	M/s Bayer Biosciences Pvt. Ltd., New Delhi
<i>Oryza sativa</i> EC630492-494 China	Expressing <i>Cry 2A</i> , <i>Cry 1c</i> & <i>Cry 1Ac</i> genes for imparting resistance against rice stem borer & rice leaf folder	Pioneer Overseas Corp., Hyderabad
<i>Oryza sativa</i> EC630495-96 IRRI, Philippines	Containing <i>ferritin</i> gene, insect and pest tolerance	RRS, Chinsurah West Bengal
<i>Zea mays</i> EC 613093-97 USA	Inbred lines with Bt corn (MON 89034) namely LT2001-LT2005	M/s Monsanto India Ltd, New Delhi
<i>Zea mays</i> EC618165 Philippines	Modified <i>MEPSPS</i> gene from corn imparting tolerance to Glyphosate (GAZI)	M/s Syngenta India Ltd., Pune
<i>Zea mays</i> EC626511-515 USA	Transformed with 6 plasmid vectors containing <i>GUS</i> reporter gene & different promoters from corn	Dupont India Pvt. Ltd. Hyderabad
<i>Zea mays</i> EC628300 USA	Transgenic stalk corn hybrids Hishell (MON 89034X NK603)	M/s Monsanto India Ltd. New Delhi
<i>Zea mays</i> EC633153-157 USA	Containing <i>Cry 1 F</i> and <i>PAT</i> gene conferring resistance to lepidopteran pest & tolerant to herbicide Glufosinate ammonium	Dow Agro Sciences, Mumbai

<i>Zea mays</i> EC633163-66 USA	Containing <i>Cry 1 F</i> & <i>Cry 1 Ab</i> gene	UAS, Bangalore
<i>Gossypium hirsutum</i> EC617735-84 USA	Containing Roundup Ready (RR) Flex Glyphosate resistant trait (RPF CPUEPS) event 88913	India Pvt.Ltd. C/o Monsanto India Ltd, Hyderabad
<i>Gossypium hirsutum</i> EC617785-834 USA	Bollgard II, insect resistant ( <i>Cry 1 Ac</i> & <i>Cry 2 Ab</i> gene)	M/s Emergent Genetics India Pvt.Ltd. C/o IMonsanto India Ltd, Hyderabad
<i>Gossypium hirsutum</i> EC618167 USA	Containing 2 MEPSPS gene	M/s Bayer Biosciences Pvt Ltd., Hyderabad
<i>Gossypium hirsutum</i> EC618168- 70 USA	Lines H1318, H1010 and H1352 containing combination bar gene , <i>Cry 1Ab</i> & <i>Cry 2 Ac</i> gene	M/s Bayer Bio Sciences Pvt. Ltd, New Delhi

## 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 plan/ 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 after approval from ICAR/ DARE as per the guidelines.

### Details of export of seed/ planting material during 2008

Number of countries to which material exported: 6

Number of accessions exported: 811

**Cereals:** *Oryza sativa* (101) to Philippines, (3) to Norway; *Triticum aestivum* (36) to Australia, (571) to Kenya, (3) to Norway;

**Oilseeds:** *Brassica napus* (91) to Australia; *Carthamus tinctorius* (5) to Italy

**Grain legumes:** *Cicer arietinum* (2) to Syria

**Country-wise export of PGRs:** Australia (127) *Brassica napus*, *Triticum aestivum*; Italy (5) *Carthamus tinctorius*; Kenya (571) *Triticum aestivum*; Philippines (101) *Oryza sativa*; Syria (2) *Cicer arietinum*; Norway (5) *Triticum aestivum* *Oryza sativa*.

## 5.3 Inland supply of Plant Genetic Resources

The seed and planting material of diverse agri-horticultural crops were supplied to ICAR institutes/ coordinated projects, agricultural universities and other users in India. Based on specific requests received 9,681 samples were supplied by the Bureau as per details given below under the Material Transfer Agreement (MTA).

Crop/crop group	Number of samples	Recipients	Sources of supply
<b>Cereals (5,296)</b>			
Wheat	2,841 34*	BHU;TERI Different locations	GED, NBPGR GCD, NBPGR
Rice	967	CRRI, NBRI, Jamia Hamdard, NIANP ;ICAR Res. Complex, Ela	GED, NBPGR NBPGR RS Thrissur, NBPGR RS Shillong DRR Hyderabad
Maize	58	BAU, Ranchi; NARP, Aurangabad	GED, NBPGR
Barley	109	GBPUAT; UDWDP Bageshwar	GED, NBPGR NBPGR RS Bhowali
<b>Millet (82)</b>			
Italian millet	37	NPGR-JNU	NBPGR RS Hyderabad
Amaranth	45	ANGRAU, Utkal Univ Bhubneswar	NBPGR RS Shimla
<b>Grain Legumes (770)</b>			
Chick Pea	15	Jamia Hamdard	GED, NBPGR

Cowpea	225	IGFRI, HAU ; KAU, RARS Pattambi	GED, NBPGR
Mungbean	121	NIPGR-JNU	GED, NBPGR
<i>Vigna</i> sp	19	BARC,	NBPGR, RS, Thrissur
Lathyrus	50	Barkatullah Univ	
Pigeon Pea	135	IIPR	GCD, NBPGR
French bean	52	NARP Pune, SBS PG Institute Dehradun	NBPGR, RS, Shimla NBPGR, RS, Bhowali
Urd bean	01	HAU, Hisar	GED, NBPGR
Moth bean	150	SD Agric Univ. Gujarat	NBPGR, RS, Jodhpur
Dolichos bean	2	HAFRP, Ranchi	GCD, NBPGR
<b>Oilseeds(466)</b>			
Sesame	235	Bose Institute, University of Allahabad, UAS, MAU Parbhani, ANGRAU, MPKV, Pondicherry Univ., COA Latur	NBPGR RS Akola NBPGR RS Thrissur GED, NBPGR
Niger	103	Pondicherry Univ., COA Latur,	NBPGR RS Akola GED, NBPGR
Toria	8	SKUAST(K), Mustard Res. & Promotion Consortium - Janakpuri	GED, NBPGR
Yellow sarson	60	SKUAST(K)	GED, NBPGR
Brown sarson	12	SKUAST(K), MPKV	GED, NBPGR
Chinese mustard	1	SKUAST(K)	GED, NBPGR
Rapeseed	16	SKUAST(K), NRC RM	GED, NBPGR
Taramira	1	SKUAST(K)	GED, NBPGR
Castor	30	Jaypee Univ. of Information & Tech	NBPGR RS Akola
<b>Vegetables (2558)</b>			
Brinjal	1,081	TNAU, AP Hort Univ., MLK PG College, Balrampur; RARS,Tirupati; IARI	NBPGR RS Hyderabad GED, NBPGR
Okra	452	TNAU, AP Hort Univ., BCKV, PDKV, UAS, GKVK-UAS, CCR PG College Muzzafarnagar ; JNAU Jabalpur, Kisan PG College, Simbhaoli,	GED, NBPGR GExpl., NBPGR NBPGR RS Akola NBPGR RS Thrissur IIHR, Bangalore
Tomato	755	AP Hort Univ.;	GED, NBPGR NBPGR RS Hyderabad IIHR, Bangalore
Chilli	67	TNAU, BSKV-Dapoli; UAS Dharwad; RARS Tirupati	NBPGR RS Hyderabad NBPGR RS Bhowali IIHR, Bangalore
<i>Allium</i> sp.	10	BHU; For Herbal garden, Polytec. College, Nainital	TCCU, NBPGR
<i>Cucumis</i> sp	25	Karnatka Univ., GBPUAT, Pantnagar	GExpl., NBPGR NBPGR RS Thrissur
<i>Momordica</i> sp.	114	AP Hort Univ., IARI, TNAU, AP Hort Univ.	GED, NBPGR
Bottle gourd	40	Allahabad Agril Institute, ANGRAU, Univ of	GED, NBPGR
Ash gourd	2	MPKV	GED, NBPGR
Ridge gourd	10	KAU, Thrissur	GED, NBPGR
<i>Solanum nigrum</i>	2	Delhi Univ.	GED, NBPGR
<b>Fibres (27)</b>			
Cotton	26	NBRI	GCD, NBPGR
Kenaf	1	Delhi Univ.	GCD, NBPGR
<b>Fruits (37)</b>			
Persimmon	1	Herbal garden, Polytec. College, Nainital	NBPGR, RS, Bhowali
Apple	8	CITH Reg. Stn.;Uttarakhand	NBPGR, RS, Bhowali
Pear	14	CITH Reg. Stn.; Uttarakhand	NBPGR, RS, Bhowali
Walnut	4	CITH Reg. Stn.; Uttarakhand	NBPGR, RS, Bhowali
<i>Annona glabra</i>	1	K.K. Waghi College of Agriculture Nasik	IIHR, Bangalore
Kiwi	10	CITH Reg. Stn.;UA;GBPUAT Hort Res.&	NBPGR, RS, Bhowali

		Exp. Centre, Nainital, Herbal garden, Polytec. College, Nainital	
<b>Ornamentals (2)</b>			
Gladiolus	2	IARI, N. Delhi	TCCU, NBPGR, New Delhi
<b>Forages (65)</b>			
Oats	60	HPKV, GBPUAT, HAU, JNKV, PAU, BAU-Ranchi, Delhi Univ.	GED, NBPGR
Lucerne	1	Delhi Univ. .	GCD, NBPGR
Clover	1		GCD, NBPGR
Buffel grass	2		GCD, NBPGR
Guria grass	1		GCD, NBPGR
<b>Medicinal and Aromatic Plants (190)</b>			
Lemon grass	1	Delhi Univ.	
Mucuna	19	MV Inst. Of Tech, Sahyore; BAU Ranchi	GED, NBPGR
Bhoomi amla	1	Delhi Univ.	GED, NBPGR
<i>Mimosa pudica</i>	1	Delhi Univ.	GED, NBPGR
Aloe	63	GJU, Dayalbagh Edn. Inst. ; BAU, Ranchi	GED, NBPGR
Asparagus	30	GJU, Hisar; BAU, Ranchi; For Herbal garden, Polytec. College, Nainital	GED, NBPGR NBPGR RS Bhowali
Psoralea	3	BAU, Ranchi; BHU, Varanasi	GED, NBPGR
Ashwagandha	6	MPKV, Rahuri; Jamia Hamdard, Delhi	GED, NBPGR
Tulsi	27	BAU, Ranchi; CCS Univ., Meerut	GED, NBPGR
Periwinkle	2	BAU, Ranchi	GED, NBPGR
Palmrosa	1		GED, NBPGR
Vetiver	3		GED, NBPGR
Danti	1		GED, NBPGR
Tinospora	4	BAU, Ranchi; MPKV, Rahuri	GED, NBPGR
Kalmegh	5	MPKV, Rahuri; BAU Ranchi	GED, NBPGR
<i>Dichanthium annulatum</i>	1	Delhi Univ.	GED, NBPGR
<i>Heteropogon contortus</i>	1	Delhi Univ.	GED, NBPGR
<i>Morinda citrifolia</i>	5	NRC M&AP	GED, NBPGR
<i>Artemisia sp.</i>	4	Sri PMVV, Tirupati; for Herbal garden, Polytec. College, Nainital	NBPGR RS Bhowali
<i>Hyoscyamus niger</i>	1	BAU Ranchi	GED, NBPGR
<i>Berberis aristata</i>	1	Herbal garden, Polytec. College, Nainital	NBPGR RS Bhowali
Wild thyme	1	Sainik School, Ghorakhal, Nainital	NBPGR RS Bhowali
Sweet marjoram	1		NBPGR RS Bhowali
Rose geranium	1		NBPGR RS Bhowali
Garden sage	1		NBPGR RS Bhowali
Sweet flag	1		NBPGR RS Bhowali
Rosemary	1		NBPGR RS Bhowali
Stevia	1		NBPGR RS Bhowali
Jambu ( <i>Allium griffthianum</i> )	1		NBPGR RS Bhowali
Valerian ( <i>Valeriana jatamansi</i> )	1		NBPGR RS Bhowali
<b>Under-utilized Crops (188)</b>			
Kokum	1	Univ of Rajasthan	NBPGR RS Thrissur
Amaranth	30	Hooghly Mohsin College, Chinsurah	NBPGR RS Shimla
Malabar Tamarind	1	Univ of Rajasthan	NBPGR RS Thrissur
<i>Canavalia sp.</i>	14	DU-CEMDE	GED, NBPGR
Clusterbean	26	GKV-KUAS, Bangalore	GED, NBPGR
Ricebean	10	KU, SGB Amravati Univ.	GED, NBPGR
Kulthi	23	Jalna Education Society	NBPGR RS Akola
Sesbania	2	MPKV, Rahuri	GED, NBPGR
Jatropha	81	University of Calcutta; Navsari Ag. Univ, Gujarat; SVBP Univ. of Ag &Tech, Meerut	NBPGR RS Hyderabad NBPGR RS Jodhpur GExp., NBPGR



For the supply of germplasm, the requests of indentors were forwarded to national active germplasm (NAGS) which are mostly the crop based institutes of ICAR. However, the response from NAGS for supply of germplasm was very poor, and most of the germplasm was supplied by the NBPGR.

### Training organized

A short term course on “Germplasm Exchange- Policies

and Procedures in India” sponsored by ICAR was organized from November 17-26, 2008, by Germplasm Exchange Unit, at NBPGR, New Delhi. The course was designed to educate participants about various rules, regulations, policies and procedures of germplasm import and export for research purposes. A total of 19 participants from ICAR institutes, SAUs and State Agriculture Departments attended the course.



Faculty members and participants of short term training course

#### Research Programme (Code, Title and Programme Leader)

PGR/GEX-BUR-DEL-01.00: Exchange of plant genetic resources with foreign countries, inland supply of the resources and related information to the scientist/users in the country (**Arjun Lal**)

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

PGR/GEX-BUR-DEL-01.01: Import, export and inland supply of PGR in field crops and exchange of related information to the Scientists & users in the country. (**Vandana Tyagi**, Deep Chand, Pratibha Brahmi, Vandana Joshi, Nidhi Verma)

PGR/GEX-BUR-DEL-01.02: Import, export and inland supply of PGR in horticultural crops and exchange of related information to the Scientists and users in the country. **Nidhi Verma**; Deep Chand, Vandana Joshi, Vandana Tyagi, SK Yadav)

PGR/GEX-BUR-DEL-01.03: 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**; Deep Chand, Vandana Joshi, Vandana Tyagi, Nidhi Verma, SK Yadav)

PGR/GEX-BUR-DEL-01.04: Survey and assembly of literature on Plant Genetic Resources and its documentation for procurement of elite/trait specific germplasm. (**SK Yadav**; Deep Chand, Pratibha Brahmi, Vandana Joshi, Vandana Tyagi, Nidhi Verma)

## 6. TISSUE CULTURE AND CRYOPRESERVATION UNIT

**Summary:** A total of 2,011 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. Research work continued on aspects related to *in vitro* slow growth and cryopreservation in aforementioned group of crops. Employing several slow growth strategies, subculture duration could be extended to varying periods in *Dahlia* and *Pyrus* sp. Cost-effective conservation experiments yielded encouraging results in *Gladiolus* cv. and *Kaempferia rotundata*. Experiments to test the potential of synseeds in *Zingiber officinale* yielded encouraging results. Cryopreservation experiments led to varying degree of pre-and post-freezing success in *Cicer microphyllum*, *Gentiana kurroo*, *Musa* sp. and *Zingiber officinale*. Genetic stability studies employing various morphological or molecular marker (RAPD, SSR) in *Colocasia esculenta* revealed that there were no significant differences between *in vitro*-conserved accessions and their respective mother plants. A total of 345 accessions comprising orthodox, intermediate and recalcitrant seed species, dormant buds and pollen were cryopreserved during the year totaling 8,804 accessions in the cryogenebank. Successful cryopreservation was achieved in seeds, embryos and embryonic axes of *Salvadora* sp., *Prunus armeniaca*, *P. dulcis* and *Juglans regia*.

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, 54 accessions were added in the *in vitro* genebank and these include *Allium sativum* (3), *Chlorophytum* sp. (1), *Colocasia esculenta* (5), *Curcuma* sp. (1), *Dahlia* (2), *Dioscorea* spp. (10), *Picrorhiza kurroa* (1), *Plumbago rosea* (1), *Musa* spp. (2), *Pyrus* sp. (15), and *Rubus* spp. (13). A total of 2,011 accessions belonging to different crop groups were maintained *in vitro* and subcultured at periodic interval (Table 1).

**6.1.1 Tropical fruits:** Germplasm conservation of *Musa* spp. (411 accessions) and *Vitis vinifera* (3 accessions) was continued using *in vitro* methods standardized in the previous years. During the year, 2 new accessions of *Musa* were added to the *in vitro* collection. To reduce the total time required for cryopreserving a banana accession, experiments were conducted to test the efficacy of sucker-derived meristems for direct cryopreservation, without *in vitro* multiplication. For this dual purpose banana cv. Karpura Chakkarakeli (AAB; Mysore subgroup; IC250497) was selected. Shoot recovery between the cryopreserved meristems from *in vitro*-shoots (IVM) and suckers (SM) were compared. No significant difference was recorded in mean shoot regeneration in PVS2-treated

IVM ( $83.3 \pm 7.5\%$ ) and SM ( $60 \pm 11.5\%$ ). Similarly, in LN-treated explants, regenerated shoots from IVM ( $54.4 \pm 5.8\%$ ) were not significantly different from SM ( $60.0 \pm 11.55\%$ ). Importantly, the total duration for cryopreserving plants from SM was about 2 months; whereas it took 6-8 months for IVM. The study indicates that meristems from suckers can be directly used for cryopreservation in banana, without undergoing the elaborate *in vitro* multiplication phase and facilities.

To validate the genetic stability of the cryopreservation protocol of banana (proliferating meristems cryopreserved using vitrification technique) devised in the previous years, morphological data on the plants that were hardened and transferred to the field in the previous year was recorded. Twelve growth and yield parameters such as pseudostem height, pseudostem girth, petiole length, leaf area, time taken for bunch maturation, bunch weight (in kg), no. of hands/bunch, no. of fruits/hand, total no. of fruits etc. were evaluated and subjected to statistical analysis. No significant difference was observed in the growth and morphology between control and LN-treated plants.

**6.1.2 Bulb crops:** *In vitro* maintenance of 182 accessions belonging to 4 genera comprising 18 species (*Allium* spp., *Cicer microphyllum*, *Dahlia* and *Gladiolus* cv.) was carried out under culture room conditions and/or at low temperature through periodic subculture (4-24 months) or through reesterilization.

A total of 5 accessions belonging to 2 genera were added in the *in vitro* genebank and these include *A. sativum* (3) and *dahlia* (2).

In dahlia, cultures could be conserved upto 12 months under culture room conditions on B5 supplemented with BAP and AgNO<sub>3</sub>.

Regarding cost-effective conservation, in *Gladiolus* cv., two gelling agents i.e. agar and isabgol were used along with two carbohydrate sources i.e. sucrose and market grade sugar. Following replacement of LR grade sucrose with market grade sugar and/or that of agar with isabgol, cultures exhibited (100%) survival, after 12 months of conservation, under culture room conditions.

Employing vitrification technique, cryopreservation experiments initiated in *Cicer microphyllum* cultures, revealed that non-frozen controls could tolerate PVS2 as a cryoprotectant upto 40 mins but failed to survive LN freezing.

**6.1.3 Medicinal, aromatic and rare/ endangered plants:** *In vitro* maintenance of existing cultures of 192 accessions (~5,200 cultures) belonging to 24 genera and 33 species was achieved through periodic subculture and resterilization (4-24 months) either under culture room conditions and/or at low temperature.

Three accessions of 2 genera, *Kaempferia galanga* (2) and *Plumbago indica* (1) from KAU were planted in pots for *in vitro* introduction. A total of 3 accessions belonging to 3 genera were added in the repository and these include *Chlorophytum* (1), *Picrorhiza kurroa* (1) and *Plumbago rosea* (1).

Regarding short- to medium-term conservation, cultures were successfully conserved in *K. rotundata* using sugar cubes in place of LR-grade sucrose and isabgol as a gelling agent, for 15 months. In *Gentiana kurroo*, cryopreservation experiments were continued using encapsulation-dehydration technique. With modified encapsulation matrix, 10% shoot tips regenerated after LN freezing, using ED technique. In *Bacopa monnieri*, multiplication and transfer of plants from shoot tips regenerated after LN freezing, using both ED and vitrification technique, was done for genetic stability studies.

**6.1.4 Spices, plantation and industrial crops:** A total of 372 accessions (~5,000 cultures) comprising *Zingiber* species (184), *Curcuma* species (152), *Piper*

(7), *Elettaria cardamomum* (5), *Vanilla planifolia* (4), *Simmondsia chinensis* (6 each of male and female) and *Humulus lupulus* (8) were maintained under short- to medium-term storage. During the year, one accession of *Curcuma* sp. was added in the *in vitro* genebank.

To test the potential of synseeds or artificial seeds in ginger (*Zingiber officinale*) for *in vitro* conservation and germplasm exchange, axenic shoot buds encapsulated in 4% Sodium alginate were dehydrated using air, sucrose, and silica to decrease the moisture content for storage. The fresh, air- and sucrose-dehydrated synseeds were stored in cryovials for one month in dark at 25°C to study their suitability for germplasm exchange. In the sucrose-dehydrated (0.25M for 16h) synseeds stored at 25°C, the shoot recovery was recorded in 73% synseeds, whereas it was recorded as 53% in fresh synseeds after 1 month of storage in dark. These results coupled with better morphogenic response of sucrose-dehydrated synseeds in terms of number of shoots/ synseed, number of roots/ shoot and root length is highly encouraging for exchange of ginger germplasm. For *in vitro* conservation, synseeds were stored in cryovials at 25°C, 15°C and 4°C for 3 months. Sucrose-dehydrated synseeds stored at 25°C and 15°C remained viable upto 3 months with 13% shoot recovery. Plantlets regenerated from *in vitro*-conserved synseeds (fresh and 0.25M sucrose-dehydrated) hardened with 90% survival in *ex vitro* conditions.

Cryopreservation experiments in ginger (*Z. officinale*) were continued using the encapsulation-vitrification method. The benefit of preculture of shoot tips using liquid MS medium containing 0.09 M sucrose and 0.4 M sucrose for 24 h, before pre-incubating shoot tips using encapsulation-vitrification (4% Sodium alginate + 2M glycerol + 0.4 M sucrose, pretreated in CaCl<sub>2</sub> with 1.2 M sucrose) at various PVS2 durations was examined. It was found that a 1-day preculture in 0.4 M sucrose solution produced a significantly higher level of shoot formation than 0.09 M sucrose in non-frozen explants. However, when these explants were given LN treatment, 0-40% survival was obtained and whole plants could not be recovered. Vitrification (upto 54.6%) and encapsulation-vitrification (upto 40%) methods are useful for survival of explants after cryopreservation. However, whole plant recovery after cryopreservation could not be accomplished, mainly due to presence of endogenous bacteria in the explants.

**Table 1: Status of *in vitro* conserved germplasm (as on December 31, 2008)**

Crop group	Genera (no.)	Species (no.)	Cultures (no.)	Accessions (no.)
<b>Tropical Fruits</b> (banana, grape)	2	18	3,275	<b>414</b>
<b>Temperate and Minor Fruits</b> (mulberry, strawberry, apple, pear, blackberry)	9	41	4,310	<b>290</b>
<b>Tuber crops</b> (sweet potato, yam, taro)	5	12	9,756	<b>561</b>
<b>Bulbous and other crops</b> (garlic, gladiolus)	4	18	2,634	<b>182</b>
<b>Medicinal and aromatic plants</b> (species of <i>Bacopa</i> , <i>Mentha</i> , <i>Rauvolfia</i> , <i>Tylophora</i> )	25	34	5,130	<b>192</b>
<b>Spices and industrial crops</b> (ginger, turmeric, pepper, cardamom, hops, jojoba)	7	34	5,000	<b>372</b>
<b>TOTAL</b>	<b>52</b>	<b>157</b>	<b>30,105</b>	<b>2,011</b>

**6.1.5 Temperate and minor fruit crops:** A total of 290 accessions (~5,500 cultures) belonging to 9 genera and 41 species were conserved as *in vitro* cultures under culture room conditions and/ or at low temperature. The average subculture period varied from 6-12 months. During the year, a total 28 accessions belonging to *Pyrus* spp. (15) and *Rubus* spp. (13) were added in the *in vitro* collection.

Direct *in vitro* shoot regeneration was obtained from leaf explants of blackberry cv. Black Satin cultured on MS medium supplemented with TDZ.

Regarding effect of culture tube closures on shelf life of *in vitro* cultures of *Pyrus communis* (pear), polypropylene caps were better than cotton plugs in prolonging subculture duration from one to four months. However, inclusion of mannitol (1-6%) in the medium was not effective in increasing the shelf-life of cultures. In *P. cossonii*, cryopreservation of *in vitro* shoot tips was attempted employing encapsulation-dehydration technique. There was no regrowth of shoot tips after LN freezing. Experiments are continued to optimize the protocol for successful cryopreservation.

**6.1.6 Tuber crops:** A total of 561 accessions (~9,700 cultures) of tuber crops comprising 3 of *Alocasia indica*, 181 of *Colocasia esculenta*, 113 of *Dioscorea* spp., 255 of *Ipomoea batatas*, and 9 of *Xanthosoma sagittifolia* were maintained through periodic subculture and reesterilization (4-12 months) under culture room conditions. During the year, a total of 10 accessions of yams and five of *C. esculenta* were added in the *in vitro* genebank and 181 accessions (~2,700 cultures) were maintained. *In vitro* corms were induced in 75 accessions of *C. esculenta* on MS medium

supplemented with high sucrose (6%).

## 6.2 Genetic Stability of *In Vitro* Conserved Germplasm

Genetic stability assessment was done in 15 accessions of taro (*Colocasia esculenta*), using morphological, isozyme, RAPD and simple sequence repeats (SSR) markers. There were no significant differences among *in vitro* conserved plants based on 16 morphological, three isozymes, 10 RAPD primers and 12 SSR markers.

## 6.3 *In Vitro* Germplasm Supply

Germplasm of gladiolus cultures (2 accessions) were multiplied and supplied to IARI, New Delhi and those of *A. sativum* (1 accession) and *A. tuberosum* (1 accession) were supplied to CAS in Botany, BHU, Varanasi for research purpose.

## 6.4 IVG Database

For effective management and dissemination of information related to all the accessions and activities carried out in the *In Vitro* Genebank (IVG) at NBPGR, New Delhi, a software for Information System for *In Vitro* Genebank was developed, in collaboration with the ARIS Cell. This activity was carried out under the NAIP-funded network project on 'AGROWEB – Digital Dissemination System for Indian Agricultural Research (ADDSIAR)', where NBPGR is the Consortium Leader. The software has been designed to facilitate the genebank curators and users, besides being a source for information on the status of germplasm being maintained at the IVG. The system has been designed to store and retrieve information on



the national identity (IC/EC no.), passport information, culture history and status of all the accessions conserved in the IVG. The system is internet-based and can be accessed through the URL <http://www.nbpgr.ernet.in/invitro>.

## 6.5 Seed, Pollen and Dormant Buds Cryopreservation

A total of 8,804 accessions comprising orthodox, intermediate and recalcitrant seed species have been conserved in the cryogenebank so far (Table 2). A total of 527 accessions of diverse germplasm were received from NBPGR regional stations at Thrissur and Srinagar. This included germplasm collected through explorations and belonged to fruits and nuts, spices, industrial crops, medicinal plants and dormant buds of temperate and sub-temperate species. During the year, two exploration trips were undertaken to collect germplasm of non-orthodox seeds species in different zones namely parts of Rajasthan for tropical minor fruits and *Salvadora*, and Mizoram for *Citrus* species and wild relatives of crop plants. In all 125 accessions were collected.

A total of 345 accessions were cryostored as seeds and embryonic axes during this period at temperatures between  $-160$  to  $-180^{\circ}\text{C}$ . Cryostored accessions comprised of temperate fruits and nuts (124), spices (9), medicinal plants (66), industrial crops (142) which also included released varieties, wild species and wild relatives of crop plants.

Basic studies on seed viability, moisture content, desiccation and freezing sensitivity were conducted on *Salvadora oleoides*, *S. persica*, *Grewia asiatica*, *Capparis decidua* and several *Citrus* species viz., *Citrus sinensis* (Vaniglea, Sanguinella, Mediterranean sweet orange) *C. reticulata* cv. Fremont, Nagpur Mandarin, King, Willow leaf, Wilkins, *C. aurantium*, *Citrumelo* (*Poncirus trifoliata*  $\times$  *C. paradisi*). *Euryale ferox* (Makhana) seeds were highly sensitive to desiccation and freezing indicating recalcitrant seed storage behavior. Seed germination methods were standardized in *Calophyllum inophyllum* and *Alangium salvifolium*. In *C. inophyllum* apomictic nature of seed was indicated as seed pieces were highly totipotent and gave rise to root/ shoot akin to *Garcinia* species. Morphology, physiology and *in vitro* regeneration was studied in dormant buds of *Prunus* and *Juglans* spp.

Successful cryopreservation was achieved in seeds, embryos and embryonic axes of *Salvadora* sp., *Prunus armeniaca*, *P. dulcis* and *Juglans regia*. Vitrification and encapsulation techniques were attempted with embryonic axes of *C. macroptera*.

**Table 2: Status of cryopreserved germplasm in TCCU (as on December 31, 2008)**

Categories	Accessions (no.)
<b>Recalcitrant &amp; Intermediate</b>	
Fruits & Nuts	2,384
Spices & Condiments	137
Plantation Crops	19
Agro-forestry & Forestry	1,639
Industrial crops	973
<b>Orthodox</b>	
Cereals	240
Millets and Forages	287
Pseudo-cereals	76
Grain Legumes	632
Oilseeds	470
Fibers	64
Vegetables	437
Medicinal & Aromatic Plants	849
Narcotics & Dyes	34
Miscellaneous	15
<b>Sub-total</b>	<b>8,256</b>
<i>Dormant buds</i>	<b>238</b>
<i>Pollen grains</i>	<b>310</b>
<b>Total</b>	<b>8,804</b>
<b>Wild Relatives*</b>	942
<b>Rare &amp; Endangered plants*</b>	78
<b>Varieties*</b>	653
<b>Elite*</b>	4
<b>Registered germplasm*</b>	22
<b>Number of species</b>	722

\* Included in respective categories stored as orthodox seeds

Morphological characterization was done for fruit and seed characters of 63 citrus accessions including *C. megaloxycarpa*, 22 accessions of *Salvadora oleoides*, 18 accessions of *Cordia myxa*, 123 accessions of almond and 51 accessions of walnut. Wide variation in TSS, fruit weight, shape and size and seed weight, size and color was observed.

Periodic testing for viability of accessions of orthodox

and non-orthodox seeds (45) and mulberry dormant buds (5) using *in vitro* methods was undertaken. Retesting revealed retention of original viability in most of the accessions. Mulberry plantlets raised after cryostorage were sent to CSGRC, Hosur for assessing genetic stability using ISSR markers. There were no differences between the cryostored plantlets and their unfrozen controls.

### International Training Course organized

An International training course on ‘*In Vitro* and Cryopreservation Techniques for Conservation of Plant Genetic Resources’ was organized by National Bureau of Plant Genetic Resources (NBPGR) and Bioversity International, South Asia Office, New Delhi under the Centre of Excellence programme of ICAR. Under the

COE programme, this was the third international training and this year it was co-organized by Asia Pacific Consortium for Agricultural Biotechnology (APCoAB). There were 16 participants from 12 countries namely Malaysia, Saudi Arabia, South Africa, Philippines, Fiji Islands, the Czech Republic, Sri Lanka, Nigeria, Egypt, Mauritius, Taiwan and within India, from three ICAR Institutes - CTCRI, Trivandrum, CITH, Srinagar and NRC Banana, Tiruchirapalli.

The training course comprised lectures and practicals, conducted by 16 faculty from TCCU of NBPGR, NRC on DNA Fingerprinting, Bioversity International and APCoAB. External faculty was Dr Bart Panis from University of Leuven, Belgium and Dr R.S. Paroda, Executive Secretary, APAARI.

#### 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 (Project 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)

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

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

PGR/TCCU-BUR-01.04 *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 fruit crops. (**Sandhya Gupta**, K Pradeep)

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

**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, Davender Nerwal)

## 7. PGR POLICY PLANNING UNIT

The PGR Policy Planning Unit is functioning at NBPGR since 1996 with the following objectives:

1. 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.
2. To provide analytical inputs as per requirements of the policy makers for negotiations and formulations of policies at various national and international for issues related to PGR management.

### 7.1 PGR Management and related Issues

#### 7.1.1 Implementation of the International Treaty on Plant Genetic Resources for Food and Agriculture

- Implementation issues at national level for the treaty were discussed and suggestions about proposed regulations were sent to ICAR/ Department of Agricultural Cooperation.
- An attempt for shortlisting of germplasm for Designation under MLS of the Treaty was made for approval at ICAR. A list of germplasm of Annex I crops available at NBPGR Genebank has been finalized.

#### 7.1.2 Processing application of extant varieties for registration (Protection) with the PPVFRA Authority

- A total of 650 applications of extant-notified and new varieties were scrutinized, documented and submitted to PPV &FRA.
- A meeting of the nodal officers designated by SAUs was conducted in May, 2008 for facilitation of filing application of state released and SAU owned varieties.
- Review meeting for progress of submission of remaining applications of ICAR-SAUs system with all PD/ PCs and officers from ICAR Head

Quarters and NBPGR was conducted in November, 2008.

#### 7.1.3 Institute Technology Management Committee (ITMC)

One application of copyrights protection for a software developed by NBPGR Scientist was processed for submission to Registrar, Copy Rights, through NRDC New Delhi.

#### 7.1.4 Technical Inputs to ICAR/ DARE/ Ministry of Environment and Forests (MoEF)

- Technical Inputs for CBD Cop- 9 on the issue of importance to agro- biodiversity on lessons from *in-situ* on farm conservation and sustainable use of agro- biodiversity, and overdose of Nitrogen in fields-mitigation and recommendations for optimum use of Nitrogen were sent to ICAR/ MoEF.
- Inputs for IV Country Report of CBD, from India were provided to ICAR/ MoEF.
- Comments and suggestion on National Biodiversity Action Plan developed by MoEF were sent to ICAR.
- Interface meeting between ICAR- NBA and NBPGR, was attended for facilitating the pending cases of export of PGR to other countries. Proceedings of the meeting were approved by NBA, and the Export facilitation committee constituted. 16 cases of export of PGR were discussed during this period, and sent to NBA for approval.

#### 7.1.5 Inputs to National Biodiversity Authority

- As member of Expert Committee for export of material outside India and IPRs applied (applications).
- Drafting guidelines for transfer of research results as member of their Expert Committee. Final draft guidelines have been submitted, after two consultations meeting.

- Comments on guidelines for designation of repositories under the Biological Diversity Act.

## 7.2 Policy Issues related to Plant Biosecurity

### 7.2.1 Inputs to Ministry of Agriculture

- Provided input to the Department of Agriculture and Cooperation on Plant Quarantine (Regulation for Import into India) Order 2003 on
  - Establishment of National Agricultural Biosecurity System under the MoA
  - Participated in the discussions with the officials in MoA, prepared comments and provided inputs for preparation of the document to be submitted to the MoA
  - Participated in discussions on establishment of pest free areas for brown rot and ring rot of potato in Punjab
  - Prepared counter comments on the comments by AQIS on Mango PRA for its export to Australia
  - Prepared comments on
    - Electronic certification trial for Australian exports
    - Import of Atlantic variety potato tubers by M/s Pepsico
    - Import of certain biocontrol agents, algae, bacterial cultures and other microbial cultures
- Revision of International Standards on Phytosanitary Measures (ISPMs)
  1. Regulating wood packaging material in international trade (Revision of ISPM No. 15)
  2. Categorization of commodities according to their phytosanitary risk
  3. Fruit fly trapping (proposed Annex 1 to ISPM No. 26 (*Establishment of pest free areas for fruit flies (Tephritidae)*))
  4. Glossary of phytosanitary terms (Amendments to ISPM No. 5)
  5. Terminology of the Convention on Biological Diversity (CBD) in relation to the Glossary of phytosanitary terms (proposed supplement to

ISPM No. 5)

6. Structure and operation of post-entry quarantine facilities
  7. Pest-free potato micropropagative material and minitubers for international trade
  8. Guidelines for the importation of plant breeding material for scientific research and development purposes.
  9. Regional standard for scale insects
- Quarantine aspects of import/ export to EXIM Committee and in trade negotiations with other countries.
  - Participated as resource person and presented Outcome of Task Force on Strengthening Phytosanitary Capacity in India presented during the meeting and the Discussion points on Building National Phytosanitary Capacity during the Open-ended Working Group on Building National Phytosanitary Capacity FAO, Rome, Italy, 8-12 December, 2008.
  - Developed a Chapter on Agricultural Biosecurity for the publication of *State of Indian Agriculture* to be brought out by NAAS with inputs from experts in plant protection, animal husbandry, livestock and poultry and fisheries in ICAR, DAC and SAUs.

### 7.2.2 Inputs to Ministry of Environment and Forests

Technical inputs provided on

- Agricultural biodiversity and invasive alien species for the Subsidiary Body on Scientific, Technical and Technological Advances and CoP-9 meeting of the CBD at Rome, Italy from 18- 22 February, 2008
- On the follow-up of CoP-9 and agenda items for the fourth meeting of the COP-MOP 4 to the Cartagena Protocol on Biosafety held at Bonn, Germany, from 12 to 16 May 2008
- Inter-ministerial Committee for Capacity Building and in the India-Canada Joint Technical Workshop on Regulatory Cooperation Regarding Agricultural Products of Biotechnology.
- Participation in regular meetings of



- Consultative Group on Biodiversity
- Technical inputs provided as member of
  - Expert Group on Consistent Interpretation of the Precautionary Principle
  - Expert Group on Liability and Redressal issues under Cartagena Protocol
  - Committee for revision of list of pests under EPA Rules 1986 to the National Committee of Weapons of Mass Destruction and their Delivery System Act

### 7.2.3 Inputs to Department of Biotechnology

Regular input provided in meetings of Review Committee of Genetic Manipulation, Monitoring and Evaluation Committee and Project Evaluation Committee

### 7.2.4 Inputs to Ministry of Home Affairs

Provided inputs in regular meetings of Inter-ministerial Working Group of Experts on Bioweapons as nodal person of Ministry of Agriculture and prepared the chapter on “Agroterrorism” for inclusion in the National Disaster Management Guidelines- Management of Biological Disasters

### Events Organized:

#### National Workshop on Agricultural Biosecurity on 25 March 2008

- Organized on behalf of ICAR to address the issue of National biosecurity holistically .
- The programme included lead lectures on status of biosecurity in relation plants including GMOs, animals including livestock and poultry, fish and invasive weeds with two panel discussion sessions on Policies and Procedures related to Biosecurity- A Gap Analysis and Researchable Issues and Capacity Building in Biosecurity.

#### 2nd Indo-US SPS Workshop under Agricultural Knowledge Initiative (AKI) from 22- 23 July 2008

- Organized on behalf of ICAR for assessing the current situation and to deliberate on the future collaborations between the two countries.
- Attended by five experts from USDA and Indian experts cutting across various sectors, ICAR HQ, DPPQS, APEDA, RIS, NBPGR, IARI, other ICAR institutes, legal experts, NGOs and seed industry.
- Recommendations pertaining to both India and USA were:
  - Establishment of Joint US-India forum for exchange of information on policies, technical requirements, issues and gap analyses.
  - Need for more Indo-US collaborative studies.
  - Need for fine-tuning of the existing US-India trade policy forum and more dialogue among the partners.

#### Brainstorming Session on Plant Quarantine including Internal Quarantine Strategies in view of Onslaught of Diseases and Insect Pests held on 4 November 2008

- Jointly organized by NAAS and NBPGR for assessing the current situation and to deliberate on the course of action to meet the future challenges.
- Attended by 23 participants from ICAR Institutes, SAUs and private sector including some senior retired experts.
- Recommendations pertaining to upgradation of international quarantine system, implementation of domestic quarantine system, researchable issues and HRD were made.

#### 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 (RK Khetarpal, Rajan, Kavita Gupta)

## 8. NRC ON DNA FINGERPRINTING

**Summary:** NRC on DNA Fingerprinting has so far developed protocols for cultivar identifications in 33 crops of national importance using the molecular marker techniques like STMS, AFLP and ISSR. The crops include cereals (rice, wheat, barley), millets (finger millet, sorghum, pearl millet), pulses (chickpea, French bean, horsegram, lentil, peas, pigeonpea, mungbean, ricebean, urdbean, soybean), oilseeds (mustard, safflower, sesame, niger), fibres (cotton, jute), vegetables (tomato, chillies, cucurbits) fruits and nuts (banana, mango, cashew, citrus) and medicinal plants (chlorophytum, neem, vetiver). More than 2,500 varieties in different crops were fingerprinted till December 2008. The analysis of diversity in molecular markers of important crops like rice, mungbean, oilseed brassicas and tomato have provided insight into the genetic base of Indian crop varieties. Such information will form the basis for developing efficient strategies for their breeding and genetic resources management.

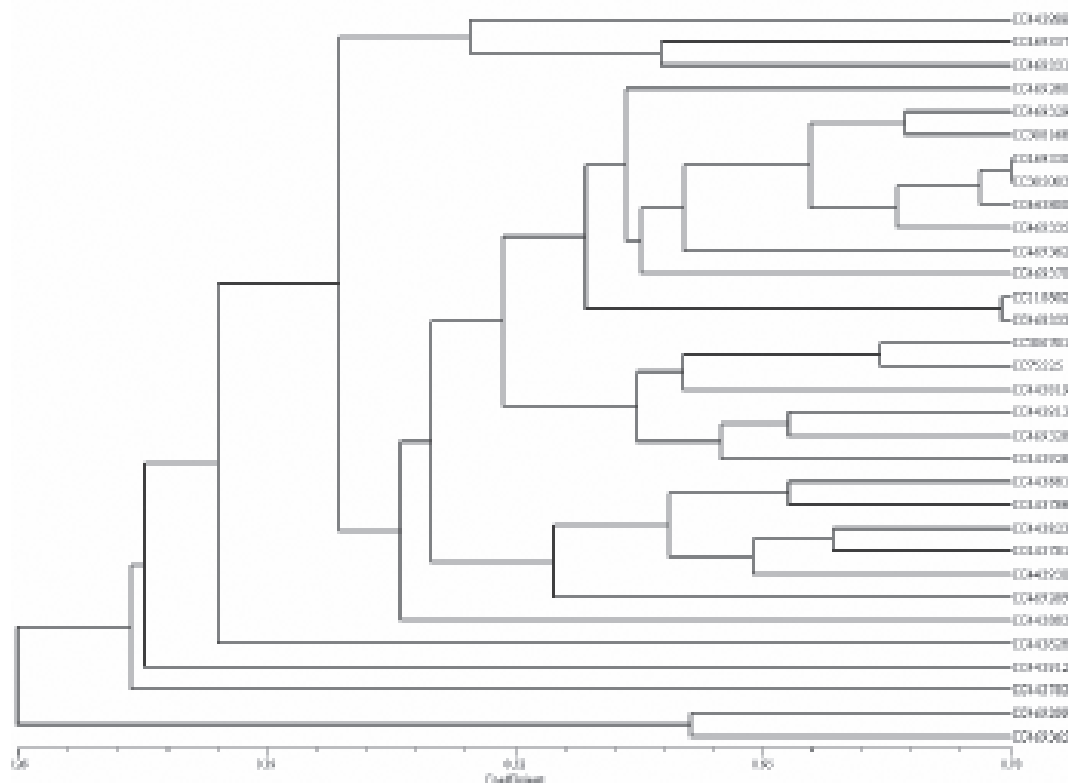
PCR-based detection protocols have been developed for the several genes in transgenic planting materials some using multiplex PCR for simultaneous detection of promoter, terminator and marker gene along with endogenous genes in duplex, triplex, tetraplex formats in genetically modified crops. Developed protocol for simultaneous amplification of six commonly used marker genes, viz., *nptII*, *aadA*, *hpt*, *bar*, *pat* and *uidA* for detection of GM crops.

Genetic diversity analyses and DNA profiling was conducted in mungbean, finger millet, pearl millet, sesame, water melon using STMS, ISSR and RAPD markers. The analyses helped in the estimation of available genetic diversity in the collections and also in generating DNA fingerprints of these indigenous cultivars.

### 8.1 DNA fingerprinting and cultivar identification

**8.1.1 Rice (*Oryza sativa* L.):** Seventeen SSR primers were screened for fingerprinting of thirty-two rice varieties. Fifteen primers which showed good polymorphism were used for fingerprinting all the thirty-

two rice varieties. Fifty-one bands were generated with fifteen SSR primers and polymorphism was 88.2%. Genetic similarity was calculated based on 51 markers using Jaccard's coefficient and it ranged from 0.26-0.78. Cluster analysis (Figure 1) was done using UPGMA method. IC443883, IC443828, IC443912 and IC443783 did not group into any cluster.



**8.1.2 Pearl millet (*Pennisetum glaucum*):** STMS profiling work was initiated in pearl millet. A total of 21 STMS primer pairs were screened and 14 were selected for further analysis. A total of 20 samples including released varieties (10), hybrids and the parental lines of pearl millet (4) were profiled with five STMS primer pairs. Diversity index ranged from 0.185 to 0.535. A representative STMS profile with primer pair 3035 is shown in Figure 2.

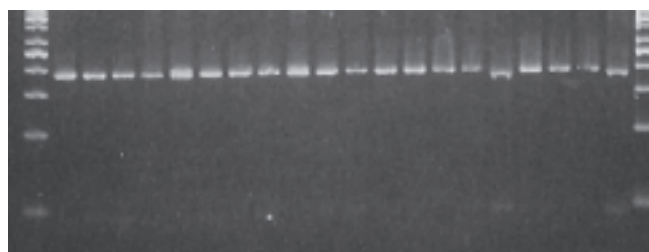


Figure 2. STMS profile of 20 pearl millet accessions with primer pair 3035

**8.1.3 Chickpea (*Cicer arietinum* L.):** Thirty-eight extant varieties of chickpea (*Cicer arietinum* L.) were fingerprinted using SSR makers. Out of 46 SSR primers used for fingerprinting only 38 showed good amplification. Data scoring and analysis has been done for all 38 primers. Jaccard's similarity coefficient varied from 0.64 to 0.89. All varieties are grouping into four major clusters.

**8.1.4 Cucurbits (*Cucumis sativus*):** Ten varieties of cucurbits developed at Central Institute of Arid Horticulture were fingerprinted using RAPD markers.

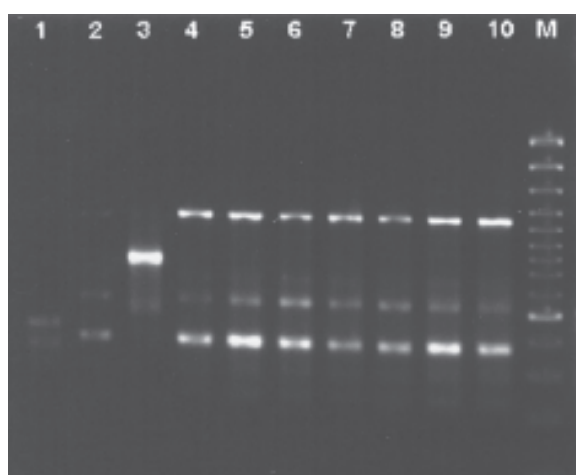


Figure 3. RAPD profile of mateera with the primer OPA19. Lanes 1: AHW19; 2: AHW 65; 3: Thar Manak; 4,5: AHW1; 6,7,8: AHW3; 9,10: Sugar baby; M: 50 bp molecular weight marker

These include three varieties of mateera (AHW 19, AHW 65, Thar Manak), two of kachri (AHK 119, AHK 200), two of salad kakri (AHC 2, AHC 13), two of snap melon (AHS 10, AHS 82) and the variety Thar Samridhi of bottle gourd. These were analysed at a total of 220 loci amplified using 29 RAPD primers to distinguish them from the existing varieties. The varieties Thar Manak and AHW 19 of mateera were found to have unique DNA profiles (Figure 3).

**8.1.5 Citrus:** Fifteen accessions each of Jhamberi, Galgal and Rangpur lime were fingerprinted using twenty-five STMS primer pairs. A total of forty-two loci were amplified. Further analysis is in progress.

## 8.2 Genetic diversity analysis

**8.2.1 Finger millet (*Eleusine coracana*):** Forty finger millet elite germplasm lines of Indian and African origin were profiled with 24 random primers showed 64.5% polymorphism. The Nei's genetic diversity was calculated using programme POPGENE 1.31., which revealed 19% genetic variation in the lines studied. The Nei's genetic diversity was also calculated separately for elite germplasm lines of indigenous origin and African origin. Finger millet elite germplasm lines of African origin showed slightly higher diversity as compared to lines of Indian origin. Dendrogram (Figure 4) generated based on UPGMA method of cluster analysis grouped 40 germplasm lines into two major clusters. One cluster consisted of germplasm lines of African origin only and other cluster consisted of sub-cluster of germplasm lines of Indian origin and also sub-cluster with germplasm lines of Indian as well as African origin.

Thirty varieties of finger millet were also profiled with ten ISSR primers which could be grouped into two sub-clusters. Some of the varieties having common pedigree are grouped closely in one cluster. Most of the varieties having African germplasm in their pedigree were clustered together and most of the varieties which were selections from local germplasm were also grouped together. Sixty four finger millet elite germplasm lines of Indian and African origin were profiled with 18 ISSR primers. All the accessions could be distinguished using a set of 18 ISSR primers. Cluster analysis grouped some of the African and Indian accessions into separate sub-clusters and in rest of the sub-clusters African and Indian accessions were intermixed.

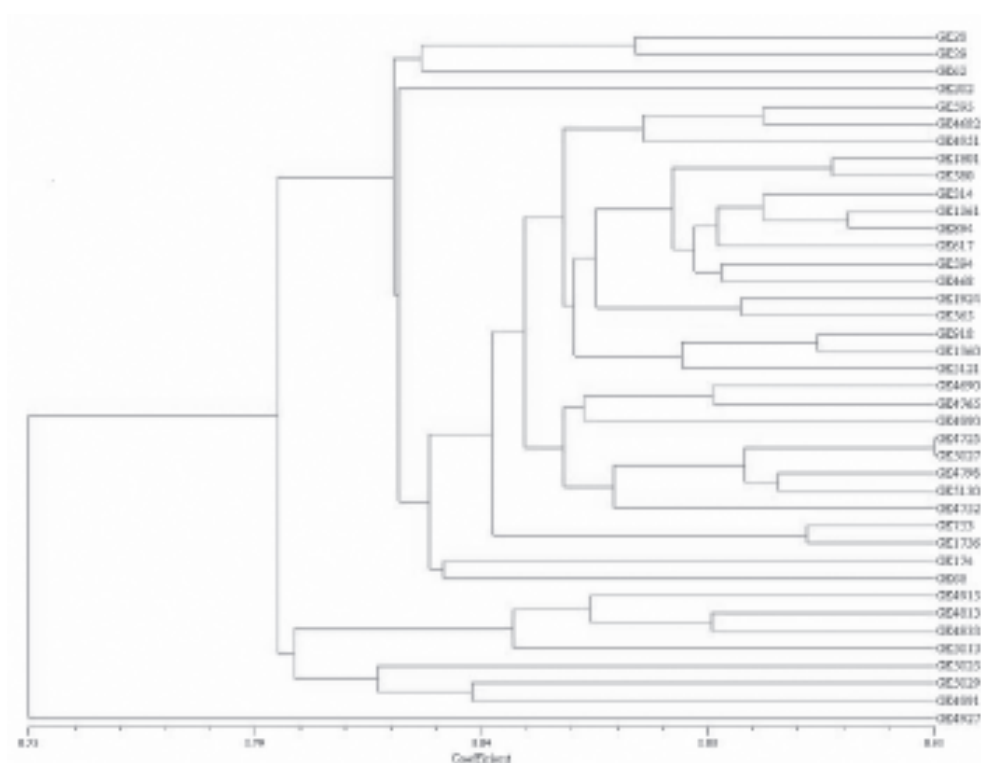


Figure 4. Dendrogram showing genetic diversity in Finger millet elite germplasm lines of Indian and African origin based on RAPD markers

**8.2.2 Cucumber (*Cucumis sativus*):** Available STMS markers for *Cucumis* sp. were used for assessing genetic diversity of thirty six accessions of *C. sativus* and eleven accessions of *C. hardwickii* assembled from different parts of the country. STMS primer pairs (40) were screened and of these 27 polymorphic during

screening were selected for profiling all accessions. The 27 pairs of primers used produced a total of 60 alleles out of which 59 were polymorphic with an average of 2.22 alleles per locus. Maximum number of alleles/primer was four and PIC values of these primers ranged from 0.006 to 0.47. Cluster analysis by UPGMA (Figure 5) showed two main clusters in the dendrogram. Only two accessions are present in one cluster, these are significantly different from the rest of the accessions and can be used for breeding purposes in future. All the rest cucumber accessions fall in one cluster highlighting the narrow gene pool of most cucumber accessions.

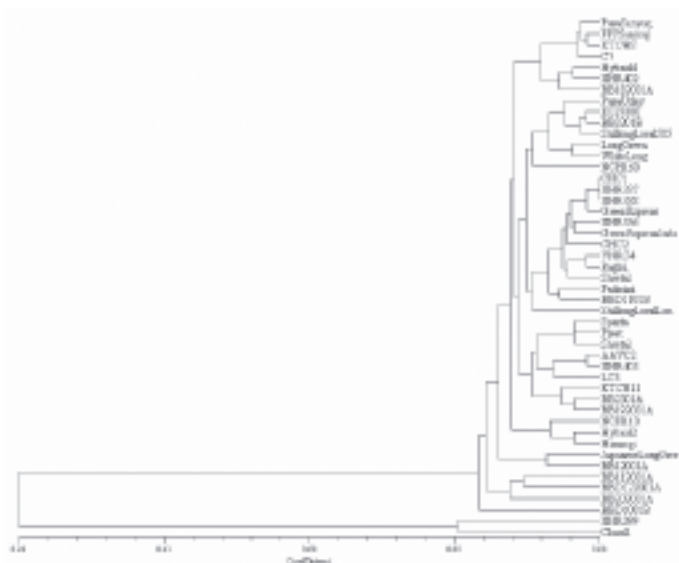


Figure 5. UPGMA dendrogram of the 47 accessions of cucumber showing two main clusters

**8.2.3 Vetiver (*Vetiveria zizanioides* L.):** RAPD primers (104) were screened, of which 64 primers showed good amplification. Out of this, eighteen primers were used for the fingerprinting of thirty-eight accessions. NTSYS software was used to study the diversity present in the accessions and Jaccard's similarity coefficient was used to generate similarity matrix. Dendrogram was constructed for amplicons generated using the RAPD makers using the UPGMA method (Figure 6). Eighteen polymorphic primers could separate all the accessions and accession IC82470 and IC82479 showed maximum similarity upto 0.73.





the UPGMA method (Figure 8). Thirty-four polymorphic primers could separate all the accessions and accession IC281971 and IC281961 showed maximum similarity upto 0.87.

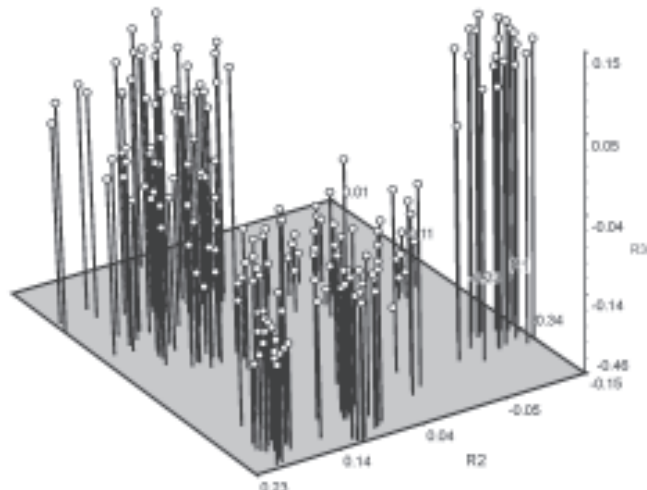
**8.2.6 *Jatropha* (*Jatropha curcus*):** Under the NOVOD Board funded project on “DNA Fingerprinting and molecular characterization of *Jatropha* germplasm

collected from diverse agro-climatic zone of India” the 550 accessions submitted to cryobank in NBPGR were analysed. Based on the available passport data, 182 accessions collected from 19 states were selected for DNA fingerprinting and genetic diversity analysis using molecular markers. The brief details of the representation of accessions from different states are presented below in Table 1.

**Table 1: Source of the 182 *jatropha* accessions fingerprinted using RAPD markers in this study**

S No.	District	State	No of accessions selected	S No.	District	State	No of accessions selected
1	Rangareddy	AP	2	46	Mokokchung	Nagaland	1
2	Guntur	AP	1	47	Ganjam	Orissa	1
3	Mahaboob Nagar	AP	2	48	Kundra	Orissa	1
4	Sonepat	Haryana	2	49	Kendrapada	Orissa	1
5	Panjab	Haryana	2	50	Ludhiana	Punjab	2
6	Karnal	Haryana	2	51	Amritsar	Punjab	1
7	Sahabad	Haryana	1	52	Kapurthala	Punjab	1
8	Kaithal	Haryana	2	53	Hoshiarpur	Punjab	1
9	Hissar	Haryana	2	54	Faridkot	Punjab	1
10	Fatehabad	Haryana	2	55	Moga	Punjab	1
11	Rewari	Haryana	2	56	Rajsamand	Rajasthan	9
12	Bhiwani	Haryana	1	57	Bhilwara	Rajasthan	2
13	Jind	Haryana	1	58	Kota	Rajasthan	1
14	Mahendargar	Haryana	1	59	Tonk	Rajasthan	1
15	Gurgaon	Haryana	1	60	Udaipur	Rajasthan	8
16	Kathua	J&K	2	61	Chittorgarh	Rajasthan	5
17	Jammu	J&K	2	62	Dungarpur	Rajasthan	3
18	Udhampur	J&K	6	63	Pali	Rajasthan	1
19	Neemach	MP	2	64	Ahmedabad	Rajasthan	1
20	Jabalpur	MP	5	65	Banswara	Rajasthan	1
21	Sagar	MP	2	66	Banwara	Rajasthan	1
22	Gwalior	MP	1	67	Coimbatore	Tamil Nadu	2
23	Shivpuri	MP	2	68	Erode	Tamil Nadu	1
24	Damoh	MP	1	69	Lalitpur	UP	2
25	Guna	MP	1	70	Sitapur	UP	1
26	Rajagarh	MP	2	71	Allahabad	UP	2
27	Indore	MP	3	72	Etawah	UP	1
28	Barwani	MP	1	73	Kanpur	UP	2
29	Khargon	MP	2	74	Eta	UP	1
30	Khandawa	MP	2	75	UP	UP	6
31	Ahmednagar	Maharashtra	3	76	Almora	Uttaranchal	3
32	Buldana	Maharashtra	7	77	Bageshwar	Uttaranchal	3
33	Jalna	Maharashtra	3	78	Nainital	Uttaranchal	9
34	Pune	Maharashtra	2	79	Manipur	Manipur	2
35	Satara	Maharashtra	1	80	Kerala	Kerala	1
36	Aurangabad	Maharashtra	2	81	MP	MP	1
37	Washim	Maharashtra	2	82	Hamirpur	HP	1
38	Amaravati	Maharashtra	1	83	Rajasthan	Rajasthan	1
39	Nashik	Maharashtra	2	84	Bilaspur	Chhatisgarh	1
40	Rahuri	Maharashtra	3	85	Dharwad	Karnataka	1
41	Maharashtra	Maharashtra	1	86	West	Tripura	2
42	West Garo Hills	Meghalaya	1	87	South	Tripura	2
43	Mendipathar	Meghalaya	1	88	North	Tripura	1
44	Ribhoi-Mawlasmi	Meghalaya	1	89	Ribhoi-Mawlasmi	Meghalaya	1
45	East Garo Hills	Meghalaya	2	90	Dimapura	Meghalaya	1
Total samples studied							182

These elite *Jatropha* accessions were used for DNA extraction and screening of the primers for DNA profiling. Sixty AFLP primers were screened in addition to 150 RAPD and 30 ISSR primers in order to identify the markers polymorphic enough to distinguish distinct genotype of the *Jatropha*. A set of 30 RAPD, 10 ISSR, 15 AFLP primers were identified as suitable for genetic diversity analysis and DNA fingerprinting of the *Jatropha* genotypes. Twenty out of the 30 suitable RAPD primers were used for profiling of the 182 accessions.



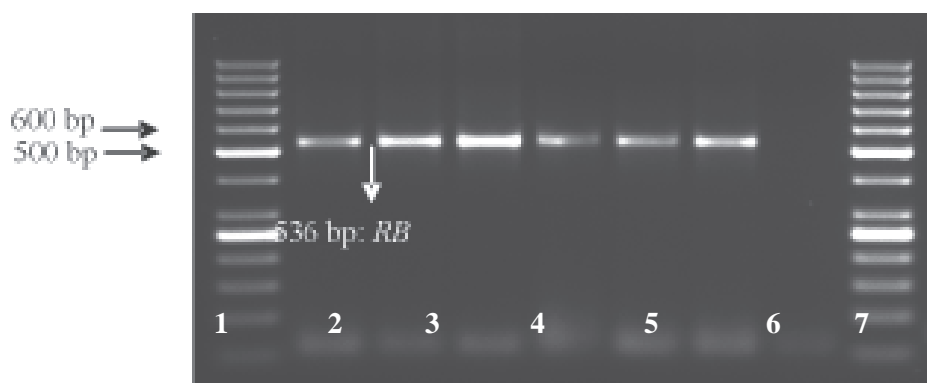
**Figure 9.** Result of principal component analysis of RAPD profiles of 182 *Jatropha* accessions from 19 states. The clustering pattern indicates presence of 4 distinct groups among the accessions and five of the accessions were highly diverse

Results of the RAPD analysis (Figure 9) indicated presence of moderate diversity in the representative accessions of *Jatropha*. Based on this analysis four distinct groups were identified in addition to five highly diverse accessions which did not group with any of the clusters. The analysis was also useful in identification of diversity rich region for further intensive collections

so that greater diversity is introduced into *Jatropha* plantations.

### 8.3 Molecular Diagnosis of Transgenic Planting Materials

- PCR-based detection protocols have been developed for the following transgenic planting materials:
  - Multiplex PCR for simultaneous detection of *AmA1* gene, *CaMV* 35S promoter, *nos* terminator and *nptII* marker gene along with endogenous *UGPase* gene in duplex, triplex, tetraplex formats in genetically modified (GM) potato with *AmA1* gene.
  - Multiplex PCR for simultaneous detection of *cryIAb* gene, *CaMV* 35S promoter, *nptII* marker gene and endogenous *UGPase* gene in GM potato with *cryIAb* gene.
  - PCR for detection of late blight resistant *RB* gene in GM potato with *RB* gene upto a limit of detection of 0.01% (Figure 10).
  - PCR for detection of *cryIAc* gene in Bt Okra and Bt cauliflower upto a limit of detection of 0.01%.
  - Multiplex PCR for detection of *cryIAc* gene, endogenous  $\alpha$ -tubulin (*TubA*) gene and *nos* terminator/*nptII* marker gene in Bt rice (Figure 11).
  - Development of protocol for simultaneous amplification of six commonly used marker genes, viz., *nptII*, *aadA*, *hpt*, *bar*, *pat* and *uidA* for screening of GM crops



M: 50 bp DNA ladder; 1-6: LOD dilutions of GM potato with *RB* gene, 100%, 10%, 1%, 0.1%, 0.05%, 0.01%; 7: Non-GM potato

**Figure 10.** PCR amplification for detection of *RB* transgene using *RB1* primer

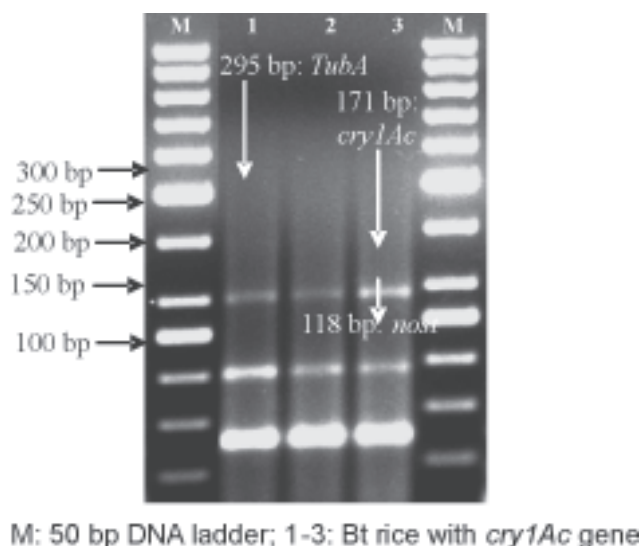


Figure 11. Multiplex PCR for simultaneous detection of *cry1Ac* gene, endogenous  $\alpha$ -tubulin gene and *nos* terminator in Bt rice

- Qualitative detection has been standardized using Real Time PCR.
  - *cry1Ac* gene in Bt cotton (MON 531 event)
  - *cry1Ac* and *cry2Ab* genes in Bt cotton (MON15985)
  - *cry1Ac* gene in Bt brinjal
  - *AmA1* gene in GM potato with *AmA1* gene

### 8.3.1 Molecular Testing of Imported Transgenic Planting material:

Two hundred sixty three accessions of imported transgenic planting materials constituting *Zea mays* (35 accessions) containing *cry1A.105*, *cry2Ab2*, *cry1F*, *cry1Ab* for insect resistance, *epsps*, modified *epsps* for herbicide tolerance, *gus* (reporter gene); *Gossypium* sp. (154 accessions) containing *cry1Ac*, *cry2Ab2*, *cry1Ab*, *cry2Ae* for insect resistance, *cp4epsps*, *2mepsps* for herbicide tolerance; *Oryza sativa* (74 accessions) containing *cry1Ca*, *cry1Ac*, *cry2A*, *cry1C* for insect resistance, *ferritin* and  $\alpha$ -amylase for improved nutrition were tested for the absence of embryogenesis deactivator gene with *cre* recombinase gene-specific primer pair amplifying 1031 bp amplicon in the positive control only (Figure 12).

All imported transgenic accessions were tested for presence of their specific transgenes. Figure 13, shows multiplex PCR for simultaneous detection of *CP4epsps*, selectable marker gene *aadA* and endogenous gene *fs-ACP* in Bt-Round-up Ready Flex cotton.

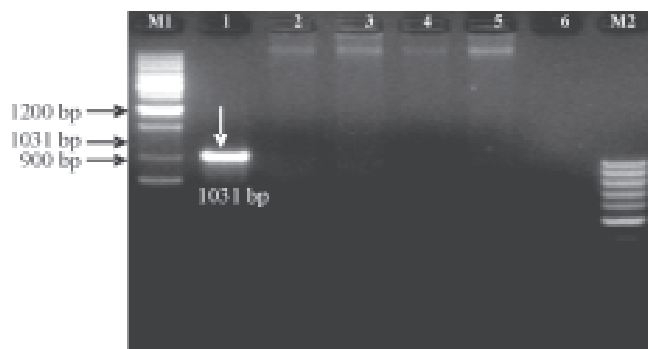


Figure 12. PCR based detection of *cre* recombinase gene in transgenic *Gossypium hirsutum*

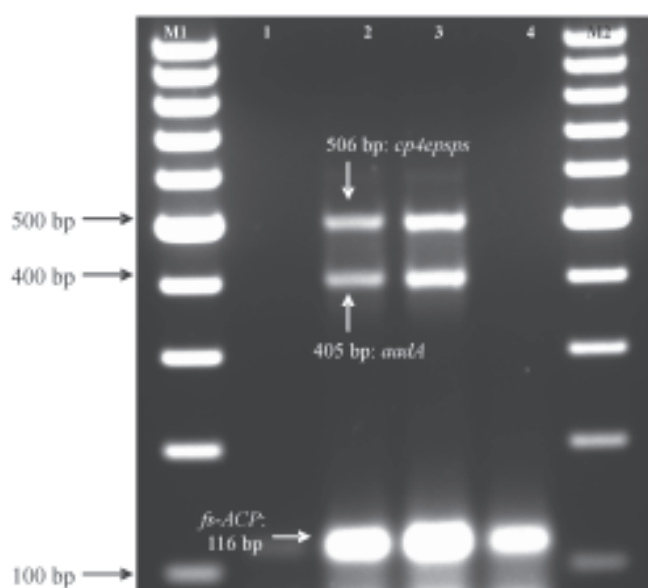


Figure 13. Multiplex PCR for simultaneous detection of *CP4epsps*, selectable marker gene *aadA* and endogenous gene *fs-ACP* in Bt-Roundup Ready Flex cotton

## 8.4 Generation of new sequence tagged microsatellite (STMS) markers

**8.4.1 Sesame (*Sesamum indicum*):** SSR enriched genomic library was constructed in *pGEMT* plasmid with *DH5 $\alpha$*  *E. coli* host cell following the protocols of Kandpal *et al.*, (1991). The library was based on the sesame genomic DNA fragments enriched for (CA)<sub>20</sub>, (GA)<sub>20</sub>, (AT)<sub>20</sub>, (AAT)<sub>15</sub>, (CAT)<sub>15</sub>, (AAC)<sub>15</sub>, (GGC)<sub>15</sub>, CCT)<sub>15</sub>, (AGG)<sub>15</sub> and (GACA)<sub>10</sub> repeats. More than 8,000 positive colonies were picked and presence of SSRs in inserts was confirmed by PCR screening using



the SSR repeats as primers. This resulted in amplification of only the inserts containing the corresponding SSRs. About 3000 of these selected inserts were sequenced. The resulting sequences have been curated for errors in base-calling. Preliminary analysis of the sequences indicated that 850 of these sequences contained SSR repeats (30%) which are within the acceptable limits. The sequences are being processed to identify the primers for PCR amplification of these specific regions. A comparison of the SSR sequences identified indicated that the abundance of the SSRs screened are in the following order - (GT)<sub>n</sub> > (AT)<sub>n</sub> > (GACA)<sub>n</sub> > (AAT)<sub>n</sub> in the regions sequenced so far.

**8.4.2 Green gram (*Vigna radiata*):** A small insert partial genomic library of the landrace 'MCV' was constructed in pUC18 vector. Approximately 20 µg of kit purified genomic DNA was sheared by nebulization.

The DNA was end polished using the blunting and ligation kit (MBI Fermentas) and ligated to adaptors. The ligated fragments were selectively amplified using primers complementary to the adaptor sequence and the amplified products were electrophoresed through 2% agarose gel. Fragments between size range 400-1,000bp were eluted from the gel. These were then purified, heat denatured and hybridized with biotin labeled oligonucleotides (AG)<sub>n</sub>, (TG)<sub>n</sub> and (GT)<sub>n</sub> for enrichment of the library. Streptavidin-coated beads were used to capture the hybridized fragments. The purified and labeled fragments were eluted from the Streptavidin column and amplified using polymerase chain reaction. These were then ligated into the vector pUC18 and transformed into electrocompetent *E. coli* strain DH10b. Keeping the minimum number of repeat length as five, twenty seven loci have been identified for design of primer pairs (Table 2).

**Table 2: Nature of a few of the new SSRs identified in green gram**

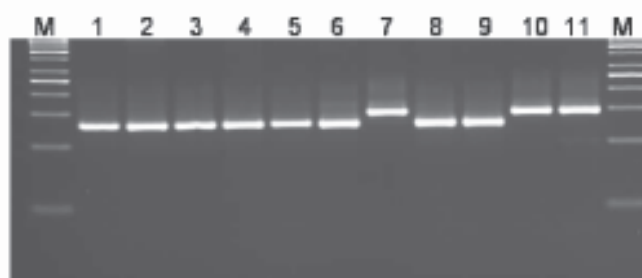
S. No	Sequence	Motif	No. of Repeats	SSR start	SSR end	Seq Length
1.	D1_T7-1	ag	5	275	284	677
2.	H2_T7-1	ag	5	89	98	390
3.	A5_T7-1	gt	6	117	128	482
4.	A5_T7-2	tg	6	387	398	482
5.	B11_T7-1	gt	6	72	83	600
6.	B11_T7-2	tg	8	236	251	600
7.	B11_T7-3	ag	5	282	291	600
8.	B11_T7-4	gt	7	309	322	600
9.	B11_T7-5	tg	6	470	481	600
10.	B11_T7-6	tg	5	492	501	600
11.	B11_T7-7	tg	10	526	545	600
12.	C10_T7-2	ag	7	789	802	838
13.	C10_T7-3	ag	7	813	826	838
14.	E12_T7-1	gt	10	85	104	203
15.	F5_T7-1	tg	7	109	122	229
16.	F5_T7-2	tg	6	129	140	229
17.	F5_T7-3	tg	7	163	176	229
18.	F5_T7-4	tg	5	187	196	229
19.	F5_T7-5	gt	6	216	227	229
20.	H7_T7-1	ag	5	72	81	497
21.	C9_M13F-1	tg	5	307	316	361
22.	C9_M13F-2	tg	5	324	333	361
23.	D12_M13F-1	gt	5	132	141	152
24.	E8_M13F-1	gt	5	108	117	183
25.	E8_M13F-2	gt	6	124	135	183
26.	E8_M13F-3	tg	6	151	162	183
27.	H7_M13F-1	tg	5	119	128	128

**8.4.3 Finger millet:** A total of 1,740 EST sequences obtained from dbEST NCBI database were used to develop simple sequence repeats (SSRs). The SSR identification and primer designing was done using one pipeline tool "SSR Primer" which is a integrated program of SPUTNIK (SSR repeat finder) and Primer3 (a PCR

primer design). SSR Primer could identify 463 primer pairs. Initial subset of 31 SSRs belonging to di, tri, tetra and penta-nucleotide repeats was selected for primer synthesis. In the present study, four hundred and sixty three SSRs were found in 351 sequences of the 1,740 finger millet EST sequences examined, which was a

frequency (20.2%) higher than expected based on reports from other crops. Among 463 SSRs, 53(11.4%), 349(75.4%), 23 (5.0%) and 38 (8.2%) had di, tri, tetra and penta-nucleotide repeats respectively. The most common di-nucleotide repeat was AG/GA/CT/TC (66%). Among tri-nucleotides CGG/ GGC/GCG/GCC/ CCG/CGC (40.4%) was the most common repeat motif. Thirty one primer pairs were tested for amplification in 11 elite germplasm lines of finger millet. Out of 31 loci tested, 17 primer pairs (Table 3) showed clear amplification products while 14 were not showing proper amplification. Out of 17 loci tested, nine gave polymorphic alleles in the accessions tested. All the polymorphic loci showed 2 alleles per locus (Figure 14). Four of the loci amplified alleles in the higher size range as compared to the expected size indicating the existence of introns. The EST-derived SSRs thus

developed can be used for understanding of SSR distribution and frequency, development of EST-SSR genetic and physical maps in finger millet and can also be used for comparative genomics.



**Figure 14. Allelic polymorphism with EST-SSR primer pair FM 23, M is the 50bp molecular weight marker and 1-11 are elite germplasm lines of finger millet (1:GE 68, Uttaranchal; 2:GE 292, West Bengal; 3:GE 314, Andhra Pradesh;4: GE 469, Kerala; 5:GE 1028, Karnataka; 6:GE 4,752, Kenya; 7:GE 4833, Malawi; 8:GE 4951, Zambia; 9:GE 4,990, Tanzania; 10: GE 4991, Tanzania and 11: GE 5029, Zimbabwe)**

**Table 3: Characteristics of EST-SSR primer pairs developed in finger millet**

Locus Name	Accession Number	Repeat Motif	Forward and Reverse Primer Sequence	Allele Size(Finger millet)	
				Expected (bp)	Observed(bp)
FM 2	CX265472	(GA)12G	CGAGATTAGTTAGCTGGTGGCG CCATTATTGCTATCTCTC	101	96-102
FM 3	CX265472	(AG)8A	GCGAGTGAGAGAGAGAGAGAAC GACGAGTCGTACTTGAAC	205	400*
FM 4	CX265472	(TG)6T	CGACGTCCTAGTGTTCAAGTGGA TCGATACAATACATCATCA	369	430-440*
FM 6	CX265357	(GC)7G	TGTAGAAGAAGCAGAGGAGGGCA AGAACTTCCAAACAGAC	237	236
FM 9	CX265329	(TCCC)5	GTCGATCAGTCAGTCATGCGCGA GGTATATATAGAGGCG	127	127
FM 10	CX265194	(CA)7	GCGGACCAAAGTGTAATAGATTC ACAATTTTCATTTCCCA	220	220-236
FM 12	CX265194	(GCG)7G	AGAACTACATGCAGACGGAGATTC ACAATTTTCATTTCCCA	348	343-349
FM 13	CX265020	(AGA)18	CACTACACCGCATCATCTCGTAG TGGAGTAGGCGATGG	268	233-269
FM 16	CX264978	(AG)16	AGTGAGAGAGGGAGCTTAGAGTGC TGCAGATGAAGTAATTG	395	506-518*
FM 17	CX264718	(GA)7	ACTCTCCTGTGAGTGAGTGAAGGG TGGAGATGAATCAG	148	148
FM 18	CX264962	(GCG)7	TTGTCCATCTCGTCAGTTCTCTC CGACCTAAACATCAAGA	107	175*
FM 23	CX264765	(AAGAG)7	CACCTGCTCCATCTACATCTCACAA GGACGATCGCAAC	151	126-146
FM 27	EB086245	(TC)15	GGACTCTAGTTTCCGCTTTCGGCG AGATGGTTAATGTAGA	378	380
FM 28	EB086162	(TC)9T	AAGTGATGATGATCGTTTCTACTAC ATCTATGACCGCCC	174	170-176
FM 31	EB086242	(GGC)6	GCGGCTAAGGTAGTGAGTAGAGGG ACTCGAGAGAATAAGC	374	380
FM 32	DY625749	(CGG)6	CGGATAAGAGTATCGATTGGCATAT CCACTAGTACCCGCT	180	176-182
FM 34	EB187410	(TTC)8TT	TGTTCACTTTCAGAGAGGTTGA CTGCAATATGCACAACT	205	205

\* Allele size is higher than the expected value

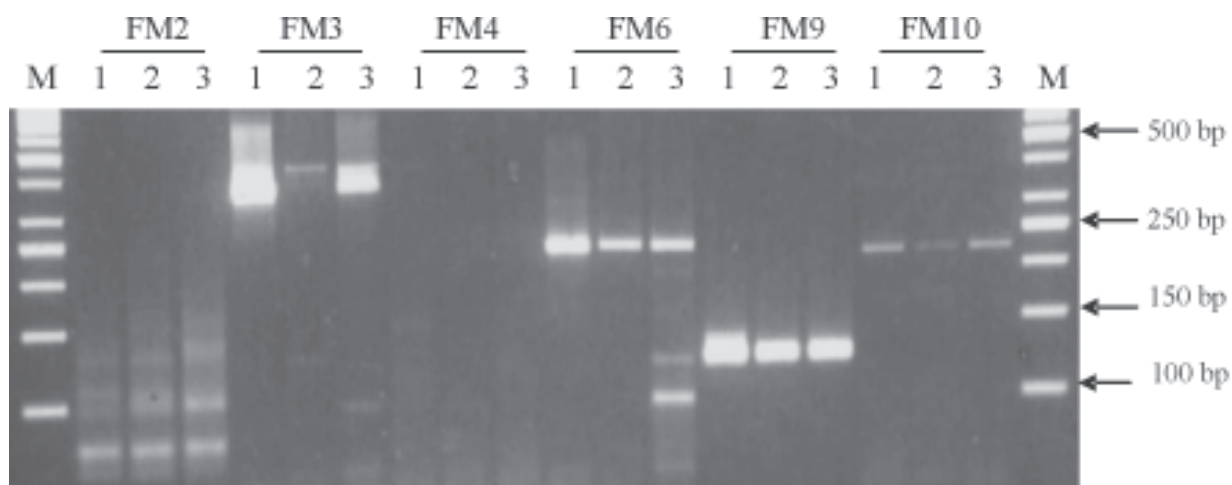


Figure 15. EST-SSRs (FM 2, FM 3, FM 4, FM 6, FM 9 and FM 10) amplification in three varieties of pearl millet (1: ICMV 155, 2: HC 10, 3: ICTP 8203). M is 50 bp molecular weight marker

**8.4.4 Pearl millet (*Pennisetum glaucum*):** EST-SSR markers of finger millet were evaluated in three varieties of pearl millet and could be transferred. PCR amplification was detected in 11 out of 17 SSRs tested, ranging from one to two alleles with a transfer rate of 64.7% (Figure 15).

## 8.5 Development of EST-SSR markers in watermelon

Watermelon has very few Simple Sequence Repeat (SSR) markers available. Expressed Sequence Tag-Simple Sequence Repeats (EST-SSRs) markers from watermelon were developed by mining available databases. 1,762 EST sequences from watermelon were analyzed. Two hundred and thirty-two SSRs were detected. All motifs identified are presented in the Table 5. 11.29% of SSRs containing ESTs were identified, which is comparable to 16.35% and 12.01% ESTs, reported in other cucurbit crops such as *Cucumis sativus* and *C. melo*. Primer pairs were designed for these 232 sequences and a set of 40 new primer pairs flanking di, tri, tetra and penta nucleotide repeat sequences were synthesized. These primer pairs were evaluated for amplification and polymorphism using DNA from seven watermelon varieties from India (Figure 16). Clear amplification products were obtained for 31 primer pairs, of which seven were found to be polymorphic with a mean allele number of two per locus. Further, primer pairs will be synthesized and evaluated subsequently. This study resulted in providing a new set of EST-SSR markers for watermelon which can be used in genetic diversity analysis, for varietal identification and in genetic improvement of watermelon.

Table 4: Repeat type, repeat motif, and number of SSRs present in ESTs of watermelon

Repeat Type	Motif	Number
Dinucleotide	TA/ AT	17
	TG/GT	9
	GA/AG/TC/CT	23
	<b>Total</b>	<b>49</b>
Trinucleotide	TTA/TAT/ATT/AAT/ATA/TAA	12
	TAG/AGT/GTA/ATC/TCA/CAT	13
	TCT/CTT/TTC/GAA/AAG/AGA	46
	TGA/GAT/ATG/CTA/TAC/ACT	12
	GTG/TGG/GGT/CCA/CAC/ACC	11
	GCA/CAG/AGC/TCG/CGT/GTC	11
	TGT/GTT/TTG/AAC/ACA/CAA	5
	CGC/GCC/CCG/CGG/GGC/GCG	11
	CCT/CTC/TCC/GAG/AGG/GGA	9
	TGC/GCT/CTG/CGA/GAC/ACG	6
	<b>Total</b>	<b>136</b>
Tetranucleotide	TATG	1
	TTCT/TTTC	3
	CTAG/TCGA	2
	GTTT/TTTG	2
	AAAG	1
	TAAT	1
	GATG	1
	GAAG/CTTC	2
	AGGC	1
	GTTC	1
	AGTA/CATT	2
	<b>Total</b>	<b>17</b>
Pentanucleotide	AAAAG/TTTTTC	7
	TTTTG	1
	AAAAT	1
	CTTTC/TCCTT	8
	TGCCC	1
	GTTTG/TTGGT	2
	CTAAG/GATTTC	2
	CGGGT	1
	AAGCC	1
	TTTCG	1
	CCGGT	1
	ATTCA	2
	<b>Total</b>	<b>30</b>
<b>Grand Total</b>		<b>232</b>

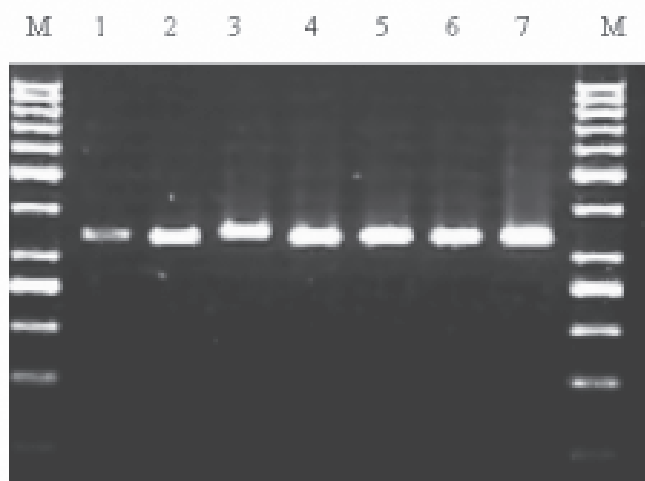


Figure 16. EST-SSR primer pair WM 4 showing polymorphism among seven watermelon varieties. M is a 50 bp DNA ladder

## 8.6 Construction of molecular map in indigenous crop plants

**8.6.1 Sesame (*Sesamum indicum*):** Recombinant inbred line for mapping: Under the National Agricultural Innovation Project on sesame, a mapping population comprising 210 recombinant inbred lines of sesame was planted in an augmented block design with five improved cultivars as checks during June 2008 in Delhi. The five checks were planted in five replications. The experiment was laid out in four blocks. The following traits scored were: days to flowering, days to 50 % flowering, number of capsules per node, number of capsules per plant, number of primary branches per plant, days to maturity, nature of capsule bearing, leaf shape, hairiness of stem, hairiness of capsules, first capsule bearing node. Further, parental polymorphism survey for the STMS and AFLP markers was also conducted in order to identify the polymorphic markers that can be used for molecular mapping. The identified markers are being used for construction of a framework map in sesame.

Association mapping of yield contributing traits in sesame: The core collection in sesame comprising 321 accessions and 52 released varieties, that form an important part of the cultivated genepool in sesame were planted in an augmented block design at Delhi. Over 18 agronomically important traits were recorded in this experiment and data is being analyzed. DNA from this set of accessions was also extracted. These are being used for genotyping of these 373 accessions for association mapping to identify genes controlling these important traits.

### 8.6.2 Identification of genes for high linolenic acid in sesame:

The cDNA sequences (over 55) available in NCBI's Gene Bank were downloaded along with the information on splice sites. Sixteen sets of primers were designed for complementarities to the end sequences. The sequences targeted included 10 fatty acid desaturase genes and six lignan synthesis genes. These were tested for their ability to amplify target regions using a set of 25 diverse sesame accessions from the core collection. All 16 primer sets were observed to amplify the target regions of known length. However, sequence analysis of these PCR products indicated that for six of these regions, there is a need to clone the fragments before sequencing since they did not yield good quality sequences for further analysis. The PCR conditions and primer sequences are now being modified so as to identify primers for specific amplification of only the target regions. Comparison of the sequence information obtained for 10 of the regions indicated that the region amplified complementarily to the targeted sequences.

A preliminary analysis for steroyl ACP desaturase, fatty acid desaturase 2 (FAD 2), fatty acid desaturase 3 (FAD 3) enzymes which are essential for synthesis of linoleic (16:2) and linolenic acids (16:3) in sesame has been completed. Sesame oil has over 35% of linoleic acid, while linolenic acid fraction is in traces. Hence, increase in this 16:3 fraction is likely to enhance the nutritional quality of sesame oil.

**8.6.3 Greengram (*Vigna radiata*):** The crosses Asha (green gram cv) x BBL29-2K (*Vigna radiata* var *sublobata*) and SML100 x BBL29-2K were planted for generation advance. Over 250 F<sub>2</sub> families in each of the crosses were advanced to next generation for development of RILs in this crop. These mapping populations will be used for construction of molecular map in green gram using STMS and AFLP markers.

### 8.6.4 Analyses of molecular phylogeny and domestication

Identification of phylogenetically informative traits and markers: The list of traits suitable for describing identities of species under the three genera, *Vigna*, *Cucumis*, *Abelmoschus* was prepared after visiting the major BSI herbaria and study of the literature related to taxonomy. The list was fine-tuned after circulation among the partners. In order to identify phylogenetically informative nuclear, chloroplast and mitochondrial DNA regions, pilot



analyses were conducted using distinct species collections. This resulted in identification of several taxonomically informative DNA sequences. These short-listed regions are being screened further to focus on a few of the most informative regions for phylogenetic analyses. Some of the identified regions are:

- Nuclear DNA: ITS1, ITS2 and expressed ribosomal protein regions for describing relationships between populations within a species since these are not ideal for species relationship studies
- Chloroplast DNA: psbA, trnH, matK, rbcL
- Mitochondrial DNA: coxII, 18s RNA, nad1B, nad4 exons, rps

Identification of genomic regions for *in situ* hybridization studies: Over 100 RAPD primers were screened using sets of domesticated species and their wild relatives in each of the genera to identify amplicons that can be used as probes for *in situ* hybridizations. About eleven amplicons were identified in each genus and these were cloned into pGEMTeasy vector to facilitate their sequencing, characterization and multiplication for cytological analyses.



**Figure 17.** Shri Kapil Sibal, Hon'ble Union Minister for Science and Technology and Earth Sciences releasing the transgene detection kits on 7 April 2008 at the Press Information Bureau, New Delhi

## 8.7 Technology Development

**8.7.1 Release of PCR-based Diagnostic Kits:** PCR-based diagnostic kits have been developed for detection of endogenous genes, specific transgenes and 35S promoter sequence in five genetically modified crops viz., cotton (*cryIAc*, *cry2Ab* genes), brinjal (*cryIAc* gene), cauliflower (*cryIAc* gene), mustard (*barnase* and *barstar* genes) and tomato (*osmotin* gene). These kits were released by Shri Kapil Sibal, Hon'ble Union Minister for Science and Technology and Earth Sciences on 7<sup>th</sup> April 2008 at the Press Information Bureau, New Delhi (Figure 17).

**8.7.2 Biosystematics of *Vigna*, *Cucumis* and *Abelmoschus*:** A new project was launched in September 2008, with funding from the NAIP (ICAR) on "Biosystematics of the genera *Vigna*, *Cucumis* and *Abelmoschus*". This project in consortium mode has three partners, NBPGR, New Delhi as Consortium leader; and North Eastern Hill University, Shillong and Shivaji University, Kolhapur as partners. The project has three major objectives:

- Establishing a firm basis for taxonomic delineation of species under the genera *Vigna*, *Cucumis* and *Abelmoschus* based on morphological, anatomical and cytological criteria.
- Establishing molecular basis for taxonomic delineations of *Vigna*, *Cucumis* and *Abelmoschus* species.
- Phylogenetic relationships among genes for resistance to yellow mosaic virus in *Vigna* species.

The consortium involves the expertise of Taxonomists, Cytogeneticists, Plant Geneticists, Plant Breeders and Molecular Biologists to address the long standing problems of species identities, relationships, domestication process and crossability barriers in the three leading Asiatic genera and proposes to generate basic information that will be useful in plant germplasm management and crop improvement programmes. The consortium involves a total of nine experienced scientists in this field.

**Research Programme (Programme Code: Title, Leader)**

PGR/DFP- BUR-DEL-01.00: Technology Development for DNA Fingerprinting of Agri-horticultural Crops (**SK Sharma**)

**Project code: Title (PI and Co-PIs)**

PGR/DFP-BUR-DEL-01.01: Technology Development for DNA Fingerprinting of Cereals and Millet Crops (**Lalit Arya**, Rakesh Singh, GJ Randhawa, SS Malik and Manjusha Verma)

PGR/DFP-BUR-DEL-01.02: Technology Development for DNA Fingerprinting of Pulses, Oilseeds and Fibre Crops (**KV Bhat**, MK Rana, Rakesh Singh and AB Gaikwad)

PGR/DFP-BUR-DEL-01.03: Technology Development for DNA Fingerprinting of Horticultural Crops (**AB Gaikwad**, Sunil Archak and KV Bhat)

PGR/DFP-BUR-DEL-01.04: Technology Development for DNA Fingerprinting of Medicinal and Aromatic Plants (**Rakesh Singh** and GJ Randhawa)

PGR/DFP-BUR-DEL-01.05: Crop DNA Finger Print Database and Statistical Analysis Package (**Madhu Bala**)

PGR/DFP-BUR-DEL-01.06: Technology Development for DNA Fingerprinting of Forage and Fodder Crops (**MK Rana**, Manjusha Verma and Lalit Arya)

PGR/DFP-BUR-DEL-01.07: Analysis of Genetic Diversity and DNA Fingerprinting of Cucurbitaceous Crops (**Manjusha Verma**, MK Rana, Lalit Arya and AB Gaikwad)

PGR/DFP-BUR-DEL-01.08: Bioinformatics Softwares Portal (**Madhu Bala**, Sunil Archak and RC Agarwal)

**Externally-funded projects:**

Network Project on Molecular Breeding (ICAR) (**KV Bhat**)

Referral centre for molecular diagnosis of transgenic planting materials (DBT) (**GJ Randhawa**)

Development of STMS and SCAR markers in bitter melon (*Momordica charantia* L.) and their utilization for genetic characterization and tagging of gynoecious trait (DBT) (**AB Gaikwad**)

Molecular characterization of cotton germplasm (TMC MM 1) (**Mukesh Rana**)

DNA fingerprinting and molecular characterization of Jatropha germplasm collected from diverse agroclimatic zones of India (NOVOD Board) (**KV Bhat**)

Molecular tools for exploitation of heterosis, yield and oil quality in sesame (NAIP) (**KV Bhat**)

Development of STMS markers and mapping in green gram (*Vigna radiata* L. Wilczek) (DBT) (**KV Bhat**)

Biosystematics of the genera *Vigna*, *Cucumis* and *Abelmoschus* (NAIP) (**KV Bhat**)

National Genomic Resources Centre (ICAR) (**SK Sharma**)

## 9. REGIONAL STATION, AKOLA

**Summary:** During a collaborative exploration and collection mission to the tribal pockets of Madhya Pradesh undertaken, a total of 216 accessions of germplasm comprising cereals (2), pseudo-cereal (1), minor millets (34), oilseeds (130), vegetables (11), pulses (9), medicinal plants (5), fibre crop (1) and wild relatives of crop plants (23) were collected. During *Rabi* 2007-08, 2,997 accessions comprising Amaranth (1,158), Chick pea (1,010), Grass pea (119), Linseed (193) and Safflower (517) and during *Kharif* 2008, 4,250 accessions of germplasm comprising millets (599), pulses (991), oilseeds (1,419), vegetables (619) and wild relatives of crop plants (622) were regenerated and multiplied. A total of 1,387 accessions of linseed (193), safflower (538) and chick pea (656) and 726 accessions comprising *Sesamum* spp. (132), *Abelmoschus tuberculatus* (84), *A. manihot* var. *tetraphyllus* (132), *A. ficulneus* (86) and castor (292) were characterized during *Rabi* (2007-08) and *Kharif* 2008, respectively. A total of 955 accessions of okra (578), winged bean (68), Safflower (80), linseed (15) and 214 accessions of exploration material were sent for conservation in the NGB. A total of 1,401 accessions of germplasm were supplied to 25 user agencies (indenter).

The Regional Station was established to explore, collect, evaluate, maintain and conserve the plant genetic resources of different agri-horticultural crops of the Central Indian region i.e. Maharashtra, Chhatisgarh, 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 Coordinated Research Project on Under-utilized Plants.



NP/08-52: A high yielding accession of niger from MP

### 9.1 Plant Exploration and Germplasm Collection

**9.1.1 Exploration for the collection of Niger and wild relatives of crops:** During an exploration and collection mission in tribal pockets of Madhya Pradesh undertaken 11 districts of Madhya Pradesh, namely Betul, Chhindwara, Narsimhapur, Mandla, Dindori, Anuppur, Umaria, Shahdol, Katni, Jabalpur and Seoni and the Amravati district of Maharashtra were explored. A total of 216 accessions of germplasm comprising



N/08-104: A promising large fruited accession of ash gourd from tribals of MP



N/08-118. A promising large sized bottle gourd collected from tribals of MP



N/08-95: *Cucumis hardwickii* fruits collected from MP

cereals (2), pseudo-cereal (1), minor millets (34), oil seeds (130) vegetables (11), pulses (9), medicinal plants (5), fibre crop (1) and wild relatives of crop plants (23). A total of 116 accessions of the targeted species *Guizotia abyssinica* were collected containing the entire morphological and spatial variability available in

the surveyed area. Intraspecific variability was observed in plant height, branching habit, days to maturity and seed size in the niger germplasm accessions assembled. The remaining 100 accessions of germplasm collected belonged to 32 species spread over 27 different genera.

**Table 1: Exploration and collection of germplasm during 2008**

Crop Group(Accns.)	Crop/Common Name	Species Name	Accns. collected
Cereals (2)	Rice	<i>Oryza sativa</i>	1
	Maize	<i>Zea mays</i>	1
Pseudo-cereal (1)	Grain Amaranth	<i>Amaranthus hypochondriacus</i>	1
Minor millets (34)	Little millet	<i>Panicum sumatrense</i>	11
	Kodo millet	<i>Paspalum scrobiculatum</i>	21
	Foxtail millet	<i>Setaria italica</i>	2
Oil seeds (130)	Soybean	<i>Glycine max</i>	3
	Niger	<i>Guizotia abyssinica</i>	116
	Barbados nut	<i>Jatropha curcas</i>	2
	Linseed	<i>Linum usitatissimum</i>	7
	Sesame	<i>Sesamum indicum</i>	2
Vegetables (11)	Ash gourd	<i>Benincasa hispida</i>	2
	Cucumber	<i>Cucumis sativus</i>	1
	Pumpkin	<i>Cucurbita moschata</i>	5
	Bottle gourd	<i>Lagenaria siceraria</i>	1
	Bitter gourd	<i>Momordica charantia</i>	2
Pulses (9)	Grass pea	<i>Lathyrus sativus</i>	6
	Lentil	<i>Lens culinaris</i>	3
Medicinal plants (5)	Vasaka	<i>Adhatoda vasica</i>	1
	Bael	<i>Aegle marmelos</i>	1
	Downy thorn apple	<i>Datura metel</i>	2
	Elephant's foot	<i>Elephantopus scaber</i>	1
Fibre crop (1)	Red sorrel	<i>Hibiscus sabdariffa</i>	1
Wild relatives of crops (23)		<i>Abelmoschus manihot</i> var. <i>tetraphyllus</i>	1
		<i>A. tuberculatus</i>	1
		<i>Cucumis hardwickii</i>	3
		<i>Dioscorea bulbifera</i>	1
		<i>Lycopersicon pimpinellifolium</i>	4
		<i>Sesamum mulayanum</i>	5
		<i>S. radiatum</i>	1
		<i>Solanum aculeatissimum</i>	1
		<i>S. viarum</i>	2
		<i>Trichosanthes lobata</i>	4
TOTAL	28 Genera	33 species	216

## 9.2 Germplasm Maintenance

A total of 7,247 accessions of germplasm were grown and maintained in the experimental farm, of which 2,997 accessions were raised during *Rabi* 2007-08 and 4,250 accessions were raised during *Kharif* 2008. The crop group-wise accessions grown during *Kharif* and *Rabi* are millets (599), pulses (991), oilseeds (1,419), vegetables (619) and wild relatives of crop plants (622) during *Kharif* season and pulses

(1,129), oilseeds (710) and under utilized crops (1,158) during *Rabi* season. The crop-wise details are Barnyard millet (94), Finger millet (161), Foxtail millet (199), Kodo millet (54), Little millet (72), Proso millet (19), Horse gram (991), Sesame (988), Niger (431), Castor (292), Okra (573), Spine gourd (46), *Abelmoschus* spp. (459), *Glycine* spp. (3), *Setaria* spp. (25), *Sesamum* spp. (135), Amaranth (1,158), Chick pea (1,010), Grass pea (119), Linseed (193) and Safflower (517).





N/08-22: Downy thorn apple (*Datura metel*)- A medicinal plant collected from MP



N/08-35: A deep red fruited cherry tomato (*Lycopersicon pimpinellifolium*) with persistent green calyx collected from MP

Table 2: Crop-wise accessions maintained during 2008

Season/ crop group	Crop	No. of accessions	Checks
<i>Rabi</i> 2007-08			
Under utilized crops	Amaranth	1,158	Suvarna, Akola local
Pulses	Chick pea	1,010	Chaffa, PG-12
	Grass pea	119	Narayangaon local
Oilseeds	Linseed	193	J-23-10 & C-429
	Safflower	517	Bhima
<i>Kharif</i> 2008			
Millets (599)	Barnyard millet	94	K-21, PS-118
	Finger millet	161	VL-149, PR-202
	Foxtail millet	199	K-221, PS-118
	Kodo millet	54	GPUK-3, IPS-147
	Little millet	72	PRC-3, Co-2
	Proso millet	19	PRC-3, Co-2
Pulses (991)	Horsegram	991	
Oilseeds (1,419)	Sesame	988	JLT 7, JLT 26, TC 25 & Swetha
	Niger	431	CHH-1, CHH-2
	Castor	292	48-1, DCS-9
Vegetables (619)	Okra	573	Parbhani Kranti, Selection 2
	Spine gourd	46	
Wild relatives (622)	<i>Abelmoschus</i> spp.	459	
	<i>Sesamum</i> spp.	135	
	<i>Glycine</i> spp.	3	
	<i>Setaria</i> spp.	25	
<b>Total</b>		<b>7,247</b>	



Cultivation practice of cucurbitaceous vegetables in tribal hamlets of MP

## 9.3 Characterization of Germplasm

### 9.3.1 Rabi 2007-08

**Linseed:** A total of 193 accessions of linseed REGIONAL STATION, AKOLA

germplasm were grown in an augmented design in three metre row length and row to row spacing of 60 cm. Six qualitative and five quantitative traits were recorded. The qualitative traits studied were flower colour, flower shape, flower size, seed size, seed luster and seed coat colour. The range, mean and CV % of quantitative traits in 193 accessions of linseed germplasm are given in Table - 4. The promising accessions identified on the basis of 1,000 seed weight



Traditional maize storage practice of tribals of MP

superior over the best check RLC-6 (5.80 g) are IC415665 (7.60 g), IC96727 (7.20 g) and IC320984 (7.10 g). On the basis of yield per plant IC 96504 (31.30 g), IC96696 (30.03 g) and IC415665 (28.64 g) were identified promising over the best check RLC-6 (14.25 g)

**Table 3: Range, Mean and CV % of quantitative traits of linseed germplasm**

Characters	Range	Mean $\pm$ SEM	Phenotypic CV (%)
Plant height (cm)	28.58-69.5	43.6 $\pm$ 0.54	17.48
No. of capsules/plant	39.4-180.2	86.57 $\pm$ 1.90	30.5
Days to 80% maturity	112-122	118 $\pm$ 0.18	2.12
100 seed weight (g)	0.24-0.76	0.43 $\pm$ 0.008	20.97
Yield/plant (g)	3.69-31.3	12.58 $\pm$ 0.40	45.07

**Safflower:** A total of 517 accessions of safflower germplasm were grown in an augmented design in three metre row length and row to row spacing of 60 cm. The checks used were A-1 and AKS-207. Ten qualitative and four quantitative traits were recorded. The traits included leaf margin, branching habit, branching pattern, extent of leaf spininess, corolla colour, corolla colour of dry flower, capsule shape, location of spines on outer involucral bracts, seed shape and seed colour. The quantitative traits included plant height, number of capitula per plant, days to 50% flowering, 100 seed weight and yield per plant. The accessions identified superior for the number of capitula/ plant over the best check A-1 (33.6) are NIC7113 (75.8), NIC7143 (73.8), NIC7116 (70.2) and IC96004 (67.4). On the basis of yield per plant IC95994 (47.71g), NIC7106 (39.50g), NIC7111 (38.68g) and IC96011 (35.22g) were found promising over the best check AKS-207 (31.13 g).

**Table 4: Range, Mean and CV % of quantitative traits in 517 accessions of safflower germplasm**

Characters	Range	Mean $\pm$ SEM	Phenotypic CV (%)
Plant height (cm)	46.12-129.26	92.96 $\pm$ 0.60	14.97
No. of capitula /plant	11.2-75.8	32.95 $\pm$ 0.43	32.5
100 seed weight (g)	2.03-6.31	4.16 $\pm$ 0.03	18.09
Yield/plant (g)	0.02-80.24	15.60 $\pm$ 0.38	57.42

**Chickpea:** A total of 656 accessions of chickpea germplasm were grown in an augmented design in three metre row length and row to row spacing of 60 cm. The checks used were Chaffa and PG-12. Six qualitative and five quantitative traits were recorded. The traits included early plant vigour, plant growth habit, number of leaflets per leaf, leaflet size, biomass and pod shape. (Table 5).

**Table 5: Range, Mean and CV % of quantitative traits of chickpea germplasm**

Characters	Range	Mean $\pm$ SEM	Phenotypic CV (%)
Plant height	46.12-129.26	92.96 $\pm$ 0.60	14.97
Plant height (cm)	14.3-58.6	37.88 $\pm$ 0.29	17.66
No. of primary branches/plant	2-43.3	5.27 $\pm$ 0.07	38.63
Number of pods/plant	10-67.6	31.48 $\pm$ 0.55	45.56
Number of seeds/pod	1.0-2.4	1.45 $\pm$ 0.01	45.07
100 seed weight (g)	7.53-29.05	12.55 $\pm$ 0.09	19.85



**Fruit variability in pumpkin germplasm collected from tribal pockets of MP**

### 9.3.2 Kharif 2008

**Characterization of wild okra germplasm:** During Kharif 2008, a total of 302 accessions of wild okra germplasm comprising *Abelmoschus tuberculatus* (84), *A. manihot* var. *tetraphyllus* (132) and *A. ficulneus* (86) were characterized for various agro-morphological traits. The qualitative traits studied include branching habit, stem pubescence, stem colour, leaf shape (above the sixth node), stem colour, shape of epicalyx segments, persistence of epicalyx segments, immature fruit colour, mature fruit colour, fruit shape and fruit pubescence (Table 6).

**Sesamum spp.:** During kharif 2008, 135 accessions of *Sesamum malabaricum* germplasm were characterized for agro-morphological traits. The qualitative traits studied include plant vigor, branching habit, corolla hairiness and density of capsule hairiness (Table 7).

**Table 6: Range, mean and CV % of quantitative traits in wild okra germplasm**

Characters	Range	Mean + SE	CV ( %)
<b><i>Abelmoschus tuberculatus</i> (n=84)</b>			
Days to 50% flowering	67-95	81.8 ± 0.91	10.30
No. epicalyx segments	7-12	9.83 ± 0.12	11.58
Epicalyx length	5 -11	9.07 ± 0.15	15.09
Length of peduncle	1 -1.8	1.22 ± 0.01	11.20
Days to maturity	96-134	112.8 ± 1.18	9.66
100 seed weight (g)	1.73-3.13	2.38 ± 0.04	13.88
<b><i>A. manihot</i> var. <i>tetraphyllus</i> (n=132)</b>			
Days to 50% flowering	82-105	93.36 ± 0.43	5.30
Leaf lobing	3-5	4.9 ± 0.01	3.49
No. of epicalyx segments	4-5	4.03 ± 0.01	4.27
Epicalyx length	8 -19	13.0 ± 0.19	17.63
Epicalyx width	3-9	5.41 ± 0.10	22.70
Length of peduncle	1.1-2.0	1.43 ± 0.01	14.34
Days to maturity	118-141	128.0 ± 0.48	4.32
100 seed weight (g)	1.84-2.71	2.14 ± 0.01	6.36
<b><i>A. ficulneus</i> (n=86)</b>			
Days to 50% flowering	90-121	106.76 ± 0.9115	7.92
No. of epicalyx segments	5-9	7.26 ± 0.12508	15.99
Epicalyx length	3-9	6.69 ± 0.16	21.8
Length of peduncle	1-2	1.34 ± 0.02	16.50
Days to maturity	122-164	140.3 ± 0.942	6.23
100 seed weight (g)	1.33-1.95	1.62 ± 0.01	8.39

**Table 7: Range, mean, CV(%) of quantitative traits in 135 accns. of *Sesamum malabaricum***

Characters	Range	Mean + SEM	CV(%)
Days to maturity	88-107	97.86 ± 0.78	9.49
Internode length	6-11	8.73 ± 0.10	14.04
No. of capsules /plant	3.3-26.4	12.95 ± 0.48	44.19
Plant height (cm)	23.2-99.4	71.37 ± 1.26	20.96
No. of seeds /capsule	4.2-58.2	25.33 ± 0.78	36.74
Capsule length	11.3-28.3	19.41 ± 0.3	18.79

## 9.4 Conservation of Germplasm in the National Genebank

A total of 955 accessions of germplasm comprising 578 accessions of okra, 68 accessions of winged bean, 80 accessions of safflower, 15 accessions of linseed and 214 accessions of exploration material comprising cereals (2), pseudo cereals (1), minor millets (34), oilseeds (130), vegetables (11), pulses (9), medicinal plants (4), fibre crops (1) and wild relatives of crop plants (22) were sent for conservation in the NGB.

## 9.5 Germplasm Supply

During 2008, a total of 1,401 accessions of germplasm

comprising Niger (480), Sesame (456), Linseed (182), Okra (60), Horse gram (52), Grass pea (50), Castor (30), *Abelmoschus ficulneus* (20), *A. tuberculatus* (20), *Sesamum mulayanum* (12), small millets (6), *Abelmoschus manihot* (5), *Cucumis hardwickii* (4), *Sesamum radiatum* (3), *Simarouba glauca* (2), *Sesamum prostratum* (1), rice (1), Bitter gourd (1), *Momordica charantia* var. *muricata* (2), *Cucumis setosus* (1), *Rauvolfia serpentina* (1), *Hardwickia binata* (1), *Solanum incanum* (2), *Solanum indicum* (2), *Solanum insanum* (1), *Trichosanthes cucumerina* (2), *Vigna radiata* var. *Setulosa* (1), *Vigna trilobata* (1), *Vigna vexillata* (1) and *Zingiber microstachyum* (1) were supplied to 25 user agencies (indenter).

## 9.6 Medium Term Storage of Germplasm in the Regional Genebank

A total of 19,424 accessions of germplasm comprising millets and minor millets (1,340), pulses (4,868), vegetables (2110), oilseeds (10,462), wild relatives of crop plants (630) and others (4) are being maintained in the medium term storage module under controlled conditions at 7 °C and 20% RH.

### Research Projects (Code: title, PI and CoPI)

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

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



## 10. REGIONAL STATION, BHOWALI

**Summary:** Two crop-specific explorations were undertaken and 171 accessions including landraces and primitive cultivars comprising cereals (90), spices (30), pulses (13), vegetables (6), oil seeds (5), M. & AP. (17), Wild relatives (9) and ornamental (1) were collected from remote areas of Uttarakhand hills under National Exploration Programme. A total of 404 accessions were received 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): Rose- Geranium (24,336 Nos.), *Ginkgo biloba* (44 nos.), Lavender (75,864 nos.), *Rosa damascena* (554 nos.), *Rosmarinus officinalis* cv. French – 27,204, *Rosmarinus officinalis* cv. Italian -5,554 nos.; Horticultural Plants: Kiwi (2,324 nos.), Kagzi nimbu (251 nos.); Agricultural Crops: Wheat–HB-208 (08 kg) were supplied to different farmers/ indentors. A total of 162 accessions were supplied to user scientists in the country and 256 accessions deposited in National Gene Bank for conservation.

The Regional Station was established in 1943, for potato seed multiplication work and also for brown rot disease (*Pseudomonas solanaeum*) testing. In 1956, with the commencement of Wheat Improvement Scheme under PL-480, it was transferred to Indian Agricultural Research Institute (ICAR) and its name was changed as “Wheat Research Station”. In 1984 it was transferred to Vivekanand Parvatiya Krishi Anusandhan Shala (VPKAS), Almora and remained under the control of VPKAS, Almora for a period of two years. In April 1986, it was retransferred to National Bureau of Plant Genetic Resources (NBPGR), New Delhi. Since then, it is with NBPGR as one of its Regional Stations.

### 10.1 Exploration and Collection of Germplasm

A total of 171 germplasm accessions were collected through two explorations (crop-specific). Under the first crop specific exploration, the crops viz., wheat, barley, fenugreek and coriander were collected from district of Pauri with collaboration of NRC on Seed Spices, Ajmer, Rajasthan and VPKAS, Almora. Another second crop specific exploration was undertaken collaboration

with VPKAS, Almora for cold tolerant paddy from district Pithoragarh, Champawat and U.S. Nagar. The collected germplasm comprised of cereals (90), spices (30), pulses (13), vegetables (6), oil seeds (5), M. & AP. (17), Wild relatives (9) and ornamental (1) as per the details given in Table 1.

#### 10.1.1. Enrichment

A total of 404 accessions comprising of rice varieties - 12 varieties; *Perilla frutescence*-10 acc.; Ricebean-116 acc. (96+2+10+0), *Hypericum* spp. – 5 acc., *Geranium* spp. – 2, Winter wheat nursery –228 acc., *Fragaria* sp. (Honeoye and Jewel varieties)–2 acc., Exotic winter wheat germplasm *Triticum aestivum* – 21 acc. and Garlic – 8 acc. have been received from VPKAS, Almora; UUC and GEX, NBPGR, Pusa, New Delhi; NBPGR, R/S Phagli, Shimla.

### 10.2 Germplasm Evaluation

**10.2.1 Germplasm characterization, regeneration and seed multiplication:** The germplasm accessions

**Table1: Explorations undertaken during 2008**

Crop/ Crop group	Areas Explored	Germplasm collected	I Cereals	II Pulses	III Spices	IV M. & AP.	V Oil seeds	VI Vegetables	VII WEUPs	VIII Ornamentals
*Crop Specific (Wheat, barley and seed spices germplasm)	District of Pauri, UK (Specially from cold rainfed areas)	80	44	4	30	—	—	2	—	—
**Crop specific (Cold Tolerant Paddy, Sesamum, French bean, Soybean (Black seeded), M. & AP.)	Districts of Pithoragarh, Champawat and U.S. Nagar, U.K	91	46	9	—	17	5	4	9	1
<b>Total</b>		<b>171</b>	<b>90</b>	<b>13</b>	<b>30</b>	<b>17</b>	<b>5</b>	<b>6</b>	<b>9</b>	<b>1</b>

- \* **Crop specific** - Collaborative tour with VPKAS, Almora (UK) and NRC on Seed Spices, Ajmer (Rajasthan) collected germplasm of Rabi crops i.e., Wheat, Barley, and seed spices
- \*\* **Crop specific** - Collaborative tour with VPKAS, Almora, UK collected germplasm of Kharif crops i.e, Cold Tolerant Paddy, Sesamum, French bean, M. & AP. & Soybean (black seeded)



collected from Kumaon and Garhwal regions of Uttarakhand were grown at Bhowali for characterization, regeneration and multiplication during Kharif and Rabi seasons 2007-2008 (Tables 2-6).

**Table 2: Germplasm characterization during *Kharif* 2008**

Crop	No. of Acc.	Checks Used
Barnyard millet	17	VL-172, VL-158, VL-29 & VL-181.
French bean (Climber)	51	PLB – 10-1, Ramgarh local, Dharchula local, Niglat local and Chaffi local
French bean (Dwarf)	36	PLB-14-1, VL-125 & VL-63
Meetha karela	27	Bhowali local, Bhimtal local, Almora local & Bageshwar local
Perilla IVT Hills 2008	10	Bhowali local, Almora local & Pithoragarh local
Rice bean IVT, AVT-I & II Hills 2008	24	RBL-1, RBL-6, PRR-1 & PRR-2
Rice bean germplasm	96	RBL-1, RBL-6, PRR-1 & PRR-2
Soybean	18	VL-77, VLS-54, VLS-47, VLS-21 & VLS-2
Chilli	50	Pant C-1, Pant C-2, JCA-283 and JCF-206
Paddy (Rainfed)	140	Majhera-7, VL-207, VL-208, VL-209
Paddy (Irrigated)	129	VL-61, VL-62, VL-65, VL-82 & VL-86



**Pea (*Pisum sativum*) germplasm grown for characterization**



**Irrigated cold tolerant paddy/upland rice (*Oryza sativa*) germplasm grown at for characterization and disease screening**

**Table 3: Multiplication/ Seed Increase for Long Term Storage (LTS) in National Gene Bank during Kharif 2008**

Crop	No. of Acc.
Bitter gourd	5
Black gram	2
Cowpea	7
Cucumber	5
Finger millet	2
Okra	1
Perilla	3
Pumpkin	34
Ridge gourd	36
Sesame	5



**Unique collection made from Bathai/ Deedihat, district Pithoragarh of *Gladiolus* sp. (NMB-2883) for large number of florets and crimson colour**



**Rainfed cold tolerant paddy/ upland rice (*Oryza sativa*) germplasm grown for characterization and screening for diseases**

**Table 4: Promising accessions identified in various crops during *Rabi* 2007-2008 and *Kharif* 2008**

Crop	Main attributes	Accessions identified for specific/desired traits
Pea Powdery mildew nursery (67 acc.) <b>Checks:</b> Harbhajan, Selection-18, Bhowali local A, Bhowali local B, Arkil and Rachna	No. of pods/ plant (>9.9) Plant height (cm) (>80.07)  100 grain weight (cm) (>15.48) Field tolerant against P.M. (0-1) All checks prone to P.M. (09)	IC267181 (18), IC218999 (17), IC208370 (16), IC342028 (16) IC208385 (142.2), IC208371 (126.1), IC208377 (115), IC208387 (112.3) IC208387 (18.3), IC208371 (18.0), IC398604 (17.4) IC208366, IC208378, IC267152, IC288367 and EC507770 (LM / MY)
Pea II <sup>nd</sup> year nursery (71 acc.) <b>Checks:</b> Selection-18, Harbhajan, VL-8, Arkil & Lincon	Days to 50% flowering (<115) No. of pods/plant (>7) Plant height (cm) (>101.5)  Days to 80% maturity (<162) 100 grain weight (cm) (>14.26)	IC291553 (97), IC326345 (107), IC342034 (107) IC026905 (16), IC469144 (14), IC469151 (14), IC469164 (14) IC469162 (140), IC469156 (130.5), IC278701 (119), IC469161 (110.5) IC026905 (155), IC469134 (155), IC279142 (155), IC279116 (155) IC279125 (21.8), IC469145 (18.8), IC342046 (17.0), IC279120 (16.6)
Wheat– <i>Triticum aestivum</i> (118 acc.) <b>Checks:</b> VL-616, VL-719, VL-738, VL-829 & HB 208	Days to 75% ear emergence (<131) Plant height (cm) (>107.9)  Grain yield/plant (g) (>11.58)  Days to 80% maturity (<192)  100 grain weight (g) (>5.46)	IC335943 (120), IC335944 (123), IC335973 (126), IC335976 (126) IC553147 (140.4), EC514382 (140.2), IC553145 (138.6), EC519410 (138.6) EC549292 (24.04), EC519498 (19.17), EC519507 (15.41), EC512660 (14.12) IC335943 (181), IC335940 (184), IC335942 (185), IC335944 (185) EC512660 (6.78), EC540810 (6.1), EC519503 (6.02), EC540812 (5.93)
Promising accessions identified from exotic winter wheat nurseries against diseases (71 acc.) <b>Checks:</b> HB-208, VL-616, VL-829, VL-719, VL-738	Spike length (cm) (>10.78) Plant height (cm) (>119.6)  Yield (q/ha) and field tolerant against PM and YR (>41.3)	ET119083 (11.94), 10 WWON-IR 06-07-288 (11.12), 10 WWON-IR 06-07-201 (11.1) 9 WWON-SA 06-07-436 (134.6), ET118863 (129.8), 9 WWON-SA 06-07-461 (129.2) ET119151 (47), ET118933 (44.3), ET118922 (44)
Barley (19 acc.) <b>Checks:</b> VLB-1, VLB-56, VLB-64 & VLB-85	Days to 75% spike emergence (<136.33) Plant height (cm) (>102.2) Grain yield/plant (g) (>8.02) 100 grain weight (g) (>4.27) Days to 80% maturity (<193)	IC553094 (133.67) IC553149 (114.6), IC553114 (109.7), IC553103 (109.1) IC553103 (10.6), IC553108 (10) IC553114 (4.4) EC492350 (181), IC553121 (185)
French bean (51) Climber/ Pole type <b>Checks:</b> PLB-10-1, Ramgarh local, Chaffi local, Niglat local and Dharchula local	Days to 50% flowering (<45) Plant height (cm) (>135.70) Pod length (cm) (>11.53) No. of pods/plant (>10.93) Days to 80% maturity (<96)  Seed yield/plant (g) (>17.33)  100 seed weight (g) (>38.77)	IC418396 (44), IC422002 (44), EC500691 (44) IC538043 (201.00), EC500894 (198.50), IC418396 (197.40) IC280838 (15.15), IC538043 (12.9), EC500691 (12.3) EC500691 (14.1), EC500894 (13.5), IC444096 (13.2) IC418371 (134), IC383482 (131), IC419904 (128), IC419893 (124) EC530898 (25.50), EC530919 (22.70), IC419889 (21.4), IC280838 (21.1) IC417360 (38.90)
French bean (36) Dwarf/ Bush type <b>Checks:</b> PLB-14-1, VL-63 & VL-125	Days to 50% flowering (<38) Plant height (cm) (>37.57)  No. of pods/plant (>9.43) Days to 80% maturity (<70) No. of seeds/pod (>4.43) Seed yield/plant (g) (>7.23) 100 seed weight (g) (>28.1)	IC419961 (29), IC370764 (29), IC340923 (29), IC412985 (31) EC530938 (57.13), IC417351 (39.4), IC421997 (38.4), IC548700 (37.93) EC015257 (17.53), P. Anupama (15.40), IC548700 (11.33) IC412985 (65), IC444095 (66), IC278499 (66) IC444095 (6.37), EC530938 (5.80), EC015257 (5.57) EC238461 (23.33), P. Anupama (16.13), EC015257 (14.28) IC548700 (56.75), EC238461 (54.00), IC316133 (53.18)
Cold tolerant paddy (Irrigated)-129 <b>Checks:</b> VL-61, VL-62, VL-65, VL-82 & VL-86	No. of tillers/plant (>7.6)  Days to 75% penicle emergence (<105) Plant height (cm) (>113.3)  Days to 80% maturity (<129)	IC444253 (10.0), IC556545 (9.8), IC548417 (9.0), IC558285 (8.6) IC548357 (78), IC548633 (79), IC548634 (81), IC556509 (83) IC548401 (161), IC548398 (154.2), IC436985 (154), IC548661 (141.8) IC436985 (103), IC548633 (111), IC548634 (111), IC548722 (113)

Cold tolerant paddy (Rainfed)-140 <b>Checks:</b> Majhera-7, VL-207, VL-208, VL-209	100 grain weight (g) (>2.4)	IC548622 (3.35), IC548639 (3.3), IC548651 (3.09), IC548668 (3.2)
	Grain yield/plant (g) (>3.8)	IC548639 (13.52), IC444223 (13.41), IC548622 (11.54), IC548398 (10.2)
	Days to 75% penicle emergence (<138)	IC548720 (116), IC548722 (117), IC548716 (117)
	Plant height (cm) (>130.23)	IC548401 (172.2), IC548398 (169.6), IC548651 (167), IC548668 (165.6)
	Days to 80% maturity (<175)	IC548722 (164), IC548720 (165), IC548717 (165), IC548716 (166)
	100 grain weight (g) (>2.41)	IC556533 (3.48), IC548622 (3.28), IC556531 (3.26), IC548639 (3.25)
Meetha karela (27) <b>Checks:</b> Bhowali local, Bhimtal local, Almora local & Bageshwar local	Grain yield / plant (g) (>7.72)	IC548363 (14.06), IC548674 (13.29), IC556557 (13.03), IC548376 (11.41)
	Days to 50% flowering (<58.67)	IC382668 (53.00), IC383628 (53.00), IC393261 (53.33), IC393255 (54.00)
	Days to first fruit harvest (<136.67)	IC421984 (135)
	Days to last fruit harvest (<155.33)	IC393259 (150.67), IC393255 (152), IC393250 (153.67)
	05 fruit weight (g) (>9.10)	IC361337 (11.33), IC382668 (10.40)
	100 seed weight (g) (>5.28)	IC382668 (5.87), IC436969 (5.65), IC383628 (5.43)
Soybean (18) <b>Checks:</b> VLS-2, VLS-21, VLS-47, VLS-54 & VLS-77	Leaf length (cm) (>12.19)	IC548665 (13.57), IC556551
	No. pods/plant (>79)	IC538013 (146), IC548612 (145.33), IC548669 (139.67)
	Days to 80% maturity (<112)	IC548719 (102), IC548632 (103), IC548669 (108)
	Plant height (cm) (>62.2)	IC548665 (115.4), IC548669 (108.93), IC548623 (108.90)
	Seed yield / plant (g) (>23.33)	IC548665 (33.20), IC548623 (28.30), IC548640 (26.10)
Barnyard millet (17) <b>Checks:</b> VL-29, VL-158, VL-172 & VL-181	Ear head length (cm) (>15.93)	IC548696 (17.03), IC548635 (16.81), IC548697 (16.77)
	Plant height (cm) (>116.07)	IC548681 (141.07), IC548696 (138.87), IC548658 (138.30)
	100 seed weight (g) (>2.28)	IC548641 (2.37), IC538089 (2.33), IC548697 (2.32)
Ricebean (96) <b>Checks:</b> PRR-1, PRR-2, RBL-1 & RBL-6	No. of primary branches (>05)	LRB-438 (07), LRB-439 (07), LRB-437 (07), LRB-433 (07)
	No. pods/plant (>110.60)	LRB-396 (234), LRB-339 (217), LRB-403 (205), LRB-343 (203)
	Pod length (cm) (>11)	LRB-327 (13.3), LRB-314 (13.1), LRB-321 (12.6)
	Plant height (cm) (>174.96)	LRB-367 (233.3), LRB-366 (233), LRB-336 (226.6), LRB-333 (215)
	Days to 80% maturity (<120)	LRB-307 (105), LRB-308 (105)
	100 seed weight (g) (>7.21)	LRB-432 (8.24), LRB-443 (8.08), LRB-440 (8.07)
	Yield (q/ha) (>14.72)	LRB-408 (50), LRB-338 (47.5), LRB-340 (45)

**Table 5: Range, mean and coefficient of variation in various crops during Rabi 2007-2008 and Kharif 2008**

Crop	Character	Range		Mean	PCV%
		Min	Max		
Pea II <sup>nd</sup> Year nursery (71 acc.)	Days to 50% flowering	97	135	124	4.99
	No. of pods/ plant	4	16	8	32
	Plant height (cm)	40.3	140	83.44	24.80
	No. of seeds/pod	3	10	5.4	24
	Days to 80% maturity	155	180	169	4.26
	100 seed weight (g)	3.1	21.8	13.1	20.18
Pea powdery mildew nursery (67 acc.)	Days to 50% flowering	118	140	130	4.94
	No. of pods/ plant	4	18	9.4	37
	Plant height (cm)	22.8	142.2	76.51	30.27
	No. of seeds/pod	2	6	5	24
	Days to 80% maturity	140	180	174	3.5
	100 seed weight (g)	3.9	18.3	11.66	39.5
Wheat - <i>Triticum</i> <i>aestivum</i> (118 acc.)	Days to 75% ear emergence	120	179	150	8.67
	Plant height (cm)	30.5	140.4	104.1	18.94
	Grain yield/ plant (g)	1.15	24.04	7.478	48.6
	Days to 80% maturity	181	233	199	4.1
	100 grain weight (g)	1.51	6.78	3.97	29
Promising accessions Identified from exotic winter wheat nurseries	Days to 75% ear emergence	138	175	158	5.19
	Spike length (cm)	7.56	11.94	9.42	8.96
	Plant height (cm)	85	134.6	105.1	10.67

Against Diseases (71 acc.)	Grain yield/plant	20.7	47	34.6	19.4
Barley (19 acc.)	Days to 75% spike emergence	133.67	155	145.58	2.55
	Plant height (cm)	86.8	114.6	102.7	4.33
	No. of grains/ spike	45.28	197.4	60.71	11.81
	Grain yield/ plant (g)	2.69	10.6	7.17	26.71
	100 grain weight (g)	2.77	4.4	3.43	14.66
	Days to 80% maturity	181	203	191.9	0.508
Barnyard millet (17)	Days to 50% flowering	70.67	86.00	77.98	3.87
	Ear head length (cm)	12.65	17.03	15.04	11.84
	Plant height (cm)	119.40	141.07	129.72	8.55
	Days to 80% maturity	105.00	115.00	110.96	3.64
	100 seed weight (g)	0.92	2.37	1.95	26.84
French bean Dwarf/ Bush (36)	Days to 50% flowering	29	49	35	4.22
	Plant height (cm)	23.13	57.13	30.96	7.54
	No. of pods/ plant	4.67	17.53	7.32	11.31
	Days to 80% maturity	65	91	77	2.62
	No. of seeds/ pod	2.50	6.37	4.27	14.18
	Seed yield/ plant	3.57	23.33	7.82	8.31
	100 seed weight (g)	15.49	56.75	26.97	2.81
French bean Climber/ Pole (51)	Days to 50% flowering	44	78	58	15.56
	Plant height (cm)	80.5	201	142.58	24.58
	No. of pods/ plant	1.49	14.1	8.58	26.50
	Days to 80% maturity	87	134	111	8.88
	No. of seeds/ pod	2.9	7.6	5.22	20.34
	Seed yield/ plant	3.02	25.5	10.87	43.60
	100 seed weight (g)	9.1	38.9	23.43	34.48
Ricebean (96)	Days to 50% flowering	80	92	88.36	4.33
	No. of primary branches	4	7	5.29	19.76
	No. pods/ plant	36	234	106.20	43.31
	Pod length (cm)	8.6	13.3	10.75	9.05
	Plant height (cm)	70	233.3	158.16	22.07
	Days to 80% maturity	105	135	126.48	4.65
	100 seed weight (g)	5.58	8.24	6.82	7.86
	Yield (q/ ha)	1	50	24.76	45.56
Soybean (18)	Days to 50% flowering	50.00	65.00	55.19	8.09
	No. pods/ plant	53.33	146.0	114.22	35.72
	No. of seeds/ pod	2.00	3.00	2.54	18.25
	Days to 80% maturity	102	127	116.83	4.32
	Plant height (cm)	55.53	115.40	88.33	22.66
	Seed yield/ plant (g)	7.80	33.20	17.88	61.23
	100 seed weight (g)	6.34	16.53	8.70	22.73
Meetha karela (27)	Days to 50% flowering	53.00	62.00	58.14	2.61
	Days to first fruit harvest	135.00	143.33	139.17	2.97
	Days to last fruit harvest	150.67	162.00	157.16	2.33
	05 fruit weight (g)	5.93	11.33	8.36	25.6
	Fruit length (cm)	5.14	6.48	5.87	11.15
	Fruit width (cm)	1.87	2.53	2.30	11.87
	100 seed weight (g)	4.52	5.87	5.15	10.7
Cold tolerant paddy (Irrigated)-129	No. of tillers/ plant	2.80	10.00	5.17	26.52
	Days to 75% panicle emergence	78.00	113.0	96.65	7.64
	Plant height (cm)	77.20	161.0	121.7	13.63
	No. of grains/ panicle	42.8	173.2	105.0	18.61
	Days to 80% maturity	103.0	176.0	127.5	7.64
	Grain length (cm)	6.10	9.80	8.22	8.18
	Grain width (cm)	1.70	3.80	2.94	11.64
	100 grain weight (g)	0.25	3.35	2.28	23.1
	Grain yield/ plant	0.01	13.52	3.10	86.72
Cold tolerant paddy (Rainfed)-140	No. of tillers/ plant	2.60	23.50	8.58	36.55
	Days to 75% panicle emergence	116	174	137	7
	Plant height (cm)	49.40	172.20	130.81	13.68
	No. of grains/ panicle	44.60	174.00	99.13	19.79
	Days to 80% maturity	164	187	175	2
	Grain length (cm)	5.80	9.50	7.98	8.31
	Grain width (cm)	2.06	3.90	2.91	11.24
	100 grain weight (g)	0.26	3.48	2.38	20.71
	Grain yield/ plant	0.04	14.06	5.54	55.86



**Table 6: Germplasm evaluation and characterization during Rabi 2008-09**

Crop	No. of	Date of Sowing acc.	Checks Used
Wheat (winter wheat nursery 255 + 41 new collections + 33 II Year evaluation + 39 Disease screening + 13 seed increase + 70 for rainfed testing)	451	20.10.2008	VL-616, VL-719, VL-738, VL-829 and HB-208
Barley (new collections-23 + 18 II year evaluation + 06 screening of yellow rust)	47	20.10.2008	VLB-1, VLB-56, VLB-64 and VLB-85
Pea (for screening of powdery mildew)	67	10.11.2008	Harbhajan, Bhowali local, Bhimtal local, Rachna, Super Lincon, DMR-11, HFP-4, Selection-18, Arkil and VL-8
Coriander	33	15.10.2008	Pant harit, ACR-250, Kashipur local and ACR-41
<b>Multiplication/ Seed increase</b>			
Garlic	132	07.11.2008	Lohit and Bhowali local
Lentil	08	15.10.2008	VL-1, VL-105, PL-406, PL-830
Radish	01	25.08.2008	—
Fenugreek	16	15.10.2008	Pusa early & Bhowali local
Spinach	06	15.10.2008	Bhowali local, Pithoragarh local and Ramgarh local
<i>Triticum</i> spp.	28	20.10.2008	—
<i>Aegilops</i> spp.	29	20.10.2008	—
<i>Avena</i> spp.	12	20.10.2008	—
Colocasia	211	26.12.2008	—
Turmeric	72	08.03.2007	—
Rapeseed/mustard	21	10.11.2008	PT-303, Bhowali local, Pusa Jai Kishan, Pithoragarh local and Ramgarh local

## 10.2 Horticultural Plants

### 10.2.1 Germplasm characterisation/ evaluation

#### 10.2.1.1 Fruit germplasm evaluation: *Citrus* spp.

**germplasm:** A total of 142 accessions comprised of 19 species were characterized and evaluated for 65 traits (qualitative and quantitative). Characterisation of Kagazi Nimbu (31) *C. aurantifolia* germplasm showed much variability. In Kagazi Nimbu Fruit length varied from 2.51–4.77 cm, fruit width varied from 2.10–4.28cm and fruit weight ranges from 15.81-93.54 g whereas they were showed non-significant effect on TSS of fruit juice while the mean performance for TSS ranged from 7.10-7.52°Brix. Slight difference in acidity and ascorbic acid content was observed and ranges from 5.60–7.91 and 45.22–53.83% respectively. In *Citrus medica* (13) *C. medica* IC319067 (Uttaranchali Hill lemon) showed the best performance among all with a

fruit length 10.57–12.18 cm, fruit diameter 4.36-4.67 cm, fruit weight 350-435 g and 16-26 seed per fruit and good eye-catching appeal.

**10.2.1.2. Vegetable germplasm evaluation:** Chilli (*C. annuum* 85) were sown in an augmented design with four checks – Pant C-1, Pant C-2, JCA-283 and LCF-206 in five blocks) where row length, row spacing and plant to plant distance was 2.10 m, 45 cm and 30 cm respectively. *C. frutescens*-07, *C. annuum* var *annuum*-08 ) and other 17 acc. were multiplied. Due to heavy rains only 50 accessions showed good performance. The range of variation for plant height (18.2–90 cm), number of fruit/ plant (12.2-74), fruit length (1.64-10.8), fruit width (0.74–1.44), fruit yield / plant (20-275g) and number of seed per fruit (15.4 - 121.4) were observed.

**Table 7: Range, mean and coefficient of variation in Chilli during Kharif 2008**

Character	Mean	Range		CV%	Checks			
		Min	Max		Pant C-1	Pant C-2	JCA-283	JCF-206
Plant height (cm)	60.46	18.2	90	20.28	40.6	52.8	55.08	47.8
No. of fruit / plant	37.4	12.2	74	38	21.4	35.44	33.76	31.16
Fruit length (cm)	7.5	1.64	10.8	21.3	5.52	7.06	6.95	7.71
Fruit width (cm)	1.12	0.74	1.44	14.79	1.01	1.07	1.07	1.09
Yield per plant (g)	87	20	275	67	70	62	64	78
No. of seed / fruit	74.45	15.4	121.4	23.14	70.54	72.4	85.12	69.76

**Table 8: Promising accessions identified in Chilli during *Kharif* 2008**

Character	Best Checks	Promising accessions identified
Plant height (cm)	JCA-283 (>55.08)	IC517100 (90), IC537594 (89.4), IC538091 (79.4), IC538014 (77)
No. of fruit / plant	Pant C-2 (>35.44)	IC383173 (74), IC537594 (70.8), IC383150 (69), IC361912 (62.8)
Fruit length (cm)	JCF-206 (>7.71)	IC324886 (10.8), EC497639 (9.68), EC497635 (9.6), EC497633 (9.1)
Yield per plant (g)	JCF-206 (>78)	IC383173 (275), IC537594 (250), EC497632 (175), IC538036 (175)
No. of seed / fruit	JCA-283 (>85.12)	IC324887 (121.4), EC497638 (104.8), EC497631 (98.4), EC497639 (96)

**10.2.1.3. Physico-chemical analysis:** Samples of *Rubus* sp. (1) Kaku (4) and Nimbu (1) accessions were sent to Department of Horticulture, College of Agriculture, GBPUA&T, Pantnagar, Udham Singh Nagar, Uttarakhand for physico-chemical evaluation. Nimbu contains 10.08 TSS, Ascorbic acid 7.71 % and acidity 81.08 mg per fruit with mesocarp thickness 0.44 – 0.67 cm, seed length 1.11 – 1.30 cm, seed width 0.63 – 0.83 cm and ten seed weight 1.63–2.94 g. Peel extracted for essential oil content and observed 0.37%.

### 10.3 Management and Maintenance of Horticultural Germplasm

**10.3.1. Conservation and maintenance:** Fruits (470), vegetables 1,212 (chillies –1,201, Chow-chow-11), flowering perennial plants (109), flowering annual plants and other horticultural crops (78) are maintained in greenhouse (plants in 2,500 pots and 3,000 polythene packets) / field gene bank/ MTS at R/S Bhowali. Time schedule maintenance of computer updating with ERNET, India and ICAR linkages with smooth connectivity and Green House Complex were maintained.

### 10.4 Transfer of Technology

- a. **Propagation / cultivation technique:** Technical know how of Kiwi propagation through cuttings and grafting and Citrus propagation through nucellar seedlings/ cuttings given at four Farmers fields.
- b. **Elite germplasm popularisation:** Uttaranchali Chow-chow IC340574 were planted at > 150 farmer's field in areas of Nainital and Almora, districts for popularisation mainly Bhimtal block, Ramgarh block, on January 3, 2008, in Okhalkanda block on November 28, 2008, in Betalghat block December 8, 2008 in Nainital and in Almora w.e.f. November 29- December 5, 2008.

### 10.5 Wild Economically Useful Plants

**Preliminary evaluation of *Allium* spp.:** A total of 41 accessions of *Allium* spp. (wild only) are being maintained and evaluated in field gene bank. Few of them i.e., *Allium auriculatum*, *A. consanguineum*, *A. carolinianum*, *A. clarkei*, *A. griffithianum* and *A. roylei* are being multiplied for seed increase.

**Maintenance of arborescent plants:** A total of 190 accessions of arborescent plants comprising of 150 species (92 genera of 50 families of both exotic and indigenous origin) have been maintained in the station's Biodiversity Botanical Garden.

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

**Maintenance of temperate forage grasses:** A total of 54 accessions of temperate forage grasses have been maintained in the field gene bank.

### 10.6 Medicinal and Aromatic Plants

A total of 445 accessions (indigenous -304, exotic-141, vegetatively propagated - 125 and 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. Nearly 30 species of the promising and high prized aromatic plants such as *Aloe*, *Alpinia*, *Artimisia*, *Asparagus*, *Bunium*, *Carum*, *Centella*, *Chrysanthemum*, *Cymbopogon*, *Hedychium*, *Lavandula*, *Matricaria*, *Marjorana*, *Melissa*, *Mentha*, *Ocimum*, *Origanum*, *Pelargonium*, *Plantago*, *Pyrethrum*, *Rosa*, *Rosmarinus*, *Salvia*, *Spilenthus*, *Stevia*, *Tagetes*, *Thymus*, *Valeriana*, *Withania* and *Zanthoxylum* were multiplied for their supply to the indentors. The essential oil from lemon grass was extracted through steam distillation process.

### 10.6.1 Determination of percentage of essential oil:

A total of 42 accessions of aromatic plants were processed for 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*–Lemon grass (0.21-1.34); **Hydro Distillation Unit (Clevenger apparatus):** *Achillea millaefolium* (0.08-0.14), *Acorus calamus* (DWB-3.5-5.5), *Citrus sp.* (0.3), *Curcuma zedoria* (0.11-0.84), *Cymbopogon flexuosus* (2.5-3.5), *Hedychium spicatum* (FWB-0.27-1.67; DWB-0.43-2.25), *Lavendula angustifolia* (dried spikes 0.09-2.69, dried straw without spike 0.18), *Mellisa officinalis* (0.03-0.05), *Mentha cardiaca* (0.35-0.42), *M. citrata* (0.63), *M. longifolia* (0.36), *M. piperata* (0.31), *M. spicata* (0.35-0.67), *Origanum vulgare* (0.8), *Pelargonium graveolens* (0.09-3.2), *Pogostemon cablin* (0.35-0.63), *Salvia officinalis* (0.49), *Skimmia laureola* (0.66), *Valeriana jatamansi* (FWB-0.20-1.14; DWB-0.4-8.0) and *Zingiber chysenthemum* (DWB-0.8).



Flower spikes of two promising accessions of lavender (IC273870 long spike & IC212822 short spike) found suitable for temperate like conditions



Large scale of nursery management of promising strains of lavender (*Lavendula angustifolia*) at Bhowali for prograssive farmers

## 10.7 Externally Funded Projects

### 10.7.1 Pantnagar Centre for Plant Genetic Resources (PCPGR) – Management of Plant Genetic Resources at NBPGR Regional Station, Bhowali “under Mini Mission I of the Horticultural Technology Mission (PCPGR – HTM MM -I Bhowali Unit)

**Greenhouse maintenance (Clonal repository):** All regular operations were timely attended for the maintenance of clonal repository/ regeneration of the promising fruit material/ collected materials (2,500 pots).

**Field genebank maintenance:** Exotic horticultural germplasm was established 43 acc. viz. apple (11), pear (14), walnut (04), citrus (06) and strawberry (08) in Field Gene Bank/ Green House and all regular cultural operations were undertaken time to time. Germplasm evaluation is continuously done in the Field Gene Bank. Observation/ data are in progress.

**Regeneration/ multiplication/ nursery management:** Kiwi (EC64093, EC24672, EC64094, EC64090, EC137263, EC64092), Uttaranchali Kagzi Nimboo (*Citrus aurantifolia*) IC319045, Uttaranchali Chow-Chow (*Sechieum edule*) IC340574, Uttaranchali Kaku/Japanese persimmon (*Diospyros kaki*-) IC219062, Uttaranchali Hisalu IC219063, Uttaranchali Hill lemon IC319067 and perennial. Phlox (IC319010, IC319011, IC319012) accessions were regenerated through cuttings, grafting and other vegetative means and through seeds for onward supply to different indentors. Budding operation on different intervals for 1,000 plants in kiwi was done. Bud showed dormancy but not sprout upto 4-5 years after budding. Application of growth regulators 30 ppm GA3 + 30 ppm NAA to dormant bud after 15 days interval resulted in sprouting even after 5 years.

### Distribution of elite planting material/ germplasm:

**Grafted/ rooted cuttings of fruit crops (1,280 plants):** Fruits 653 (Grape 12, Kagazi Nimbu 251, Kiwi–245, Passion fruit 65, strawberry 80), ornamentals 227 - (Bignonia 10, Cryptomeria 11, Glardia-200, Hydrangea 2, Japanese quince 2, Wisteria 2) vegetables 400 (chilli 400). Raised Kiwi planting material grafted and stem cuttings were distributed in the ratio of 1:5

male and female plants to VPKAS Almora/ among farmers of Uttarakhand.

**From farmer's field:** Technical knowhow for propagating kiwi fruits (grafting and cuttings) were provided time-to-time to selected farmer's under PCPGR-HTM I-Bhowali Unit 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 Horticultural Technology Mission Project were 44,442 – Apricot (273) Bara nimbu (2,373), Kiwi (8,655), Malta (8,535), Peach (9,930), Plum (597), Santra (10,32), Uttaranchali Kagazi Nimbu (12,813) and Walnut (234).

### 10.7.2 Studies on relationship between ecogeography of the chemotypic variation of nine important but highly threatened medicinal plant species and prospects of their cultivation (w.e.f. Oct. 2008)

All collected accessions (40) were propagated in beds and glass house (in pots) for germplasm enrichment/ regeneration/ multiplication/ conservation and domestication practice.

#### Details of Analysis on Oil Extraction

Botanical name	Idento No.	Plant part	Observed	Reported value	Material
<i>Hedychium spicatum</i>	NMB-2882	Rhizome + rootlets	0.42	4.0	Semi-dry
	NMB-2960	—do—	0.60		Semi-dry
	NMB-2886	—do—	0.63		Semi-dry
	NMB-2940	—do—	0.63		Semi-dry
	NMB-2939	—do—	1.12		Semi-dry
	NMB-2874	—do—	0.61		Semi-dry
	NMB-2938	—do—	0.64		Semi-dry
	NBRI-02	—do—	0.60		Semi-dry
	NKO-2965	—do—	0.87		Semi-dry
	NKO-2965	—do—	1.2		Semi-dry
	NKSK-07	—do—	1.4		Semi-dry
	NKSK-01	—do—	0.8		Semi-dry
	NKSK-06	—do—	2.25		Semi-dry
<i>Origanum vulgare</i>	NMVMKO-14	Aerial parts	0.8	0.15-0.40	Dry
<i>Valeriana jatamansi</i>	NKO-11	Rhizome + rootlets	1.0		Semi-dry
	NMB-2889	—do—	0.4		Dry
	NKSK-03	—do—	1.0		Dry
	NMB-2942	—do—	1.6		Dry
	NMB-2961	—do—	1.6		Dry
	NMVNKO-13	—do—	1.2		Dry
	NMB-2915	—do—	2.3		Dry

As the project covers entire Himalayan region, five districts of Kumaon Himalaya of Uttarakhand state were explored (the assigned three plant materials *H. spicatum*, *V. jatamansi* and *O. vulgare* do not occur in Udham Singh Nagar district so this area has been excluded).

**Trip 1:** Districts of Kumaon Himalaya viz., Almora, Bageshwar, Champawat and Pithoragarh were explored to collect assigned plant materials from different geographical settings.

**Trip 2:** District Nainital (Ramgarh-Mukteshwar) was explored.

**Trip 3:** NBPGR and nearby area.

The mandated threatened medicinal plants were collected in bulk for oil extraction, anatomical characterization/ physico-chemical analysis, nursery practice and germplasm conservation. Field observations on *H. spicatum*, *V. jatamansi*, *O. vulgare* and *A. calamus* were made. The samples are under process and accessions are being preserved as specimens and further analytical work in 70% alcohol.



## Chemical Ingredients of Essential Oils

Species	Compounds	
	Major	Minor
<i>H. spicatum</i>	1, 8-cineole Germacrene B	Limonene $\alpha$ -terpineol
<i>V. jatamansi</i>	Patchauli Alcohol	$\alpha$ -santalene
<i>O. vulgare</i>	Bicyclic sesquiterpene Thymol	Geranyl acetate

## 10.8 Germplasm Conservation

A total of 256 accessions of different crops viz. **Cereals:** Wheat (67), Barley (19); **Pseudo cereals:** Buck wheat (9); **Vegetables:** Radish (2), Carrot (1), Pea (1) and Spinach (6), Cucumber (13), Meetha karela (10), Okra (08), Pumpkin (4), Ridge gourd (6), Sponge gourd (2), Sword bean (1); **Pulses:** Cowpea (3), French bean (12), Rice bean (9), Soybean (14); **Oil seeds:** Ground nut (2), Sunflower (1); **Spices and condiments:** Coriander (12), Fenugreek (2), Perilla (7), Chillies (43); **Wild relatives:** *Cucumis hardwickii* (1); **Ornamental:** Asclepias (1) were supplied to LTS (NGB) for their conservation.

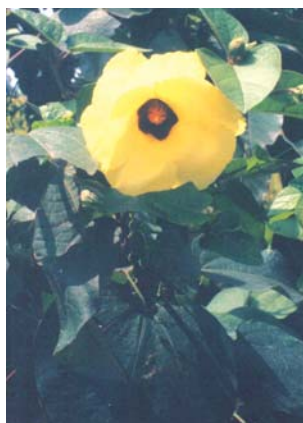
A total of 11,367 accessions of germplasm have been maintained in MTS of NBPGR, R/S Bhowali. The details are here under: Cereals (3,708), Pseudo cereals (604), minor millets (551), pulses (3,505), oil seeds (549), vegetables (317), spices and condiments (1,556), M. & AP. (181), wild relatives of crops (374) and ornamental crops (22).

## 10.9 Germplasm Supply

**MTA supply:** One hundred sixty two accessions of



Unique collection of bold seeded French bean- *Phaseolus vulgaris* (NMB-2953) specific due to broad & wide shape and also used as dual purpose (vegetable as well as pulse).



Ban kapasi, Jungli bhindi, *Thespesia lampas* syn. *Azanza lampas* (NMB-2964), wild relative of okra collected from on way to Lalkuan, U.S. Nagar, Uttarakhand.

different crops were supplied to various research organisations/ indentors under MTA: **Agr. Crops:** Wild species of wheat and *Aegilops* i.e., *Triticum urartu*, *Aegilops speltiodes*, *A. tauschii* -3 acc. to the Project Director, Directorate of Seed Research, Kushmair, Mau Nath Bhanjan, UP; French bean (Dwarf)-18 acc. to Dept. of Bio technology, Sardar Bhagwan Singh PG Institute of Bio medical Sciences and Research, Balawala, Dehradun, UK; Oat (*Avena sativa*)-15 acc. to GBPUA&T, Pantnagar, UK; **Hort. Crops:** Apple (8), Pear (14), Walnut (4), Kiwi (7) and *Cucumis hardwickii* (15 acc.) to CITH, R/S Mutkeshwar, Ditt. Nainital and Dept. of Vegetable Science, GBPUA&T, Pantnagar, Uttarakhand; Chilli (12) to Department of Vegetable Science, KRC, Colleege of Horticulture, UAS Dharwad, Arbhavi-591 310, Karnataka; Kiwi –Allison (10 plants) to GBPUA&T, Horticutlure Research Centre Jyolikot, Nainital; **M. & AP.:** M & AP., Kiwi & Passion fruit (26 acc./26 species) to Department of Pharmacy, Government Polytechnic College, Nainital (UK) for establishment of herbal garden, M & AP. (*Acorus*, *Allium*, *Gardensage*, *Lavendula*, *Marjorana*, *Pelargonium*, *Rosmary*, *Stevia*, *Thymus*, *Valeriana*)-10 acc. to Sainik School Ghorakhal for exhibition purpose, *Artimisia annua* (4 acc.) to Dept. of Bio-technology, SPMVV, Tirupati, Tamil Nadu; **Wild relatives:** *Allium* spp. (*A. ampeloprasum*, *A. angolosum*, *A. ascalonicum*, *A. cernuum*, *A. griffithianum*, *A. royleii*)-6 acc. PS, TCCU, NBPGR, Pusa, New Delhi; *Allium* spp. (*A. auriculatum*, *A. ascalonicum*, *A. clarkei*, *A. consanguinianum*, *A. consanguinianum*, *A. fistulosum*, *A. fistulosum*, *A. fistulosum*, *A. griffithianum*, *A. hookeri*, *A. oreoprasum*, *A. royleii*, *A. scorodoprasum*, *A. senescens*, *A. tuberosum*)-18 acc. to NRC for Onion and Garlic, Pune, Maharastra; *Hordeum bulbosum* (01 acc.) to ACF, UDWDP, Sugam, Bageshwar, U.K.

**NBPGR supply/ exhibition:** A total of 39 acc. of different crops were also supplied within Bureau and other institute for exhibition purposes i.e., Agr. Crops: **French bean (dwarf) BBS-13** (1.250 kg) and BBS-24 (1.250 Kg), Amaranth (Swarna-100 gm and

Annapurna-100 gm) seeds were distributed to local farmers of Pauri district and block Narayan bagar, Dewal, Ghat and Dasauli of Chamoli district, *Phaseolus coccineus* (IC312431 & 312432) supplied to GCD, NBPGR, New Delhi; **Hort. Crops:** Cryptomeria (4 nos), Kiwi (07 nos.), Passion fruit (05 nos.), Grape (2 nos.), Geranium (1 no.); **M. & AP.:** *Viola canescens* and *V. betonicifolia* (2 acc.) to PQD, NBPGR, Pusa, New Delhi; Wild relatives: *Cucumis hardwickii* (3 acc.) and *C. sativus* (3 – Pusa Udai, Pusa Sanjay and Long green checks) to NBPGR, R/S Trissur, Kerela; 20 species of *Allium* supplied to Plant Molecular Biology Lab, NBRI, Lucknow for Protein analysis and RNA isolation.

**Farmers/ indentors supply:** Seed samples and live rooted plant material viz. **Hort. crops:** Apple- 07 Kg, Chilli seedlings- 400 nos., Cryptomeria- 12 nos., Gladiolus spikes- 16 nos., Glardia- 200 nos., Grape- 15 nos., Hydrangea- 04 nos., Japanese Quince- 04 nos., Kiwi- 2,324 nos.+ 50 (stem cuttings)+ 38.5 kg, Kagzi neebu- 251 nos., Passion fruit- 20 nos., Peach- 36 nos. + 124 kg, Plum- 29 kg, Pear- 17.5 kg, Strawberry- 80 nos., Walnut- 9.5 Kg, *Wisteria*- 2 and *Bignonia*- 10; **Agri. Crops:** *Brassica* spp.- 41 nos., Barley- 5 Kg; Wheat (mixed grains)- 2.5 q.; HB208- 08 Kg, Cabbage- 65 kg; **M. & AP.:** *Achillia millefolium*- 50 nos., *Allium tuberosum*- 75 g, *Artemisia annua*- 90 g + 10 nos., *A. maritima*- 25 nos., Ashwagandha- 15 nos., *Curcuma zedoria*- 50 nos., *Cymbopogon flexuosus*- 65 nos., *Digitalis*- 20 nos.+ 200 g, *Ginkgo biloba*- 44 nos., Isabgol- 10 nos., Kapoor tulsi- 10 nos., *Lavendula angustifolia*- 75,864 nos., *Marjorana hortensis*- 525 nos., *Melissa officinalis*- 60 nos., *Menta caridiaca*- 15 nos., *M. citrata*- 15 nos., *Pelargonium graveolens*- 24,336 nos.+ 5,000 nos. (stem cuttings), *Rosa damascena*-554 nos., Rosmary blue flowered- 27,204 nos., Rosmary white flowered- 5,554 nos., *Ruta graveolens*-10 nos.+ 40 g, *Salvia officinalis*- 25 nos.; *S. sclarea*- 25 nos., *Satureja montana*- 25 nos., *Scindapsus officinalis*- 50 nos., *Stevia rebaudiana*- 38 nos., Winter savory- 4 nos.; WEUPS: Bamboo- 2 log were supplied to different farmers/indentors.

## 10.10 All India Co-ordinated Trial

**Rice bean:** All India Coordinated Trial of Initial Varietal

Trial, Advance Varietal Trial I & II–Hills of rice bean consisting of 24 varieties was conducted. RBL-03 (23.50 q/ha), RBL-463 (22.00 q/ha), LRB-10 (21.25 q/ha), LRB-22 (20.00 q/ha) performed better in terms of grain yield over other entries.

## 10.11 Registration of germplasm

**Meetha reetha/ sweet soap nut tree (*Sapindus mukorossi* Gaertner)- IC538068 (INGR-08060)**– Sacred and aesthetic value tree associated with divine Sikh Guru Nanak in the Reetha Sahib, district Champawat, Uttarakhand. Genetic stock for geographical indications (Gis). Fruits distributed as a PRASAD. Guru Nanak Vatika a kind of arboretum maintained by Management Committee of Gurudwara near by Reetha Sahib in the confluence of Radhiya and Ladhiya River. Deciduous medium size 10-15 m high. Fruit fleshy, globose, 1- seeded drupe, with pale-brown or brown, translucent and wrinkled pericarp when ripe. Fruit ripened during the month of May – Dec. Fruit sweet in taste (TSS – 0 Brix 12 – 14). Seed black, globose and smooth. 100 seed weight-175 g. flowering and fruiting during the month of May-Dec. Nearly 10-15 trees procured through air layering is being maintained and established in the Bio-diversity Botanical Garden NBPGR, R/S Bhowali.

**Uttaranchali Kagazi Nimbu (INGR 08098/ IC319045/ P/N/SKV-1863)-**

*Citrus aurantifolia* (Christm.) Swingle collected by Bhowali, Nainital (Uttarakhand) in 1990 was registered genotype showed the best performance with unique feature of frost tolerance among all other accessions. Medium fruit size, market value, also observed that not a single fruit skin, plant twig was found damage even during heavy snowfall. Upright, much branched, plant bears 200-300 fruit/ tree/ year; leaf length 7.20 cm; leaf width 2.62 cm; flower diameter 1.96 cm with bright lemon yellow round fruit having fruit length 4.77 cm, fruit width 4.28 cm and TSS 7.1<sup>0</sup> Brix, suitable for cultivation in hills up to 2000 asl.

### Research Programme (Programme Code: Title, 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**)

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

PGR/PGC-BHO-01.01: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources of field crops with emphasis on ethno botanical aspects (**KC Muneem**, KS Negi, SK Verma, and PS Mehta)

PGR/PGC-BHO-01.02: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources of temperate horticultural crops (**SKVerma**, KC Muneem, KS Negi, 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, Principal Scientist, Economic Botany. (**KC Muneem**, SK Verma and A Raina)

### Externally funded projects

Studies on relationship between eco-geography of the chemotypic variation of nine important but highly threatened medicinal plant species and prospects of their cultivation (NAIP) (Consortium partner NBRI, Lucknow, UP.–leader; NBPGR, R/S Bhowali and NRC on M & AP Anand, Gujrat-consortium partners- AKS Rawat, **KS Negi** and P Manivel)

Biosystematics studies on the genera of *Vigna*, *Cucumis* and *Abelmoschus*(NAIP) (Consortium partner NBPGR, New Delhi and its Regional Stations Thrissur, Bhowali and Jodhpur; Shivaji University Kolhapur, MS and North Eastern Hill University, Shillong- Consortium partners- KV Bhat, IS Bisht, SK Malik, K Joseph John, M Lata, **KS Negi**, G Krishnan, S Rama Rao and SR Yadav)

## 11. EXPLORATION BASE CENTER, CUTTACK

**Summary:** Four explorations including a special mission for flood affecting areas of Orissa were undertaken and 488 accs. were collected. The important germplasm collected include submergence tolerant rice accessions : *Kalakadama*, *Dhoia madhabi*, *Putia*, *Nandi maguri*, *Jangalijatta*, *Kelikadamba*, *Pani dubki*, *Saleijhatti*, *Champeisali*, *Begunia mota*, *Boudia champa*, *Bugudi gelheigutti*, *Landijhalka*, *Jalbuda dhan*, *Balia dadha*, *Talamuli*, *Bhuta*, drought tolerant rice : *Saria*, *Sathia*, *Puni*, *Danesaria*, *Sanara*, *Kankeria* and *Jhunturi*, scented rice: *Tulsibasa*, *Chandanpedi*, *Banspatri*, *Mulamanji*, *Palas phula*, *Sitapati*, *Kalajira*, *Mugajai* and *Krushna ballav*. In addition variability in pulses germplasm for the traits viz; maturity duration (75-115 days), plant type (bushy, trailing), pod shape & size, number of pods per plant, color & size of seeds, average yield/ plant etc were also recorded.

During *Kharif* 2008, 170 accs. of scented rice were grown for characterization and evaluation with five checks in augmented design. The range of variability for plant height (106.96-186.88cm), EBT (5.0-25.4), leaf length (42.86-71.28cm), leaf width (0.72-1.58cm), panicle length (21.42-36.64cm), 100 grain weight (4.77-15.45) and yield/ plant (9.2-27.6gm) were recorded. Among horse gram germplasm, the range of variability was recorded for No. of pods/plant (23-180), Pod length (3.03-5.53cm), No. of seeds/ pod (3.0-7.0), 100 seed wt. (2.08-4.92mg) and yield/ plant (1.08-25.12gm). Another set of 1,844 accs. of cultivated rice (IRRI rice germplasm) was grown jointly with CRRI, Cuttack for repatriation into national gene bank. Under germplasm exchange activity, a set of 2,371 accs. comprising cultivated rice (2,052), root and tuber crops (11), wild *Oryza* species (50) and sesame (258) accessions were received/ supplied to various institutes for research purposes. A total of 3,782 accessions were deposited comprising 3,294 accs. for LTS, 394 accs. for MTS and 94 accs. for field gene bank.

A total of 2,911 accs. comprising cultivated rice (2,053), medicinal and aromatic plants (321), sesame (300), wild *Oryza* species (156), other wild relatives of crop plants (34), sylvicultural economic plants (24), banana (17) and horticultural crops (6) are being maintained at Cuttack.

The National Bureau of Plant Genetic Resources, Base Centre, Cuttack was established in July, 1986 with the responsibility for exploration and collection of indigenous agri-horticultural crops of Orissa and adjoining regions along with the characterization and conservation of rice genetic resources of northern and eastern plain regions of India. The Centre is located in the campus of Central Rice Research Institute, Cuttack (Orissa).

### 11.1 Exploration and Germplasm Collection

During the reporting period four exploration missions were conducted including three special missions to flood affected areas of Orissa. Out of which two exploration trips were conducted by the scientists of NBPGR (HQ), New Delhi. A total number of 488 accs. comprising pulses (96) and multi crops from flood affected areas (392) accs. were collected as per the details given below.

**Table 1: Details of exploration and germplasm collection during 2008**

Crops	Areas	Collection sites	No. of spp.	No. of accs.
Pulses	Jajpur & Ganjam (Orissa)	32	4	96
Trait specific germplasm (Submergence & drought tolerance)	Dhenkanal, Jajpur, Keonjhar, Angul, Sambalpur, Puri, Bargarh, Sonepur (Orissa)	41	15	129
	Nayagarh, Boudh, Bolangir, Kalahandi, Gajapati	21	27	125
	Cuttack, Kendrapara, Jagatsingpur, Puri, Khurda, Jajpur, Bhadrak	54	12	138

The first exploration mission was undertaken during April, 2008 for collection of pulses germplasm from Jajpur and Ganjam districts of Orissa. A set of 96 accessions comprising *Vigna radiata* (31), *Vigna mungo* (35), *Macrotyloma uniflorum* (17) and *Lathyrus sativus* (13) were collected during the exploration programme. The district-wise diversity collected includes 37 accessions from Jajpur, and 59

accs. from Ganjam districts of Orissa. Wide range of diversity and variability were observed for maturity duration (75-115 days), plant type (bushy, trailing), pod shape & size, number of pods per plant, color & size of seeds, average yield/ plant etc.

During late September, about 19 districts of Orissa faced an unprecedented flood posing a severe damage to



vegetation, crops animals and human lives. About 5,771 villages under 137 blocks in 19 districts of Orissa (Cuttack, Kendrapara, Jajpur, Bhadrak, Jagatsingpur, Khurda, Puri, Dhenkanal, Keonjhar, Angul, Sambalpur, Bargarh, Subarnapur, Nayagarh, Boudh, Bolangir, Kalahandi, Rayagada, Gajapati) has been affected causing serious threat to cultivated rice, wild rice, and other agri-horticultural crops in the field. Around 4, 79,361 hectares of crop area has been submerged for 7 days to 19 days with turbid water. As a special exploration programme for collection of submergence tolerant germplasm, three teams from NBPGR, CRRI and CTCRI conducted exploration and collected 392 accs. from 132 collection sites in 19 flood affected districts of Orissa. Under special mission collection of germplasm from seven flood affected districts viz., Dhenkanal, Jajpur, Keonjhar, Angul, Sambalpur, Bargarh, Sonepur of Orissa were under taken by this centre and a total of 129 accessions were collected comprising cereals (58), millets (1), tuber crops (45), pulses (5), spices (3), leafy vegetables (12), vegetable crops (4) and oil seeds (1).

#### 11.1.1 Trait specific accessions collected

##### Submergence tolerant rice accessions:

*Kalakadama, Dhoia madhabi, Putia, Nandi maguri, Jangalijatta, Kelikadamba, Pani dubki, Saleijhatti, Champeisali, Begunia mota, Boudia champa, Bugudi gelheigutti, Landijhalka, Jalbuda dhan, Balia dadha, Talamuli, Bhuta*

**Drought tolerant rice accessions:** *Saria, Sathia, Puni, Danesaria, Sanara, Kankeria and Jhunturi.*

**Scented rice accessions:** *Tulsibasa, Chandanpedi,*

*Banspatri, Mulamanji, Palas phula, Sitapati, Kalajira, Mugajai and Krushna ballav.*

**Tuber crops:** A total of 45 accs. of tuber crops comprising *Colocasia esculenta* (30), *Dioscorea alata* (8), *Ipomoea batatas* (5), *Amorphophallus campanulatus* (2) were collected. The variability in rhizome shape, size and colour in *Colocasia* and the shape and colour of tubers in case of *Ipomoea batatas* were recorded.

**Leafy vegetables:** A total of 12 accs. of leafy vegetables comprising *Amaranthus viridis* (6), *A. tricolour* (5) & *A. hybridus* (1) were collected. Variability in the colour of stem and leaves, branching pattern, inflorescence type etc. was recorded.

**Pulses:** Five accessions of pulses germplasm comprising *Vigna mungo* (2) and *V. radiata* (3) were collected which were suitable for sowing in the flood affected areas immediately after receding of water from the field.

**Vegetable crops and spices:** Four different vegetable crops (one acc. each) namely *Luffa acutangula*, *Ablemoschus esculentus*, *Vigna unguiculata*, *Capsicum annum* and three accs. of *Curcuma longa* were collected for further study. These landraces of various crop groups possess unique traits (e.g. disease/ pest tolerance, abiotic stress tolerance) which have been reported by farmers. The farmers have been conserving these landraces for generations through *in situ* on farm conservation and use the same seeds for growing in next season. The detailed collections made from the flood affected areas are given in Table-2.

**Table 2: Crop-group wise collections made from flood affected areas of Orissa**

Crops	Botanical name	Team-I	Team-II	Team-III	Total
<b>Cereals (208)</b>					
Rice	<i>Oryza sativa</i>	90	60	58	208
<b>Millets(06)</b>					
Bajra	<i>Pennisetum spp.</i>	-	1	1	2
Ragi	<i>Eleusine coracana</i>	-	2	-	2
Mandia	<i>Eleusine indica</i>	-	2	-	2
<b>Tuber crops (96)</b>					
Taro	<i>Colocasia esculenta</i>	25	8	30	63
Canna	<i>Canna edulis</i>	-	1	-	1
Greater yam	<i>Dioscorea alata</i>	8	2	8	18
Arrowroot	<i>Maranta arundinacea</i>	1	1	-	2
Sweet potato	<i>Ipomoea batatas</i>	1	1	5	7
Elephant foot yam	<i>Amorphophallus campanulatus</i>	1	2	2	5

<b>Pulses (23)</b>					
Green gram	<i>Vigna mungo</i>	-	5	2	7
Black gram	<i>Vigna radiata</i>	-	3	3	6
Horse gram	<i>Macrotyloma uniflorum</i>	-	3	-	3
Bengal gram	<i>Cicer arietinum</i>	-	1	-	1
Arhar	<i>Cajanus cajan</i>	-	6	-	6
<b>Spices (04)</b>					
Turmeric	<i>Curcuma longa</i>	-	1	3	4
<b>Leafy Vegetables (22)</b>					
Amaranth	<i>Amaranthus</i> spp.	3	7	12	22
<b>Vegetable Crops (19)</b>					
Chilli	<i>Capsicum annum</i>	-	5	1	6
Ridgegourd	<i>Luffa acutangula</i>	1	1	1	3
Pumpkin	<i>Cucurbita pepo</i>	1	1	-	2
Coriander	<i>Coriandrum sativum</i>	1	-	-	1
Rice bean	<i>Vigna umbellata</i>	-	2	-	2
French bean	<i>Phaseolus vulgaris</i>	1	1	-	2
Ladys finger	<i>Abelmoschus esculentus</i>	-	-	1	1
Cowpea	<i>Vigna unguiculata</i>	-	1	1	2
<b>Oilseed crops (06)</b>					
Sesame	<i>Sesamum orientale</i>	-	2	1	3
Linseed	<i>Linum usitatissimum</i>	-	1	-	1
Mustard	<i>Brassica napus</i>	-	1	-	1
Castor	<i>Ricinus communis</i>	-	1	-	1
<b>M &amp; AP (04)</b>		-	4	-	4
<b>Wild relatives (05)</b>					
Wild rice	<i>Oryza rufipogon</i>	5	-	-	05
		<b>138</b>	<b>125</b>	<b>129</b>	<b>392</b>

**N.B- Team-I :** Dr. G. Gangopadhyay, NBPGR, Dr. B.C. Patra, CRRI & Scientists of CTCRI, **Team-II-** Dr. R.K. Srivastava, NBPGR, Dr. H.N. Subudhi, CRRI & Dr. M. Nedunchezian, CTCRI, **Team-III-** Dr. D.R. Pani, NBPGR, Mr. P.N. Nayak, CRRI & Dr. K. Laxminaraynam, CTCRI.

## 11.2 Germplasm Characterization

**Cultivated rice:** A set of 170accs. of scented rice with five checks were characterized during *Kharif*, 08. Observations on various morpho-agronomic characters were recorded as per the minimal descriptor. The range of variability recorded for various agronomic traits are given in (Table-3).

**Table 3: Range of variation in quantitative traits (*Kharif* -2008)**

Traits	Range		Mean
	Minimum	Maximum	
Plant height (cm)	106.96(IC258928)	186.88(IC283221)	146.92
EBT	5(IC257265)	25.4(IC203545)	15.2
Leaf length (cm)	42.86(IC203281)	71.28(IC203536)	57.07
Leaf width (cm)	0.72(IC257264)	1.58(IC283311)	1.15
Panicle length (cm)	21.42(IC203291)	36.64(IC203540)	29.03
100 grain wt. (gm)	4.77(IC203563)	15.45(IC283204)	10.11
Yield/Plant (gm)	9.2(IC256821)	27.6(IC257231)	18.4

Out of 1,131 accessions of cultivated rice germplasm, characterized and multiplied during *Kharif* 2007 in augmented design with five checks (Panidhan, Jaya, Jyoti, Tulsi, Mahsuri) the accessions viz., IC514684, 514744, 514911, 514764, 515184, 514654 and 514698 were found promising on the basis of grain yield performance over the best check.

**Horse gram:** A set of 87 accessions of horse gram germplasm were grown in augmented design with four checks during *Rabi*-2008. The range of variability recorded for various traits viz., germination, plant vigor, plant growth habit, leaf and stem characters are given in (Table-4). (87 accs., design- augmented, checks-4)

**Table 4: Range of variation in quantitative traits (Rabi-2008)**

Traits	Range		Mean
	Minimum	Maximum	
No. of pod	23.0(IC107114)	180(IC283726)	10.15
Pod length (cm)	3.03(IC313361)	5.53(IC426520)	4.28
No. of seeds/Pod	3.0(IC313361)	7.0(IC470263)	5
100 seed wt. (mg)	2.08(IC108080)	4.92(IC106911)	3.5
Yield/Plant (gm)	1.08(IC106910)	25.12(IC526967)	13.1

**Promising lines:** Based on yield performance over the best check- IC526967, 470226, 470258, 283726 and 426520 were found promising on the basis of yield/ plant over the best check

**Brinjal (Core set):** A set of 181 accs. of brinjal (core set) germplasm were transplanted in augmented design with nine checks for evaluation during July, 08. Due to water stagnation in the experimental field, only 71 accs. could survive and maintained for seed multiplication which will be further grown for evaluation during *Kharif* -09.

### 11.3 Seed Multiplication

**Cultivated rice:** A total of 2,053 accessions of cultivated rice germplasm including 1,844 accessions received from germplasm conservation division were multiplied for LTS in collaboration with CRRI, Cuttack.

**Table 5: Details of germplasm exchange activities**

Crops	No. of accs.	Received	Supplied	Purpose
Cultivated rice	1,844	NBPGR, New Delhi	Crop improvement division, CRRI, Cuttack	Seed multiplication
Cultivated rice	208	New Collections from Orissa	Crop improvement division, CRRI, Cuttack	Characterization and conservation
Root and tuber crops	11	New Collections from Orissa	CTCRI, RS,Bhubaneswar	Characterization and conservation
Wild <i>Oryza</i> species	40	Maintained at NBPGR, Base centre,Cuttack	Crop Protection Division, CRRI, Cuttack	Evaluation
Wild <i>Oryza</i> Species	10	Maintained at NBPGR, Base centre,Cuttack	ANGRAU, Hyderabad	Research
Sesame	258	NBPGR, RS, Akola	—	Seed multiplication
<b>Total</b>	<b>2,371</b>			

### 11.5 Germplasm Conservation

A total of 3,782 accessions comprising 3,294 accs. for

All the rice germplasm were harvested and processed for conservation in National Gene Bank.

**Sesame:** A set of 898 accessions of sesame germplasm received from NBPGR Regional station, Akola was shown in the experimental field in augmented design with 30X10 cm spacing for seed multiplication. Each accession was maintained in two rows of 3m. length. Out of these a set of 890 accs. were processed and deposited in the NGB for long term storage.

### 11.4 Germplasm Exchange

A set of 2,371 accs. comprising cultivated rice (2,052), root and tuber crops (11), Wild *Oryza* species (50) and sesame (258) accessions were received/ supplied to various institutes for research purposes. The details are given in (Table-5).

LTS, 394 accs. for MTS and 94 accs. for field gene bank were deposited as per the details given in (Table-6).

**Table 6: Details of germplasm conservation activities**

Cropsname	LTS	MTS	FGB	Total
Rice	2,404	208	-	2,612
Wild Rice	-	05	-	05
Sesame	890	-	-	890
Pulses	-	96	-	96
Vegetable crops		85		85
Tuber crops	-	94	CTCRI, Bhubaneswar & NBPGR Base Centre, Cuttack	94
<b>Total</b>	<b>3,294</b>	<b>394</b>	<b>94</b>	<b>3,782</b>

## 11.6 Germplasm Maintenance

A total of 2,911 accs. comprising 2,053 accs. of cultivated rice, 321 accs. of Medicinal and aromatic plants, 300 accessions of sesame, 156 accs. of wild

*Oryza* species, 34 accs. of other wild relatives of crop plants, 24 accs. of sylviculturally economic plants, 17 accs. of banana and six accs. of horticultural crops are being maintained at NBPGR Base Centre, Cuttack.

### Research Project (Project Code, Title, PI)

PGR/EXP-BUR-CUT-01.00: Augmentation, characterization, evaluation, maintenance, regeneration, conservation and documentation of genetic resources in Orissa and adjoining regions (**DR Pani**)



## 12. REGIONAL STATION, HYDERABAD

**Summary:** A total of 31,208 samples [12,660-imports & 18,548-exports] were received for quarantine processing during the period under report. 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 and several pests of quarantine significance were intercepted. A total of 1,909 imported samples were found infested/ infected with pathogens (1,714), insects(81) and nematodes (114). A total of 1,655 samples were salvaged, 249 detained and 5 samples were rejected. A total of 18,548 samples were processed for export to different countries. In all, 154 phytosanitary certificates were issued.

A total of nine explorations were undertaken for the collection of indigenous diversity and 815 collections of various crops were made. A total of 879 accs of different agri-horticultural crops consisting of black gram (60), horse gram (150), sorghum (210), brinjal (115) and chillies (125), cowpea (80), dolichos bean (78) and leafy vegetables (61) were grown for characterization/ evaluation/ multiplication during Rabi 2007-08. A total of 1,063 accessions of small millets, black gram, sesame, brinjal, chillies, cowpea, field bean and wild legumes were grown in the field along with appropriate checks for characterization/ evaluation/ multiplication in Kharif 2008. A total of 478 accessions of leafy vegetables, chillies, cotton, linseed, wild legumes and others collected during exploration surveys were sent to Germplasm Handling Unit, NBPGR Delhi for national accessioning and medium term storage.

### 12.1 Quarantine

During the year 2008, a total of 31,208 samples of different crops were received and processed for quarantine clearance. Out of these, 12,660 samples (paddy- 3,899; maize- 3,682; sorghum- 603; pearl millet- 355; finger millet- 5; chickpea- 212; pigeonpea- 313; mungbean- 27; soybean- 193; *Brassica napus*- 8; Roselle- 75; groundnut- 46; bambara nut- 2; sunflower- 463; safflower- 123; castor- 75; cotton- 193; chilli- 423; tomato- 239; okra- 96; onion- 231; *Vicia* sp- 24; watermelon- 1,273; cucumber- 5; squash- 50; jojoba-9; Eucalyptus- 11 and other vegetables- 20) were imported from different countries and the remaining 18,548 (Maize- 678; sorghum- 4,537; pearl millet- 3,187; chickpea- 4,580; pigeonpea- 808; groundnut- 3,594 and small millets-1164) were meant for export to different countries.

**12.1.1 Import quarantine:** All the import samples were subjected to various seed health tests like visual examination, blotter test, X-ray radiography, enzyme linked immunosorbent assay (ELISA), centrifugation and microscopic examination.

During the period under report, 11,641 samples including paddy samples (3,114), maize (3,721), sorghum (486), pearl millet (423), finger millet (5), chickpea (212), pigeonpea (180), mungbean (27), groundnut (46), *Brassica napus* (8), sunflower (430), safflower (123), soybean (193), castor (75), cotton (110), roselle (75), chilli (434), tomato (187), okra (96), *Vicia* spp (24), onion (228), cucumber (7), squash (50), watermelon (1264), jojoba (9), other vegetables (23), tobacco (80) and Eucalyptus (11) were released to the respective REGIONAL STATION, HYDERABAD

**Table 1: Pathogens intercepted during the reporting period**

Pathogens	Crop	Country
<i>Alternaria ricini</i>	Castor	USA
<i>Aphelenchoides besseyii</i>	Paddy	Philippines
<i>Botrytis allii</i> and <i>Alternaria porii</i>	Onion	USA
<i>Cercospora</i> sp.	Watermelon	USA
<i>Colletotrichum capsici</i> and <i>Alternaria solani</i>	Chilli	Taiwan
<i>C.dematium</i>	Okra	AVRDC, Taiwan
<i>C. graminicola</i>	Sorghum	Mali
<i>Fusarium oxysporum</i>	Maize	CIMMYT, Mexico
<i>F. oxysporum</i>	Pearlmillet	Niger
<i>Pseudomonas syringae</i>	Tomato	USA
<i>Puccinia carthami</i>	Safflower	USA
<i>Rhizoctonia solani</i>	Pigeonpea	Kenya

The healthy accessions were released after giving the necessary salvaging treatments.

**Table 2: Details of quarantine processing**

Total number of samples infested/ infected in imports	1,909
Pathogens	1,714
Insects	81
Nematodes	114
Number of samples salvaged	1,655
Number of samples detained	249
Number of samples rejected	5

consignees after giving the mandatory treatments.

### 12.1.2 Post-entry quarantine observations

#### 12.1.2.1 Crop samples grown in the greenhouse

**(NBPGR):** To salvage and release healthy germplasm of groundnut from Japan, 381 accessions (about ten plants each), grown in greenhouse for virus observations, were released to ICRISAT for further growing in post entry quarantine isolation field.

All 24 accs of *Vicia* spp imported from Syria, subjected to grow-out test and ELISA for *Bean common mosaic virus* (BCMV) and *Peanut mottle virus* (PMV) were found free from these seedborne viruses.

**12.1.2.2 Crop samples grown in the greenhouse (ICRISAT):** ELISA tested samples/treated samples/samples suspected with infection were grown in the greenhouse, the details of which are given below. Plants suspected with infection were removed and destroyed.

Crop	Country	Samples (no.)
Groundnut	Japan,	535
	USA	44
Chickpea	Australia	118
	Ukraine	72
	USA	33
<b>Total</b>		<b>802</b>

Majority of groundnut accessions from Japan have shown *Peanut stripe virus* (PStV) symptoms. Suspected samples were confirmed by ELISA; seedlings were uprooted and incinerated, and prophylactic sprays made to avoid spread of the disease. Another consignment of groundnut from USA consisting of 44 germplasm accessions was grown in plant quarantine greenhouse. Incidence of *Peanut bud necrosis virus* (PBNV), mites and thrips was noticed and advised the spray of Monocrotophos (0.02%) and Kelthane (0.2%) against thrips and mites respectively. These accessions were found free from exotic seed-borne diseases and these were released.

Of the 212 chickpea accessions released, 33 from USA were grown in the greenhouse at ICRISAT for observation on bacterial infection (unknown etiology) as these were found infected with bacteria during blotter test. Collar rot (*Sclerotium rolfsii*) and leaf spot (*Alternaria alternata*) symptoms were observed. Collar rot was also observed on three (EC-600103; 600104 and 600106) of the nine accessions of chickpea from Israel (in greenhouse) for which Benomyl

drenching was advised to contain the disease.

### 12.1.2.3 Crop samples grown in post-entry quarantine isolation area at ICRISAT farm

During the post-rainy season, 776 pearl millet germplasm accessions, 2 sorghum breeding lines. 5 finger millet accessions and 303 maize accessions were planted in PEQIA. In addition, 498 maize accessions (410 from Mexico and 88 from Thailand) that belonged to ICRISAT-based SM Sehgal foundation were also planted in PEQIA for detecting exotic seed-borne pathogens.

Post-entry quarantine inspection was carried out at regular intervals on 381 groundnut accessions (10 plants each) from Japan and plants suspected with PStV symptoms (40 accessions) were uprooted for ELISA testing for further confirmation.

Groundnut germplasm (621 accessions) imported from Japan, upon reprocessing, found infected with *Peanut stripe virus* (PStV) in seed ELISA test, grow-out test in greenhouse and post-entry quarantine isolation field. Hence, the entire consignment was uprooted and incinerated.

**12.1.2.4 Private Industry Post-Entry Quarantine Inspections:** The details of crop germplasm that is being grown and inspected in the fields of Private industry are as below: The infected /suspected plants were uprooted and incinerated.

**12.1.2 Pre-export crop inspection:** During the rainy season, a total of 1,148 germplasm accessions (groundnut -643 and pigeonpea- 505) consisting of reference collection, diverse germplasm and regeneration accessions were inspected in the field plots during active growth period for their plant health status. In pigeonpea, Sclerotium rot during seedling stage in 25 accessions and yellow vein mosaic in 5 accessions were observed. In groundnut, crown rot caused by *Aspergillus niger* was noticed (0.5% in few accessions) during the seedling stage. Infected plants were uprooted and burnt. To prevent the spread of these diseases, Carbendazim (0.05%) + Mancozeb (0.2%) were sprayed thrice, at 2-week intervals to control *Cercospora* leaf spots (*Cercospora arachidicola* and *Phaeoisariopsis personata*) of groundnut.

Crop	Country	No. of samples	Private company	Remarks
Maize	Thailand	94	Syngenta India Ltd., Bangalore	One maize accession with leaf blight symptoms
	USA	3	Monsanto India Ltd., Hyderabad.	Inspection at the time of sowing At active crop growth stage: stem borer incidence upto 1%
Maize (treated)	Indonesia	2	Vibha Agrotech Pvt Ltd., Hyderabad	All were healthy
Maize (treated)	USA	2	Ei-Dupont Ltd., Bangalore	All were healthy
Maize (treated)	USA	2	Monsanto India Ltd., Hyderabad	All were healthy
Sunflower	Argentina		Advanta India Ltd.,	All were healthy
Sunflower	Egypt	8	HyTech Seed Pvt Ltd	All were healthy
sorghum	USA	15	NARDI, Hyderabad	All were healthy
Sweet sorghum	Australia	18	Advanta India Ltd., Hyderabad	All were healthy
Maize hybrids	Thailand	28		
Transgenic paddy	Belgium	61 events	Bayer Crop Science Pvt Ltd., Khanapur, Rangareddy, AP;	All were healthy
Chilli, Tomato	AVRDC, Taiwan	1519	Vibha Agrotech Pvt Ltd., Hyderabad	All were healthy
Chilli	AVRDC, Taiwan	17		
Tomato		50		
Okra		90	Indo-American Hybrid Seeds Ltd., Bangalore	All were healthy
Paddy	Belgium	6	Metahelix Life Sciences Pvt Ltd., Bangalore.	The downy mildew affected maize plant was uprooted and incinerated and advised to give metalaxyl spray to the remaining plants
	Philippines	139		
Maize	USA	11		
	Columbia	4		
	Mexico	46		
Sunflower	USA	50		
Chilli	Taiwan	15		
Paddy	Philippines	40		
Transgenic paddy	USA	18	M/S. DevGen seeds, Patancheru	All were healthy
		32 events	M/s. Bayer Bioscience Pvt Ltd., Patancheru,	All were healthy
Maize	USA	200	Vibha Agro Tech Pvt Ltd., Hyderabad	All were healthy
		96		
Transgenic cotton	USA	150	Greenhouse of Monsanto India Ltd., Kallakal,	All were healthy
Squash (treated)	Egypt	50	HyTech Seed Pvt Ltd., Hyderabad	<i>Tobacco streak virus</i> infection noticed on two accessions (M-13 and M-23) and the affected plants were uprooted and destroyed. ELISA on infected samples confirmed the infection

During the post-rainy season, sorghum 1,695 and pearl millet 600 accessions consisting of reference set, regeneration for long-term conservation, and critical germplasm accessions were planted and these will be inspected during active growth period for plant health.

**12.1.3 Export germplasm processed:** A total of 18,548 export samples consisting of maize (678), sorghum (4,537), pearl millet (3,187); chickpea (4,580);

pigeonpea (808); groundnut (3,594) and small millets (1,164) samples were processed for export to different countries. In all, 154 phytosanitary certificates were issued during the reporting period. A total of 241 seed samples (about 1% of the total) (sorghum-90, pearl millet-24, chickpea-16, pigeonpea-51 and groundnut-60) was rejected. The remaining 18,307 healthy samples were exported to different countries. In all, 157 phytosanitary certificates were issued during the reporting period.

Crop	Samples*		
	Processed	Rejected	Released
Sorghum	4,537	90	4,447
Pearl millet	3,187	24	3,163
Small millets	1,164	-	1,164
Chickpea	4,580	16	4,564
Pigeonpea	808	51	757
Groundnut	3,594	60	3,534
Maize	678	-	678
<b>Grand Total</b>	<b>18,548</b>	<b>241</b>	<b>18,307</b>

The rejections in the export germplasm of ICRISAT mandate crops were mainly due to failure of germination, seed contamination by *Bipolaris setariae*, *Fusarium oxysporum* f.sp. *ciceri*, *Botryodiplodia theobromae*, *Rhizoctonia bataticola*, *R. solani* etc.), stored-grain pests and bacteria of unknown etiology.

### Processing of germplasm for export to Global Seed Vault, Norway

A set of 20,950 samples of ICRISAT mandate crop germplasm, meant for export to Norway for conservation in the Svalbard Global Seed Vault, was verified and the voucher samples were examined thoroughly for their seed health status.

#### 12.1.4 Supportive Research

Soybean and green gram samples received from Dharwad were ELISA tested for *Peanut bud necrosis virus* (PBNV). One sample of soybean and eight samples of green gram were positive to PBNV. Ten varieties each of black gram and green gram were screened against PBNV in the greenhouse and all were found susceptible.

ELISA testing of necrosis infected plant samples (92 each) of urdbean and mungbean from Anantapur indicated the presence of TSV in 39 and 7 and PBNV in 40 and 71 samples, respectively.

Chilli samples (37) received from Guntur were ELISA tested against PBNV, *Cucumber mosaic virus* (CMV) and *Tobacco streak virus* (TSV). Results indicated that all 37 samples were positive to CMV.

Groundnut germplasm lines (80) were received from NRCG, Junagadh for testing against PBNV and TSV.

Ten lines screened against PBNV by sap inoculation were found susceptible.

ELISA testing of chilli samples (18) received from DATT centre, Khammam indicated positive reaction on four samples to CMV and seven samples to PBNV.

## 12.2 Plant Genetic Resources Activities

### 12.2.1 Plant exploration and germplasm collection:

A total of nine explorations were undertaken for the collection of indigenous diversity and 815 collections of various crops were made.

**Leafy vegetables:** The survey was undertaken in parts of Khammam district of Andhra Pradesh and adjoining regions of Chhattisgarh. A total of 125 accessions of 20 species including *Aerva lanata*, *Amaranthus dubius*, *A. gangeticus*, *A. oleracea*, *A. spinosus*, *Basella alba*, *B. rubra*, *Brassica* sp., *Cassia tora*, *Celosia argentea*, *Chenopodium album*, *Coriandrum sativum*, *Hibiscus cannabinus*, *Hymenodictyon excelsum*, *Moringa oleifera*, *Portulaca oleracea*, *Rumex acetosa*, *Spinacea oleracea* and *Trigonella foenum-graecum* were collected. In addition, 17 accessions of other crops were also collected including pulses (3), vegetables (3) and medicinal plants and wild relatives (11) including two accessions of cherry tomato from Dantewada district of Chhattisgarh, along with white seeded *Abrus precatorius*. Among the leafy vegetables, variation was observed in leaf and stem colour of *Amaranthus ganeticus*, *Basella alba*, leaf size of *A. oleracea*, *Protulacca oleracea* and *Basella alba* and stem colour of *A. spinosus*. *Cassia tora* besides being collected from the wild was also cultivated in several tribal homes in Khammam and Bastar and Dantewada. Trees of *Hymenodictyon excelsum*, usually grown around tribal homes in Chhattisgarh, yielded succulent leaves (Bohar Bhaji) that are used to prepare dishes that are highly relished by the locals.

**Onion and shallot onion:** A survey was undertaken in Visakhapatnam, West and East Godavari districts of Andhra Pradesh and Koraput district of Orissa in collaboration with Acharya N.G.Ranga Agricultural University. Diversity was collected from the tribal and traditional growing areas in East Godavari, Visakhapatnam and Koraput district of Orissa. Good variation in size and shape of the collected germplasm. A total of 37 accessions were collected which included





Variability in the size, shape and colour observed in the onion (*Allium cepa*) germplasm collected from Andhra Pradesh and Orissa

23 accessions of onion and 14 accessions of shallot onion.

**Wild edible legumes & medicinal plants:** A survey was conducted in tribal pockets of Khammam, East Godavari, Visakhapatnam and Srikakulam districts. A total of 82 accs. were collected including Wild legumes: 40 accs. (*Bauhinia* spp., *Canavalia* spp., *Cassia* spp., *Mucuna* spp., *Sesbania* spp. and others); Cultivated legumes: 21 accs. (cowpea, french bean, lima bean, pigeon pea, rice bean and others); Medicinal: 11 accs. (*Aristolochia*, *Gloriosa*, *Hemidesmus*, *Plumbago* and others); Miscellaneous: 2; and Wild relatives: 6 accs. (*Dioscorea*, *Luffa*, *Solanum*, *Trichosanthes*).

**Tuber crops & chillies:** This survey was undertaken in West Godavari, East Godavari, Visakhapatnam, Vizianagaram and Srikakulam districts of South and North Coastal region of Andhra Pradesh in collaboration with ANGRAU. A total of 172 accs. of germplasm which include 119 accs. of tuber crops, 27 accs. of chillies and *Capsicum frutescens* and 26 accs. of other collections / wild relatives including *Alpinia* sp., *Amorphophallus paeoniifolius* var. *campanulatus*, *Capsicum frutescens*, *Caryota urens*, *Colocasia esculenta* var. *aquaticilis*, *Cucumis hardwickii*, *Curcuma angustifolia*, *C. aromatica*, *Lycopersicon pimpinellifolium*, *Melothria* sp., *Mucuna monosperma*, *Piper* sp., *Solanum indicum*, *Stemona tuberosa*. The important landraces collected under tuber crops include: **Greater Yam-** *Cheda dumpa*, *Pendalamu*; **Dioscorea spp.-** *Adavi tega*, *Arika pendalamu*, *Cheda dumpa*, *Konda teega*, *Kunda dumpa*, *Nagali dumpa*, *Nagalimatam dumpa*, *Saapu tega*, *Siragadi dumpa*, *Tega*, *Wyma dumpa*; **Taro-** *Chema*, *Chinna chema*, *Peer chema*; **Elephant foot**



Diversity of the shallot onion (*Allium cepa* l. var. *aggregatum*) germplasm from Andhra Pradesh and Orissa

**yam-** *Dula gandha*, *Durada kanda*, *Gandha*, *Kanda*, *Teepi kanda*; **Tannia/ Cocoyam-** *Arati chema*, *Chema*, *Chema dumpa*, *Durada saara*, *Pala chema*, *Pedda chema*, *Rangam saara*, *Saara dumpa*, *Saara kanda*, *Sanku chema*, *Teepi sara*; **Sweet potato-** *Chilakada dumpa*, *Kandamula dumpa*, *Tiyya dumpa*; **Cassava-** *Karra pendalamu*, *Pendalam dumpa*; **Queensland Arrowroot-** *Tamara dumpa* and under **Chillies** include: *Agency*, *Anakapalli potti*, *Bongu mirchi*, *Deshawali*, *Laavulu*, *Pachcha mirapa*, *Pottikaya* and *Rasagulla*. Endemic variability in tuber crops was observed for stem spineness, leaf size, tuber surface and in side colour, shape, size, taste with the acrid and acidity-free types, presence/ absence of ornamentation and root remnants and yield. In chillies, variability was observed for plant height, fruit shape, fruit size, fruit length, thick ness, immature fruit colour, mature fruit colour and pungency. Queensland arrowroot, a minor tuber crop is associated with *Nuka dora* and *Kodhu* ethnic communities with the cultivation of this tuber crop in Visakhapatnam district. Out of the tuber crops, in cassava and sweet potato, the local landraces/ traditional



PSRV12494 - red flowered perennial cotton *Gossypium arboreum* from Koppal district, Karnataka



**PSRNM12428 - *Amorphophalus paeonifolius* var *campanulatus* from Srikakulam, Andhra Pradesh**

cultivars are almost replaced by improved introductions/ cultivars. In chillies, the local landraces are on the verge of replacement by improved varieties and other profitable crops like maize/ other vegetables in view of vagaries of nature, declining irrigation sources, pests and disease problems, lack of assured market and demand. Cultivar *Pachcha mirapa*, the fruits of which are yellow in colour and used in the preparation of yellow pickles is currently on the verge of extinction due to lack of demand and market. In spite of onslaught of improved varieties in Chillies, landraces *Pottikaya* in East Godavari district and *Deshawali/ Laavulu/ Bongu mirapa* in West Godavari district are cultivated over large areas cultivation as they are very popular and have large demand in view of their apt suitability for domestic use and preparation of pickles.

**Linseed:** The survey was undertaken from North Telangana region of Andhra Pradesh and adjoining southern parts of Maharashtra including the districts of Medak, Nizamabad & Adilabad and Nanded. A total of 104 accs. were collected including 85 accessions of linseed and 19 accessions of other agri-horticultural crops/ wild relatives comprising of black gram-2, chickling pea-3, green gram-3, lentil-1, mustard-2, niiger-1, pea-2, safflower-3, *Canavalia* sp-1/ and *Solanum surattense*-1. Significant diversity was observed in linseed for capsule size, number of seeds/ capsule (6 - 8), seed size, shape and colour (shades of brown).

**Cotton:** This survey was undertaken in Kurnool & Anantapur districts of Andhra Pradesh and Bellary & Raichur districts of Karnataka in collaboration with ANGRAU/ UAS Dharwad. A total of 78 accessions including *Gossypium arboreum* (30), *G. arboreum* (2-perennial), *G. herbaceum* (35) and 11 accs. of other crops / wild relatives (11-*Caesalpinia bonduc*, *Luffa*

*tuberosa*, *Lycopersicon pimpinellifolium*, *Solanum trilobatum*, *Solanum xanthocarpum*) were collected. Landraces of *Gossypium arboreum* cotton include *Bokda*, *Mungari* and *Pandarpur* and for *G. herbaceum* *Anneri*, *Hingari*, *Javvari*, *Jawari*, *Jayadhar* and *Sannaththi*. Significant variability was observed in plant height, branching, flower colour, boll size, boll shape, no. of bolls/ plant, no. of seeds/ boll and seed size. *G. herbaceum* cottons are almost replaced by the Bt. Cotton in the hitherto conventional areas of Kurnool and Anantapur districts of Andhra Pradesh and Raichur district of Karnataka. The perennial cottons of *G. arboreum* traditionally cultivated in the backyards of houses exclusively for preparation of wicks for worshipping are no longer to be seen and on the verge of extinction in view of indifference and eroding religious customs and orthodoxy which played a significant role in the perpetuation of this particular species.

**Pongamia:** A survey for the collection of *Pongamia* germplasm was undertaken in the districts Medak. Rangareddy and Mahaboobnagar districts of Andhra Pradesh under Andhra Pradesh State government funded RSAD project. A total of 16 accessions of *Pongamia* germplasm were collected. The variability collected includes *Pongamia* plants which are trees to shrubby habit, spreading to drooping branches, dark green to light green leaves and pods in clusters of up to 8 pods/ cluster.

**Palmyra Palm:** The survey was undertaken in the Salem district of north central region of Tamil Nadu in collaboration with TNAU and APHU. A total of nine accessions were collected. Diversity was observed in tree height and girth, number of leaves, number of fruits/ tree, fruit colour, shape, size and weight, flesh and nut weight and seed size.

**Luffa and other vegetables:** The survey was undertaken in southern region of Andhra Pradesh and adjoining eastern parts of Karnataka including parts of the districts of Anantapur, Cuddapah, Chittoor and Kurnool (AP) and Bellary, Chickballapur, Kolar and Raichur (Karnataka). The exploration was undertaken in collaboration with IIVR, APHU & UAS-Bangalore. A total of 175 accs. were collected including *Luffa* species: *L. acutangula*- 38; *L. cylindrica*- 27; *L. acutangula* var. *amara*- 8; *L. tuberosa*- 14; other vegetables: cucurbits: 33 (bitter gourd, bottle gourd, cucumber, ivy gourd, oriental pickling melon, pumpkin,





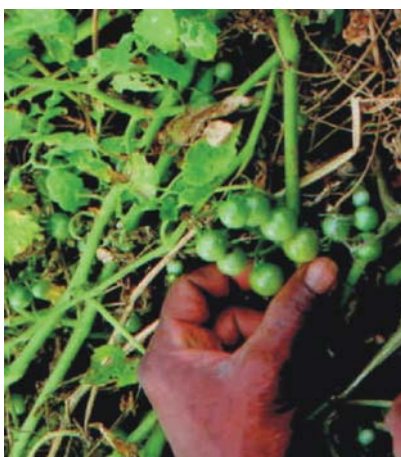
PSRNM12273 – round-fruited medium pungent popular chilli landrace ‘Puttikaya’ from East Godavari, Andhra Pradesh



PSRNM 12351 – Purple coloured *Xanthosoma saggitifolium* from Visakhapatnam, Andhra Pradesh



*Portulaca oleracea* (VKAS 178) - Robust, large-leaved succulent accession from Chindga, Bastar, Chhattisgarh



*Lycopersicon pimpinellifolium* (Cherry tomato) (VKAS 102) – from Dantewada, Chhattisgarh; spreading type with branches about 12 to 15' long and 7 fruits/cluster

snake gourd), beans: 25 (cluster bean, dolichos bean, field bean; lima bean), solanaceous vegetables: 10 (brinjal, chillies), others: 9 (kenaf, okra, onion, roselle); medicinal species: 2 (*Abrus precatorius*, *Clitoria ternatea*); wild relatives: 9 ((*Abelmoschus ficulneus*, *Canavalia* sp., *Hibiscus* sp., *Melothria* sp., *Schouwia purpurea*, *Solanum pubescens*, *Vigna trilobata*). Significant diversity was observed in ridged gourd and smooth gourd for fruit length, size, shape, colour, no. of seeds/ fruit and seed size. Related

*tuberosa* which are endemic to the region could also be collected.

## 12.2.2 Germplasm Characterization and Evaluation

### Rabi 2007-08

A total of 879 accs of different agri-horticultural crops consisting of black gram (60), horsegram (150), sorghum (210), brinjal (115) and chillies (125), cowpea (80), dolichos bean (78) and leafy vegetables (61) were grown for characterisation/ evaluation/ multiplication during Rabi 2007 –08.

**Black gram:** A total of 60 accessions were grown for multiplication for long term conservation in the National Gene Bank (NGB) and also for medium term conservation in the MTM at the Station.

**Horse gram:** A total of 150 accessions were grown for evaluation and multiplication in Augmented block design (ABD) with three check varieties Palem-1, Palem-2 and AK-21. Out of all characters clusters/ plant and plant height seem to be more diverse. Accessions IC261288 and IC14352 were found to be promising for pod length (6.7 cm) and 100 seed weight (6.1 g) respectively as compared to best checks Palem-1 (4.9 cm) and Palem-2 (4.0 g) respectively.

**Sorghum:** A total of 210 accessions were characterized and evaluated in ABD along with 2 check varieties (M-35-1 and CSV-16). High diversity was observed for some quantitative traits which include plant height, leaf length, leaf width, total number of leaves, panicle length and panicle width. Some accessions were identified as

promising over the checks.

**Brinjal:** A total of 115 accessions were grown for characterization and evaluation in ABD with three checks Bhagyamathi, Pusa Purple Long and Shyamala. Out of all characters fruit weight and fruit length seem to be more diverse. High diversity was observed in different quantitative traits as follows: fruit length (3.8 – 27.3 cm), fruit width (3.1 – 10.8 cm) and fruit weight (10.0 – 425.0 g). Accessions identified as promising over the best check: fruit weight: IC545872 (425.0 g/ Shyamala-108.6 g) and fruit length: IC545894 (27.3 cm/ Pusa Purple Long-13.1 cm).

**Chillies:** A total of 125 accs. were characterized, evaluated and multiplied in an ABD with CA-960, LCA-334 and Pusa Jwala as check varieties. A total of 45 qualitative and quantitative descriptors pertaining to plant, flower, inflorescence and fruit were recorded. Out of all characters branches (no.), fruit width and plant height seem to be more diverse. A wide range of variation was recorded for different traits which include viz. branches (no.) (2.0 - 12.0), days to flowering (105 – 187), fruit length (1.2 – 11.8 cm) and fruit width (7.8 – 25.1 mm) etc. The promising accessions include EC399556 (105/ CA-960-130.2) for days to flowering, EC399047, EC389238 and EC399539 (161/ CA-960-181) for days to maturity and EC389238 (12.0 cm/ Pusa Jwala- 7.2 cm) for fruit length.

**Cowpea:** 80 accessions were grown for characterisation and evaluation in ABD with three checks C-152, CoVu 702 and GC-3. Promising accs. were identified for days to flowering, pod length and seeds/ pod. Accession IC519745 was found resistant to *Black eye cowpea mosaic virus* (BICMV).

**Dolichos bean:** A total of 78 accs. were characterized, evaluated and multiplied in an ABD with Arka Jay, Arka Vijay and RND-1 as check varieties. Out of all characters pod length and pod width seem to be more diverse. A wide range of variation was recorded for different traits which include viz. branches (no.) (2.0 - 5.3), days to flowering (63 – 124), internode length (1.5 – 5.0 cm), pod length (4.0 – 17.1 cm) and pod width (1.2 – 5.1 cm) etc. The promising accessions include IC546340 (5.3 cm/ RND-1- 3.5 cm) for primary branches and IC383197 (5.1 cm/ Arka Jay- 3.2 cm) for pod width.

**Leafy Vegetables:** A total of 61 accs. of leafy vegetables consisting of *Amaranthus dubius*, *A. paniculatus*, *A. spinosus*, *A. tricolor* and *Spinacea oleracea* were taken up for multiplication.

**Wild legumes:** A total of 26 accessions of *Canavalia ensiformis* and 10 accs. *Mucuna pruriens* were



**Basella alba (VKAS 105)** – Vigorously growing with purple stems and oval shaped leaves from Dantewada, Chhattisgarh

characterised for agro-botanical characters. Proximate analysis of *C. ensiformis* for protein content and fatty acid composition was taken up. A total of 37 accs. consisting of *C. ensiformis*, *Cassia angustifolia*, *C. auriculata*, *C. occidentalis*, *C. tora*, *Crotalaria verrucosa*, *Tephrosia purpurea* and *Vigna trilobata* were grown for multiplication.



**Amaranthus gangeticus (VKAS 22)** – in kitchen garden of Ms N Nagamani of Nagaram (V), Borgampadu (M), Khammam (Dt.) with potential for multi-cuts over 6-7 months

### Kharif, 2008

A total of 1,063 accessions of small millets, black gram, sesame, brinjal, chillies, cowpea, field bean and wild legumes were grown in the field along with appropriate checks for characterization/ evaluation/ multiplication.



Crop	No. of Accs.	Checks	Activity
Barnyard millet	17 (RBD)	K-1, VL-29	Evaluation
	76		Multiplication
Black gram	35 (RBD)	T-9, PU-19, LBG-20	Characterization, evaluation & multiplication
	135 (ABD)		
Finger millet	22 (RBD)	PR-202, VL-149	Evaluation
Italian millet	130		Multiplication
Little millet	22 (RBD)	CO-2, OLM-203	Evaluation
	52		Multiplication
Kodo millet	30		Multiplication
Pillipesara bean	20 (RBD)	LBG-20, ML-267	Characterization, evaluation & multiplication
Proso millet	13		Multiplication
Sesame	23 (ABD)	JLT-7, JLT-26, TC-25,	Evaluation & multiplication
Brinjal	181	Arka Neelkanth, Bhagyamathi, KS-331, PPL, Punjab Sadabahar, Pusa Ankur, Pusa Kranti, Pusa Upkar, Shyamala	Validation of Core set
Chillies	88	CA-960, LCA-334, Pusa Jwala	Characterization, evaluation & multiplication
Cowpea	117	GC-153, C-152, CoVu-702	Characterization, evaluation & multiplication
Field bean	66	Arka Jay, Arka Vijay, TFB-1	Characterization, evaluation & multiplication
Wild legumes ( <i>Canavalia</i> and <i>Mucuna</i> )	36		Characterization & multiplication

**Black gram:** Accessions IC398989 (4.9cm, 6.4) and IC436676 (4.9cm; 6.4) were found superior to the best check (T-9-4.9cm; 5.6) for pod length and seeds/pod.

**Italian millet:** In Italian millet, IC257877 is the earliest to flower in 39 days when compared to check variety Lepakshi which flowered in 46 days.

**Barnyard millet:** In barnyard millet, IC257799 is the earliest to flower in 42 days when compared to check variety VL-29 which flowered in 52 days.

**Little millet:** In little millet, IC372034 is the earliest to flower in 43 days when compared to check variety CO-2 which flowered in 60 days.

**Finger millet:** In finger millet, PSR-10095 appears to be promising as an early accn. with 59 and 87 days to flower and mature when compared to VL-149, which flowered and matured in 63 and 100 days, respectively.

**Brinjal:** Analysis of brinjal evaluation data pertaining to 181 accs. is in progress.

**Chillies:** Characterization, evaluation, and multiplication

of 88 accs. of Chilli germplasm is in progress. IC215008 was the earliest to flower in 93 days when compared to Pusa Jwala which flowered in 96 days.

**Cowpea:** Accession IC282138 (20.6cm) was identified better than the best check for pod length (best check CoVu 702 (14.3cm)); and IC282061 (16.9) for seeds/pod (best check C 152 (15.7)).

**Field Bean:** Characterization, evaluation, and multiplication of 66 accs. of field bean germplasm is in progress. Check TFB-1 was the earliest to flower and mature in 61 and 85 days respectively when compared to germplasm.

**Wild legumes:** A total of 36 accessions of wild legumes namely *Canavalia* and *Mucuna* are being maintained in the field for characterization and multiplication.

### **Rabi, 2008-09**

A total of 629 accessions of linseed, sesame, sorghum, brinjal, chillies and dolichos bean were grown in the field along with checks for characterization/ evaluation/ multiplication.

Crop	No. of Accs.	Checks	Activity
Linseed	81 (ABD)	Checks	Characterization, evaluation & multiplication
Sesame	89 (ABD)	JLT-7, JLT-26, TC-25,	Evaluation & multiplication
Sorghum	67 (ABD)	M 35-1, CSV-15, CSV-16	Evaluation & multiplication
Brinjal	62 (ABD)	Bhagyamathi, PPL, Shyamala	Characterization, evaluation & multiplication
Chillies	201 (ABD)	CA-960, LCA-334, Pusa Jwala	Characterization, evaluation & multiplication
Dolichos bean	80 (ABD)	Arka Jay, Arka Vijay, RND-1	Characterization, evaluation & multiplication
Wild legumes ( <i>Clitoria ternatea</i> , <i>Atylosia albicans</i> , <i>A. scarabaeoides</i> , <i>Crotalaria medicaginea</i> , <i>Indigofera tinctoria</i> , <i>Rhyncosia suaveolens</i> , <i>Tephrosia purpurea</i> , <i>Mucuna pruriens</i> , <i>Canavalia ensiformis</i> , <i>C. cathartica</i> )	49		Multiplication

## 12.3 Germplasm Conservation

A total of 478 accessions of leafy vegetables, chillies, cotton, linseed, wild legumes and others collected during exploration surveys were sent to Germplasm Handling Unit, NBPGR Delhi for national accessions and medium term storage.

A total of 1,191 accessions including import voucher samples (797) and exploration collections (394) were added to the MTM.

Seed of 47 accessions of wild *Arachis* species along with cuttings of three accessions were sent to NRCC, Junagarh for evaluation and maintenance while a set of 22 accessions were sent for long-term storage in the NGB.

Seed of 41 accessions of black gram (38 accs) and green gram (3 accs.) were sent for long-term storage in the NGB.

## 12.4 Germplasm Distribution and Supply

A total of 265 accessions of including brinjal (128), black gram (29), cowpea (19), pillipesara bean (6), and tomato (83) were distributed to RARS, ANGRAU.

Twenty accessions each of black gram and green gram along with eight accessions of finger millet were supplied to Department of Pathology, College of Agriculture, ANGRAU (Baptala) and ANGRAU (ARS, Perumallapally) respectively for research. In addition

45 accessions of Italian millet were supplied to RARS, Nandyal.

Ten accessions of *Jatropha* germplasm lines were supplied to SVBP University of Agriculture and Technology, Meerut P through Germplasm Exchange Division, NBPGR.

A total of 206 accessions including Chillies (169), tomato (6), Brinjal (31) were supplied to Biotechnology Department, ANGRAU, RARS, Tirupati and UAS, Bangalore for research as per their indent. In addition 10 accessions of *Jatropha* were sent to SBVP University of Agrl and Techn., Meerut as per their request. Further, 46 accessions including Brinjal (31) and tomato (15) were sent to NBPGR (HQ) for onward supply to M L K B G College, Balrampur, UP.

A total of 37 accessions of onion germplasm (including 13 shallots) were supplied to Head, Evaluation Division for multiplication, evaluation and maintenance. A total of 104 accessions of onion (37), chillies (38) and cotton (77) were also shared with collaborators ANGRAU, Hyderabad, CICR, Nagpur, RARS, Nandyal and UAS, Dharwad.

## 12.5 Germplasm Registration

Seven promising germplasm accessions of agri-horticultural crops were registered with ICAR. These include chillies (INGR 08097) as a source of resistance to thrips and powdery mildew and (INGR 08095) with resistance to thrips and mites; cowpea (INGR 08084)

for resistance to *Black eye cowpea mosaic virus*; *Jatropha curcas* (INGR 08086 and 08087) with high oil content; and *Lycopersicon peruvianum* (INGR

08094 and 08096) as sources of resistance to root-knot nematode (*Meloidogyne javanica*). The certificates of registration for the above were received.

#### Research Programme (Programme Code: Title, Leader)

PGR/PQR- BUR-HYD-01.00- Quarantine Processing of Plant Germplasm Under Exchange and Supportive Research (**KS Varaprasad**)

#### Research Projects (Project Code, Title, Project Leader; 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, RK Khetarpal RDVJ Prasada Rao, SK Chakrabarty, B Sarath Babu, N Sivaraj and Babu Abraham)

PGR/PQR- BUR-HYD-01.02- Developing a Database on Pests and Pathogens of Quarantine Significance (**B Sarath Babu**, KS Varaprasad, RDVJ Prasada Rao, 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 (**RDVJ Prasada Rao**, KS Varaprasad, SK Chakrabarty, B Sarath Babu, K Anitha and Babu Abraham)

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**)

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 Venkateshwaran**)

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**)

## 13. REGIONAL STATION, JODHPUR

**Summary:** One exploration and collection trip was undertaken and 51 germplasm collections of different crops and their wild relatives were made from different parts of Rajasthan. Besides this, two trips in collaboration with other institutes resulted in collection of 37 germplasm collections. Observations were recorded on morpho-agronomic traits of 174 and 2,065 accessions raised during *Summer* and *Kharif* 2008, respectively. Genetic stocks with unique traits such as determinate habit with early maturity; and branched as well as all node cluster bearing ability in guar were identified and characterized during *Kharif* 2008. Blocks of horticultural plants and plants of economic importance were maintained and data were recorded in *Aloe barbadensis*, anola, bael, *Capparis decidua*, jamun, mulberry, *Salvadora* spp., *Jatropha curcas* and jojoba germplasm. In all 30,047 germplasm accessions are conserved in the MTS facility, including accessions processed and kept in MTS facility during 2007. A total of 19 accessions were sent to NGB for LTS. A total of 759 germplasm accessions of different taxa were maintained in the field gene bank at this station. Seed samples of 531 germplasm accessions were supplied to various indentors and seed samples of 68 accessions were received from different sources. A genetic stock of guar (INGR No. 08027) with foliaceous bracts in the inflorescence has been registered.

### 13.1 Exploration and Collection

One exploration and collection trip was undertaken and 51 germplasm collections were made from different parts of Rajasthan.

The germplasm collections include ash gourd (1), bitter gourd (2), bottle gourd (9), ivy gourd (3), *Cucumis prophetarum* (1), Cucumber (6), *C. sativus* var. *hardwickii* (4), *Cucurbita argyrosperma* (1), Kankoda (1), *L. acutangula* var. *amara* (1), *L. cylindrica* (1),

*L. hermaphrodita* (1), *Momordica balsamina* (3), Pumpkin (4), Ridge gourd (3), *Vigna radiata* var. *sublobata* (7) and *V. trilobata* (3). A wide range of variability in the vegetable germplasm was collected especially in the bottle gourd germplasm.

Besides this, the Station, also collaborated with NBPGR, New Delhi and Central Sericulture Germplasm Resources Centre, Hosur for one exploration each and was involved in the collection of 37 germplasm collections through these trips during 2008 (Table 1).

**Table 1: Collaborative exploration and collection trips during 2008**

Explorations (Target species)	Area explored	Collaborating Institute	Germplasm collections
<i>Salvadora</i> spp. & Ker	Parts of western Rajasthan (May 14 – 16, 2008)	NBPGR, New Delhi	13
Mulberry	Parts of western Rajasthan (November 16 – 24, 2004)	CSGRC, Hosur	24

#### 13.1.1 Germplasm augmentation

Germplasm of *Caralluma edulis* (1), *Celastrus paniculatus* (1), *Ceropagia bulbosa* (1) *Cymbopogon*



Variability observed for fruit shape, size and colour in the bottle gourd germplasm collections from Udaipur district of Rajasthan.

*citratum* stapf. (1), *C. martini* (Roxb.) Wats (1), *Leptadenia reticulata*, *Nyctanthes arbor-tristis* Linn. (1), *Opuntia dillenii* Haw. (1), *Salvadora oleoides* decne (2) and *Vitex negundo* Linn. (1) were augmented from local sources.

### 13.2 Germplasm Characterization and Evaluation

#### Summer 2008

A total of 174 determinate guar accessions were raised



*Momordica dioica* - fruits and tubers collected from Udaipur district of Rajasthan.



during *Summer* 2008, which includes characterisation (104 acc.), evaluation (20 acc.) and multiplication (174 acc.). Data on variability in various parameters was recorded on the germplasm accessions as per the descriptors.

### Kharif 2008



Ripe fruits of *Momordica balsamina* (Balsam apple) with seeds exposed due to cracking of fruits.

In all, 2,065 accessions of field crops namely pearl millet (147), cowpea (138), guar (1,070), mothbean (115), mungbean (38), castor (56) and sesame (480) were raised for characterization/ evaluation/ multiplication during *Kharif* 2008 (Table 2). The data on various descriptor traits was recorded.



Variability in fruits of *Cucumis sativus* var. *sativus* and *C. sativus* var. *hardwickii* collected from Udaipur.

**Table 2: Germplasm accessions of various crops grown during Kharif 2008**

Crop	No. of Accessions	Checks	Activity
Pearlmillet	147	CZP-9802, Raj-171, ICMV-221, Pusa-383, JBV-2	Characterization
Cowpea	138	FTC-27, GC-3, NS-24/8-2, V-240, V-585	Characterization
Guar	1,070	GDM-1, PLG-85, RGC197	Characterization (104)
		Durga Kanchan, IC11388, PLG-85, Pusa Navbahar, Suvridha	Evaluation (46); multiplication (920)
Mothbean	115	Jadiya, Maru moth, RMO-40	Evaluation (15); rejuvenation (100)
Mungbean	38	M1319B, Pusa Vishal, Pusa 105	Characterization (18); evaluation (20)
Castor	56	48-1, DCS-9, TMV5-1	Multiplication (56)
Sesame	480	-	Multiplication (480)
Cucumis spp.	21	-	Multiplication (21)
<b>Total</b>	<b>2,065 accessions</b>		

### Identification and Characterization of New Genetic Stocks

In guar, new stable genetic stocks possessing unique traits have been developed and characterised. Some of the important genetic stocks identified during *Kharif* 2008 include genetic stocks with determinate habit and early maturity; branched as well as all node cluster bearing habit and dwarf plant height.

### Horticultural Crops

**Cuttings:** Cuttings of 17 collections of *Carissa edulis* (17 acc.), *Capparis decidua* (7 acc.) and pomegranate (19 acc.) were raised in pots for multiplication.

**Transplantation:** Seedlings of ber (2 acc.), *Cordia myxa* (10 acc.), *C. crenata* (1 acc.), *C. rothii* (1 acc.),



Leaves, flowers, unripe and ripe fruits of *Momordica balsamina* (Balsam apple) - collected from Rajsamand district of Rajasthan.

*Emblica officinales* (1 acc.) and *Prosopis cineraria* (1 acc.) were transplanted in the field gene bank.

### Hybridization:

Interspecific crosses were attempted between different species of *Cucumis* namely *C. callosus*, *C. melo* var. *melo*, *C. sativus* var. *hardwickii*, *C. trigonus* and *C. prophetarum*.



Diversity in fruit characters in three species of *Momordica* collected from Udaipur district.

**Data recording:** Data on survival was recorded in 19 different accessions of pomegranate germplasm. Monthly data on plant height, flowering and canopy was recorded in anola, bael, ber, *Carissa carandus*, *C. edulis*, *C. grandiflora*, custard apple, date palm, guava, jamun, ker, lasora, lemon, mulberry, phalsa, pomegranate and tendu.

### Economic Plants

**Seed sowing:** Seeds of 14 different species of *Acacia* (14 acc.), *Jatropha curcas* (24 acc.) were sown in pots for germination and other studies.

**Transplantation:** Seedling/ cuttings of *Acacia albida* (2 acc.), *A. amplicaps* (1 acc.), *A. ancistocarpa* (1 acc.), *A. difficalis* (1 acc.), *A. lysiphlea* (1 acc.), *A. hemselgii* (1 acc.), *A. pachycarpa* (1 acc.), *A. stenophylla* (1), *A. validinarwa* (1), *Capparis decidua* (1 acc.), *Jatropha curcas* (48 acc.), *Nyctanthes arbor-tristis* (1 acc.), *Opuntia dillenii* (1 acc.), *Salvadora oleoides* (1 acc.), *Prosopis cineraria* (9 acc.), 138 suckers of *Aloe barbadensis* (IC333202), 16 plants of *Celastrus paniculatus* (5) and *Leptadenia reticulata* (10) and *Vitex negundo* (1 acc.) were transplanted in the field. Besides this, six accessions of *Jatropha curcas* received from Germplasm Conservation Division, NBPGR, New Delhi were transplanted in the polythene bags; 8 plants of *Caralluma edulis* (6) and *Ceropagia bulbosa* (2) were transplanted in earthen pots.

### GSDM 46 (IC421811-5) – A unique determinate genotype of guar

GSDM 46 (IC421811-5) is an early maturing high yielding determinate guar accession with the following desirable attributes

#### Important features

- Photoinsensitive; early termination of stem; early and uniform maturity
- All node cluster bearing habit; average no. of clusters / plant – 18.8; mean cluster length – 9.11 cm



GSDM 46 (IC421811-5) – An early maturing high yielding determinate guar accession.

- Average no. of pods/ cluster – 8.7; no. of pods/ plant – 144.4
- Mean seed yield/ plant – 17.74 g

**Data recording:** Survival was recorded in 14 different species of *Acacia* (14 acc.); *Commiphora wightii* (1 acc.) and *Jatropha curcas* (10 acc.). Observations on plant height, flowering canopy, survival of plants were recorded in *Jatropha*, jojoba, *Moringa oleifera*, *Barleria acanthoides* and *Withania coagulens* maintained in the field. Flowering and fruiting was recorded in *Caralluma edulis* (1 acc.), *Ceropegia bulbosa* (1 acc.) and *Asparagus racemosus* (2 acc.)

**Maintenance:** All economic plants in various blocks of *Aloe barbadensis*, *Acacia* spp., *Agave*, *Commiphora wightii*, *Jatropha*, jojoba, *Prosopis*, *Moringa concanensis*, *Moringa oleifera*, *Celastrus paniculata*, *Leptadenia reticulata*, *Vitex negundo*, *Nyctanthes arbor-tristis*, *Putranjiva roxburghii* and *Saraca asoca* are being maintained in the field. *Tinospora cordifolia* (2 acc.), *Tylophora indica* (2 acc.), *Pergularia daemia* (1 acc.) are maintained in the shed and *Caralluma edulis*, *Cissus quadrangularis*, *Ceropegia bulbosa* (2 acc.), different species of cacti and bougainvillea are being maintained in the pots. Newly transplanted seedling of *Acacia pachycarpa* (EC170448) also got established in the field.



**Harvesting:** Seeds of *Acacia albida* (1 acc.), *A. crassicarpa* (1 acc.), *Cassia angustifolia* (1 acc.), *C. auriculata* (2 acc.), *C. helmsii* (1 acc.), *C. sturtii* (1 acc.), *Commiphora wightii* (1 acc.), *Moringa concanensis* (1 acc.), *Tinospora cordifolia* (1 acc.) and *Withania somnifera* (1 acc.) were harvested. Fruits were harvested from jojoba (59 acc.), *Pergularia daemia* (1 acc.) and *Tylophora indica* (2 acc.)

#### BANG 4 – A unique guar genotype

BANG 4 (IC421844-4/P<sub>1</sub>-4) is a superior high yielding branched as well as all node cluster bearing guar genotype.

##### Important features

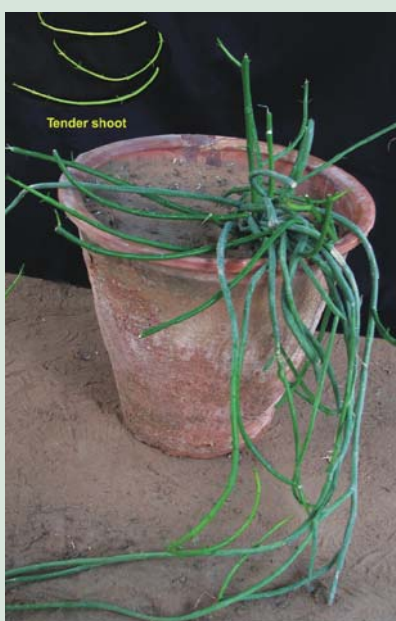
- Basal branching habit; photoin sensitive
- Four primary branches and four secondary branches
- All node cluster bearing habit
- Average no. of clusters in main stem – 15
- Total no. of clusters/pl. – 63
- No. of pods/pl. – 188.2
- Average seed yield/pl. – 12.2 g



**BANG 4 (IC421844-4/P<sub>1</sub>-4) – Superior branched all node bearing guar.**

#### Famine food plants

*Caralluma edulis* R. Br. (Family – Asclepiadaceae) commonly known as “Pimpiyan” is an erect, succulent and nearly leafless herb usually with angled stems. *Caralluma edulis* is being used for centuries in arid and semi-arid areas of India as famine food plant and is distributed in north western Rajasthan in India. The whole plant is eaten as vegetable in the arid region of Rajasthan. It is also known for its antidiabetic properties



***Caralluma edulis***

#### *Ceropegia bulbosa*

Roxb. (Family – Asclepiadaceae) commonly known as “Hedulo” is a climber with stem trailing or twining, usually glabrous with globose tuber. In India, it is found to be distributed in Punjab, Maharashtra, Rajasthan and Uttar Pradesh. *C. bulbosa* Roxb. is used as food during famine in the arid regions of India. The tubers and leaves are eaten. The tubers are relished by shepherd-boys to quench their thirst. An alkaloid, ceropegine, is present in tubers which makes them bitter, somewhat like raw turnips. The fresh tubers are usually boiled before they are eaten, to remove the bitterness. The tuber extract is used against indigestion and also as tonic.



***Ceropegia bulbosa***

### 13.3 Germplasm Conservation

**13.3.1 MTS Facility:** A total of 589 accessions of different crops were added to the MTS facility at this station. The germplasm additions include bitter gourd (2), bottle gourd (2), ivy gourd (3), cucumber (10), *Cucumis prophetarum* (1), *Cucumis* spp. (46), *C. sativus* var. *hardwickii* (4), kankoda (1), *L. acutangula* var. *amara* (1), *L. hermaphrodita* (1), *Momordica balsamina* (3), *Vigna radiata* var. *sublobata* (7) and *V. trilobata* (9), guar (268), mothbean (108) and mungbean (42) collected/ multiplied at the regional station, Jodhpur; muskmelon (4), *Acacia* species (2), *Alysicarpus vaginalis* (1), *Chamaecrista pumila* (1),

**Table 3: Germplasm maintained in the field gene bank at Regional Station, Jodhpur**

S. No.	Crop/ taxa group	Number	
		Crops/ taxa	Accessions
1.	Fruits	26	263
2.	Ornamentals	10	50
3.	Oil yielding plants	5	211
4.	Medicinal & Aromatic plants	36	145
5.	Multipurpose trees	16	28
6.	Fibre yielding plants	1	8
7.	Forage grasses	4	14
8.	Others	9	10
<b>Total</b>		<b>107</b>	<b>729</b>

*Crotalaria* species (2), *Indigofera* spp. (7), *Mimosa hamata* (1), *Rhynchosia minima* (1), *Sesbania* species (2) and *Tephrosia* spp. (6) received from other sources. Altogether, a total of 30,047 germplasm accessions have been conserved at the MTS facility of this station.

**Field Gene Bank:** The field gene bank at this station holds 729 accessions belonging to 107 taxa (Table 3).

**Germplasm Sent to LTS:** During 2008, a total of 19 germplasm accessions of different crops namely guar

(1), mungbean (2) and muskmelon (16) were sent to NGB, NBPGR, New Delhi for long-term conservation.

### 13.4 Germplasm Exchange

**Germplasm supplied:** During 2008, a total of 531 germplasm accessions including cereals (2 acc.), legumes (394 acc.), oilseeds (50 acc.), horticultural crops (36 acc.) and economically important plants (49 acc.) have been supplied to different indentors (Table 4).

**Table 4: Germplasm supplied to various indentors during 2008.**

Name of the crop (No. of acc.)	Indenting Institute
<b>Cereals (2 acc.)</b> Barley (2)	JNV University, Jodhpur
<b>Legumes (394 acc.)</b> Vegetable guar (26) Mothbean (212)	UAS, GKVK, Bangalore Main Pulses Research Station, SDAU, Sardarkrishinagar (150); SKUAST-K, Srinagar (50); NBPGR RS, Thrissur (12)
Mungbean (150) <i>V. trilobata</i> (6)	National Institute for Plant Genome Research, New Delhi (100); NBPGR RS, Hyderabad
<b>Oilseeds (50 acc.)</b> Sesame (50 acc.)	Annamalai Univeristy, Chidambaram
<b>Horticultural Crops (36 acc.)</b> <i>Cucumis melo</i> var. <i>momordica</i> (1) <i>C. melo</i> var. <i>utilissimus</i> (1) <i>Cucumis callosus</i> (5) <i>C. melo</i> var. <i>melo</i> (5) <i>C. melo</i> var. <i>momordica</i> (5) <i>C. prophetarum</i> (10) <i>C. sativus</i> var. <i>hardwickii</i> (5) <i>C. trigonus</i> (4)	Karnataka Unviersity, Dharwad Karnataka Unviersity, Dharwad NBPGR Regional Station, Thrissur NBPGR Regional Station, Thrissur NBPGR Regional Station, Thrissur NBPGR Regional Station, Thrissur NBPGR Regional Station, Thrissur NBPGR Regional Station, Thrissur
<b>Economically Important Plants (49 acc.)</b> <i>Jatropha curcas</i> (30) <i>J. gossypifolia</i> (4) <i>Mimosa hamata</i> (1) <i>Mucuna prurita</i> (14)	Navsari Agrl. Univ., Navsari (10); SVBP Univ. of Agriculture and Technology, Meerut (10); Jaypee University of Information Technology, Solan (10) SVBP Univ. of Agriculture and Technology, Meerut JNV University, Jodhpur NBPGR RS, Ranchi
<b>Total</b>	<b>531 accessions</b>

**Germplasm received:** A total of 68 germplasm accessions of legumes (18 acc.) and horticultural crops (50 acc.) have been received from different sources, which are summarized in Table 5.

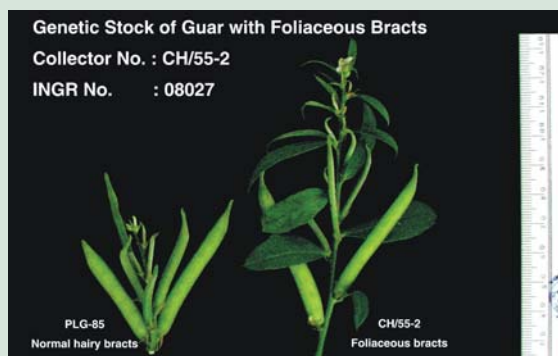
**Table 5: Germplasm received from different sources during 2008**

Name of the crop (No. of acc.)	Source
<b>Legumes (18 acc.)</b> Mungbean (18)	Germplasm Exchange Division, NBPGR, New Delhi
<b>Horticultural Crops (50 acc.)</b> <i>Cucumis</i> spp. (42) <i>Cucumis sativus</i> (4) <i>C. sativus</i> var. <i>hardwickii</i> (4)	Germplasm Exchange Division, NBPGR, New Delhi Germplasm Exchange Division, NBPGR, New Delhi NBPGR RS, Akola



## 13.5 Germplasm Registration

A genetic stock of guar (CH/55-2) with foliaceous bracts in the inflorescence has been registered (INGR No. 08027). The accession IC116895 produces foliaceous bracts, wherein the bracts are modified into small leafy structures. The bracts are hirsute with 2-armed non-glandular trichomes. They are initially green and turn yellow at pod maturity. At full maturity, the bracts are 15 – 45 mm in length and 5 - 15mm in breadth. This accession is important as it can serve as an ideal morphological marker in breeding programmes. Further, it can be used in the study of evolution of bracts in clusterbean.



### Compilation of characterization/ evaluation data:

Evaluation data of 646 germplasm accessions of different crops grown during summer 2007 namely determinate guar (104); and crops grown during *Kharif*

2007 namely pearl millet (88), cowpea (60), determinate guar (104), guar (16), vegetable guar (12), mothbean (120), mungbean (89) and castor (56) was compiled and sent to NBPGR, New Delhi.

### Research Programme (Programme Code: Title, Leader)

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)

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

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 (Gopala Krishnan S, NK Dwivedi and Neelam Bhatnagar)

PGR/GEV-BUR-JOD-01.02: Augmentation, characterization, evaluation, maintenance, regeneration, conservation, documentation and distribution of genetic resources of legumes and oilseeds. (Gopala Krishnan S (Since August 2008), NK Dwivedi and Neelam Bhatnagar)

PGR/GEV-BUR-JOD-01.03: Augmentation, characterization, evaluation, maintenance, regeneration, conservation, documentation and distribution of genetic resources of fodder, forage, fuel, medicinal and aromatic and other economic plants. (NK Dwivedi, (since June 2008), Neelam Bhatnagar and Gopala Krishnan S)

### Externally Funded Projects

- Collection, assembly and conservation of genetic resources of physic nut (*Jatropha curcas* Linn.) – DBT (NK Dwivedi)
- Biosystematics of the Genera *Vigna*, *Cucumis* and *Abelmoschus* – NAIP (Gopala Krishnan S)

## 14. EXPLORATION BASE CENTER, RANCHI

**Summary:** A total of 38 germplasm collected were planted and established in the field gene bank. Characterization and multiplication of 392 accessions Kulthi germplasm was undertaken. Observations were made on primary branches per plants, days to 50% flowering, number of pods/plant, pod length (cm), plant height (cm), number 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 and the data was analyzed for quantitative traits. Besides, the characterization work of brinjal core collections was undertaken.

National Bureau of Plant Genetic Resources, Base Centre, Ranchi is located at latitude 23°N and longitude 85°E and in the tribal belt of Chotanagpur plateau. It has an altitude of about 625 m above the mean sea level. The average rainfall is about 1300 mm. The region is endowed with rich agro-ecological diversity superimposed with tribal and ethnic diversity of very primitive order. The region is well known for its immensely rich primitive crop plant diversity including wild related species of many crop plants. The agriculture is most traditional. The spread of improved technology by the Government Department/ State Agriculture Universities imposed the danger to landraces and wild relatives in the region. The primary responsibility of this station is exploration and collection of crop diversity in Bihar.

### 14.1 Augmentation and Establishment of Valuable Germplasm

*Cocos nucifera* (2), *Punica granatum* (2), *Pouteria sapota* (2), *Sesbania grandiflora* (1), *Citrus aurantium* (1), *Averrhoa carambola* (1), *Eleocarpus ganitrus* (2), *Eleocarpus floribundus* (2), *Pistacia vera* (1), *Syzygium aromaticum* (1), *Pandanus amaryllifolius* (1), *Cinnamomum camphora* (2), *Adenanthera pavonina* (1), *Murraya koenigii* (1), *Cajanus cajan* (bold poded) (1), *Psidium chinensis* syn. *P. fredischthalicum* (2), *Areca catechu* (2), *Jesminum sambac* (1), *Magnolia champaca* (1), *Pimenta dioica* (2), *Polianthes tuberosa* (1), *Cestrum nocturnm* (1), *Maranta arundinaceae* (1), *Cordia obliqua* (1), *Terminalia chebula* (1) *T. belerica* (1), *Simarauba glauca* (1), *Garcinia indica* (1), *G. cambogia* (1) and *Carissa caranda* were collected, planted and established in the field gene bank, Ranchi. *Pandanus amaryllifolius* (Roxb.) belongs to the Pandanaceae family and only aromatic species. The leaves aroma is distinct and pleasant and similar to aromatic Basmati rice.

Ripe fruits of *Averrhoa carambola* are eaten out-of-hand, sliced and served in salads. Carambola juice is served as a cooling beverage. To make jelly, it is necessary to use unripe “sweet” types or ripe sour types and to add commercial pectin or some other fruit rich in pectin such as green papaya, together with lemon or lime juice. The acid types of carambola have been used to clean and polish metal, especially brass, as they dissolve tarnish and rust. The juice will also bleach rust stains from white cloth. In India, the ripe fruit is administered to halt hemorrhages and to relieve b l e e d i n g hemorrhoids; and the dried fruit or the juice is taken to counteract fevers. A



*Psidium chinensis* syn. *P. redischthalicum* (resistant to wilt disease)



*Jatropha podagrica*

relieve a “hangover” from excessive indulgence in alcohol. A salve made of the fruit is employed to relieve eye afflictions is believed to have a beneficial effect in



the treatment of eczema. A decoction of combined fruit and leaves is drunk to overcome vomiting. Leaves are bound on the temples to soothe headache. Crushed leaves and shoots are poulticed on the eruptions of chicken-pox, also on ringworm. A decoction of the crushed seeds acts as a galactagogue and emmenagogue and is mildly intoxicating. The powdered seeds serve as a sedative in cases of asthma and colic.

Rudraksha (*Eleocarpus ganitrus*) is used in the mental disturbances, nervous diseases, headache, hypertension, heart and liver related problem, jaundice and fever. It also improves the circulation of the body. It also has miraculous healing property.

The clove oil (*Syzygium aromaticum*) is used to prepare microscopic slides for viewing and is also a local anesthetic for toothaches. It is a strong antiseptic and preservative. It is used to treat flatulence, colic, indigestion and nausea. Eugenol is used in germicides, perfumes and mouthwashes. It is used in Ayurvedic preparations.

Camphor (*Cinnamomum camphora*) is widely planted as a shade tree, screen, or windbreak. Camphor oil has a strong penetrating fragrance, a pungent bitter flavor, and feels cool on the skin like menthol. Camphor has been used to treat ailments ranging from parasitic infections to



*Pimenta dioica*

toothaches. Scientific evidence has confirmed that chemicals in the plant have value in antiseptics and medications for treating diarrhea, inflammation, itching, and nervous conditions. Camphor wood is prized for its attractive red and yellow striping, amenability to woodworking, and insect repelling properties. Camphor is also used in perfumes.

*Adenanthera pavonina* (L.) (family Leguminosae,



*Pandanus amaryllifolius*

subfamily Mimosoideae) is useful tree and known by a host of common names, including red-bead tree, red sandalwood tree. It provides quality fuelwood, wood for furniture, food, and shade for economic crops like coffee and spices. The tree has been planted extensively throughout the tropics as an ornamental and has become naturalized in many countries. The bright red seeds are still used today in fashioning necklaces and decorative ornaments.



Chinese rose (red coloured)



Chinese rose (white coloured)

The seeds of Areca nut (*Areca catechu*) are cut into narrow pieces and rolled inside betel pepper leaf, rubbed over with lime and chewed by the natives. They stain the lips and teeth red and also the excrement. They are hot and acrid when chewed. Areca nut contains a large

quantity of tannin, also gallic acid, a fixed oil gum, a little volatile oil, lignin, and various saline substances. Four alkaloids have been found in Areca nut - Arecoline, Arecain, Guracine, and a fourth existing in very small quantity. Arecaine is the active principle of the Areca nut. Areca nut is aromatic and astringent and is said to intoxicate when first taken. The flowers are very sweet-scented. The nut has long been used as a taenifuge for tapeworm. Arecoline Hydrobromide, a commercial salt, is a stronger stimulant to the salivary glands than Pilocarpine and a more energetic laxative than Eserine. It is used for colic in horses.

*Jasminum sambac* (syn. *Nyctanthes sambac*) is a species of jasmine native to southern Asia. In Bengali, the flower is known as “beli” and is extremely popular for its sweet fragrance. It is used to make garlands to adorn women’s hair. The flowers are produced in clusters of 3-12 together, strongly scented, with a white corolla 2-3 cm diameter with 5-9 lobes. The flowers open at night, and close in the morning.

The flowers of *Magnolia champaca* seed to make the world’s most expensive perfume ‘Joy’. The extremely aromatic orange blooms appear nearly all year round. Nature made this creation leading to the development of “JOY”, the most expensive perfume fragrance in the world. On a warm humid night, the scents can easily be enjoyed several hundred feet away.

*Pimenta dioica*, spice or condiment, allspice, is made from the dried, unripe fruit of the allspice or pimento tree. The fruit is a brown berry like drupe, about 0.25 (0.6 cm) long. The leaves and fruit smell like a combination of cloves, black pepper, nutmeg, and cinnamon, hence the common name. It may not flower and fruit outside its native range, but the big glossy aromatic leaves are an attraction. Allspice is used in pickles, ketchup and marinades, and to flavor pumpkin pies, cakes and candies. Oil pressed from the fruits is used in perfumes and cosmetics.

The tuberosa (*Polianthes tuberosa*) is a perennial plant of the agave family Agavaceae, extracts of which are used as a middle note in perfumery. The tuberosa is a night-blooming plant thought to be native to Mexico along with every other species of Polianthes. The flowers are used in wedding ceremonies, garlands, decoration and various traditional rituals. Its Hindi name is “Rajni-gandha”. The tuberosa grows in elongated spikes up to

45 cm (18 in) long that produce clusters of fragrant waxy white flowers that bloom from the bottom towards the top of the spike. It has long, bright green leaves clustered at the base of the plant and smaller, clasping leaves along the stem.

*Cestrum nocturnum* also known as night blooming Jasmine, is grown in subtropical regions as an ornamental plant for its strongly-scented flowers. All parts of the plant are highly poisonous.



*Nyctanthes arbortristis*



*Averrhoa carambola*

*Simarouba glauca* is useful plant and seeds are economically very important as seed kernels contain 60% edible oil. The oil can be used in the manufacture of vegetable fat and/or margarine/ bio-diesel. It is well suited for the manufacture of quality soaps, lubricants, paints, polishes, pharmaceuticals etc. The oilcake being rich in nitrogen (7.7 – 8.1%), phosphorus (1.07%) and potash (1.24%) is valuable organic manure.

## 14.2 Evaluation of Germplasm

**14.2.1 Characterization and multiplication of Kulthi germplasm:** A total of 392 accessions of kulthi germplasm were evaluated in augmented design with 15 blocks. Four rows of 5 metre length were used for each accession. Two checks Madhu and Birsa Kulthi-1



(BK1) were used in the experiment. The spacing between rows (30cm) and between plants (10cm) was kept. The observations on 10 plants of each accession were recorded and average was taken. The observation on primary branches per plants, days to 50% flowering, number of pods/plant, pod length (cm), plant height (cm),

number 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. The data was analyzed for quantitative traits (Table-1).

Accession No.	Primary branches	Days to 50% flowering	Pods per plant	Pod length (cm)	Plant height (cm)	Seeds/pods	Yield per plant (g)	100 seed weight (g)
Minimum	1.00	31.00	23.00	4.00	30.00	4.00	3.02	1.94
Maximum	16.00	59.00	480.00	6.20	132.00	8.00	48.90	5.67
Mean	7.06	42.34	131.90	4.88	82.26	6.37	15.67	3.00
CV(%) -Phenotypic	33.93	15.63	61.13	8.14	25.13	10.25	53.84	21.99
CV(%) -Error	18.65	14.89	19.22	7.59	25.04	9.69	21.85	19.97
CD (0.05)	2.43	15.81	105.85	0.93	21.65	1.55	5.23	1.50
BK-1	7.14	39.36	115.14	4.71	101.43	6.86	17.99	2.85
Madhu	6.93	40.86	127.57	4.79	106.07	6.71	20.62	2.85



Characterization of kulhi germplasm



Characterization of brinjal core collections

Some accessions were found having better values than checks as mentioned below:

No. of Primary branches		Pod length (cm)		Pods /plants		100-seed weight	
Accession No.	Value	Accession No.	Value	Accession No.	Value	Accession No.	Value
GMD 39	13	IC361648	5.8	IC139564	335	IC139521	5.64
IC398703	16	IC361675	5.8	IC139559	403	IC139522	5.21
IC349791	14	IC398700	6.2	IC320912	480	IC139542	5.27
IC418453	13	IC398703	6.0	IC320913	470	IC139545	5.67
IC43503	15	IC349791	5.8	IC320970	368	IC139548	4.7
IC561037	14	IC406379	5.8	IC341268	400	IC139552	4.51
IC561039	14	IC417908	5.8	IC347182	329	IC139553	4.8
BK-1 (Check)	7.14	IC43503	5.8	IC347893	464	IC139554	4.93
		IC561047	5.8	IC336445	398	IC139555	4.97
		Madhu (Check)	4.97	IC336443	352	IC139569	4.38
				GMD39	329	IC243478	5.02
				IC398703	325	IC242487	5.21
				IC349791	394	IC243502	5.07
				Madhu (check)	127.57	IC243504	5.11
						IC243514	5.23
						IC361648	4.62
						IC361649	4.65
						IC105646	4.36
						BK-1(Check)	2.85

**Mucuna germplasm:** A total of 36 accessions of *Mucuna* germplasm were evaluated in RBD with two replications. Each accession had three rows of five metres length. The spacing between rows and plants was 1x1m. The observations on 50% flowering, plant height, number of primary branches, number of pods/plant, pod length, pod shape, pod surface, number seeds/pod, seed colour, 100-seed weight and yield per plant were recorded. Some entries are late maturing so data could not be analysed.

**Core collections of brinjal germplasm:** A total of 181 accessions of core collections were planted in two rows each along with seven national checks and two local checks (Swarna Pratibha, Swarna Shyamli). An augmented design was used with row length of six metres and spacing of 90 x 60 cms. The observations on 50% flowering, plant spread, no of primary branches, leaf length & breadth, leaf petiole length, fruit length & breadth, shape (long, round, oblong & oval), fruit peduncle length, number of fruit/plant, total fruit wt./plant were recorded/are being recorded.

**Sem:** Thirteen accessions of sem with two replications were sown on 6.09.2008 in RBD for multiplication. Similarly five accessions of niger were sown for multiplication to deposit in gene bank.

### 14.3 Germplasm Maintenance in Field Gene bank

Jackfruit	154	Barhal	14
Tamarind	51	Aonla	19
Jamun	46	<i>Mangifera</i> sp.	19
Bael	53	<i>Musa</i> sp.	17
<i>Lawsonia indica</i>	25	<i>Moringa oleifera</i>	14
Medicinal Plants	320		



*Punica granatum*



*Eleocarpus floribundus*

### 14.4 Exchange

- Cuttings of 20 accessions (five each) of *Jatropha* germplasm were given to CSMRI, Bhawnagar on 12.03.08
- Cuttings of 92 accessions (seven each) of *Jatropha* germplasm were given to NBRI, Lucknow on 03.03.08.

#### Research Programme (Programme Code: Title, 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 projects (Code: title (PI and CoPI)

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)

PGR/PGC-BUR-RAN-01.02: Augmentation characterization, evaluation maintenance, regeneration, conservation and documentation of genetic resources of horticultural crops& perennial medicine (JB Tomar)

#### Externally Funded Projects

- Genetic Improvement of *Jatropha curcas* for adaptability and oil yield (NMITLI)
- Establishment and maintenance of herbal garden and capacity building in the production about the medicinal plants of Jharkhand and adjoining areas. (JB Tomar)

## 15. REGIONAL STATION, SHILLONG

**Summary:** During the exploration programmes covering parts of Assam, Arunachal Pradesh, Nagaland, Meghalaya and West Bengal assembled 306 accs. of various crop germplasm. Germplasm was also collected from the insurgency prone areas of NC Hills district of Assam, where rice and tuber crop diversity is distinct. For characterization of crops, a total 2,184 accs. covering 12 crops were sown of which 1,824 accs. were harvested. Promising accs. were identified in each crop, based on the yield data. A total of 462 accs. of Buckwheat, Job's tear, Maize, Ricebean, Rice, Taro, Yam in addition to *Momordica cochinchinensis*, *Mucuna pruriens* and medicinal plants were supplied to 15 indentors. A total of 142 accs. comprising rice and maize were sent for LTS to National Gene Bank and one accession of rare bamboo germplasm species was sent for cryo-storage at NBPGR, New Delhi.

### 15.1 Exploration and Collection of Germplasm

A total 306 accs. of different crop germplasms have been collected from this NE Region. In Arunachal Pradesh, the major cereal crops are rice, maize and finger millet. Accessions of these crops were collected from remote areas of East and West Siang districts in association with GBPIHED, Itanagar. Collections of King Chilli and Rice accessions were made from Peren and Dimapur districts of Nagaland. In this endeavour, State Horticulture Directorate, Kohima and SASRD, Nagaland University, Medziphema has taken active role. In association with Haflong College collected 150 accs. of various crop germplasm in two phases and deposited with the station. Many crop accs. from insurgency prone areas of NC Hills, Assam which remained unexplored earlier were also collected. Majority of the collections belonged to rice, maize, vegetable and rhizomatous crops. Many landraces, primitive cultivars of rice bean were also collected from Nadia, Murshidabad and Maldah districts of West Bengal in association with

BCKVV, Kalyani. The following collections from the different parts of Northeastern states were made (Table-1).

### 15.2 Germplasm Characterization and Maintenance

A total of 2,184 accessions of germplasm belonging to different agri-horticultural crops were characterised. Of these, 1824 accs. were harvested (Table-2). Crop accessions of Ricebean, Ginger, Chilli and *Dioscorea* were under severe stress conditions, hence, many accs. were lost at germination stage. However, rice, maize and turmeric accs. performed well and superior genotypes were identified in these crops and these have crossed the yield quantity of the genotypes that were sown during the previous years.

**Table 1: Exploration trips during the year 2008**

State	Crops	Total
Arunachal Pradesh	Rice, Maize, Coix, Finger millet, Sesame	29
Nagaland	Chilli Rice	46
Assam	Misc. crops (N.C. Hills) Misc. crops (N.C. Hills)	150
West Bengal	Rice bean	63
Meghalaya	Rice bean Rhizomatous crop and Citrus	18
<b>Total</b>		<b>306</b>



*Capsicum frutescens* L. var. *grossum* Willd., under maintenance and characterization



A land race of *Cucumis sativus* L. genotype collected from Arunachal Pradesh



**Table 2: Crops characterized during 2008**

Crop	No. of germplasm accs		Yield (q/ha)	Superior genotype (Single locations)
	Sown	Harvested		
Upland Paddy	223	206	42.00	IC540207
Lowland Paddy	264	256	45.00	IC545324
Maize	194	194	106.25	IC419720
Rice bean	472	254	12.50	LRB-384
<i>Perilla</i>	88	80	6.81	IC374609
Buckwheat	88	88	6.67	IC013141
Job's Tear	55	54	15.00	IC203985
Ginger	165	148	285.00	IC330089
Turmeric	160	160	296.00	IC545212
<i>Colocasia</i>	284	261	315.00	IC009605
Chillies	122	80	90.30	IC010399
<i>Dioscorea</i>	69	43	400.00	IC309204
<b>Total</b>	<b>2,184</b>	<b>1,824</b>		



Population of *Alpinia galangal* (L.) Swartz., under field characterization



Rice bean (*Vigna umbellata*) crop accessions under characterization

### 15.3 Germplasm Supplied under MTA

Institute/ Indentor	Crop	No. of Accessions
Dr. E.A. Siddique, National Professor, APAU, Hyderabad.	<i>Momordica cochinchinensis</i>	5
Prof. N.K. Chrungoo, NEHU, Shillong	<i>Vigna umbellata</i>	10
Officer-in-Charge, NBPGR Regional Station, Shimla	<i>V. umbellata</i>	2
Dr. T.P. Mall, Bahraich (U.P.)	<i>Zea mays</i>	25
Dr. S. Biswas, ICAR (NEH), Lembuchhara, Tripura	<i>Oryza sativa</i>	10
Dr. P.K. Goswami, Scientist-F, NEIST (CSIR), Jorhat, Assam.	<i>O. sativa</i>	38
Head, Genetics & Pl. Breeding, SASRD, Medziphema, Nagaland	<i>Colocasia esculenta</i>	10
Dr. L. Kharlukhi, Reader, NEHU, Shillong	<i>V. umbellata</i>	28
Dr. K.K. Sharma, Sr. Forage Agronomist, AAU, Jorhat	<i>V. umbellata</i> (40), <i>Coix lacrymajobi</i> (20)	60
Officer-in-Charge, NBPGR Ranchi, Jharkhand.	<i>Mucuna pruriens</i>	1
Dr. A.S. Panwar, ICAR (NEH), Umiam, Meghalaya	<i>V. umbellata</i> , <i>Fagopyrum esculentum</i>	10
Dr. S. Gupta, Plant Breeder, ICAR (NEH), Umiam, Meghalaya	<i>V. umbellata</i>	50
Prof. N.K. Chrungoo, NEHU, Shillong	<i>Fagopyrum esculentum</i>	7
Prof. S.S. Parihar, Division of Seed Science & Technology, IARI, New Delhi	Various medicinal plant species	12
Director, CTCRI, Trivandrum	<i>Colocasia</i> spp.(17), <i>Dioscorea</i> spp. (311)	328



## 15.4 Germplasm Conservation

A total of 62 accessions of upland rice; 38 accs. of maize; 42 accs. of lowland rice have been sent for LTS. One (1) acc. of *Chimnobambusa griffithiana* (Munro) Nakai, has been sent for cryo-storage at NBPGR, New Delhi - 12.

### New Agrotechnique for Cultivation of *Alpinia galangal* (L.)

This station has developed an agrotechnique for the cultivation of *Alpinia galangal* (L.) Swartz, belongs to the family Zingiberaceae. The species occurs in wild condition to limited pockets of the region. The study was conducted to develop its agrotechnique under the ISM&H Project, sponsored by the Ministry of Health and Family Welfare, Govt. of India. The agrotechnique of the species is now well established scientifically and the large scale cultivation is underway in the state of Meghalaya, Nagaland and Mizoram through the entrepreneurs with assured market opportunity. Once the wild plant comes under domestication and cultivation it would economically benefit rural farmers and bioprospecting for the drug industries.



*Solanum mammosum* L., an exotic species, naturalized in certain pockets of NE region



*Kaempferia rotundus* L. under maintenance in Field Genebank

### Research Programme (Code: Title (Programme Leader))

**PGR/BUR-SHL-01.00:** Augmentation, Characterization, Evaluation, Maintenance, Regeneration, Conservation, Documentation and Distribution of Plant Genetic Resources in North Eastern India (**DK Hore**)

### Research Project-I (Project Code, Title, Leader, Associate)

**PGR/PGC-BUR-SHL-01.01:** Augmentation, Characterization, Evaluation, Maintenance, Regeneration, Conservation, and Documentation of Genetic Resources of agricultural and horticultural crops, plants of economic importance, their wild relatives and underutilized crops under the AICRP (**DK Hore**)

**PGR/PGC-BUR-SHL-01.02:** Augmentation, Characterization, Evaluation, Maintenance, Regeneration, Conservation, and Documentation of Genetic Resources of indigenous and exotic lines of Chillies, Ginger, Turmeric, Yams, Taros, *Citrus*, Banana and Passion fruits (**DK Hore**)

## 16. REGIONAL STATION, SHIMLA

**Summary:** Four explorations were accomplished and 273 accessions comprising cereals (76), pseudocereals (12), millets (5), pulses (35), fruits and nuts (29), ornamentals (42), medicinal plants (17), wild relatives of temperate fruits (15), wild *Brassica* (3) and others (3) were collected from Himachal Pradesh. Collected about 50 named landraces of rice viz. *beguni*, *bohana*, *chuartu*, *dabel*, *ghyrsu*, *himtu*, *jatoo*, *jhini*, *jiri*, *kali jhini*, *kard*, *karsai*, *katheri*, *phulpatash*, *ramjwain*, *rodu*, *sukara*, *sunu* and *tapta*. Despite rich variability recorded, the landraces especially in rice and maize are facing major threat of extinction from the modern varieties and changing cropping patterns due to influx of cash crop. 224 herbarium specimens were prepared and deposited at National Herbarium of Cultivated plants at NBPGR. A total of 1816 accessions of agri-horticultural crops were characterized and multiplied for conservation. 474 accessions of various grain crops were submitted for long term storage. One thousand one hundred fifty three accessions of fruit crops, their wild relatives, medicinal plants and ornamentals were conserved and maintained in field gene bank at Shimla and 9788 accessions of various crops were conserved in MTS at Shimla. Germplasm accessions of agricultural crops (782) and horticultural crops (612 rooted plants and 1137 bud sticks) were supplied to various indenters.

### 16.1 Plant Exploration and Collection of Germplasm

Four explorations were undertaken during the period under report and 273 germplasm accessions were collected from various parts of Himachal Pradesh (Table 1). A total of 224 herbarium specimens were prepared and submitted to the National Herbarium of Cultivated plants (NHCP) at NBPGR (HQs).

**Table 1: Germplasm explorations undertaken from January to December, 2008**

Exploration	Area explored	Germplasm collected
Rosa spp.	Solan, Shimla, Bilaspur, Mandi, Hamirpur and Kangra	42
Fruits & Medicinal plants	Mandi and Kullu	46
Wheat, Barley and wild relatives	Lahaul-Spiti	92
Rice and maize landraces	Kangra, Mandi, Hamirpur and Kullu	93



Apricot – St Ambrosia



Chinese ber - a new fruit for dry temperate region

In *Rosa* germplasm exploration 16 species were collected which comprised of spontaneous hybrids of *R. moschata* with *R. chinensis*, *R. multiflora* and uncommonly cultivated rose species viz. *R. beggeriana*, *R. gallica*, *R. laevigata*, *R. x alba*, *R. foetida*, *R. x fortuniana*, *R. wichuraiana*. In fruit and medicinal plants some very popular old varieties like Cox Orange Pippin, Jonathan, and Winter Delicious of apple, China pear and Victoria plum were collected from an orchard established by John Banon in 1857 at Manali. In wheat and barley exploration *Nei*-bluish grained landrace of naked barley, *Toe* - landrace of wheat were collected from Lahaul-Spiti. In addition, germplasm of field pea, *Cicer microphyllum*, *Linum perenne*, *Allium carolinianum*, and *Hippophae* were also collected. In rice exploration 50 landraces were collected and important were - *beguni*, *bohana*, *chuartu*, *dabel*, *ghyrsu*, *himtu*, *jatoo*, *jhini*, *jiri*, *kali jhini*, *kard*, *karsai*, *katheri*, *phulpatash*, *ramjwain*, *rodu*, *sukara*, *sunu* and *tapta*.

Despite rich variability recorded, the landraces especially in rice and maize are facing major threat of extinction from the modern varieties and changing cropping patterns due to influx of cash crop. Maize is another important





Local landraces of maize collected from Kangra (HP)

crop of this region and has lot of variability. Local maize is grown throughout the region and some local types were found very high yielding. *Chitknu*, *Sathoo* and other local types of white and yellow maize were collected, though the area under these local types is decreasing at an alarming rate. Similarly naked barley and field pea both are important crop of cold arid region but facing major threat of extinction due to introduction of apple and garden peas cultivation at large scale.



Variability in pecan nut

## 16.2 Germplasm Characterization and Evaluation

**Field Crops:** A total of 1,703 germplasm accessions comprising of different field crops were characterized and evaluated. All crops were evaluated in Augmented Block Design along with the standard checks as given in below in Table 2.

Table 2: Germplasm of various field crops evaluated

Crop	Accessions	Checks
French bean	678	Vaspa, Laxmi, Jwala, Triloki, Kailash, PLB 10-1, Kentucky Wonder
Amaranth	444	Annapurna, PRA-2, PRA-3, Durga
Buckwheat	148	Himgiri, Himpriya, SanglaB-1, VL 7
Chenopod	166	EC507741, IC022503
Adzuki bean	55	HPU51, EC108080
Rice bean	96	PRR-1, PRR-2, RBL-1 and RBL-6
Pea	116	Lincoln, Azad, Rachna, DMR-7, DMR-11
<b>Total accessions</b>	<b>1,703</b>	



*Rosa laevigata*- exotic and rarely cultivated lush green leaves large petals and mild fragrance



Local landraces of naked barley have bluish-red grain colour

Data were recorded as per the descriptors developed by NBPGR. The data recorded were analyzed for mean and range and promising accessions identified

for important traits (Table 3). The evaluation data revealed wide range of variability in the germplasm for yield and yield contributing traits.

**Table 3: Range, mean and promising accessions identified for important traits**

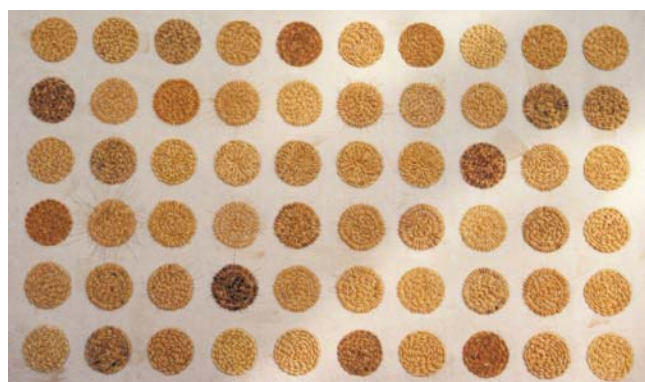
Character	Range	Mean	Promising accessions
<b>Amaranth</b>			
Plant height (cm)	116.0- 300.5	210.56	IC107313, IC042323, IC042340, IC042322, IC042326
Leaf length (cm)	7.65- 26.4	16.57	EC323005, IC107119, IC041985, IC041987, IC042398
Inflorescence length (cm)	33.1- 91.55	58.33	EC328896, EC322998, IC042279-5, IC107119, IC107133
Days to maturity	138- 177	159	IC551502, EC018877, EC359410, EC359439, EC359436
1000 seed weight (g)	0.5- 1.1	0.80	IC042322, IC042334, IC082625, IC084222, IC095591
Grain yield/ plant (g)	25.36- 134.69	88.54	IC551490, IC041985, IC42315-2, IC041999, IC042328
<b>Chenopod</b>			
Plant height (cm)	30.7- 334.4	170.40	IC341700, IC107167, IC469275, NC58231, NIC022532
Inflorescence length (cm)	21.75- 65.25	40.20	IC540836, NIC022515, NIC022506, IC540842, NIC022513
Leaf length (cm)	4.1- 16.5	10.55	IC313278, NIC022509, IC329184, IC109193, IC109235
Leaf width (cm)	2.1- 16.35	10.60	IC107185, IC107296, IC107535, IC313278, IC341700
Days to maturity	97- 160	130.00	IC411824, IC411825, NIC022506, IC540834, IC108817
1000 seed weight (g)	0.4- 1.4	1.00	IC540831, EC507741, IC540823, EC201680, IC107167
Grain yield/ plant (g)	3.91- 47.81	26.30	IC107185, IC469275, IC107296, IC447575, IC469276
<b>Buckwheat</b>			
Plant height (cm)	41.6- 181.0	115.45	EC323726, EC018864, EC125935, EC125397, EC323730
Leaf length (cm)	3.35- 13.25	8.66	EC018864, IC018870-1, EC218764, EC323723, EC216630
Leaf width (cm)	5.30- 13.65	10.20	EC323730, EC216635, EC323726, IC109458, IC202262
No. of Infl./ plant	14.0- 44.0	29.54	IC109726, IC109757, EC125397, EC125936, IC202247
Days to maturity	90- 122	115	IC187110, IC109549, IC109690, IC109721, IC202226
1000 seed weight (g)	13.10- 44.80	29.56	EC216635, EC323723, EC018864, EC125940, EC159500
Grain yield/ plant (g)	1.92- 69.42	27.82	IC109549, IC109753, IC109546, IC109548, IC109550
<b>Adzuki bean</b>			
Plant height (cm)	46.1- 110.4	80.69	EC018151, EC290652, IC030270, EC000262
No. of cluster/ plant	5.0- 14.0	10.25	EC018151, EC340260, EC030253, EC340258, EC000262
No. of pods/ cluster	1.5- 3.5	2.15	EC015256, EC000377, EC340260, EC030256, IC030253
No. of pod/ plant	12.0- 36.0	26.50	EC018151, EC340260, IC030253, EC340249, IC341938
Days to maturity	116- 133	128.20	IC188854, IC241041, EC340262, EC290251, EC240251
1000 seed weight (g)	39.0- 121.2	85.00	EC000262, EC024523, EC240251, IC341942, IC341938
<b>French bean</b>			
Pod length (cm)	3.2- 23.8	10.56	EC394667, EC403966, EC040048, EC500448, IC515486
No. of seeds/ pod	3.0- 9.0	6.80	IC328848, IC556460, IC556461, EC500448, EC500681
No. of pod/ plant	4.0- 30.0	15.00	IC449000, IC448999, IC448989, IC566461, IC016911
Leaflet length (cm)	6.5- 18.8	11.60	IC089199, IC545760, IC545762, IC545756, IC017909
Leaflet width (cm)	3.0- 14.3	8.88	IC545747, IC545760, IC041671, IC041673, IC181451
Days to maturity	77- 187	135.00	IC556463, IC556464, IC018121, IC037145, IC037156
100 seed weight (g)	11.72- 98.08	55.61	IC089201, IC084263, IC039058, IC545760, IC545759
<b>Pea</b>			
Pod length (cm)	3.65- 8.75	6.54	IC291544, IC469145, IC381453, IC279125
No. of pods	3.50- 31.00	18.20	IC342028, IC310833-A, IC209114, IC291544
No. of seeds/ pod	2.50- 6.5	5.25	IC342028, IC469145, IC342026, IC109555, IC469166
100-seed wt. (g)	6.88- 22.68	17.26	EC412883, EC398599, EC414479, IC267152, IC208387
Day to maturity	166- 207	180.00	IC342028, IC291544, IC469145, IC381453, IC279125
Grain yield/ plant (g)	2.19- 65.92	32.45	IC109555, IC279125, IC469145, IC469135, IC342033



### Promising accession for multiple traits

Crop	Accessions	Traits
Amaranth	IC107119	Leaf length and inflorescence length
	IC041985	Leaf length and grain yield
	IC42323	Plant height, seed weight and leaf length
Buckwheat	IC323730	Plant height and leaf length
	EC018864	Plant height, leaf length and seed weight
	EC323723	Leaf length and seed weight
French bean	IC545760	Seed weight, leaf width and leaf length
	EC500448	Pod length and no of seeds/pod
Pea	IC208377, IC208389	Pod length and vegetable type
	IC384573, IC381866	No. of pods, bold seed and pod length
	IC208367, IC208366, IC267142	High yield and resistant to powdery mildew

The germplasm accessions superior by 15% over the best check value were identified for multiple traits on the basis of check value.



Rice landraces collected from HP

**Horticultural crops:** Germplasm accessions of apple (14), pear (13), peach (10), plum (14), walnut (36) and meetha karela (36) were characterized. The data were analyzed for range, mean, phenotypic coefficient of variability (PCV) and promising accessions identified. In apple, maximum PCV was observed for fruit weight (32.5%) followed by fruit length (17.1%). Fruit weight ranged from 20.1 -141.0g, fruit length 28.9-64.0mm, fruit width 32.8-74.6mm and TSS 9.8-15.7%. In pear, high PCV was observed for fruit weight (75.6%) followed by total soluble solids (47.6%). The days to fruit harvest varied from 88-197days, fruit length 15.9-81.5mm, fruit weight 1.9-215.6g and TSS 7.7-26.3%. In peach, maximum PCV was for fruit weight (51.5%, followed by days to fruit harvest (36.3%) and pulp to stone ratio (34.7%). The days to fruit maturity ranged 58-144days, fruit weight ranged from 24.8-120g and pulp to stone ratio 8.4-19.7. In plum, high PCV was observed for fruit weight (55.0%) followed by fruit width (25.7%) and TSS (24.5%). Days to fruit harvest ranged from 75-123days, fruit weight 20.3 – 50.5mm and TSS 7.2-17.1. In walnut, variability was observed for nut shape (round, long, trapezoid, broad elliptic, ovate and elliptic),

nut length 2.0-4.2cm, nut weight 4.2-18.2g, shell thickness 1.1-2.6mm, kernel weight 1.0-67g and kernel percentage 20.2-53.5%. In meetha karela, variability was found for days to fruit harvest 101-130days, no. of fruit/plant 20.1-42.3, fruit weight 9.2-14.6g and fruit length 49.8-66.7mm. Promising accessions for important characters in temperate fruit crops and meetha karela were identified (Table 4).

**Table 4: Promising accessions for different characters along with superior value**

Crop	Character	Promising accession
Apple	Earliness(<100days)	EC38732, EC331125
	Fruit weight(g)	IC558030, IC558026,
	>150g	IC57981, EC451348
Pear	TSS (>15%)	IC432171, IC558031,
		IC557981
	Earliness	EC552674
Peach	Fruit weight(>150g)	IC447940, EC57516
	TSS (>20%)	IC558114, IC209689,
		IC538507
Plum	Earliness(<80days)	EC312408, Silver King,
	Fruit weight (>100g)	IC19367
	TSS (>15%)	EC488324
Walnut	Pulp-stone ratio (.15)	EC19377, Silver King,
		IC19367
	Earliness(<75days)	EC38736, EC488324,
Meetha karela	Fruit weight(>50g)	IC349924
	TSS (>15%)	IC558069, EC127176-B
		EC393741, EC538998,
Walnut	Nut weight(>15g)	EC393742, EC538999
	Kernel weight (>5g)	IC558985, IC557990,
	Kernel percentage(>50)	EC393741, EC127176-B
Meetha karela	Soft shelled	IC19369, IC20070, IC20075
		IC19369, IC19376, IC200107,
		IC20108
Meetha karela	Earliness(<100days)	IC316411, IC20115, IC20108
	No. of fruits/pl (>40)	EC24502, IC19378, IC20065,
	Fruit weight>14g	IC20114
Meetha karela	Tubercle free	IC411611
		IC278835, IC411618,
		IC415520
Meetha karela		IC20296, IC326922,
		IC329216
		IC415317, IC145420

## 16.3 Germplasm Conservation

**16.3.1. Germplasm conserved in the LTS:** A total of 474 accessions of various crops were sent to the NGB for long-term storage. Crop wise break-up of germplasm deposited in LTS is given in Table 5.

**Table 5: Germplasm supplied for LTS**

Crop	Accessions	Crop	Accessions	Crop	Accessions
Amaranth	97	French bean	53	Tomato	07
Buckwheat	138	Pea	112	Medicinal plants	03
Chenopod	03	Chilli	61	Total	474

**16.3.2. Medium Term Storage:** A total of 9,626 accessions of various crops were conserved in MTS. Crop wise break-up of germplasm being conserved in MTS is given in table 6.

**Table 6: Germplasm accessions being conserved in the MTS**

Crop	Accs	Crop	Accs	Crop	Accs
Amaranth	2958	Adzuki bean	155	Horse gram	136
Buckwheat	890	Finger millet	410	Pea	436
Chenopod	166	Foxtail millet	278	Lentil	54
French bean	3620	Barnyard millet	71	<i>Cuphea</i>	16
Rice bean	236	Proso millet	160	<i>Meetha karela</i>	40

**16.3.3. Field Gene Bank:** A total of 1,153 germplasm accession of perennial crops such as fruits, medicinal and aromatic plants and other economic plants conserved in the field gene bank. Crop wise break-up of germplasm being conserved in FGB is given in Table 7.

**Table 7: Germplasm accessions being conserved in the FGB**

Crop	Accs.	Crop	Accs.	Crop	Acs.	Crop	Acs.
Apple	233	Kiwi fruit	9	<i>Ribes</i>	5	Fig	5
Pear	67	Pomegranate	102	<i>Docynia</i>	2	<i>Viburnum</i>	3
Peach	44	Pineapple guava	2	<i>Quince</i>	9	Mulberry	4
Plum	42	Strawberry	5	Olive	6	<i>Elaeagnus</i>	1
Apricot	35	Grapes	11	<i>Crataegus</i>	3	<i>Rosa</i> spp.	31
Walnut	271	Cherry	6	<i>Mespilus</i>	4	M & AP	70
Pecan nut	51	Persimmon	9	Chest nut	1	Others	54
Almond	20	Chinese ber	3	Hops	6		
Hazelnut	21	<i>Rubus</i> spp.	10	Citrus	5		

**Conservation of wild relatives of crop plants:** With special focus on important wild/ wild relatives of cultivated agri-horticultural crops are being maintained at the station (Table 8).

**Table 8: Wild relatives of agri-horticultural crops, minor fruits and important medicinal plants conserved in FGB**

Crop	Wild Relatives/ Species
Amaranth	<i>Amaranthus hybridus</i> , <i>A. retroflexus</i> , <i>A. lividus</i> , <i>A. viridis</i> , <i>A. graecizans</i> , <i>A. dubius</i> , <i>A. spinosus</i> , and <i>A. tricolor</i>
Buckwheat	<i>Fagopyrum emerginatum</i> , <i>F. tataricum</i> var. <i>himalaicum</i> and <i>F. gigataenium</i>
Chenopod	<i>Chenopodium amranticolor</i> , <i>C. botrys</i> , <i>C. murale</i> , and <i>C. ambrasoidesi</i>
Frenchbean	<i>Phaseolus lunatus</i> , and <i>P. coccineus</i>
Faba bean	<i>Vicia hirsuta</i> , <i>V. tetrasperma</i>
Apple	<i>Malus baccata</i> , <i>M. baccata</i> var. <i>himalaica</i> , <i>M. baccata</i> var. <i>dringensis</i> , <i>M. sikkimensis</i> , <i>M. orientalis</i> and <i>M. glaucensis</i>

Pear	<i>Pyrus pyrifolia</i> , <i>P. pyrifolia</i> var. <i>kumaoni</i> , <i>P. jacquemontii</i> , <i>P. pashia</i> , <i>P. serotina</i>
Prunus	<i>Prunus nepaulensis</i> , <i>P. arminiaca</i> , <i>P. cerasoides</i> , <i>P. mira</i> , <i>P. cornuta</i> , <i>P. serrulata</i> , <i>P. pissardii</i> , <i>P. laurocerasus</i> , <i>P. mume</i>
Walnut	<i>Juglans nigra</i> , <i>J. mandshurica</i> , <i>J. ailantifolia</i>
Kiwi	<i>Actinidia callosa</i> , <i>A. arguta</i>
Grapes	<i>Vitis ficifolia</i> , <i>V. arizonica</i> , <i>V. riparia</i> , <i>V. barlandierii</i> , <i>V. acerifolia</i> , <i>V. gerdiana</i> , <i>V. aestivalis</i> , <i>V. amurensis</i> , <i>V. cinerea</i> , <i>Parthenocissus quinquefolia</i> , <i>V. himalayana</i> , <i>V. vinifera</i>
Pistachio	<i>Pistachio atlantica</i> , <i>P. terebinthus</i>
<i>Rubus</i> spp.	<i>Rubus ellipticus</i> , <i>R. niveus</i> , <i>R. paniculatus</i> , <i>R. racemosus</i> , <i>R. lasiocarpus</i> , <i>R. fruticosus</i> , <i>R. macilentus</i> , <i>R. mallacanus</i> , <i>R. assamensis</i>
<i>Ribes</i> spp.	<i>Ribes nigrum</i> , <i>R. rubrum</i>
Minor fruits	<i>Punica granatum</i> , <i>Cotoneaster acuminata</i> , <i>C. bacillaris</i> , <i>C. salicifolia</i> , <i>C. zabelli</i> , <i>C. franchettii</i> , <i>Crataegus wendlandii</i> , <i>C. malanocarpa</i> , <i>C. oxycantha</i> , <i>C. soongarica</i> , <i>Feijoa sellowiana</i> , <i>Cydonia oblonga</i> , <i>Docynia hookeriana</i> , <i>D. indica</i> , <i>Viburnum cotinifolium</i> , <i>V. lanata</i> , <i>Cornus rugosa</i> , <i>C. nigra</i> , <i>C. kousa</i> , <i>Elaeagnus umbellata</i> , <i>Castanea crenata</i> , <i>Olea cuspidata</i> , <i>Ziziphus jujuba</i> , <i>Diaspora lotus</i> , <i>Ficus palmata</i> , <i>F. carica</i> , <i>Corylus jacquemontii</i>
Wild <i>Allium</i> spp.	<i>Allium fistulosum</i> , <i>A. przewalskianum</i> , <i>A. carolinianum</i> , <i>A. tuberosum</i> , <i>A. schoenoprasum</i> , <i>A. auriculatum</i> , <i>A. graffithianum</i> , <i>A. consanguinum</i> , <i>Allium sativa</i> var. <i>ophioscordon</i>
Important medicinal plants	<i>Acorus calamus</i> , <i>Asparagus adscendens</i> , <i>A. filicinus</i> , <i>Bacopa monnieri</i> , <i>Habenaria intermedia</i> , <i>Viola serpens</i> , <i>Hedychium spicatum</i> , <i>Taxus baccata</i> , <i>Heracleum candicans</i> , <i>Thymus serpyllum</i> , <i>Dioscorea deltoidea</i> , <i>Roylea elegans</i> , <i>Podophyllum hexandrum</i> , <i>Polygonatum cirrhifolium</i> , <i>P. verticillatum</i> , <i>Valeriana wallichii</i> , <i>Roscoeia procera</i> , <i>R. alpina</i> , <i>Achillea millefolium</i> , <i>Betula edulis</i> , <i>Ephedra Gerardiana</i> , <i>Lilium polyphyllum</i> , <i>Picrorhiza kurroo</i> , <i>Stevia rebaudiana</i> , <i>Saussurea costus</i> , <i>Arctium lappa</i> , <i>Withania somnifera</i>

#### 16.4. Germplasm supply

Germplasm of agricultural crops (782 accessions) and horticultural crops (612 rooted plants and 1137 bud sticks) were supplied to various indenters as follows.

- **Seeds:** Amaranth (155), buckwheat (162), French bean (290), chenopod (64), horse gram (30), pea (53) and rice bean (28).
- **Rooted plants:** Apple (39), kiwi (67), peach (19),

plum (9), pear (27), pepino (58), persimmon (9), hazelnut (1), *Stevia* (224), *Rubus* spp. (10), apricot (4), pecannut (4), Assam apple (1), pomegranate (19), *Rosa* spp. (13), walnut (3), pineapple guava (22), grape (2), Chinese ber (10), fig (8) and M&AP (63).

- **Bud sticks :** Apple (110), kiwi (170), peach (230), plum (35), pear (60), pepino (22), persimmon (10), hazelnut (20), apricot (210), rose (105), almond (5), cherry (25), and walnut (85).

#### Research Programme (Project Code: Title (Programme Leader))

PGR/GEV/BUR-SHM-01.00: Augmentation, characterization, evaluation, maintenance, regeneration, conservation, documentation, and distribution of genetic resources of the North-Western Himalayan region. (VD Verma)

#### Research projects (Code: title (PI and CoPI))

PGR/GEV/BUR-SHM-01.01: Augmentation, characterization, evaluation, maintenance, regeneration, conservation, documentation, and distribution of genetic resources of pseudocereals, pulses, and other lesser known hill crops (JC Rana, K Pradheep and V D 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, K Pradheep, JC Rana and Sandhya Gupta)

#### Externally funded ad-hoc research projects

- Mass propagation and promotion of cultivation of Geranium and Lavender in Himachal Pradesh (JC Rana)
- Assessing available biomass for meeting demand and supply of energy-A case study in three watersheds of Himachal Pradesh (JC Rana)
- On farm conservation and promotion of cultivation of small millets and pseudo-cereals in participatory mode in Himachal Pradesh (JC Rana)
- Mass multiplication of quality planting material of some new fruits as an alternative to diversity fruit cultivation in HP (JC Rana)

## 17. REGIONAL STATION, SRINAGAR

**Summary:** Explorations of agri-horticultural crops were undertaken in Kashmir and Leh regions. A total of 401 accessions of seabuckthorn (148), apricot (101), pumpkin (43), brinjal (55), bottle gourd (37), cucumber (14) and bitter gourd (3) were collected. The 605 accessions of wheat (330), barley (164) and mustard (111) were characterized and evaluated during *Rabi* 2007-08 and 576 accessions of wheat (303), barley (145) and sarson (128) were sown in *Rabi* 2008-09 for characterization and evaluation.

The NBPGR, Regional Station, Srinagar was established in 1989 with responsibility of plant exploration and germplasm collection of agri-horticultural crops and their wild relatives from the region and their characterization and evaluation. It is located about 14 km from Srinagar city at KD Farm near old airfield, Rangreth. In spite of unfavourable socio-political environment in the region, PGR activities were carried out and annual report is presented below.

### 17.1 Germplasm Exploration and Collection

A total of 401 germplasm accessions of different agri-horticultural crops were collected from Kashmir and Leh regions.

**17.1.1 Collection of seabuckthorn (*Hippophae rhamnoides* Linn) germplasm:** The 148 wild accessions of sea buckthorn were collected from different jungles and villages of Leh regions.

Sea buckthorn is a deciduous winter-hardy shrub with yellow to orange 6 to 8 mm small berries, which remain on the shrubs throughout the winter. Sea



Genetic diversity in wild Sea buckthorn

buckthorn reaches 2 to 5 m in height. Its leaves are alternate, narrow and silver-grey coloured. The small, yellow flowers appear in spring before leaves.

Both male and female sea buckthorn plants are needed for fruit production. Sea buckthorn is used for land reclamation and to prevent soil erosion because of its extensive root system and its ability to fix nitrogen and other nutrients. The sea buckthorn berries are used to make juice but also bark and leaves are used for the production of pharmaceuticals or to make sea buckthorn tea. Sea buckthorn oil is produced from the fruits and seeds.

The berries have very high levels of beta-carotene, vitamin C, vitamin E and flavonoids. The vitamin C level of 3600 ppm is about 10 times higher than that of oranges. The sea buckthorn berries are also rich in vitamins B1, B2, K and P.

Although sea buckthorn has many benefits, it is most frequently used for the treatment of diseases of skin and digestive tract. It has anti-inflammatory and antimicrobiological activity, relieves pain and promotes tissue regeneration. Sea buckthorn oil is traditionally used to treat cervical erosion, radiation damage, burns, ulcers and skin damage. It may also improve heart health.

The most studied property of sea buckthorn is the improvement of wound healing. Topical treatment of wounds with extracts or oil from sea buckthorn relieves pain and accelerates wound healing. It stimulates the healing of gastric ulcer.

**17.1.2 Collection of apricot (*Prunus armeniaca* L.) germplasm:** One hundred and one accessions of apricot from different villages of Leh and Kargil districts were collected. Variability was observed for size, colour, softness, taste, juice content of the fruit.

Apricots are small, golden orange fruits, with velvety



skin and flesh: not too juicy but definitely smooth and sweet. Their flavor is almost musky, with a faint tartness that is more pronounced when the fruit is dried. Nutrients in apricots can help protect the heart and eyes, as well as provide the disease-fighting effects of fiber. The high beta-carotene and lycopene activity of apricots makes them important heart health foods. Both beta-carotene and lycopene protect LDL cholesterol from oxidation, which may help prevent heart diseases. Apricots contain nutrients such as vitamin A that promote good vision. Vitamin A, a powerful antioxidant, quenches free radical damage to cells and tissues. The degenerative effect of free radicals, or oxidative stress, may lead to cataracts or damage the blood supply to the eyes and cause macular degeneration.

**17.1.3 Collection of pumpkin (*Cucurbita moschata* L.) germplasm:** Forty three accessions of pumpkin were collected from Gandarbal, Pulwama, Shopain districts of Kashmir valley. The diversity was observed for fruit weight, taste, colour, shape, size, juice etc.



**Variability in shape and size of pumpkins collected from Kashmir valley**

Pumpkin possesses some really top quality essential nutrients that are required for many processes in the human body and can serve as effective herbal medication. Pumpkin flesh is very low in calories yet contains abundant quantities of extremely good dietary fiber. Many important disease fighting nutrients are also found in large quantities in the flesh and pulp as well as the seeds of the pumpkin, these includes the essential mineral potassium, the vitamin pantothenic acid, the essential mineral magnesium and the important vitamins C and E aside from many other nutrients. Due to the presence of a synergistic combination of the class of organic compounds known as carotenoids in the

pumpkin, the pumpkin is considered to be one of the super foods in the plant kingdom in terms of its essential nutrient content alone. The amount of bio-available carotenoids in the pumpkin forms one of the richest single sources of this nutrient in the diet of people.

**17.1.4 Collection of diversity of brinjal (*Solanum melongena* L.):** Fifty five accessions of brinjal were collected from the villages of Budgam districts of Kashmir. The variability was observed for shape, size and colour of fruits.



**Variability in brinjal**

Possessing a deep violet colour in its ripe form, brinjal contains many essential nutrients which are needed for the overall well-being of the body. Having a high content of water, fiber and potassium, brinjal is believed to possess many medicinal properties which can help in fighting cancer, hypertension and diabetes amongst other problems. This is because brinjal, commonly known as the eggplant, has anti diabetic and antihaemorrhoidal properties along with being a cholesterol regulator. Thus, its intake can help in preventing as well as curing various health related disorders.

**17.1.5 Collection of bottle gourd (*Lagenaria siceraria* L.) germplasm:** Thirty seven accessions of bottle gourd were collected from the villages of Kashmir valley. The variability was observed for shape and size of fruit.

The bottle gourd is common vegetable in India. It is pale, green-yellow in colour and is in a shape of a bottle. It has white pulp, with white seeds with spongy flesh. It grows best in a warm climate. The bottle gourd is mild tasting and can be cooked on its own in a curry or with lentils. However, it should never be eaten on its own as it may cause an irritation to the intestines.



Variability in bottle gourd



Variability in bitter gourd

**17.1.6. Collection of diversity of bitter gourd (*Momordica dioica* L.):** Three accessions of kerala were collected from different parts of Kashmir valley.

Fourteen accessions of cucumber (*Cucumis sativus* L.) also were collected from the villages of Kashmir valley

## 17.2 Germplasm Characterization and Evaluation

A total of 605 accessions comprising of wheat (330) barley (164) and mustard (111) were characterized and

evaluated in a Augmented Block Design during *Rabi* 2007-08 under rainfed condition. The 576 accessions of wheat (330), barley (164) and mustard (111) have been sown in the field during *Rabi* 2008-09 for characterization and evaluation under rainfed condition.

## 17.3 Maintenance of Germplasm

The 39 accessions comprising *Dioscorea deltoidea* (23) strawberry (5), pran (5), mint (3) and *Iris* spp. (3) were maintained as live plants.

### Research Project (Code, Title, Project leader, Associates)

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 Singh** and D Gautam).

## 18. REGIONAL STATION, THRISSUR

**Summary:** A total of 189 accessions were collected in 5 exploration and collection missions carried out in 6 districts of Kerala, 13 districts of Tamil Nadu, 1 district of Puducherry and 3 districts of Andaman & Nicobar (A & N) Islands. This resulted in the collection of 77 accessions from Tamil Nadu, 63 from Kerala, 48 from A & N Islands and 1 from Puducherry. The collected germplasm included 2 landraces of rice ('khusbui' and 'Burma') from A & N Islands. Profusely bearing heavier bunches in karanj, physicnut which bears fruit throughout the year, a wild relative of drumstick, leafy amaranth with robust habit and thick stem were the unique and interesting collections made. Out of the collected germplasm, 102 accessions were sent for long-term storage in the National Genebank, NBPGR, New Delhi and 57 were maintained at MTS facility of the station. During *rabi* 2007-08, 113 accessions of rice (*Oryza sativa*) and 117 of horsegram (*Macrotyloma uniflorum*) were evaluated. In summer 2008, 24 accessions of Chinese spinach (*Amaranthus tricolor*), 10 of spleen amaranth (*A. dubius*), 18 of mango (*Mangifera indica*) and 9 of kokum (*Garcinia indica*) were characterised/ evaluated. During *kharif* 2008, 100 accessions of okra (*Abelmoschus esculentus*), 174 of brinjal core set (*Solanum melongena*), 10 of Chinese potato (*Solenostemon rotundifolius*), 21 of lesser yam (*Dioscorea esculenta*) and 34 of Malabar tamarind (*Garcinia cambogia*) were characterised/ evaluated. Sent seeds of 395 multiplied accessions for long-term storage. For cryo-preservation, 33 accessions were sent. Seeds of 278 accessions of various crops/wild relatives were added to the MTS facility of the station. Based on material transfer agreement, 599 accessions comprising 8 crops and 39 wild related species were supplied to 18 user agencies. Supplied 49 accessions of collected germplasm to FCRI, TNAU under the TBOs Project. Transferred one accession each in 16 species of *Curcuma* to IISR, Kozhikode and 2 of banana to NRC for Banana, Tiruchchirapalli and 1 each of senna and *Salvadora persica* to NBPGR RS, Hyderabad. A total of 195 accessions in 2 crops (cassava-42, and ginger-144) and 11 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*-2, *C. aeruginosa*-1 and *C. latifolia*-1) were maintained in *in vitro* conservation media. One accession each of *Bacopa monneiri* and *Alpinia calcarata* was newly initiated in to *in vitro* culture. Supplied 100 accessions of horsegram to 3 institutions for multi-location evaluation under the National Network Project on Arid Legumes. Two new externally funded project one each by NAIP and NOVOD Board were initiated during this year.

The NBPGR Regional Station, Vellanikkara, Thrissur is responsible for plant genetic resources related activities in the southern peninsular region of India comprising the Western Ghat region in the states of Kerala, Tamil Nadu, Karnataka and Goa and the Union Territories of Lakshadweep and Andaman & Nicobar (A & N) Islands. This year the prioritized crops for collection were tree-borne oilseeds (TBOs), leafy-vegetables, under-utilized vegetables (UUVs), medicinal plants and wild relatives of crops.

### 18.1 Exploration and Collection

A total of 189 accessions was collected in 5 exploration and collection missions carried out in 6 districts of Kerala, 12 districts of Tamil Nadu, 1 district of Puducherry and 3 districts of Andaman & Nicobar (A & N) Islands. Among these, one mission was executed in collaboration with NBPGR, New Delhi for collection of prioritized medicinal plants. This resulted in the collection of 77 accessions from Tamil Nadu, 63 from Kerala, 48 from A & N Islands and 1 from Puducherry in 5 missions as follows:

Districts	State / Union Territory	Target Crop(s)	Target crops collected	Others collected	Total
Alapuzha, Ernakulam, Kozhikode	Kerala	Noni	Noni-5	-	5
Coimbatore, Dindigul, Madurai, Nagapattinam, Theni	Tamil Nadu	TBOs	Karanj-13, physicnut-18, <i>Calophyllum inophyllum</i> -4	5	40
Kanyakumari, Thuthukudi, Ramanathapuram, Nagapattinam, Thiruvannamalai, Krishnagiri, Vellore, Dharmapuri, Theni, Dindigul, Madurai	Tamil Nadu	TBOs	Karanj-8, physicnut-9, <i>Calophyllum inophyllum</i> -5, <i>Salvadora persica</i> -1	10	33
Karaikkal	Puducherry		<i>Solanum incanum</i> -1	-	1
Thrissur, Ernakulam, Kollam, Thiruvananthapuram, Kanyakumari,	Tamil Nadu and Kerala (in collaboration with NBPGR New Delhi)	Prioritized medicinal plants	Noni-17, <i>Alpinia galanga</i> -8, <i>Alpinia calcarata</i> -8, <i>Indigofera tinctoria</i> -5, <i>Bacopa monneiri</i> -5, <i>Andrographis paniculata</i> -3	16	62
Middle Andaman, North Andaman, South Andaman	A & N Islands	Vegetables & wild relatives of crops	<i>Momordica cochinchinensis</i> -16, <i>M. subangulata</i> sub sp. <i>reningera</i> -6, <i>Vigna dalzelliana</i> -3, <i>V. umbellata</i> -1, <i>Cucumis callosus</i> -2, <i>Abrus precatorius</i> -2, Noni-2	16	48





A wild population of *Momordica charantia* var. *muricata*, collected from Nepatang river belt, Middle Andaman



Crossing Nepatang river in Middle Andaman after collecting 'choijwal' (*Piper ribesioides*), a wild gathered spice with high value for mature stem, from the interior upstream area

Among these, the major variability collected in terms of 4 or more accessions per taxon and the interesting collections made are given below separately:

#### Major variability collected in each taxon

Group	Crop	Botanical Name	No. of Accessions
TBOs	Indian Laurel	<i>Calophyllum inophyllum</i>	4
	Physicnut	<i>Jatropha curcas</i>	27
	Karanj	<i>Pongamia pinnata</i>	21
M&A plants	Noni	<i>Morinda citrifolia</i>	24
	Indigo	<i>Indigofera tinctoria</i>	5
	Greater galangal	<i>Alpinia galanga</i>	8
	Lesser galangal	<i>A. calcarata</i>	8
Under-utilised vegetables	Sweet gourd	<i>Momordica cochinchinensis</i>	16
	Teasle gourd	<i>M. subangulata</i> sub sp. <i>renigera</i>	6



Noni (*Morinda citrifolia*) collected from Port Blair, South Andaman



*Vigna dalzelliana* collected from Thorak Tang, Middle Andaman



*Momordica subangulata* subsp. *renigera*, male plant collected from Middle Andaman



*Momordica cochinchinensis*, female plant collected from Jirkatang forest, Middle Andaman



## Interesting collections made:

Crop/	Botanical name	Accs. No./ Coll. No.	Speciality	District	State
Cowa	<i>Garcinia cowa</i>	IC553714, IC553757	Edible fruit, first time collection	Andaman	A&N Islands
Karanj	<i>Pongamia pinnata</i>	IC560947 & IC560948 (AM/ 2008-810 & 811)	Profusely bearing heavier bunches	Coimbatore	Tamil Nadu
	<i>Calophyllum inophyllum</i>	IC560969 (AM/2008-832)	Smaller seeds	Theni	Tamil Nadu
Physic nut	<i>Jatropha curcas</i>	IC560952(AM/ 2008-815)	Started bearing within one year of planting through cuttings, had all stages of flower and fruit development at the time of collection indicating the nature of heavy bearing with 8-12 fruits per bunch, almost throughout the year	Dindigul	Tamil Nadu
	<i>Moringa concanensis</i>	IC560981(AM/ 2008-844)	Wild relative of cultivated drumstick	Dindigul	Tamil Nadu
Chinese spinach	<i>Amaranthus tricolor</i>	IC560973(AM/ 2008-836)	Robust with very thick stem, used as a dual purpose leafy vegetable after removing the external fibrous epidermis of stem	Dindigul	Tamil Nadu
Rice	<i>Oryza sativa</i>	JAS/08-32	Land race 'khusbui'	Middle Andaman	Andaman
Rice	<i>Oryza sativa</i>	JAS/08-33	Land race 'Burma'	Middle Andaman	Andaman

**Herbarium study:** Sheets of *Atylosia* (= *Cajanus*) and Flora of Lakshadweep at the Herbarium of Botany Department (CALI), Calicut University, Kozhikode, Kerala and those deposited in the Madras Herbarium (MH) of Botanical Survey of India, Coimbatore were consulted to help in collecting variability within the wild relatives of pigeon pea. Based on this, the grasslands adjacent to shola forests in Idukki and Wayand districts of Kerala, Nilgiris district of Tamil Nadu and Chikmagalur district of Karnataka were found to be places of higher concentration of *Atylosia trinervia* and proper season for collection of germplasm would be February to March. The other species (1) *A. goensis*, has been recorded from the hills of Kerala, in Nelliampathy, Wayanad, Idukki and Anamalais, the season for collection would be January-March; (2) *A. albicans* from the hills of Kerala and Tamil Nadu, the season for collection would be December-February; (3) *A. rugosa* from the hills in Tamil Nadu, the season for collection would be September-October; and (4) *A. scarabeoides* from the lower hills of Tamil Nadu, the season for collection would be November-February.

**Herbarium sent to NHCP:** Six herbarium specimens of *Cucurbita moschata*, *C. maxima*, *C. argyrosperma*, *C. pepo*, *Momordica cochinchinensis* and *Vigna*

*dalzelliana* were sent to NHCP, NBPGR, New Delhi.

## 18.2 Characterisation and Evaluation

### 18.2.1 Cereals

**Rice (*Oryza sativa*) Rabi 2007-08:** One-hundred and thirteen accessions of rice were evaluated for 12 qualitative and 10 quantitative characters along with four check varieties namely Ahalya, Jaya, Jyoti and Thulasi. No remarkable variability was found in qualitative characters except for seed coat color.

### Accessions superior to the best check for economic traits

Grain Length (mm)			
TCR No.	Collector's No.	ACC No.	Value
3697	P-650	IC086398	9.9
Jyothi			8.6
100 Grain Weight (g)			
TCRNo	Collector's No.	ACC No.	Value
3077A	A-1292 A	IC537439A	3.3
698A	37/82-5	NIC067630A	3.1
4178A1	ACC-09036A2	EC205240A1	3.1
3449A	U10-222	IC086206A	3.0
Jyothi			2.8

Grain Yield/plant (g)			
TCR No.	Collector's No.	ACC No.	Value
3863B	ACC-11053	EC204917B	21.3
1604	RKS-34	IC074615	19.8
3201	D-0010	IC085993	18.9
3205	D-0255	IC085997	18.7
Jyothi			10.4
Panicle Length (cm)			
TCR No.	Collector's No.	ACC No.	Value
4157A	ACC-16500	EC205219A	23.8
Jaya			18.7
Grain Width (mm)			
TCR No.	Collector's No.	ACC No.	Value
4178A1	ACC-09036A2	EC205240A1	3.8
3077A	A-1292 A	IC537439A	3.2
Ahalya			2.7
Days to 50% Flowering			
TCR No.	Collector's No.	ACC No.	Value
4321A	C-2051	IC086451A	44
3801A	ACC-05423	EC204855A	44
4437A	K-3859	IC086524A	44
4443A	UB-150	IC086528A	44
4460	UB-045A	IC086543	44
Ahalya			48.8

**Rice (*Oryza sativa*) Kharif 2008:** One-hundred and ten accessions of rice were evaluated for 11 qualitative and 10 quantitative characters along with four check varieties namely Ahalya, Jaya, Jyoti and Thulasi. No variability was found in early plant vigour, leaf pubescence and panicle exertion. The frequency distribution observed in other qualitative characters is detailed below:

Descriptors	Descriptor States	No. of Accessions
Coleoptile color	Green	106
	Purple	4
Basal leaf sheath color	Green	107
	Purple	3
Leaf blade color	Green	109
	Dark green	1
Panicle type	Intermediate	109
	Open	1
Awning	Short and fully awned	3
	Short and partly awned	18
	Long and fully awned	11
	Long and partly awned	3
	Absent	75
Seed coat color	White	49
	Light brown	21
	Speckled brown	3
	Brown	10
	Red	27

Hull color	Straw	72
	Brown	4
	Golden brown	5
	Brown furrows on straw	14
	Purple furrows on straw	1
	Tawny brown	9
	Black	4
	Others	1
Threshability	Easy	77
	Intermediate	21
	Difficult	11
	Very difficult	1



**Variability in seeds of Karanj (*Pongamia pinnata*) collected from Tamil Nadu**



**Arokyapacha' (*Trichopus zeylanicus* subsp. *travancoricus*) –a rare, endemic and endangered potential medicinal plant at NBPGR, Thrissur**

#### Superior accessions identified for economic characters

TCR No.	Collector's No.	Accession No.	No. of Effective Tillers
5230	SM-3169	IC567882	21.4
5213B	SM-3138	IC567888B	17.8
5181	SM-3097	IC567876	25.4
5193	SM-3115	IC567880	19.6
5200A	SM-3125	IC567884	19.7
5170	SM-3086	IC567874	16.6
5131B	SM-3037	IC145163B	18.8

5311	SD13-235	IC567916	17
5320B	SD13-244	IC276469B	16.2
5320A	SD13-244	IC276469A	17.8
5330B	SD13-254	IC145182B	18
6245	PSR 4864	IC200943	20
Best check	Thulasi		12.8

TCR No.	Collector's No.	Accession No.	Grain Length (mm)
5281B	SD13-203	IC251495B	9.9
5268	SD13-189	IC540449	10.07
5354A	SD13-278	IC547021A	10.7
5382A	SD13-306	IC567929A	11.15
5333B	SD13-257	IC276475B	9.9
5318B	SD13-242	IC567920B	10.6
5346A	SD13-270	IC540353A	9.94
5390	SD13-314	IC205986	10.6
6356	PSR 5180	IC206221	10.08
Best check	Jyoti		9.8

TCR No.	Collector's No.	Accession No.	Panicle Length (mm)
5214	SM-3139	IC567889	25.0
5242	SM-3181	IC567898	24.6
5223	SM-3162	IC567891	25.8
5173	SM-3089	IC567875	24
5284	SD13-206	IC205957	24.2
5265	SD13-186	IC567907	26
5359	SD13-283	IC567927	24.4
5286A	SD13-208	IC251498A	28.6
5333B	SD13-257	IC276475B	26
5373A	SD13-297A	IC540357A	24.2
5326	SD13-250	IC264306	24.8
6208	SMS 4210	IC444066	24.6
6355	PSR 5179	IC206220	25.6
6253	PSR 4961	IC200951	27.2
5822A	MRC 127	IC350521A	24
Best check	Jaya		23.4

TCR No.	Collector's No.	Accession No.	100 Grain Weight (g)
5198A	SM-3123	IC567883	2.9
5354A	SD13-278	IC547021A	2.87
5822B	MRC 127	IC350521B	2.87
6248	PSR 4892	IC200946	3.01
Best check	Jaya		2.85

TCR No.	Collector's No.	Accession No.	Grain Yield/Plant (g)
5213A	SM-3138	IC567888A	10.64
5230	SM-3169	IC567882	12.78
5223	SM-3162	IC567891	10.13
5359	SD13-283	IC 567927	15.07
5330B	SD13-254	IC145182B	11.03
6222A	SMS 4225	IC567983	11.76
Best check	Thulasi		9.85

Of these, IC567882 and IC145182B were found superior to combination of characters namely number of effective tillers and grain yield/plant and IC567891 and IC567927 were found superior for panicle length and grain yield/plant.

## 18.2.2 Grain Legumes

**Horsegram (*Macrotyloma uniflorum*) Rabi 2007-08:** A total of 117 accessions was characterized for 8 qualitative and 6 quantitative characters, along with 6 check varieties namely, AK-21, AK-26, AK-38, HGGP, PHG-9 and DPI 2278. IC088995, IC022823, IC026123, IC045756 and IC121635 were found superior for pod length compared to the best check HGGP with pod length more than 4.5 cm.

## 18.2.3 Vegetables

**Brinjal (*Solanum melongena*) Kharif 2008:** One hundred and seventy-four accessions of brinjal core set were evaluated in an Augmented Block Design (ABD) along with nine checks namely Pusa Ankur, Pusa Upkar, PPL, Pusa Kranti, Punjab Sadabahar, KS-331, Arka Neelkant, Harita and Surya for 4 qualitative and 11 quantitative characters. The frequency distribution for qualitative characters and superior accessions identified are given below:

### Frequency distribution of qualitative characters

Descriptor	Descriptor States	No. of Accessions	% of Variability
Fruit shape	Long	52	29.9
	Round	47	27.0
	Oblong	59	33.9
	Oval	16	9.2
Fruit color	Milky white	4	2.3
	Green	52	29.9
	Purple	65	37.4
	Purple black	4	2.3
	Black	3	1.7
	Light purple	11	6.3
	Others	35	20.1
Fruit color distribution	Uniform	62	35.6
	Mottled	50	28.7
	Irregular striped	11	6.3
	Regular stripped	3	1.7
	Others	48	27.6
Seediness	Low	15	8.6
	Medium	136	78.2
	High	23	13.2



Variability in vegetative characters in Chinese spinach (*Amaranthus tricolor*)



Fruit variability in the core-set of brinjal (*Solanum melongena*)

### Superior accessions identified

No.	Accession No.	No. of Fruits/ plant
3	EC111092	24.2
23	EC379244	24.6
28	EC393239	26.8
29	EC467271	24.4
30	EC467274	26.4
35	IC089888D	27.4
46	IC090053	23.0
48	IC090084	23.6
67	IC090981	28.3
71	IC099712	24.4
73	IC104083	59.0
74	IC111010	24.4
76	IC111019	29.4
81	IC111439	35.6
89	IC112350	25.4
93	IC112741	29.6
120	IC281072	36.4
121	IC281092	29.8
122	IC281104	30.6
123	IC281112	31.2
125	IC285140	25.0
Best check	Surya	23.4

No.	Accession No.	Fruit weight (g)
77	IC111066-2	310
92	IC112738	358
115	IC261801	325
131	IC336472	280
146	IC354604	300
149	IC374707	255
155	IC375858	280
179	NIC023958	330
Best check	Pusa kranti	250

No.	Accession No.	Fruit yield/ plant (g)
5	IC169079	2698.0
14	EC305131	1904.0
23	EC379244	2228.0
26	EC385380	2021.0
28	EC393239	2118.0
29	EC467271	2142.0
30	EC467274	2164.0
31	IC074207	2355.0
46	IC090053	2014.0
49	IC090093	2088.0
51	IC090151	2112.0
67	IC090981	2236.7
69	IC099676	1976.0
75	IC111018	2211.0
76	IC111019	2312.0
79	IC111409	2028.0
81	IC111439	1918.0
100	IC112830	2792.0
Best check	Haritha	1907.5

Forty-nine accessions namely IC169079, EC187214, EC304072, EC304983-1, EC305048, EC305096, EC305131, EC384565, EC384970, EC385380, EC386589, EC467271, IC074207, IC074239, IC089818, IC089888, IC089900, IC090026, IC090068, IC090093, IC090132, IC090987, IC099676, IC111018, IC111019, IC111387, IC111409, IC111415, IC111439, IC111443, IC112313, IC112341, IC112726, IC112738, IC112741, IC112747, IC112815, IC112818, IC112830, IC261772, IC261793, IC261801, IC281072, IC281092, IC281104, IC281112, IC285140, IC336472 and NIC023771 were found field tolerant to bacterial wilt disease and stem borer pest.

EC393239, EC467271, EC467274, IC090053, IC090981,



IC111019 and IC111439 were found promising for combined characters namely number of fruits per plant (> than 23 fruits) and fruit yield per plant (> than 1900g). IC169079, IC074207 and IC112830 were found superior for multiple characters namely single fruit yield, fruit yield/plant, less seediness, consumer preferred fruit color and tolerance to bacterial wilt and stem borer attack.

**Okra (*Abelmoschus esculentus*) Kharif 2008:** One hundred accessions of okra were taken up under the IIVR-NBPGR collaborative multi-location evaluation trial in an ABD along with four checks namely Arka Anamika, Salkeerthi, Pusa Sawani and VRO 5 for 10 yield and yield attributing traits. Fifteen accessions yielded higher than the best check, out of which, ten accessions which yielded above 400 g/plant fresh fruit are given below:

**Chinese spinach (*Amaranthus tricolor*) summer 2008:** Twenty-four accessions of Chinese spinach comprising those collected from Nicobar Islands and those received from NBPGR RS, Cuttack were evaluated for 12 qualitative and 12 quantitative traits in an ABD along with 4 checks namely Arka Suguna, Arka

TCR No.	Accession No.	Fresh Fruit weight/ plant	No. of fruits/ plant
76	IC043748	498	21.0
1679	IC018530	445	18.4
1938	IC090205	439	19.2
65	IC043737	438	17.0
1998	IC099716	423	16.6
2029	IC111440	416	16.2
1903	IC090077	412	15.2
1919	IC090175	410	18.8
2014	IC103998	405	12.8
127	IC045791	403	17.6
Arka Anamika	National check	378	15.4
Salkeerthi	Local check	371	13.2
Pusa Sawani	National check	351	14.9
VRO-5	National check	335	13.4

Arunima, CO-2 and Arun. Ten accessions were superior to all the 4 checks for herbage yield (single plant yield on 45<sup>th</sup> day, average of 6 plants). Superior accessions identified during the previous years (IC550101 with 195g; IC550145 with 196g; and IC469564 with 169g) were found consistently superior to all the 4 checks as given below:

TCR No.	Accession No.	Collector's No.	Total Herbage Yield (g)	Morphological Traits
120	IC553718	JS/07-7	130.8	Green broad leaves
121	IC553719	JS/07-8	135.8	Green broad leaves
124	IC553730	JS/07-19	118.3	Narrow, green leaves
127	IC553737	JS/07-26	137.5	Green. broad leaves
128	IC553742	JS/07-32	103.3	Green, rhomboid leaves, notched tip
131	IC553745	JS/07-35	109.2	Green leaves, bushy, prostrate
136	IC551475	DP/18-19	109.0	Branched, prostrate, leaves purple hallowed
138	IC551461	DP/18-7	102.4	Light green, broad leaves, good appearance
139	IC551484	DP/18-28	102.0	Light green broad leaves, good phenotype
140	IC551472	DP/18-16	108.0	Small, black hallowed leaves
49 Sel.*	IC469564	JR/04-64	169.0	Big, broad magenta leaves, good phenotype
116*	IC550101	JJK/06-17	195.0	Green, broad leaves
119*	IC550145	JJK/06-63	195.6	Fluorescent red stem and coppery, broad leaves, good phenotype
Arka Suguna	Check		93.0	IIHR released variety-green
Arka Arunima	Check		90.8	IIHR released variety-red
CO2	Check		94.4	TNAU variety- green
Arun	Check		84.6	KAU variety- red

\*Superior accessions identified during previous years

**Spleen amaranth (*Amaranthus dubius*) Summer 2008:** Ten accessions of spleen amaranth from Orissa and 3 from Nicobar Islands, were evaluated for 13

qualitative and 13 quantitative traits in A randomized Block Design along with 3 checks namely Co 1, IC536690 and IC536699. Infra-specific variability for

morphological characters was negligible. However, all were distinct from the released variety Co 1 and were characterized by high branching and leaf margin pigmentation. IC539856 (263g/plant) and IC551491 (250g/per plant) were high herbage yielders, compared to Co 1 (113g/plant).

**Other species of *Amaranth* (Summer 2008):** Under natural epiphytotic conditions, red-root (*A. retroflexus*) (IC550101) and bush-greens (*A. cruentus*) (IC550100) were found to be resistant to leaf-spot disease (a severe foliar disease of leafy amaranths, caused by *Colletotrichum* spp. and *Rhizoctonia* spp. during the rainy/humid months). Hitherto only *A. dubius* (Co 1) was reported to be resistant and recommended by the Kerala Agricultural University.

**Cucurbits (Rabi 2007-08):** Initial seed multiplication and establishment of taxonomic identity of 50 accessions of pumpkin were carried out. Using taxonomic traits like fruit stalk, fruit, stem and leaves, these 50 accessions were assigned their correct identity as *Cucurbita moschata* (pumpkin or squash, 39 accs.), *C. argyrosperma* (cushaw, 6 accs.), *C. pepo* (vegetable marrow, 3 accs.) and *C. maxima* (winter squash, 2 accs.). The simple taxonomic key developed for easy

identification of various taxa of pumpkin/squash/cushaw/vegetable marrow is given below:

1. Leaves blotched with mosaic pattern; sepals foliar; fruit stalk flared ..... *C. moschata*
1. Leaves not blotched with mosaic pattern; sepals non foliar; fruit stalk not flared:
2. Fruit stalk angular; twisted; grooved and stiff hairy ..... *C. pepo*
2. Fruit stalk round; non-twisted; soft hairy:
3. Stems soft; round; fruits very large (42x25 cm, 6+kg); stalk end and blossom end projected (mammiform) ..... *C. maxima*
3. Stems angular; ridged; fruits small (18-23x13-15 cm, 0.5-1 kg); stalk and blossom end depressed ..... *C. argyrosperma*

#### 18.2.4 Tubers

**Chinese potato (*Solenostemon rotundifolius*) Kharif 2008:** Second year evaluation of 10 superior accessions of Chinese potato identified during kharif 2006 was again attempted in a Randomised Block Design (RBD) with check variety Nidhi.

#### Promising accessions identified over check Nidhi for tuber traits

TCR No.	Accn. No.	Tuber Weight/ Plant (g)	Large Tuber Length (cm)	Large Tuber Width(cm)	Large 3 Tuber Weight(cm)	Root knot Nema- tode Infection %
113	IC560845	387.9	5.3	3.2	108.3	4.2
114	IC560846	421.1	5.4	3.4	143.0	5.0
120	IC468945	425.5	4.6	3.5	117.8	5.0
122	IC468947	398.9	4.9	3.1	113.9	1.7
129	IC468957	390.0	4.2	2.6	70.6	2.2
130	IC468960	306.7	3.9	2.6	73.9	1.7
136	IC468965	459.4	5.9	3.2	121.7	3.9
138	IC468968	448.9	5.8	3.4	118.3	6.7
139	IC468969	317.8	5.0	2.5	75.6	3.3
140	IC468970	405.5	5.1	2.7	97.5	6.6
<b>Check</b>		<b>399.43</b>	<b>5.17</b>	<b>3.17</b>	<b>98.87</b>	<b>6.47</b>

**Lesser yam (*Dioscorea esculenta*) Kharif 2008:** Second year evaluation of 21 superior accessions was attempted in a RBD with two check varieties, viz., Sree Latha and Sree Kala.

### Promising accessions identified over best check for tuber traits

TCR No.	IC No.	No. of Tubers/ plant	Tuber Weight/ plant (g)	Tuber Length (cm)	Tuber Girth (cm)	Largest Tuber Weight (g)
108	IC560849	18.0	594.4	12.0	4.0	98.9
109	IC560850	17.3	706.7	12.3	3.9	103.3
001	IC044268	17.7	704.4	11.5	4.3	106.7
004	IC044271	17.3	711.1	11.6	4.5	104.5
015	IC044282	16.8	710.6	9.8	3.4	185.6
022	IC044289	19.5	626.7	11.2	3.6	87.8
023	IC044290	17.7	634.5	10.2	4.2	97.8
025	IC044292	20.0	664.4	10.9	3.7	83.3
029A	IC044296A	13.3	672.2	14.1	3.8	125.0
029B	IC044296B	20.2	832.2	12.1	3.5	102.8
033A	IC044300	23.0	610.0	9.7	4.6	94.4
033B	IC044300A	12.6	608.9	12.6	3.3	116.7
037	IC046081	18.5	435.6	10.0	3.3	77.8
056	IC087439	15.9	588.9	10.3	4.1	104.5
073	IC087446	18.7	516.7	10.7	3.9	92.2
078	IC087447	14.2	428.9	9.7	3.6	83.4
095	IC266661	18.8	518.9	10.9	3.2	85.5
099	IC266665	17.9	610.0	10.6	3.6	85.5
100	IC266666	17.0	651.1	10.4	4.5	108.9
101	IC266667	9.5	548.9	11.0	4.3	109.4
106	IC349861	5.2	1,007.2	13.5	8.1	395.6

### Promising accessions identified over the best check for a combination of characters:

IC560849, IC560850, IC044268, IC044271, IC044289, IC044292, IC044296B and IC266661 are promising for yield/ plant, number of tubers/ plant and tuber length while IC044282, IC044290, IC044300, IC087439, IC087446, IC266665, IC266666 and IC560849 were found promising for yield/ plant and number of tubers/ plant. IC044300A and IC266666 are promising for number of tubers/ plant and tuber length while IC349861 is promising for yield/ plant, tuber length and girth.

### 18.2.5 Fruits

**Mango (*Mangifera indica*) Summer 2008:** In poly-embryonic mango, 20 trees in 18 accessions of 10 named landraces were characterised for 7 quantitative and 5 qualitative fruit characters besides fruit fly tolerance under field epiphytotic conditions. Among these, IC202243 (*Kotturkonam*), a landrace from the southern-most part of Kerala is found to be superior for table qualities like pulp taste, pulp texture, pulp colour and ripe fruit skin colour (consumer appeal).

### 18.2.6 Spices

**Malabar tamarind (*Garcinia cambogia*) Kharif 2008:**

Thirty-four seedling progeny trees in 27 accessions were characterised for 9 fruit and 6 seed characters. Nine superior accessions were identified as follows:

Accession No.	Trait	Value
IC136677-2	Fresh seed weight (g)	1.5
IC136683	Dry rind weight/ fruit (g)	15.0
IC244010-3	Fresh rind weight (g)	93.0
IC244096-2	Dry seed weight (g)	0.9
IC244100-2	Seed length (mm)	37.0
	Seed width (mm)	15.0
	Seed thickness (mm)	11.0
IC244101-2	Fresh rind thickness (mm)	9.9
IC244109-1	Fresh seed weight (g)	1.5
IC244110	Fresh fruit weight (g)	143.0
	Number of seeds/ fruit	8.9
IC244115	Number of seeds/ fruit	8.9

Also, 13 grafts in six accessions were characterised for 9 fruit and 6 seed characters. Among the grafts, two accessions were identified as superior to the rest. IC244100-2 was superior for highest fresh fruit weight (142.2 g), fresh rind thickness (7.9 mm), number of seeds per fruit (7.3), fresh seed weight (1.4 g), seed length (34.1 mm), seed width (13.5 mm), seed thickness (7.1 mm) and dry seed weight (0.8 g). IC244083-1 was superior for fresh fruit rind weight (102.9 g), fresh rind thickness (7.9 mm), fresh seed weight (1.4 g) and dry rind weight (15.5 g). IC244100-2 was superior both as seedling progeny and graft, with regard to seed characteristics.

### 18.3 Germplasm Conservation

**Sent to National Genebank for long-term storage (LTS):** From regenerated and multiplied germplasm, 395 accessions were sent to the National Genebank, NBPGR, New Delhi for long-term storage, which included 276 accessions of rice, 20 of okra, 45 of Chinese spinach, 12 of African okra, 14 of field bean, 27 of little bitter gourd and one of *Samadera indica*.

In addition, twenty one accessions of noni and one each of *Cardiospermum halicacabum*, *Cassia senna*, *Catunaregam spinosa*, *Holoptelea integrifolia*, *Indigofera tinctoria*, *Mimosa pudica*, *Ocimum americanum*, *Oryza sativa*, *Rauvolfia canescens*, *Santalum album*, *Saraca asoka*, *Solanum melongena*, *S.incanum*, *Strychnos nux-vomica*, *Terminalia chebula*, two each of *Abrus precatorius*, *Amaranthus tricolor*, *Cucumis callosus*, *Terminalia bellerica*, *Vigna dalzelliana*, 4 each of *Calophyllum inophyllum* and *Tabernaemontana alternifolia* were directly deposited for long-term storage immediately after collection.

**Sent to TCC Unit for cryo-preservation:** A total of 33 accessions comprising nineteen of *Piper nigrum*, 5 of *Calophyllum inophyllum*, 2 each of *Cinnamomum malabattrum*, and *Flacourtia montana* and 1 each of *Alangium salvifolium*, *Cinnamomum verum*, *Garcinia xanthochymus* and *Salacia fruticosa* were sent for cryo-preservation.

**Added to MTS Facility at Thrissur:** A total of 335 accessions of regenerated germplasm comprising 162 of okra and 173 of rice and from exploration and collection, 9 accessions of *Calophyllum inophyllum* were added.

**In vitro propagation and conservation:** Tissue culture work was continued in ginger, cassava, and wild *Dioscorea* and *Curcuma* species. A total of 194 accessions in 2 crops (cassava-40, and ginger-137) and 11 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*-2, *C. amada*-2, *C. aeruginosa*-1 and *C. latifolia*-1) were maintained in *in vitro* conservation media. One accession each of *Bacopa monneiri* and *Alpinia calcarata* was newly initiated in to *in vitro* culture.

### 18.4 Germplasm Supply

**Supply to user agencies:** Under material transfer agreement, 599 accessions comprising 8 crops and 39 wild related species were supplied to 18 user agencies, which included 100 accessions of okra to IARI, New Delhi; 35 of bitter gourd and 50 of okra to Allahabad Agricultural Institute, Allahabad; 60 of okra to AP Horticultural University, Hyderabad.

**Supply for multi-location evaluation:** Supplied 100 accessions and 6 check varieties of horsegram to 3 institutions namely, University of Agricultural Sciences, GKVK, Bangalore, Karnataka; Dandiwada Agricultural University, Banaskantha, S.K. Nagar, Gujarat and Regional Agricultural Research Station, Kerala Agricultural University, Pattambi under the National Network Research Project on Arid Legumes for multi-location evaluation during 2008-09.

**Supply for chemical evaluation at NBPGR, New Delhi:** Supplied 6 accessions of lesser galanga, 8 of greater galanga, 2 of *Alpinia zerumbet*, 1 each of *Calophyllum inophyllum*, *Cinnamomum verum*, *C. malabattrum* and Mysore gamboge, 21 of Malabar tamarind and 13 of *Madhuca longifolia* to Germplasm Evaluation Division, NBPGR for chemical evaluation.

**Germplasm transfer for maintenance/characterisation/conservation:** Transferred one accession each in 16 species of *Curcuma* to IISR, Kozhikode and 2 of banana to NRC for Banana, Tiruchchirapalli and 1 each of senna and *Salvadora persica* to NBPGR RS, Hyderabad

**Germplasm receipt:** Received 251 accessions comprising 181 of brinjal, 1 each of pumpkin and *Trichosanthes bracteata* and 13 of bitter gourd and for maintenance, characterisation and conservation.

**IC number allotment:** Forty accessions of *Jatropha curcas* collected by S.D. Agricultural University, Sardarkrushinagar, Gujarat under ICAR Network Project on TBOs were got accessioned at ARIS Cell and IC numbers (IC557058 to 557097), two accessions of cowpea received from ICAR Research Complex for Goa, Ela, Old Goa were got accessioned with IC565707 IC565708 and 97 of M&A plants received from KAU, Thrissur with 566427 to 566523 were communicated to



the respective partner.

## 18.5 Externally Funded Projects

### 18.5.1 NAIP Project on “Biosystematics of the Genera *Vigna*, *Cucumis* and *Abelmoschus*” (from July 2008 onwards)

Herbarium study for morphological variation, locality of occurrence and phenology was carried out at CALI (Botany Department, Calicut University, Kerala) and MH (Southern Circle, Botanical Survey of India, Coimbatore). A total of 258 sheets comprising 21 in *Abelmoschus* and 7 each in *Vigna* and *Cucumis* (at CALI) and 102 sheets in *Abelmoschus*, 117 sheets in *Cucumis* and 4 sheets in *Vigna* (at MH) were studied. Descriptors for taxonomic categorisation of *Cucumis* and *Abelmoschus* were prepared. A total of 45 cross combination involving 8 taxa of *Abelmoschus* (2 cultivated and 6 wild) were attempted in which fruits

were obtained in 29 inter-specific crosses (table 2). In *Vigna* 12 cross combinations involving 3 cultivated and 7 wild taxa were carried out in which pod set was observed in all crosses with varying degrees of success (table 3). In *Abelmoschus* species from the percentage of pod set it was found that 100% fruit set in crosses between *A. esculentus* and *A. tuberculatus* and its reciprocal cross, *A. esculentus* with *A. angulosus*, *A. caillei*, *A. moschatus* and *A. rugosus* indicating a close relationship among these species forming a primary gene pool. Similarly in *Vigna* species, maximum pod set was observed among crosses between *V. mungo* and *V. radiata* with *V. radiata* var. *sublobata*, *V. radiata* var. *setulosa*, *V. mungo* var. *sylvestris* and *V. trinervia* var. *bourneae* indicating closeness of these species among themselves. The cross compatibility of *V. umbellata* (cultivated) and *V. umbellata* (wild) was very meager which indicated that the two species are distinct and do not belong to the same genepool.

**Table 2: Inter-specific hybridization in *Abelmoschus***

Female Parent	Male Parent	No. of Flowers Crossed	No. of Fruit Set	Percentage Fruit Set
<i>A. angulosus</i> subsp. <i>grandiflorus</i>	<i>A. caillei</i>	22	2	9.09
	<i>A. esculentus</i>	26	0	0.00
	<i>A. ficulneus</i>	23	0	0.00
	<i>A. tetraphyllus</i>	35	2	5.71
	<i>A. moschatus</i>	41	0	0.00
	<i>A. rugosus</i>	9	0	0.00
	<i>A. tuberculatus</i>	169	0	0.00
<i>A. moschatus</i> subsp. <i>moschatus</i>	<i>A. caillei</i>	34	16	47.06
	<i>A. esculentus</i>	52	6	11.54
	<i>A. ficulneus</i>	12	2	16.67
	<i>A. tetraphyllus</i>	37	9	24.32
	<i>A. rugosus</i>	17	11	64.71
	<i>A. tuberculatus</i>	14	2	14.29
<i>A. moschatus</i> subsp. <i>rugosus</i>	<i>A. moschatus</i>	5	4	80.00
	<i>A. tetraphyllus</i>	2	1	50.00
	<i>A. tuberculatus</i>	13	1	7.69
<i>A. manihot</i> subsp. <i>tetraphyllus</i>	<i>A. angulosus</i>	11	6	54.55
	<i>A. caillei</i>	29	18	62.07
	<i>A. esculentus</i>	26	5	19.23
	<i>A. ficulneus</i>	6	0	0.00
	<i>A. moschatus</i>	14	0	0.00
	<i>A. rugosus</i>	15	0	0.00
<i>A. caillei</i>	<i>A. tuberculatus</i>	5	1	20.00
	<i>A. angulosus</i>	10	6	60.00
	<i>A. esculentus</i>	8	2	25.00
	<i>A. ficulneus</i>	7	0	0.00
	<i>A. tetraphyllus</i>	5	3	60.00
	<i>A. moschatus</i>	10	3	30.00
	<i>A. rugosus</i>	5	0	0.00
<i>A. tuberculatus</i>	<i>A. tuberculatus</i>	8	0	0.00
	<i>A. ficulneus</i>	6	1	16.67
	<i>A. tetraphyllus</i>	2	1	50.00
	<i>A. esculentus</i>	1	1	100.00
<i>A. ficulneus</i>	<i>A. caillei</i>	6	0	0.00

A. esculentus	A.esculentus	8	0	0.00
	A.tetraphyllus	5	1	20.00
	A.moschatus	6	0	0.00
	A.tuberculatus	3	0	0.00
	A.angulosus	2	2	100.00
	A.caillei	1	1	100.00
	A.ficulneus	3	2	66.67
	A.tetraphyllus	2	0	0.00
	A.moschatus	1	1	100.00
	A.rugosus	3	3	100.00
	A.tuberculatus	1	1	100.00

**Table 3: Inter-specific hybridization in *Vigna***

Female Parent	Male Parent	No. of Flowers Crossed	No. of Pods Set	Percentage of Pod Set
<i>V. radiata</i> var. <i>radiata</i>	<i>V. radiata</i> var. <i>sublobata</i>	91	16	17.58
	<i>V. radiata</i> var. <i>setulosa</i>	25	4	16.00
	<i>V. mungo</i> var. <i>sylvestris</i>	7	1	14.29
	<i>V. hainiana</i>	38	1	2.63
	<i>V. trinervia</i> var. <i>bourneae</i>	34	6	17.65
<i>V. mungo</i> var. <i>mungo</i>	<i>V. radiata</i> var. <i>sublobata</i>	81	13	16.05
	<i>V. radiata</i> var. <i>setulosa</i>	21	6	28.57
	<i>V. mungo</i> var. <i>sylvestris</i>	37	4	10.81
	<i>V. hainiana</i>	17	1	5.88
	<i>V. trinervia</i> var. <i>bourneae</i>	65	7	10.77
<i>V. umbellata</i> (cultivated)	<i>V. umbellata</i> (wild)	115	2	1.74
	<i>V. dalzelliana</i>	136	1	0.74

Fifty-five accessions comprising 43 in 6 species of *Cucumis*, 12 of moth bean were received from NBPGR RS, Bhowali for hybridisation.

### 18.5.2 ICAR *ad-hoc* Network Project on Tree Borne Oilseeds (upto 30/06/2008)

**Exploration and collection:** Collected a total of 22 accessions of tree-borne oilseeds comprising 21 of karanj and 1 of *Salvadora persica* from Tamil Nadu and transferred the same to FCRI (TNAU), Mettupalayam, Tamil Nadu for establishment, conservation, utilisation and chemical evaluation. From exploration and collection, 21 accessions of *Pongamia pinnata* were sent to NGB, New Delhi for long-term storage and the same set was added to the MTS facility of the station. One accession of *Salvadora persica* was sent to TCC Unit for cryo-preservation.

**Kokum (*Garcinia indica*) Summer 2008:** Thirteen trees in 9 accessions of kokum were characterized for 9 fruit and 6 seed characters. The range of variation observed for fresh fruit weight was 9 to 35 g, that of fresh rind weight was 4 to 18 g, fresh rind thickness was 2 to 3 mm, dry rind weight was 0.7 to 2.8 g, number of seeds per fruit was 1.5 to 6.6, fresh seed weight was 0.4 to 1.2 g, dry seed weight was 0.1 to 0.5 g, number of fruits per tree was 10 to 2730 and yield of fruits

0.091 to 54.8 kg per tree. IC136682-2 was consistently superior for number of fruits per tree (2730) and yield of fruits (54.8 kg). IC136687-2 was superior for seed length (22 mm), seed thickness (7 mm) and dry seed weight (0.5 g). IC136687-2 was also superior for kernel oil percentage (43%), containing 63% saturated fatty acid in the kernel oil, the combined stearic and oleic acid composition of the seed oil is 96%.

**Supply for chemical evaluation at NBPGR, New Delhi:** Three accessions of kokum were sent for chemical evaluation at Germplasm Evaluation Division, NBPGR, New Delhi.

**IC number allotment:** Forty accessions of *Jatropha curcas* collected by S.D. Agricultural University, Sardarkrushinagar, Gujarat under ICAR Network Project on TBOs were got accessioned at ARIS Cell and IC numbers IC557058 to IC557097 were communicated.

### Collection, Assembly and Conservation of Genetic Resources of Physicnut (*Jatropha curcas* L.)

Twenty-seven accessions of physicnut (*Jatropha curcas*) were collected from Tamil Nadu and sent to National Genebank, NBPGR, New Delhi for long-term conservation and a duplicate set kept in medium-term storage (MTS) facility at NBPGR RS, Thrissur.

### 18.5.3 Collection, Clone Multiplication, Conservation and Biochemical Profiling of Kokum (*Garcinia indica*), a Potential Source of Edible Oil found in Southern Western Ghats (from October 2008 onwards)

**Maintenance:** A total of 50 accessions (47 collected from Karnataka and 3 from Kerala) of kokum are being maintained in the field gene bank of this station.

**Characterisation:** Characterised 53 flowering trees

in 28 accessions of kokum for leaf lamina length, lamina width and petiole length which ranged from 6.0-9.9, 2.7-4.6 and 0.4-1.0 cm, respectively. The variability (%) of the above was 11.2, 10.2 and 25.8 indicating high variability in the case of petiole length. In order to make grafts during ensuing monsoon, 153 seedlings of IC136687-2 and IC136687-3 have been raised as rootstock.

**Chemical evaluation:** Four accessions of kokum were sent to NBPGR, New Delhi for biochemical profiling.

#### Programme (Code: Title, 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**)

#### Projects (Code: title, PI and CoPIs)

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**, **KC Velayudhan**, **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 Projects:

- ICAR Funded: Network Project on 'Tree Borne Oilseeds' (**Z Abraham**)
- DBT Funded: Collection, Assembly and Conservation of Genetic Resources of Physic nut (*Jatropha* L.) (**Z Abraham**)
- NAIP Project on Biosystematics of the Genera *Vigna*, *Cucumis* and *Abelmoschus* (**Joseph John K** and **M Latha**)
- 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** and **M Latha**)

## 19. GENERAL INFORMATION

### 19.1 Institute Management Committee

#### Chairman

Dr SK Sharma, Director, NBPGR, New Delhi

#### Members

1. Assistant Director General (Seed), ICAR, New Delhi –110 114
2. Sh. Surender Singh, C-33/84, Madhopur, Behind MCD Office, Varanasi, U.P.
3. Dr Sushama Chaphalkar, Director, School for Biotechnology, Vidya Nagiri, Baramati Dist., Pune Maharashtra
4. Development Commissioner (Rural) Delhi Government
5. Director (Agri.) Government of Rajasthan, Jaipur
6. Dr RK Khetarpal, Head, Plant Quarantine Division, NBPGR, New Delhi
7. Dr SS Malik, Principal Scientist, NRC-on-DNA-FP, NBPGR, New Delhi - 110 012
8. Dr KS Varaprasad, Officer in Charge, NBPGR, Regional Station, Hyderabad
9. Dr KV Prabhu, Head, Division of Genetics, IARI, New Delhi
10. Sh KK Hamza, Finance & Account Officer, IASRI, Pusa Campus, New Delhi-110 012

#### Member Secretary

Ms Sunita Sharma, Sr. Administrative Officer, NBPGR, New Delhi –110 012

The 35<sup>th</sup> IMC meeting was held on 22 December 2008.

### 19.2 Research Advisory Committee

The meeting of the X<sup>th</sup> RAC of NBPGR was held under the Chairmanship of Dr YS Nerkar, on July 30-31, 2008. RAC members, all Heads of Divisions, Officers-in-Charge of Regional Stations, Units and Cells, and other scientists attended the meeting:

#### Chairman

Dr YS Nerkar, Ex-Vice Chancellor, MPKV Rahuri, Village Ner, Tehsil Dhule, Distt. Dhule-424 303, Maharashtra

#### Members

1. Dr V Ramanatha Rao, Ex Sr. Scientist, Bioversity International, C/o Ashoka Trust for Research in Environment and Engineering, 659, 5th A main, Hebbal, Bangalore-560 024, Karnataka
2. Dr JL Karihaloo, Coordinator, Asia Pacific Consortium for Agricultural Biotechnology, NASC Complex, Todapur, New Delhi -110 012
3. Dr Sujata Arora, Additional Director, Ministry of Environment and Forests, Prayavaran Bhavan, CGO Complex, New Delhi – 110 016
4. Dr OP Dubey, Ex ADG (PP), B-9 Green View Apartment, Sector-9, Rohini, Delhi – 110 081
5. Dr SK Sharma, Director, National Bureau of Plant Genetic Resources (NBPGR), Pusa Campus, New Delhi-110012
6. Dr ND Jambhale, Assistant Director General (Seeds), Indian Council of Agricultural Research (ICAR), Krishi Bhavan, New Delhi – 110114
7. Members (2, non-official), Management Committee, NBPGR, New Delhi

#### Member Secretary

Dr RK Tyagi, Principal Scientist, NBPGR, New Delhi-110012

Based on the presentations made during the RAC meeting and the discussions held, the following important recommendations emerged:

1. More refined gap analysis using appropriate GIS information from previous missions and data from herbaria and ecogeographic studies should precede germplasm collecting missions so that the efficiency of missions can be improved and proper studies could lead to publications.
2. Work should be expedited for developing the list



of varieties and germplasm accessions of the 64 crops of Annex.1 of International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) that India would be willing to share under the multilateral system. NBPGR should play a pro-active role in consultation with the crop-based institutes for developing such lists.

3. NBPGR should develop a short-term course on biosecurity to generate awareness among the researchers of ICAR institutes and State Agricultural Universities (SAUs) in different regions of the country.
4. Mechanisms should be developed to evaluate germplasm of wild relatives of crop species for their use in breeding programmes especially for biotic stresses. This may initially be taken up with two or three crops for major disease(s) in collaboration with appropriate institute(s). Efforts should be made to identify genes for resistance using molecular tools with a long-term objective to isolate, conserve and utilize such successful resources.
5. Germplasm conserved in the National Genebank without evaluation data should be evaluated with the help of NAGS in a phased manner to facilitate its proper documentation and utilization.
6. It is recommended that allele mining for some specific genes should be carried out in the germplasm of one or two crops in which similar work is not being done by other ICAR institutes.

### 19.3 Institute Research Council

**Chairman-** Director NBPGR

**Member Secretary-** Dr Pratibha Brahmi

The first IRC Meeting for the year 2008 was held from 1 to 4 August, 2008. Dr. Ramanatha Rao, Member of

the newly constituted Research. Advisory Committee (RAC), NBPGR, and IPGRI Consultant (now Bioversity International) also attended the meeting, chaired by Dr SK Sharma, besides Heads of the Divisions, Officers-in-Charge, Regional Stations of NBPGR, Scientists and other members of the IRC. Dr SK Sharma, Chairman, IRC in his opening remarks mentioned that keeping in view the changing global scenario in PGR management; in-house projects of NBPGR should be suitably changed or modified. The Action Taken Report (ATR) of recommendations was presented followed by presentation of progress made under all the in-house projects by each PI from various Divisions/ Units and Stations. Regional stations were represented by respective Officer-in-Charge and some scientists from the Stations.

### 19.4 Institute Joint Staff Council

**Chairman-** Director, NBPGR

#### Staff Side

1. Technical: Sh. Dinesh Chandra Mishra (Secretary Staff Side), Sh Lal Singh: (also Member of CJSC)
2. Administrative: Sh. Ganga Nand, Sh. Yogesh Kumar Gupta
3. Supporting: Sh. Mahesh Ram, Sh. Sanjeev Paswan

#### Office Side

1. Dr (Mrs) Veena Gupta, Pricipal Scientist Secretary (Office Side)
2. Ms Sunita Sharma, Sr. Admn. Officer
3. Dr SK Malik, Senior Scientist
4. Dr Arjun Lal, Principal Scientist
5. Shri RP Chamola, F&AO

The IJSC meetings were held on 29 March, 30 June, 29 September and 18 December 2008.

### 19.5 Personnel

Name	Designation	Specialization
Dr SK Sharma	Director	Genetics & Plant Breeding
<b>Division of Germplasm Evaluation</b>		
1 Dr SK Mishra	Head	Genetics & Plant Breeding
2 Dr RK Mahajan	Principal Scientist	Agricultural Statistics
3 Dr SK Pareek	Principal Scientist	Agronomy
4 Dr S Mandal (retired on 31.7.08)	Principal Scientist	Biochemistry

5	Dr Ranbir Singh	Principal Scientist	Economic Botany
6	Dr (Ms) Saroj Sardana (retired on 31.1.08)	Principal Scientist	Plant Breeding
7	Dr RP Dua	Principal Scientist	Plant Breeding
8	Dr IS Bisht	Principal Scientist	Plant Pathology
9	Dr Ashok Kumar	Principal Scientist	Plant Breeding
10	Dr RC Agarwal	Principal Scientist	Agricultural Statistics
11	Dr (Ms) Vandana Joshi (upto September 2008)	Senior Scientist	Economic Botany
12	Dr KK Gangopadhyay	Senior Scientist	Horticulture
13	Mr NK Gautam	Scientist (Sel. Grade)	Economic Botany
14	Mr Gunjeet Kumar	Scientist	Horticulture
15	Dr (Ms) Sangeeta Yadav	Senior Scientist	Biochemistry
16	Dr (Ms) Archana Raina	Senior Scientist	Plant Biochemistry
17	Dr Arivalgan M (w.e.f. November 3, 2008)	Scientist	Plant Breeding
<b>Division of Plant Exploration and Germplasm Collection</b>			
1	Dr D C Bhandari (w.e.f 1.8.08)	Principal Scientist & Head	
	Dr (Ms) E Roshini Nair	Principal Scientist & Head (upto 31.7.08)	Economic Botany
2	Dr (Ms) Anjula Pandey	Senior Scientist	Economic Botany
3	Dr Rakesh Srivastava	Senior Scientist	Horticulture
4	Dr KC Bhatt	Senior Scientist	Economic Botany
<b>Division of Germplasm Conservation</b>			
1	Dr AK Singh (retired on 31.7.08)	Head	Plant Breeding
2	Dr (Ms) Kalyani Srinivasan	Principal Scientist	Plant Physiology
3	Dr (Ms) Veena Gupta	Principal Scientist	Economic Botany
4	Dr (Ms) Neeta Singh	Principal Scientist	Electrical Engineering
5	Dr Sidheshwar Prasad	Senior Scientist	Plant Physiology
6	Dr (Ms) J Radhamani	Senior Scientist	Plant Physiology
7	Ms Anjali Kak	Senior Scientist	Economic Botany
8	Dr (Ms) Chitra Pandey	Scientist (Sr. Scale)	Seed Technology
<b>Division of Plant Quarantine</b>			
1.	Dr RK Khetarpal	Head & Principal Scientist	Plant Pathology
2.	Dr Arjun Lal	Principal Scientist	Nematology
3.	Dr PC Agarwal	Principal Scientist	Plant Pathology
4.	Dr Beche Lal	Principal Scientist	Agricultural Entomology
5.	Dr (Ms) Usha Dev	Principal Scientist	Plant Pathology
6.	Dr (Ms) Manju Lata Kapur	Principal Scientist	Agricultural Entomology
7.	Dr Rajan	Principal Scientist	Nematology
8.	Dr DB Parakh	Principal Scientist	Plant Pathology
9.	Dr Baleshwar Singh	Principal Scientist	Plant Pathology
10.	Dr (Ms) Shashi Bhalla	Principal Scientist	Agricultural Entomology
11.	Dr (Ms) Celia Chalam V	Senior Scientist	Plant Pathology
12.	Dr (Ms) Kavita Gupta	Senior Scientist	Agricultural Entomology
<b>Germplasm Exchange Unit</b>			
1.	Dr Arjun Lal	Head & Principal Scientist	Nematology
2.	Dr Deep Chand	Senior Scientist	Economic Botany
3.	Dr (Ms) Vandana Joshi (w.e.f. September 2008)	Senior Scientist	Economic Botany
4.	Dr (Ms) Vandana Tyagi	Senior Scientist	Economic Botany
5.	Dr (Ms) Nidhi Verma	Senior Scientist	Economic Botany
6.	Dr SK Yadav	Senior Scientist	Economic Botany
<b>Policy Planning</b>			
1	Dr (Ms) Pratibha Brahmi	Senior Scientist	Economic Botany
<b>Tissue Culture &amp; Cryopreservation Unit</b>			
1.	Dr BB Mandal (retired on 31.1.08)	Principal Scientist	Genetics & Cytogenetics

2.	Dr (Ms) Rekha Chaudhary	Principal Scientist	Economic Botany
3.	Dr RK Tyagi	Principal Scientist	Economic Botany
4.	Dr (Ms) Ruchira Pandey	Principal Scientist	Economic Botany
5.	Dr (Ms) Neelam Sharma	Principal Scientist	Economic Botany
6.	Dr (Ms) Anuradha Agarwal	Senior Scientist	Economic Botany
7.	Dr (Ms) Sandhya Gupta	Senior Scientist	Economic Botany
8.	Dr SK Malik	Senior Scientist	Economic Botany
9.	Dr Zakir Hussain	Senior Scientist	Genetics
<b>Under Utilized &amp; Under Exploited Plants Project</b>			
1.	Dr RP Dua	Principal Scientist	Plant Breeding
2.	Dr BS Phogat	Senior Scientist	Agronomy
3.	Dr Hanuman Lal Raigar	Senior Scientist	Agricultural Statistics
<b>National Research Center on DNA Fingerprinting</b>			
1.	Dr SS Malik (retired on 31.7.08)	Principal Scientist	Economic Botany
2.	Dr (Ms) Gurinderjit Randhawa	Principal Scientist	Plant Physiology
3.	Dr KV Bhat	Principal Scientist	Plant Breeding
4.	Dr Mukesh Kumar Rana	Senior Scientist	Plant Breeding
5.	Dr Sunil Archak	Scientist (Senior Scale)	Biotechnology
6.	Ms Lalit Arya	Scientist (Senior Scale)	Biochemistry
7.	Dr (Ms) Ambika Baldev	Senior Scientist	Biotechnology
8.	Dr Rakesh Singh	Senior Scientist	Biotechnology
9.	Ms Madhu Bala	Scientist	Computer Applications
10.	Ms Manjusha Verma	Scientist (Senior Scale)	Biotechnology
11.	Sh. Amit Kumar Singh (w.e.f. November 8, 2008)	Scientist	Biotechnology
<b>Regional Station, Shillong</b>			
1.	Dr DK Hore	Principal Scientist & In-charge	Economic Botany
<b>Regional Station, Thrissur</b>			
1.	Dr Z Abraham	Principal Scientist & In-charge	Economic Botany
2.	Dr KC Velayudhan (retired on 30.4.08)	Principal Scientist	Economic Botany
3.	Dr Joseph John K	Senior Scientist	Economic Botany
4.	Dr (Ms) Asha KI	Senior Scientist	Economic Botany
5.	Dr (Ms) M Latha	Senior Scientist	Plant Breeding
<b>Regional Station, Jodhpur</b>			
1.	Dr NK Dwivedi	Principal Scientist & In-charge	Economic Botany
2.	Dr (Ms) Neelam Bhatnagar (till 31.5.08)	Senior Scientist	Economic Botany
3.	Dr Gopala Krishnan S	Scientist	Plant Breeding
<b>Regional Station, Ranchi</b>			
1.	Dr JB Tomar	Principal Scientist & In-charge	Economic Botany
2.	Dr VK Gupta (till 2.1.08)	Senior Scientist	Plant Breeding
<b>Regional Station, Shimla</b>			
1.	Dr VD Verma	Principal Scientist & In-charge	Economic Botany
2.	Dr JC Rana	Senior Scientist	Plant Breeding
3.	Dr K Pradheep	Scientist (Senior Scale)	Economic Botany
<b>Regional Station, Akola</b>			
1.	Mr Nilamani Dikshit	Scientist (Sel. Grade) & In-charge	Economic Botany
2.	Mr Abdul Nizar	Scientist (Senior Scale)	Economic Botany

<b>Regional Station, Bhowali</b>		
1. Sh KC Muneem	Principal Scientist	Plant Pathology
2. Dr KS Negi	Principal Scientist & In-charge	Economic Botany
3. Dr SK Verma	Principal Scientist	Horticulture
<b>Base Center, Cuttack</b>		
1. Mr Diptiranjana Pani	Scientist & In-Charge	Economic Botany
<b>Regional Station, Hyderabad</b>		
1. Dr KS Varaprasad	Principal Scientist & In-charge	Nematology
2. Dr RDVJ Prasada Rao	Principal Scientist	Plant Pathology
3. Dr SK Chakraborty	Principal Scientist	Plant Pathology
4. Dr B Sarath Babu	Principal Scientist	Agricultural Entomology
5. Dr SR Pandrawada	Senior Scientist	Economic Botany
6. Dr (Ms) Kamla Venkateshwaran	Senior Scientist	Economic Botany
7. Dr Natrajan Sivaraj	Senior Scientist	Economic Botany
8. Dr (Ms) Anitha Kodaru	Principal Scientist	Plant Pathology
9. Dr (Ms) T Rama Srinivasan	Scientist (Senior Scale)	Horticulture
10. Mr Sunil Neelam	Scientist (Senior Scale)	Economic Botany
<b>Regional Station, Srinagar (J &amp; K)</b>		
1. Dr Om Vir Singh	Principal Scientist & In-charge	Plant Breeding

**Strength of Technical Staff at NBPGR Headquarters and its Regional Stations/ Base Centres**

S. No.	NAME	DESIGNATION
<b>NBPGR Headquarters' at New Delhi</b>		
1.	Sh. B.P. Dahiya	T-7-8 (Elect. Engineer)
2.	Sh. Om Prakash	T-7-8 (Tech. Officer)
3.	Sh. Jitender Mohan	T-7-8 (Tech. Officer)
4.	Sh. Abhay Sharma	T-5 (Tech. Officer)
5.	Smt. Rita Rani	T-6 (Tech. Officer)
6.	Sh. Charan Singh	T-7-8 (Tech. Officer)
7.	Sh. Rajiv Mathur	T-7-8 (Tech. Officer)
8.	Sh. C.S. Raghav	T-7-8 (Tech. Officer)
9.	Dr.(Mrs.) Manju Upreti	T-7-8 (Tech. Officer)
10.	Dr. Ranbir Singh Rathi	T-7-8 (Tech. Officer)
11.	Miss Sheela Kumari	T-7-8 (Tech. Officer)
12.	Sh. Anil Kumar Singh	T-7-8 (Tech. Officer)
13.	Sh. Ram Prasad Yadav	T-6 (Tech. Officer)
14.	Sh. Rakesh Singh	T-6 (Tech. Officer)
15.	Sh. Mahabir Singh Rathore	T-6 (Tech. Officer)
16.	Miss Poonam Suneja	T-6 (Tech. Officer)
17.	Sh. Harinder Singh	T-6 (Tech. Officer)
18.	Sh. Ram Singh	T-5 (Tech. Officer)
19.	Sh. K.D. Joshi	T-6 (Tech. Officer)
20.	Sh. Daya Shankar	T-6 (Tech. Officer)
21.	Sh. Rajiv Gambhir	T-6 (Tech. Officer)
22.	Dr. Dinesh Chand	T-6 (Tech. Officer)
23.	Sh. Ashok Kumar Maurya	T-6 (Tech. Officer)
24.	Sh. Surender Singh Ranga	T-6 (Tech. Officer)

25.	Sh. Axma Dutt Sharma	T-6 (Tech. Officer)
26.	Sh. Bharat Lal Meena	T-6 (Tech. Officer)
27.	Sh. P.S. Mehta	T-6 (Tech. Officer)
28.	Sh. Dinesh Chand Mishra	T-4 (Tech. Asstt.)
29.	Sh. Rita Gupta	T-5 (Tech. Officer)
30.	Sh. Rajvir Singh	T-6 (Tech. officer)
31.	Sh. Dinesh Kumar Pokhriyal	T-2 (Lab. Asstt.)
32.	Sh. Rohtash Singh	T-2 (Lab. Asstt.)
33.	Sh. Vipin Kumar	T-1 (Lab. Asstt.)
34.	Sh. Babu Ram	T-5 (Tech. Officer)
35.	Ms. Sangeeta Tanwar	T-5 (Tech. Officer)
36.	Sh. Narendra Singh Panwar	T-6 (Tech. Officer)
37.	Sh. R.S. Yadav	T-5 (Tech. Officer)
38.	Sh. Devendra Kumar Nerwal	T-5 (Tech. Officer)
39.	Smt. Gurminder Khera	T-4 (Telephone Operator)
40.	Sh. Bhopal Singh Panwar	T-5 (Tech. Officer)
41.	Sh. Y.S. Rathi	T-5 (Tech. Officer)
42.	Sh. Ombir Singh Ahlawat	T-4 (Fieldman) (Issapur)
43.	Sh. Om Parkash (Library)	T-4 (Lab. Tech.)
44.	Sh. Satya Prakash	T-4 (Elect./Mech.)
45.	Sh. Surender Singh Bhoj	T-4 (Lab. Tech.)
46.	Sh. Narendra Pal	T-4 (Tech. Asstt.)
47.	Sh. Parmesh Kumar	T-4 (Tech. Asstt.)
48.	Sh. Anang Pal	T-4 (Tech. Asstt.)
49.	Sh. Ram Chander Yadav	T-4 (Fieldman)
50.	Sh. Bhawnesh Kumar	T-4 (Fieldman)
51.	Sh. Gopi Chand	T-4 (Fieldman)
52.	Sh. Ramesh Chander	T-4 (Lab. Asstt.)
53.	Sh. Ram Kumar Sharma	T-4 (Fieldman) – Issapur



54.	Sh. Arun Kumar Sharma	T-3 (Lab. Asstt.)
55.	Sh. Dharam Pal Singh Meena	T-4 (Fieldman) – Issapur
56.	Sh. Ram Kuwar	T-2 (Fieldman) – Issapur
57.	Sh. Om Prakash, S/o Late Sh. Meer Singh	T-3 (Fieldman)
58.	Sh. Dilawar Singh	T-2 (Lab. Tech.)
59.	Sh. Lal Singh	T-2 (Electrician)
60.	Smt. Nirmala Dabral	T-2 (Data Entry Operator)
61.	Sh. Pooran Chand Binda	T-2 (Data Entry Operator)
62.	Sh. Shashi Kant Sharma	T-3 (Computer Asstt.)
63.	Sh. Ram Milan	T-1 (Fieldman) – Issapur
64.	Sh. Vijay Kumar Mandal	T-2 (Computer Operator)
65.	Sh. Ram Nandan	T-2
66.	Sh. Harideo Prasad	T-2 (TC & CP)
67.	Sh. Naresh Kumar	T-2 (PQD)
68.	Sh. Sunil Kumar	T-2
69.	Sh. Satya Pal Singh	T-7-8 (Tech. Officer)
70.	Sh. Virender Prasad	T-2
71.	Ms.Smita Jain	T-3
72.	Sh.S.K.Ojha	T-1
<b>Drivers (Headquarters/ Reg. Station/ Base Centre)</b>		
73.	Sh. Kishan Nath	T-5, New Delhi
74.	Sh. Gordhan Singh	T-3, New Delhi
75.	Sh. Balwant Singh	T-2, New Delhi
76.	Sh. Braham Prakash	T-2, New Delhi
77.	Sh. E.N. Prabhakaran	T-2, Thrissur
78.	Sh. Joginder Singh	T-2, Shimla
79.	Sh. Khusvinder Kumar	T-2, Shillong
80.	Sh. L.T. Dabekar	T-2, Akola
81.	Sh. Mohd. Abas Ali Khan	T-2, Hyderabad
82.	Sh. Mohan Ram	T-2, Bhowali
83.	Sh. Narendra Ram	T-2, Ranchi
84.	Sh. Ram Balak Rai	T-2, New Delhi
85.	Sh. Ravinder Kumar	T-2, New Delhi
86.	Sh. Dev Sunder	T-2, (Tractor Driver) Issapur, New Delhi
87.	Sh. M.B. Thangkhiw	T-1, Jodhpur
88.	Sh. Wazir Singh	T-2, New Delhi
89.	Sh. Ranjit Singh	T-2 New Delhi
<b>NBPGR, Regional Station, Akola</b>		
90.	Sh. J.K. Ingle	T-6 (Tech. Officer)
91.	Sh. S.G. Padam	T-2 (Fieldman)
92.	Sh. M.Venkataraman	T-1
<b>NBPGR, Regional Station, Bhowali</b>		
93.	Sh. V.K. Pant	T-5 (Tech. Officer)
94.	Sh. A.S. Rana	T-5 (Tech. Officer)
95.	Sh. Rattan Ram Arya	T-5(Tech. Officer)
96.	Sh. Ramit Joshi	T-3 (Fieldman)
<b>NBPGR, Regional Station, Hyderabad</b>		
97.	Sh. Babu Abraham	T-5 (Tech. Officer)
98.	Sh. R. Gunasekharan	T-5 (Tech. Officer)

<b>NBPGR, Regional Station, Jodhpur</b>		
99.	Sh. B.C. Bachhawandia	T-6 (Tech. Officer)
100.	Sh. Bhikka Ram Saini	T-4 (Sr. Tech. Asstt.)
101.	Sh. Kheta Ram	T-5 (Tech. Officer)
102.	Sh. Bhatta Ram	T-4 (Expl. Asstt)
103.	Sh. Sri Bhagawan	T-1
<b>NBPGR, Regional Station, Ranchi</b>		
104.	Sh. Ashok Kumar Gupta	T-5 (Tech. Officer)
<b>NBPGR, Regional Station, Shillong</b>		
105.	Sh. M. Goswami	T-4 (Expl. Asstt)
106.	Sh. S.N. Sharma	T-3 (Fieldman)
107.	Sh. Sanjeev Kumar Singh	T-4 (Tech. Asstt.)
108.	Sh. Gopal Singh	T-1
<b>NBPGR, Regional Station, Shimla</b>		
109.	Sh. Brij Pal Singh	T-6 (Tech. Officer)
110.	Sh. Prakash Chand	T-2 (Fieldman)
111.	Sh. Ram Chander	T-2
112.	Sh. Dayal Singh S/o Shri Madan Singh	T-1
<b>NBPGR, Regional Station, Thrissur</b>		
113.	Sh. R. Ashokan Nair	T-6 (Tech. Officer)
114.	Sh. S. Mani	T-5 (Tech. Officer)
115.	Sh. T.T. Vellaudhan	T-4 (Fieldman)
116.	Smt.Indira Devi	T-4
<b>NBPGR, Regional Station, Srinagar</b>		
117.	Sh. Diksha Gautham	T-4

#### List of Administrative Staff as on Dec. 2008

S. No.	Name	Designation
1.	Ms. Sunita Sharma	Sr.Admn. Officer
2.	Shri RP Chamola	F&AO
3.	Shri Mohar Singh (retired on 31.5.08)	Asst. Admn. Officer
4.	Shri Parmod Chander, Shimla	Asstt. Admn. Officer
5.	Sh. Mahender Kumar	Jr. Accounts Officer
6.	Mrs. Archana Raghav	A.D. (OL)
7.	Sh. Umesh Chandra Sati	Security Officer
8.	Shri Subhash Chander (retired on 15.12.08)	Asstt Admin. Officer
9.	Shri Madan Lal Malik	Assistant
10.	Shri Kulwant Singh	Assistant
11.	Shri Geetam Kumar	Asstt Admin. Officer
12.	Mrs. Vijay Laxmi Gulati	Assistant
13.	Shri Din Dayal	Assistant
14.	Mrs. Vinay Bala Sharma	Assistant
15.	Mrs Kuljeet Kaur	Assistant
16.	Mrs. Pratibha, Shimla	Assistant
17.	Mrs. Soni Laloo, Shillong	Assistant

18.	Shri P.U. Anjankar, Ranchi	Assistant
19.	Shri N. S. Patwal, Bhowali	Assistant
20.	Shri. P. Venugopalan	Assistant
21.	Sh. Girish Chandra	Assistant
22.	Sh. S.S.Wange	Assistant
23.	Shri Dinesh Prasad	Assistant
24.	Sh. Subhash Chander	Assistant
25.	Mrs. R.S. Latha Devdas	Stenographer
26.	Mrs. V. Vijayalaxmi	Stenographer
27.	Sh. Ganga Nand	Stenographer
28.	Mrs. Kanchan Khurana	Stenographer
29.	Mrs. Urmila	Stenographer
30.	Mrs. Poonam Batra	Stenographer
31.	Mrs. Neelam Khatri	Stenographer
32.	Mrs. Graciously Dkhar Shillong	Stenographer
33.	Sh. T.V. Govindan – Thrissur	Stenographer
34.	Mrs Yashoda Rani	Sr. Clerk
35.	Mrs Surinder Kaur	Sr. Clerk
36.	Sh. Surender Kumar	Sr. Clerk
37.	Mrs. Bharti Sharma	Sr. Clerk
38.	Mrs. Savitri Devi	Sr. Clerk
39.	Mrs Sangeeta Gambhir	Assistant

40.	Mrs Vijay Laxmi Sharma	Sr. Clerk
41.	Shri Mahabir Singh Yadav	Sr. Clerk
42.	Shri Yogesh Kumar	Sr. Clerk
43.	Mrs. Satvinder Kaur	Sr. Clerk
44.	Mrs Madhu Chawla	Sr. Clerk
45.	Shri Prabal Dasgupta	Sr. Clerk
46.	Shri Purushottam Dhoke, Akola	Sr. Clerk
47.	Mrs. Leela Sharma, Jodhpur	Sr. Clerk
48.	Mrs. Radha Rani, Hyderabad	Sr. Clerk
49.	Shri Sita Ram	Sr. Clerk
50.	Shri Dinesh Sharma	Sr. Clerk
51.	Shri J.K. Singh	Sr. Clerk
52.	Sh. M. S. Rao, Hyderabad	Sr. Clerk
53.	Sh. Sanjay Kumar Lal, Cuttack	Sr. Clerk
54.	Sh. Benny Mathew, Thrissur	Sr. Clerk
55.	Mrs. Lakshmilian Kharnary, Shillong	Sr. Clerk
56.	Sh. Avdhesh Kumar	Sr. Clerk
57.	Shri Birbal Singh, Ranchi	Jr. Clerk
58.	Sh. Sanjay Dangwal	Sr. Clerk
59.	Sh. Arvind Kumar	Jr. Clerk
60.	Sh. K.C. Kundu	Jr. Clerk
61.	Sh. P. Suleman, Hyderabad	Jr. Clerk

## 19.6 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	128	10	1	12
Technical	117	14	3	-
Administrative	60	14	4	1
Supporting	126	44	5	13

## 19.7 Staff Transferred/ Retired/ New Appointments

### Transfers

- o Sri Parmod Chander transferred from HQ and joined at Regional Station, Shimla on April 15, 2008
- o Neelam Khatri, PA to Head was transferred to Division of Germplasm Evaluation w.e.f. December 2, 2008
- o Urmila Singh joined as PA to Head to Division of Germplasm Exploration & Collection w.e.f. December 2, 2008

### Retirements

- Drs B B Mandal, Professor PGR and OIC TCCU, Saroj Sardana, Principal Scientist, Division of Germplasm Evaluation; Mr Ajab Singh, SSG-IV, NRC DNAF and Mrs Maya Devi, SSG II Division

of Germplasm Evaluation retired on January 31, 2008

- Dr K C Velayudhan, Principal Scientist, NBPGR Thrissur retired on April 30, 2008
- Dr (Mrs) Neelam Bhatnagar, Senior Scientist, NBPGR Regional Station, Jodhpur took Voluntary Retirement w.e.f. May 31, 2008
- Mr Mohar Singh, AAO, NBPGR, New Delhi, Mr R S More, SSG II (Watchman), NBPGR, Akola and Mr V.R. Kattapan, SSG II, NBPGR, Thrissur retired on May 31, 2008
- Sh. Bhika Ram Saini (T-5), NBPGR Regional Station, Jodhpur retired from service w.e.f. June 30, 2008
- Drs A K Singh, Head, Division of Germplasm Conservation, S S Malik, Principal Scientist, NRC DNA FP and S Mandal Principal Scientist, Division

of Germplasm Evaluation retired on July 31, 2008

- Mr T T Velayudhan, Technical Assistant (T4, NBPGR Thrissur retired on July 31, 2008
- Mr Om Prakash SS G III, Issapur Farm retired on August 20, 2008
- Mr Jeet Singh, SS Grade-III, Regional Station Bhowali, retired on October 31, 2008
- Mr. Subhash Chand, AAO, retired (VRS) on December 15, 2008

### **New Appointments**

Sh. Arivalagan M. appointed as Scientist in the Division of Germplasm Evaluation, NBPGR, New Delhi w.e.f. November 3, 2008

Sh. Amit Kumar Singh appointed as Scientist in the NRC on DNA Fingerprinting, NBPGR, New Delhi w.e.f. November 10, 2008

## **19.8 Promotions**

### **Scientific staff:**

- Dr V K Gupta, Senior Scientist, NBPGR, Ranchi was selected as Principal Scientist and Head, ICAR Research Complex for Eastern Region, Regional Centre on Makhana, Dharbhanga, Bihar. He was relieved from NBPGR on January 2, 2008
- Dr Anjula Pandey, Senior Scientist (Economic Botany) was promoted as Principal Scientist w.e.f. August 31, 2007
- Dr Ambika Baldev Gaikwad, Scientist Senior Scale was promoted as Senior Scientist w.e.f. November 12, 2007
- Dr S K Yadav, Scientist Senior Scale was promoted as Senior Scientist w.e.f. January 4, 2008
- Dr Zakir Hussain, Scientist Senior Scale was promoted as Senior Scientist w.e.f. November 9, 2007
- Dr K I Asha re-designated as Senior Scientist from Scientist (Selection Grade) w.e.f. April 25, 2005
- Dr S R Pandravada re-designated as Sr Scientist w.e.f. August 2, 2007
- Dr Nidhi Verma re-designated as Senior Scientist from Scientist (Selection Grade) w.e.f. December

5, 2007

- Dr Deep Chand re-designated as Senior Scientist from Scientist (Selection Grade) w.e.f. January 21, 2008
- Sh Sunil Neelam, Scientist promoted as Scientist Senior Scale w.e.f. December 17, 2005
- Dr K Pradeep, Scientist promoted as Scientist Senior Scale w.e.f. April 16, 2007

### **Technical staff:**

- Mr Dayal Singh, T-1 promoted as T-2 w.e.f. May 20, 2007
- Mr Ram Milam, T-1 promoted as T-2 w.e.f. May 10, 1998
- Ms Nirmal Dabral, T-2 promoted as T-3 w.e.f. July 19, 2005
- Mr PC Binda, T-2 promoted as T-3 w.e.f. September 9, 2006
- Mr Dev Sunder, T-2 promoted as T-3 w.e.f. June 29, 2006
- Mr Balwant Singh, T-2 promoted as T-3 w.e.f. June 29, 2006
- Mr Narendra Ram, T-2 promoted as T-3 w.e.f. June 29, 2006
- Mr Braham Prakash, T-2 promoted as T-3 w.e.f. June 29, 2006
- Mr Om Praksah, T-2 promoted as T-3 w.e.f. May 2, 2006
- Mr Dharam Pal Singh Meena, T-3 promoted as T-4 w.e.f. January 1, 2005
- Mr Ramit Joshi, T-3 promoted as T-4 w.e.f. November 1, 2005
- Ms Indira Devi, T-4 promoted as T-5 w.e.f. June 12, 2005
- Mr OS Ahlawat, T-4 promoted as T-5 w.e.f. July 1, 2006
- Mr Rajav Mathur, T-5 was promoted as T-6 w.e.f. January 1, 2002
- Dr CS Raghav, T-6 was promoted as T-7-8 w.e.f. February 3, 2005
- Mr Satpal Singh T-6 promoted to T-7-8 w.e.f. July 1, 2008

- Sh Rakesh Singh, T-5 was promoted as T-6 w.e.f. January 1, 2005
- Dr NS Panwar, T-5 was promoted as T-6 w.e.f. February 23, 2006
- Sh OP Dhariwal, T-2 was promoted as T-3 w.e.f. May 1, 2006
- Mr Abraham has been promoted to T-7 w.e.f. July 1, 2007

#### Administrative staff:

- Mr Geetam Kumar, Assistant promoted to AAO w.e.f. May 9, 2008
- Mr Subhash Chander, Assistant promoted to AAO, w.e.f. June 2, 2008
- Ms Sangeeta Gambhir promoted from UDC to Assistant on November 14, 2008
- Ms Yashoda Rani promoted from Senior Clerk to Assistant w.e.f. June 10, 2008
- Mr Sanjay Dangwal promoted from Junior Clerk to Senior Clerk w.e.f. June 19, 2008

#### Supporting staff:

- Mr Rameshwar Dayal, SSG IV to LDC w.e.f. March 5, 2008
- Mr Jeet Singh, Balram Singh and Gopal Singh SSG III to SSG IV w.e.f. February 5, 2008
- Mr Bhagwan Singh, SS Gr II promoted to SS Gr III and Mr Paras Ram, SS Gr II promoted to SS Gr III w.e.f. February 5, 2008
- Mr Umesh Kumar, SSG I to SSG II w.e.f. October 7, 2006
- Mr Anand Kumar, SSG I to SSG II w.e.f. October 24, 2008
- Mr Girish Chandra, SSG I to SSG II w.e.f. May 25, 2007
- Mr T K Many, K Premakumaran, M K Prakasan, T K Vasu, V K Rugumini and V C Bhavani, SSGI to SSG II w.e.f. February 5, 2008

## 19.9 Awards/ Honours

#### Award of Ph.D Degree

Dr. Deep Chand, Sr. Scientist was awarded Ph.D degree

in Agricultural Botany (Genetics and Plant Breeding) by CCS University, Meerut in January 2008.

#### Awards/ Honours/ Prizes

1. SK Sharma awarded the Rashtriya Udyog Ratan Award (2009) by the Council for Economic Growth and Research, Mumbai.
2. SK Sharma was elected as Fellow, National Academy of Sciences, India (FNASc), 2008.
3. SK Sharma was awarded Certificate of Appreciation by College of Agriculture, Palampur Alumni Association for rendering meritorious services in the field of Agricultural Education, Research and Extension, 2008.
4. DC Bhandari, RK Khetarpal, PC Agarwal, Rekha Chaudhury, RK Tyagi and Anjula Pandey, elected as Fellow of ISPGR (FSPGR) by Indian Society of Plant Genetic Resources, New Delhi.
5. RK Khetarpal- Dr BB Mundukar Award, Indian Phytopathological Society in 2008.
6. RK Khetarpal - Fellow, Indian Virological Society in 2008.



7. SK Yadav, received the First Prize in "*Hindi Mein Vaigyanik Lekhon Ka Sarwadha Prakrashan*" Pratiyogita for the year 2008-09 at NBPGR, New Delhi.
8. Anuradha Agrawal was elected as 'Fellow', Association for Improvement of Banana and Plantain (AIPUB), Tiruchirappalli.
9. KS Varaprasad, awarded TALENTED SCIENTIST AWARD at the International Seminar on Medicinal Plants & Herbal Products" jointly organized by the Dept. of Botany, Sri Venkateswara University, Tirupati and AP Medicinal Plants Board, Hyderabad in recognition to his contributions to the conservation of



Medicinal plants in South East Coastal zone.

10. KS Varaprasad was felicitated by Dr YS Rajasekhara Reddy, Honourable Chief Minister, Andhra Pradesh on the occasion of International Biodiversity Day on May 22, 2008 at Kadapa for his dynamic service in bringing awareness among people on biodiversity.



11. M Sreenivas Rao and M B Ch K Raju were awarded the Certificate of merit in recognition of their commendable performance in the activities of the Regional Station, Hyderabad for the Year 2007-2008 on the occasion of NBPGR Foundation Day on August 1, 2008 at NBPGR, New Delhi.
12. Bhatta Ram, T-4, and Leela Sharma, Senior Clerk received best worker award from honourable DG (ICAR), Dr. Mangala Rai on NBPGR foundation day at NBPGR, New Delhi on August 1, 2008.
13. D.K. Hore received the 'Bharat Jyoti' Award, conferred by the India International Friendship society, New Delhi, on October 4, 2008.
14. Veena Gupta and Kavya Dashora awarded third prize for poster on "Major issues in commercialization of medicinal plants" at National Interactive Meet 2008 from 29-30 November

organized by CIMAP, Lucknow.

15. Bhagwan Singh, SSG III received best worker award at foundation day of NBPGR .

Dr DC Bhandari joined back as Principal Scientist and Head, Plant Exploration Division on August 1, 2008.

## 19.10 Deputations/ Visits Abroad

- o Vandana Tyagi, visited College of Agriculture and Life Sciences, Cornell University, Ithaca, NY, 14853, USA under Fulbright Hubert H Humphrey Fellowship at sponsored by United States Department of State, administered by Institute of International Education from 13 July 2007 to 13 June 2008.
- o RK Khetarpal was nominated by MoEF to participate in the 13<sup>th</sup> Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA-13) meeting of Convention on Biological Diversity at Rome, Italy from February 18- 22, 2008.
- o RK Khetarpal participated in the High-Level Conference on World Food Security: the Challenges of Climate Change and Bioenergy organized by FAO of United Nations at Rome, Italy from June 3- 5, 2008.
- o Rajan and Kavita Gupta represented India in the International Master Class on Plant Biosecurity-Issues and Responses held at Kuala Lumpur, Malaysia from June 2-13, 2008.
- o D Pani, completed the training programme on Rice Breeding Course: Laying the foundation for the second green revolution during at IRRI, Los Banos, Laguna, Philippines 30 July-14 August 2008.
- o KS Varaprasad participated in the Fifth International Conference of Nematology at Brisbane, Australia and presented a paper on Networking and resources for management of biosecurity risks posed by nematode species from July 13-26, 2008.
- o RK Khetarpal and V Celia Chalam participated in the 9<sup>th</sup> International Congress of Plant Pathology 2008 held in Torino, Italy from August 25- 29, 2008.

- o RC Agrawal visited Nigeria as International Consultant of the Food and Agriculture Organization of the United Nations for assistance in the development of database and preparation of Nigeria Country Report for the State of World's Plant Genetic Resources for Food and Agriculture from August 15-30, 2008. He provided training to the national consultant of Nigeria and local staff in the use of the software and database management necessary to record the data for the preparation of the country report and responded to queries and provided troubleshooting assistance to the national consultant in the use and management of such software and database.



**RC Agrawal with staff of Federal Ministry of Agriculture and Water Resources, Abuja, Nigeria**

- o Shashi Bhalla participated in the Endure International Conference on "Diversifying Crop Protection" held at La Grande-Motte, France from October 12-15, 2008.
- o RK Khetarpal was nominated by FAO as TCDC Expert on Plant Pest Risk Analysis under the project TCP/CMB/3104 at Phnom Penh, Cambodia and undertook the assignment in two missions- the first in July and the second in November 2008.
- o SK Sharma visited Rome, Italy from 26 November to 3 December 2008 to participate in the GIGA International Steering Committee Meeting and Users Advisory Group Meeting – 26-28 November, 2008 and Second Information Technology Consultation for the Implementation of the International Treaty FAO, December 2-3, 2008.
- o RK Khetarpal was invited as resource person for the Open-ended Working Group on Building National Phytosanitary Capacity by IPPC at FAO Headquarters, Rome, Italy from December 8-12, 2008.

## 19.11 Library and Documentation Services

NBPGR library is a special library on plant genetic resources 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, cataloguing and documentation. During the year, 443 books related to various aspects of PGR management and Hindi literature were added to Headquarter and Regional Stations libraries through purchase and exchange basis. Library procured 69 journals including 30 foreign journals and 39 Indian through subscription/ gift and exchange for the use at the Headquarters and different regional stations. Newspaper clipping services related to PGR and its related subjects were provided to readers regularly. The provided to readers at headquarters, Library possesses AGRIS, AGRICOLA, CABSAC, CAB-CD and PLANT GENE database. Bureau's publications were provided to over 270 different organizations in India and abroad and in return 260 publications as gratis from various organizations. NBPGR Annual Report, Newsletters, Crop Catalogues, Brochures and other publications were distributed to various trainees and visitors from India and abroad.

## 19.12 Field Days Organized

**A Field Day on Pulses:** A field day was organized at NBPGR Hyderabad for pulses germplasm on 2.9.08. A total of 275 accessions of pulses including blackgram, cowpea and *Vigna trilobata* in the field were assessed for different traits by seven pulse breeders from different regional stations of ANGRAU (Warangal, Palem, Guntur and Hyderabad). A total of 32 accessions were selected by them including black gram (21 accs.), pillipesara bean (6 accs.), cowpea (5 accs.) for traits



**Participants of Field Day on Pulses**



such as good yield/ bearing, lustrous/ bold seed, and determinate plant type. These accessions were distributed to the breeders under MTA.



Participants of Field day on Brinjal and Okra

**A Field Day on Brinjal and Okra:** A field day on brinjal and okra was conducted on 4th September, 2008 at NBPGR, Thrissur. A total of 15 participants representing IIHR Bangalore, UAS Bangalore, TNAU Coimbatore, KAU Thrissur and the National Horticultural Research & Development Foundation, Dindigul (Tamil Nadu) attended. A total of 178 accessions of brinjal and 174 of okra diversity in *Abelmoschus* comprising 6 wild taxa viz., *A. tuberculatus*, *A. ficulneus*, *A. angulosus* subsp. *grandiflorus*, *A. manihot* subsp. *tetraphyllus*, *A. moschatus* subsp. *moschatus* and *A. moschatus* subsp. *betulifolius* were exposed to the participants. In wrap-up session, scientists of the station interacted with the participants to develop future collection strategies.



### Parthenium Week Celebrated

Parthenium Week was celebrated at NBPGR HQ and its regional stations from September 6-11, 2008. Activities were conducted including distribution of leaflets, viewing of a CD on Parthenium menace. A lecture was also delivered by Dr Kavita Gupta, Senior Scientist, Plant Quarantine Division “*Parthenium*

*hysterophorus*- an Invasive Alien Species in India” on 11th September, 2008 as a part of awareness generation regarding this obnoxious weed. The plants of Parthenium growing in the campus and in the fields were uprooted and destroyed

### *Mikania* and *Mimosa* Eradication Week Celebrated

In order to eradicate alien invasive weeds from the campus, a “*Mikania* and *Mimosa* eradication week” was observed from 16<sup>th</sup> to 22<sup>nd</sup> September, 2009 in which all employees of the station spent one hour everyday from 3.30 to 4.30 pm and effectively removed species of these two weeds from the campus of NBPGR Regional Station, Thrissur. A second campaign for the eradication of alien invasive weeds was executed from 7<sup>th</sup> October to 31<sup>st</sup> October, 2008.

### Participation in the Agricultural Fair at ANGRAU:

Acharya NG Ranga Agricultural University, Hyderabad organized a Regional Agricultural Fair from 20.12.08 to 23.12.08. On this occasion, NBPGR Regional Station, Hyderabad, displayed the variation and diversity of agri-horticultural crops including Medicinal and Aromatic plants collected from the South east coastal zone. Information regarding plant genetic resources collection, evaluation, conservation and registration was displayed in local language (Telugu) in the form of charts. About 800 farmers visited the stall and had good discussions on various aspects of PGR management. A certificate of participation was awarded.

The celebration of the “International Day for Biological Diversity” on the theme “Biodiversity and Agriculture” was organized as a seminar with exposure to the genebank at this station on 22/05/2008. The seminar had two lectures, one on ‘United Nations Convention on Biological Diversity (CBD)’ and the second on ‘*Ex situ* Conservation of Agro-Biodiversity’. This was attended by 32 B.Sc./M. Sc. students from the College of Forestry, KAU including 2 B.Sc. students from College of Horticulture. All the participants were urged to start Eco-clubs to create awareness among villagers and farmers on the importance of conservation and sustainable utilization of biodiversity in their respective native places and their places of appointment as foresters or horticulturists or agricultural officers. The need for *in situ*/ on-farm conservation of wild relatives of crop plants, potential wild ornamentals, medicinal plants and traditional landraces was emphasised in the seminar.



DDG (CS) Chairing the Session I of Workshop



Participants of Indo-US SPS Workshop

### 19.13 Workshops/ Group Meetings/ Trainings Organized during 2008

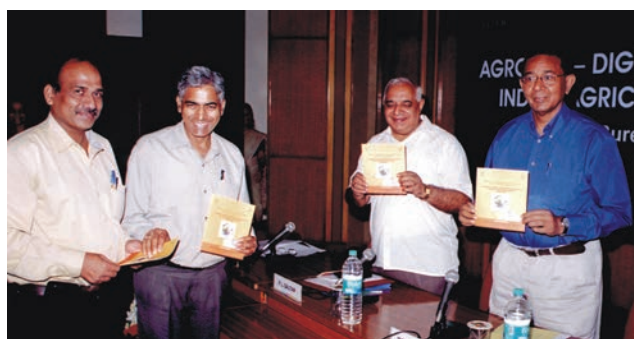
SN	Title of the programme	Duration	Venue
1.	31 <sup>st</sup> Annual Horticulture Show-2008 was organized jointly by Horticulture Society of Chotanagpur, and Horticulture and Agro-Forestry Research Programme, Ranchi	March 1-2, 2008	NBPGR Regional Station, Ranchi at Nakshttra Van, Raj Bhawan, Ranchi
2.	National Workshop on Agricultural Biosecurity	March 25, 2008.	NASC Complex, New Delhi
3.	Training for students of ICAR Training on Seed Health Testing and Quality Production from GBPUA&T Pantnagar	April 3-5, 2008	NBPGR, New Delhi
4.	One day training and field visit programme: Agricultural and Horticultural Crop Plant Genetic Resources	June 28, 2008, September 8, 2008 and December 12, 2008	NBPGR, Bhowali
5.	Launch Workshop for the NAIP funded project AGROWEB Digital Dissemination System for Indian Agricultural Research (ADDSIAR)	July 18, 2008	NBPGR, New Delhi
6.	Indo-US SPS 2 <sup>nd</sup> Workshop Agricultural Knowledge Initiative (AKI)	July 22-23, 2008	National Agricultural Science Complex, New Delhi
7.	Brain Storming Session on Issues of Access and Benefit Sharing on Genetic Resources	October 4, 2008	NBPGR, New Delhi
8.	Brainstorming Session on Plant Quarantine including Internal Quarantine Strategies in view of Onslaught of Diseases and Insect Pests	November 4, 2008	National Agricultural Science Complex, New Delhi
9.	Short training course on "Germplasm Exchange: Policies and Procedures in India	November 17-26, 2008	NBPGR, New Delhi
10.	International Training Course on in vitro and cryopreservation Techniques for conservation of Plant Genetic Resources	November 17-29, 2008	NBPGR, New Delhi
11.	DST sponsored Brain-storming Session on Plant Taxonomy and Biodiversity	December 16, 2008	NBPGR, New Delhi
12.	One day training programme on Kiwi production	December 19, 2008	NBPGR, Bhowali

**“AGROWEB- Digital Dissemination System for Indian Agricultural Research (ADDSIAR)” launched at NBPGR** on 18 July 2008. NAIP has funded for establishing a consortium for ADDSIAR with NBPGR as Lead Centre, and eight Cooperating Centres namely Central Institute of Brackishwater Aquaculture (CIBA), Chennai; Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad; Indian

Agricultural Research Institute (IARI), New Delhi; Indian Council of Agricultural Research (ICAR), New Delhi; Indian Institute of Horticultural Research (IIHR), Bangalore; National Academy of Agricultural Research Management (NAARM), Hyderabad; National Centre for Integrated Pest Management (NCIPM), New Delhi and National Dairy Research Institute (NDRI), Karnal with the following objectives:



- Ø To identify standards, develop uniform guidelines, content management strategies and a model template for websites of ICAR institutes.
- Ø To develop model websites of all consortium partners to meet requirements of stakeholders.
- Ø To design and develop ICAR 'Portal' and integrating the websites of consortium partners.
- Ø To build capacity of personnel in ICAR institutes in design, development and management of websites.



Dr. Mangala Rai, Secretary, DARE, and DG, ICAR with Dr P.L. Gautam, DDG (CS) releasing a brochure of the Agroweb Project 7.

#### 19.14 Participation of Staff in Seminars/ Symposia/ Conferences/ Workshops/ Training Programmes

Name of Employee	Title of Seminar/ Symposium/ Conference/ Workshop/ Training programmes	Place and period
Shashi Bhalla	IUPAC sponsored First international Conference on Agrochemicals Protecting Crop, Health and Natural Environment	IARI, New Delhi, 8-11 January 2008
Usha Dev and D.B. Parakh	National Symposium on Plant Disease Scenario in Organic Agriculture for Eco-friendly Sustainability	Mahatma Phule Krishi Vidyapeeth, Regional Wheat Rust Research Station, Mahabaleshwar, Maharashtra, 10-12 January 2008
Z. Abraham	XXI <sup>st</sup> ICAR Regional Committee meeting of Region No. VIII	CTCRI, Thiruvananthapuram, 11-12 January 2008
K. S. Varaprasad	National Seminar on Biodiversity Conservation and Environmental Biotechnology	Department of Zoology, VSR & NVR College, Tenali, Guntur, Andhra Pradesh, 23- 24 January 2008
K. S. Varaprasad, S. K. Chakrabarty, B. Sarath Babu, K. Anitha, S. R. Pandravada, N. Sivaraj, Kamala Venkateswaran, Rama Srinivas, N. Sunil, Babu Abraham and R. Gunasekharan	II and III meetings of the Task Force (6/2007) for developing guidelines and formulation of the benefit sharing under PPV & FR	NBPGR, Hyderabad, 28- 29 January 2008
Archana P. Raina	National Seminar on Emerging Challenges in Harnessing Plant Bio-Diversity, Marketing and Export potential of Medicinal and Aromatic Plants	C. S. Azad University of Agriculture and Technology, Kanpur, 28-30 January, 2008.
S. K. Verma and K. S. Negi	Launch Workshop of NAIP	VPKAS, Almora, 29 January 2008
Vandana Tyagi	Enhancement Workshop on Sustainability, Natural Resources Management and Human Security at Denver	Colorado, 2-7 February 2008
J. B. Tomar	National Seminar-cum-Training on Medicinal and aromatic plants	Birsa Agriculture University, Ranchi, 3-5 February 2008
N.K. Dwivedi	National workshop on Spices and Aromatic Plants	ARS, RAU, Mandore, 6-7 February 2008
Nidhi Verma	Capacity building for Intellectual Property Protection and Technology Licensing in Agriculture' under Indo-US Agricultural Knowledge Initiative	CCS HAU, Hisar, 11-13 February 2008

S. K. Verma	Annual Workshop of Horticultural Technology Mini Mission-I	VPKAS, Almora, 20 February 2008
K.K. Gangopadhyay, S. K. Yadav	National Workshop of AICRP on Vegetable Crops	OUA&T, Bhubaneswar, 23-27 February 2008
S. K. Verma and K. S. Negi	National Science Day	DSB College, Kumaon University Nainital, Uttarakhand, 28 February 2008
S. K. Mishra	ICAR- ICARDA sponsored South Asian Traveling Workshop on Lentil, Kabuli Chickpea and Lathyrus	3-9 March, 2008
K. S. Varaprasad, Anitha Kodaru	International Seminar on "Medicinal Plants & Herbal Products"	SV University, Tirupati, 7-9 March 2008
Rekha Chaudhury	National Seminar on "Opportunities and Challenges of Arid Horticulture for nutrition and livelihood"	CIAH, Bikaner, Rajasthan, 8-9 March 2008
Archana P. Raina	Advances in Floriculture Research and Development	Division of Floriculture and Landscaping, IARI, New Delhi, 14-20 March 2008
R.K. Khetarpal, K. S. Varaprasad, P.C. Agarwal, B. Lal, Arjun Lal, M.L. Kapur, Usha Dev, S. K. Chakrabarty, Shashi Bhalla, Rajan, B. Singh, D. B. Parakh, V.C. Chalam and Kavita Gupta	National Workshop on Agricultural Biosecurity	NASC Complex, 25 March 2008
Z. Abraham	Final Review Meeting of ICAR Network Project on Tree-borne Oilseeds	NASC Complex, New Delhi, 27 March 2008
Vandana Tyagi	Berger International Law Journal symposium on, Process and Procedure in WTO Dispute Settlement	Law School, Cornell University, Ithaca, New York, 4-5 April 2008
Vandana Tyagi	Symposium on Sustainability organized by College of Agriculture and Life Sciences and Department of Applied Economics and Management	Cornell University, Ithaca, New York, 10-11 April 2008
N. K. Gautam	AICRP Workshop on Rice	IGKV, Raipur, 11-14 April 2008
Archana P. Raina	Commercial Cultivation of Flower Crops	Division of Floriculture and Landscaping, IARI, New Delhi, 19-25 April, 2008
C.S. Raghav	International Conference on Naturals in Creative Perfumery	Hotel Ramada, Varanasi, Uttar Pradesh, 20-22 April 2008
D. K. Hore	Farmers' training on Spices Crops and its relevance to Farmers' rights/DUS testing	ICAR Complex for NEH Region, Umiam, Meghalaya, 23 April 2008
V.C. Chalam	ICAR Training-cum-Workshop on IP and Technology Management Theme: Genetic Engineering	Indian Agricultural Research Institute, New Delhi, 23-25 April 2008
S. Gopala Krishnan	Annual Pearl millet research workers group meeting	University of Mysore, Mysore, 25-27 April 2008
Anuradha Agrawal, Neelam Sharma, Ruchira Pandey and Sangita Yadav	National Symposium organized by TAAS and DMR on "Quality Protein Maize for Human Nutritional Security and Development of Poultry Sector in India"	NASC Complex, Pusa, New Delhi, 3 May 2008
V.C. Chalam	One day workshop on "Benefits, Risk and Biosafety of Genetically Modified Organisms"	M.P. Pollution Control Board, Indore, 7 May 2008
N.K. Dwivedi, B S Phogat and S. Gopala Krishnan	XIX group meet of All India Coordinated Research Network on Underutilized crops	ARS, RAU, Mandore, 12-13 May 2008

K. S. Varaprasad, R. D. V. J. Prasada Rao, S. K. Chakrabarty, B. Sarath Babu, K. Anitha, S. R. Pandravada, N. Sivaraj, V. Kamala, N. Sunil, B. Abraham, R. Gunasekharan	Review Meeting of Repatriation of sorghum, pearl millet, chickpea, pigeonpea and small millet germplasm to ICAR from ICRISAT	NBPGR, RS Hyderabad, 14 May 2008
Ranbir Singh	Annual Research Workers Group Meeting on Sunflower and Castor	PAU, Ludhiana (Punjab), 15–17 May 2008
Anitha Kodaru	SPS Training cum Workshop for PSC issuing authorities of southern, Eastern & North eastern regions	Regional Plant Protection Quarantine Station, Chennai, 22 May 2008
D.K. Hore	Medicinal Plant Resources and its Utilisation and Management in North East India	Northeastern Hill University, Shillong, 22 May 2008
Z. Abraham	National Conference 'DHISHANA 2008' on Streamlining India's Traditional Knowledge Towards Formulating a <i>sui generis</i> Regime	Rajiv Gandhi Centre for Bio-technology, Thiruvananthapuram, 23- 25 May 2008
K. Joseph John	Town Official Language Implementation Committee (TOLIC) meeting	Micro, Small and Medium Enterprises Development Institute, Kanjani Road, Thrissur, 26 May 2008 and 24 October 2008
R.K. Khetarpal, P.C. Agarwal and V.C. Chalam	2 <sup>nd</sup> International Symposium on Seed Health in Agricultural development	University of Mysore, Mysore, 9-12 June 2008
N.K. Dwivedi	XX meeting of ICAR Regional Committee No. VI	CAZRI, Jodhpur, 26-27 June 2008
S.K. Mishra, N.K. Dwivedi and S. Gopala Krishnan	National symposium on "Enhancing productivity, nutritional security and export potential through arid legumes"	CAZRI, Jodhpur, 28-30 June 2008
S. Gopala Krishnan	XXIV Annual Arid legumes workshop	ARS, RAU, Durgapura, 30-31 May 2008
Anuradha Agrawal, RK Tyagi Ruchira Pandey and Kamala Venkateshwaran	Launch Workshop of the National Agricultural Innovation Project (NAIP) 'AGROWEB - Digital Dissemination System for Indian Agricultural Research (ADDSIAR)'	NBPGR, New Delhi, 18 July 2008
D.K. Hore	Conference on Agricultural Development in NEH Region: Challenges and Opportunities	ICAR Complex for NEH Region, Umiam, Meghalaya, 19 June 2008
R.K. Khetarpal, P.C. Agarwal, Arjun Lal, M.L. Kapur, Usha Dev, S.K. Chakrabarty, Shashi Bhalla, Rajan, Anitha Kodaru, B. Singh, D.B. Parakh, V.C. Chalam and Kavita Gupta	Indo-US SPS 2 <sup>nd</sup> Workshop under Agricultural Knowledge Initiative (AKI)	National Agricultural Science Complex, New Delhi, 22-23 July 2008
K.S. Varaprasad	International Forum on "Conservation and stewardship of agricultural biodiversity in an area of climate change	MSSRF, Chennai, 6-9 August 2008
Ranbir Singh	Annual Research Workers Group Meeting on Rapeseed mustard	OUAT, Bhubaneswer (Orissa), 7–9 August 2008
E.R. Nayar	Second Short-term Course in Plant Variety Protection and Related Issues	Seed Science and Technology, IARI, New Delhi, 12 August 2008
D.K. Hore	National Seminar on 'Traditional Knowledge' (organized by Ministry of Commerce & Industries, Govt. of India and WIPO, Switzerland)	Northeastern Hill University, Shillong, 22 August 2008
J.B. Tomar	Annual Group Meeting on "Linseed and safflower.	BAU, Ranchi, 28-30 August 2008

S.K. Sharma, S.K. Mishra, Arjun Lal	Annual Workshop on chickpea and MULLaRP crops	MPUAT, Udaipur, 7-9 September 2008
Ashok Kumar	National Seminar on "Recent Trends in Research on Spices and Aromatic Plants"	CCS HAU, Hisar, 10-12 September 2008
K.K. Gangopadhyay	National Seminar on 'Recent Trends in Research on Spices and Aromatic Plants	CCSHAU, Hisar, 10-12 September, 2008
N.K. Dwivedi and S. Gopala Krishnan	Launch workshop and CIC meeting of the NAIP funded sub-project on "Biosystematics of the genera <i>Vigna</i> , <i>Cucumis</i> and <i>Abelmoschus</i> "	NBPGR, New Delhi, 26-27 September 2008
D.K. Hore	International Seminar on 'Multidisciplinary approaches on Angiosperm Taxonomy'	University of Kalyani, Nadia, West Bengal, 11-13 October 2008
Vandana Tyagi	2nd India-China Joint Working Group Meeting on Agricultural Research, Development Corporation	NASC Complex, New Delhi, 15-16 October 2008
Anuradha Agrawal	Second Meeting of the 'Taxonomy Advisory Group' (TAG) on bananas organized by Bioversity International	NRC Banana, Trichy, 20-25 October 2008
E.R. Nayar	Short-term Training on Herbarium Techniques	National Institute of Science Communication and Information Resources, New Delhi, 22 October 2008
R.K. Tyagi and Anuradha Agrawal	'International Conference on Quality Production of Banana for Domestic and Export Market'	National Horticultural Board, Tiruchirapalli, Tamil Nadu from October 24-26, 2008
D. B. Parakh	International Training-Workshop on Musa Virus Indexing	NRC for Banana, Trichy, 28 October- 1 November 2008
J.C. Rana	International Conference on 'Climate Change, Biodiversity and Food Security in the South Asian Region	Punjab State Council for Science and Technology Chandigarh, 2-3 November 2008
Vandana Tyagi	Training Program on Intellectual Property Rights and Related WTO Issues	Hotel Golden Tulip, Jaipur, 3-7 November 2008
J.C. Rana	National Workshop on Climate change and Sustainable Agriculture	Centre for Sustainable Agriculture New Delhi, 4-5 November 2008
R.K. Khetarpal	Extra-ordinary Meeting of the SAARC Agricultural Ministers	National Agricultural Science Complex, New Delhi, 5 November 2008
R.K. Khetarpal, Ruchira Pandey and Sandhya Gupta	International Conference on 'Wheat Stem Rust Ug99-A Threat to Food Security'	NASC Complex, Pusa Campus, New Delhi, 6 November 2008
Anitha Kodaru and Vinod Kumar	Annual Review Meeting of the Rain Shadow Areas Development (RSAD) Jatropha Project funded by the AP State Govt	AP Secretariat, Hyderabad, 6 November 2008
J. B. Tomar	28th Rabi Research Council Meeting	BAU, Ranchi, 7 November 2008
J. B. Tomar	4th Seed Research Council Meeting	BAU, Ranchi, 8 November 2008
Anuradha Agrawal and R.K. Tyagi	NAIP Workshop on 'Heuristic Evaluation of Websites of Deemed Universities in NARS'	NRC on Plant Biotechnology, IARI, New Delhi, 14 November 2008
Z. Abraham	17 <sup>th</sup> Group Meeting of All India Network Project on Medicinal & Aromatic Plants	Kerala Agricultural University, Thrissur, 15- 17 November 2008
Ashok Kumar	AINRP Group meet on Medicinal and Aromatic Plants	KAU, Vellanikkara, 15-18 November 2008



V.C. Chalam	30th Annual Conference and Symposium on Advances in Biotechnology for Plant Protection	University of Mysore, Mysore, 17-19 November 2008
Ranbir Singh	Short Term Training Course on "Germplasm Exchange: Policies and Procedures in India"	NBPGR, New Delhi, 17-26 November 2008
D.K. Hore	ICAR Training-cum-Workshop on 'Intellectual Property and Technology Management'.	ICAR Complex for NEH Region, Umiam, Meghalaya, 20-22 November 2008
Kamala Venkateswaran	IVth meeting of the Andhra Pradesh Biodiversity Board	Aranya Bhavan, Hyderabad, 22 November 2008
R.D.V.J. Prasada Rao and Anitha Kodaru	Launch Workshop of the NAIP Project "Novel Strategies for Molecular Diagnosis of Plant Viruses"	CRIDA, Hyderabad, 28 November 2008
Kamala Venkateswaran	Training Programme on "Web Standards Technologies and / Standardization"	NAARM, Hyderabad, 3-12 December 2008
Kavita Gupta	Stakeholders Consultations for the preparation of the National Medium Term Policy Framework	NASC Complex, New Delhi, 8-12 December 2008
DB Parakh and VC Chalam	XVIII National Conference of Indian Virological Society	Postgraduate Institute of Medical Education and Research, Chandigarh, 11-13 December 2008
D.C. Bhandari, E.R. Nayar, D.K. Hore, Anjula Pandey, Rakesh Srivastava, K.C. Bhatt, Kamala Venkateswaran, K. Joseph John, Kavita Gupta and Rita Gupta	Brain-storming Session on Plant Taxonomy and Biodiversity	NBPGR, New Delhi, 16 December 2008
Veena Gupta	Third World Ayurveda Congress	Jaipur, 16-21 December 2008
K. S. Negi, S. S. Koranga and S. N. Ojha	Launch workshop entitled "Studies on relationship between eco-geography of the chemotypic variation of nine important but highly threatened medicinal plant species and prospects of their cultivation" component IV of NAIP	NBRI, Lucknow, 26-31 December 2008

## 19.15 Publications

### 19.15.1 Research Papers

1. Abdul Nizar M, K Joseph John and R Karupaiyan (2007) Selection response of fruit yield in okra (*Abelmoschus esculentus* (L.) Moench) *Journal of Plant Genetic Resources* **20**(1):43-47. (pub. 2008)
2. Abraham Z, M Latha and R Brinda (2008) Character Association Studies in Elephant Foot Yam. *Journal of Root Crops* **34**(1): 70-72.
3. Abraham Z, R Senthilkumar, K Joseph John, TVRS Sharma, NV Nair, M Unnikrishnan, PM Kumaran, Johnson K George, S Uma, M Latha, SS Malik, SK Mishra, DC Bhandari and SK Pareek (2008) Collection of Plant Genetic Resources from Andaman and Nicobar Islands. *Genetic Resources and Crop Evolution* **55**: 1279-1289.
4. Agrawal A, RK Tyagi and R Goswami (2008) Cryopreservation of subgroup Monthan (ABB) of Indian cooking bananas (*Musa* spp.) *Current Science* **94**:1125-1128.
5. Amaravathi Y, Rakesh Singh, AK Singh, VP Singh, T Mahopatra, TR Sharma and NK Singh (2008) Mapping of quantitative trait loci for Basmati quality traits in rice (*Oryza sativa* L.). *Molecular Breeding* **21**: 49-65.
6. Anurudh K Singh, Kalyani Srinivasan, SK Jain, Narendra Singh, B Raut, DP Attrey and Rakesh Singh (2008) Assessing Natural Low Temperature Conditions in Himalayan Region for Long-Term Storage of Seed: Facilitating Conservation of Plant Genetic Resources. *Seed Research* **37**.
7. Arya L, M Verma, GS Sandhia, SK Singh and S Lakhanpaul (2008) Pattern of Genetic Relationships as Revealed by AFLP Markers in Indian Sorghum [*Sorghum bicolor* (L.) Moench]. *Indian Journal of Genetics and Plant Breeding* **68**: 139-144.

8. Arya L, M Verma, GS Sandhia, SK Singh and S Lakhanpaul (2008) The pattern of genetic variation as revealed by RAPD and AFLP markers in Pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *International Journal of Tropical Agriculture* **26**: 463-469.
9. Bhalla Shashi, Kavita Gupta, Manju Lata Kapur, B Lal, Charan Singh, Naresh Kumar, Meenakshi and RS Baloda (2008) Insect Pests Detected in Indigenous Germplasm during 2000-05. *Indian Journal of Agricultural Sciences* **79** (2): 40-45.
10. Bhalla Shashi, Kavita Gupta, Manju Lata Kapur, Charan Singh, Naresh Kumar, Beche Lal and R K Khetarpal (2008) Risk assessment of insect pests intercepted in imported planting material. *Indian Journal of Plant Protection*. **36**(1): 9-14.
11. Chalam VC, DB Parakh, RK Khetarpal, AK Maurya, A Jain and Shamsher Singh (2008) Interception of seed-transmitted viruses in cowpea and mungbean germplasm imported during 2003. *Indian Journal of Virology* **19** (1): 12-16.
12. Chalam VC and RK Khetarpal (2008) A critical appraisal of challenges in exclusion of plant viruses during transboundary movement of seeds. *Indian Journal of Virology* **19** (2): 139-149.
13. Dua, RP, HL Raiger, SK Mishra, SK Sharma and OP Dahiya (2008). Sources of multiple disease resistance in chickpea (*Cicer arietinum*) germplasm. *Indian J. Agric. Res.*, **78**(8): 684-689
14. Dwivedi NK (2008) Characterization of exotic green gram (*Vigna radiata* L. Wilczek) germplasm in arid region of India. *Journal of Arid Legumes*, **5**(1):49-53.
15. Gopala Krishnan S and NK Dwivedi (2008) Genetics of qualitative traits in guar (*Cyamopsis tetragonoloba* (L) Taub) - an overview. *Journal of Arid Legumes*, **5**(1): 1-7.
16. Gupta Rita, Anjula Pandey, ER Nayar and DC Bhandari (2008) Wild edible plants of semi-arid Delhi region. *Journal of Economic and Taxonomic Botany* **32** (3):663-672.
17. Hussain Z, RK Tyagi, R Sharma and A Agrawal (2008) Genetic diversity in *in vitro*-conserved germplasm of *Curcuma* L. as revealed by RAPD markers. *Biologia Plantarum* **52**:627-633.
18. Hussain S and DK Hore (2008) Collection and conservation of major medicinal plants of Arunachal Pradesh. *Indian Forester* **134**(12): 1663-1679.
19. Joseph John K, R Senthil Kumar, CP Suresh, Johnson K George and Z Abraham (2008) Occurrence, Distribution and Economic Potential of Seashore Mangosteen (*Garcinia hombroniana* Pierre). *Genet Genetic Resources and Crop Evolution* **55**:183-186.
20. Kumar Gunjeet, BL Meena, Ranjan Kar, SK Tiwari, KK Gangopadhyay, IS Bisht and RK Mahajan (2008) Morphological diversity in brinjal (*Solanum melongena* L.) germplasm accessions. *Plant Genet. Resour: Characterization and Evaluation* **6**(3): 232-236.
21. Latha M and R Murugesan (2008) Effect of Tuber Shape, Size, Length and Depth of Tuber Placement on the Harvest of Greater Yam (*Dioscorea alata* L.). *Journal of Root Crops* **34**(1): 77-78.
22. Lava Kumar P, RDVJ Prasada Rao, AS Reddy, K Madhavi Jyothirmai, K Anitha and F Waliyar (2008) Emergence and spread of Tobacco streak virus menace in India and control strategies. *Indian Journal of Plant Protection* **36** (1): 1-8.
23. Mandal S, KK Datta, DK Hore and S Mohanty (2008) Biodiversity and organic agriculture: Opportunities and Challenges for the Northeast region of India and a model for principles involved. *Outlook on Agriculture* **37**(2): 87-94.
24. Meghwal R and NK Dwivedi (2008) Diversity in mothbean in arid and semi-arid regions of India. *Journal of Arid Legumes* **5**(2): 138-139.
25. Mishra Gyan P, SK Mishra, SK Tiwari, and Atul Kumar (2008) Inheritance of lentil (*Lens culinaris*) resistance to rust (*Uromyces fabae*). *Indian Journal of Agricultural Sciences* **78**(11): 994-996.
26. Mishra SK, B Sharma, MC Tyagi, BB Singh, Daisy Basandrai, Ashwini Basandrai, DP Singh, V Hegde and BB Singh, (2008) Screening of cowpea germplasm for field tolerance against biotic and abiotic stresses. *Indian Journal of Genetics*, **68**(4): 446-448.
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3. Lal Arjun, Pratibha Brahmi, Deep Chand, Vandana Tyagi, Nidhi Verma, SP Singh and Surender Singh *Plant Germplasm Reporter* (2008) Volume 7 No. 2 2007, NBPGR, New Delhi.207p.

4. Lal Arjun, Pratibha Brahmi, Deep Chand, Vandana Tyagi, Nidhi Verma, SK Yadav, SP Singh and Surender Singh *Plant Germplasm Reporter* (2008) Volume 7 No. 3 2007, NBPGR, New Delhi.197p.
5. Lal Arjun, Pratibha Brahmi, Deep Chand, Nidhi Verma, SK Yadav, SPSingh and Surender Singh *Plant Germplasm Reporter* (2008) Volume 7 No. 4 2008, NBPGR, New Delhi.209 p.

#### **19.15.6 Annual Report/ Crop Catalogue, etc.**

1. Lal Arjun, Anjula Pandey and Kavita Gupta (2007) Annual Report 2007-2008, National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi, 154p.

#### **19.15.7 Books/ Manuals/ Teaching aids**

1. Brahmi Pratibha, RC Agrawal and SK Sharma (2009). Guidelines for Filling Applications of Plant Varieties for Registration under the Protection of Plant Varieties and Farmers' Rights Act 2001. National Bureau of Plant Genetic Resources, New Delhi, pp. 162.
2. Dua RP, HL Raiger, BS Phogat and SK Sharma (2009). Underutilized Crops: Improved Varieties and Cultivation Practices. All India Coordinated Research Network (Underutilized Crops), NBPGR, New Delhi, pp. 66.
3. Gupta Kavita, JL Karihaloo and RK Khetarpal (2008) Biosafety Regulations of Asia-Pacific Countries. Asia-Pacific Association of Agricultural Research Institutions, Bangkok; Asia-Pacific Consortium on Agricultural Biotechnology, New Delhi and Food and Agricultural Organization of the United Nations, Rome, p 96 (i-x).
4. Lal Arjun, Deep Chand, Vandana Tyagi, Nidhi Verma, SK Yadav, Vandana Joshi, SP Singh and Surender Singh (2008) Training Manual on Germplasm Exchange: Policies and Procedures in India November 17-26, 2008, NBPGR, New Delhi 334 p.
5. Raiger HL, RP Dua, M Dutta, BS Phogat and SK Sharma (2008). Annual Report on All India Coordinated Research Network on Underutilized Crops. National Bureau of Plant Genetic Resources, New Delhi, pp. 400.
6. Sharma SK, A Agrawal, R Chaudhury, RK Tyagi, R Pandey, N Sharma, S Gupta, SK Malik and Z Hussain (eds) (2008) A Laboratory Manual for *In*

*Vitro* and Cryopreservation Techniques for Conservation of Plant Genetic Resources (Third Edition), National Bureau of Plant Genetic Resources, New Delhi, India, p 45.

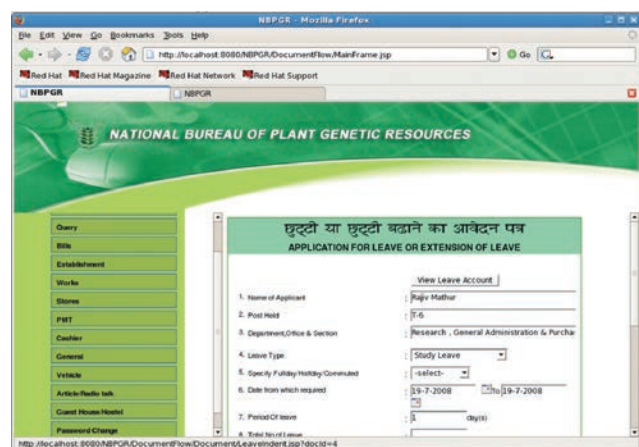
7. Tyagi Vandana (2008) Procedures for Transfer/ Exchange of Seed/ Planting Material to/ from India for Research and Evaluation Purposes in Small Quantities, CCTEC, Cornell University, Ithaca, NY 25 p. 9th June 2008, 28 p.

#### 19.15.8 Radio/ TV talks

1. KC Muneem delivered a radio talk on Sabjiyon ki rani, dalo ka raja – Rajama at Kishan Vani, AIR, Almora, Uttarakhand on July 16, 2008.
2. KS Negi delivered a radio talk on Parvatiya kshetro mein lavender ke kheti at Kishan Vani, AIR, Almora, Uttarakhand on July 16, 2008.
3. SK Verma delivered a radio talk on *Udyaniki mein rojagar* at Kishan Vani, AIR, Almora, Uttarakhand on August 07, 2008.

#### 19.16 Implementation of on-line leave management at NBPGR

The ARIS Cell has implemented the on-line management of leaves at NBPGR Head Quarters, New Delhi. Any employee can check the status of any kind of his/her leave and can apply for the sanctioning of the leaves to the competent authority (CA). The employee can know the status of his/her application with complete track. The ARIS Cell is also in the process of implementation of the on-line application for the withdrawal of GPF, ad-hoc, and many other official works.



#### 19.17 QRT of NBPGR-Meetings and visits

The Director General, Indian Council of Agricultural Research constituted a Quinquennial Review Team (QRT) on January 30, 2008 to review the work done by the NBPGR for the period from 2002-2007. The Chairman, Members and Facilitator of the QRT were as given below:

Chairman	Dr SK Vasal, Ex Distinguished Scientist, CIMMYT
Member	Dr DS Rathore, Former VC, CSK HPKV
Member	Dr RG Saini, Ex Head, Department of Plant Breeding, Genetics and Biotechnology Punjab Agricultural University Campus Ludhiana- 141 004
Member	Dr RK Singh, Consultant, ICRAF Regional Office for South Asia
Member	Dr P Pushpangadan, Director General Amity Institute for Herbal and Biotech Products Development,
Member	Dr AN Mukhopadhyay, Former Vice Chancellor, Assam Agricultural University, Jorhat, Assam.
Facilitator	Dr RK Khetarpal, Head, Plant Quarantine Division, NBPGR



QRT members visiting NBPGR Thrissur station on September 10, 2008



The QRT members Dr DS Rathore and Dr RG Saini visited the NBPGR Jodhpur station on November 9 - 11, 2008

The QRT had very detailed and meaningful interactions with the Director, scientists and other functionaries of the Bureau, besides visits to different units such as service laboratories, National Gene Bank, NRC-DNA Fingerprinting, regional/ base/ satellite stations, concerned ICAR institutions, SAUs, regional centres of Botanical Survey of India, etc. The Details of QRT meetings and visits were as follows:

Dates of meeting/ visit	Place	Purpose
May 9-10, 2008	NBPGR, New Delhi	Preliminary meeting with the DDG, Crop Sciences, ICAR and Director and Heads of Divisions of NBPGR
May 21, 2008	NBPGR, New Delhi	Preliminary meeting with the Director and Heads of Divisions of NBPGR
August 25-29, 2008	<ul style="list-style-type: none"> <li>o NBPGR, Regional Station, Shimla</li> <li>o IARI Regional Station, Shimla</li> <li>o Dr Y S Parmar University of Horticulture and Forestry Regional Station, Mashobra</li> <li>o Central Potato Research Institute, Shimla</li> <li>o Indian Institute of Advanced Studies, Shimla</li> <li>o Dr Y S Parmar University of Horticulture and Forestry, Solan</li> <li>o NRC for Mushrooms, Solan</li> </ul>	To review the PGR activities of the NBPGR Regional Station Shimla and its linkages with other organizations
September 4-7, 2008	<ul style="list-style-type: none"> <li>o NBPGR, Regional Station Hyderabad</li> <li>o Directorate of Rice Research, Hyderabad</li> <li>o Directorate of Oilseeds Research, Hyderabad</li> <li>o NRC on Sorghum, Hyderabad</li> <li>o International Crop Research Institute for Semi Arid Tropics, Patancheru</li> <li>o ANGR Agriculture University, Hyderabad</li> </ul>	To review the PGR activities of the NBPGR Regional Station Hyderabad and its linkages with other organizations
September 8, 2008	Sugarcane Breeding Institute, Coimbatore	To review the PGR activities of SBI, Coimbatore
September 9-10, 2008	<ul style="list-style-type: none"> <li>o NBPGR Regional Station, Thrissur</li> <li>o Kerala Agricultural University, Thrissur</li> <li>o Cashew Research Station (KAU), Thrissur</li> </ul>	To review the PGR activities of the NBPGR Regional Station Thrissur and its linkages with other organizations
September 14 – 18, 2008	<ul style="list-style-type: none"> <li>o NBPGR Regional Station, Umiam</li> <li>o ICAR Research Complex for NEH Region, Umiam</li> <li>o North Eastern Hill University, Shillong</li> <li>o Botanical Survey of India, Shillong</li> <li>o Guwahati University, Guwahati</li> </ul>	To review the PGR activities of the NBPGR Regional Station Umiam and its linkages with other organizations
September 24, 2008	<ul style="list-style-type: none"> <li>o NBPGR, New Delhi</li> </ul>	To review the progress of QRT work
October 13-14, 2008	<ul style="list-style-type: none"> <li>o NBPGR Base Centre Srinagar</li> <li>o Central Institute for Temperate Horticulture, Srinagar</li> </ul>	To review the PGR activities of the NBPGR Base Centre Srinagar and its linkages with other organizations
October 18, 2008	<ul style="list-style-type: none"> <li>o NBPGR, New Delhi</li> </ul>	To finalise the QRT recommendations
November 1, 2008	<ul style="list-style-type: none"> <li>o NBPGR, New Delhi</li> </ul>	To prepare the draft of QRT Report
November 9-11, 2008	<ul style="list-style-type: none"> <li>o NBPGR, Jodhpur</li> <li>o Central Arid Zone Research Institute, Jodhpur</li> <li>o Agricultural and forestry Research Institute, Jodhpur</li> <li>o Botanical Survey of India (Arid Zone circle), Jodhpur</li> <li>o Botany Department, JNV University, Jodhpur</li> <li>o Agricultural Research Station, RAU, Mandore, Jodhpur</li> </ul>	To review the PGR activities of the NBPGR Regional Station Jodhpur and its linkages with other organizations
November 12, 2008	<ul style="list-style-type: none"> <li>o NBPGR Experimental Station, Issapur, New Delhi</li> </ul>	To review the field experiments and infrastructural facilities
November 17-18, 2008	<ul style="list-style-type: none"> <li>o NBPGR, New Delhi</li> </ul>	To discuss the draft QRT Report
December 15, 2008	<ul style="list-style-type: none"> <li>o NBPGR, New Delhi</li> </ul>	To finalise the QRT Report



The Final Report of QRT and its recommendations were submitted to the Council on December 18, 2008



QRT visiting Facilities at NBPGR, Regional Station Hyderabad

### 19.18 Budget and Expenditure incurred (Rs. in lakhs) for the Financial Year 2008-2009

#### A: Non- Plan

Head	Allocation	Revised Allocation	Total Expenditure
Estt. Charges	1,020.8	1,602.0	1601.94
Wages	30.0	32.0	32.00
OTA	0.2	0.2	0.20
TA	7.0	7.0	7.00
Other charges including equipment	235.0	270.0	270.00
Works	47.0	117.0	117.00
<b>Total</b>	<b>1,340.0</b>	<b>2,028.2</b>	<b>2028.14</b>

#### B. Plan including NRC on DNA Fingerprinting & Shillong (NEH Region)

Head	Allocation	Revised Allocation	Total Expenditure
TA	15.45	15.45	15.44
Other charges including equipment	609.03	609.03	609.02
Works	172.00	172.00	171.99
HRD	4.00	4.00	4.00
<b>Total</b>	<b>800.48</b>	<b>800.48</b>	<b>800.45</b>

#### C. AICRN-UC

Head	Allocation	Revised Allocation	Expenditure
TA	2.00	1.40	1.39
Other Charges including Equipment	8.00	9.60	9.59
Works	5.00	0.00	0.00
<b>Total</b>	<b>15.00</b>	<b>11.00</b>	<b>10.98</b>



### Annexure 1: Meteorological data (temperature in degrees Celsius and rainfall in mm) at NBPGR

STATION	PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AKOLA	MAX TEMP	29.3	30.5	37.3	40.8	41.5	35.7	32.3	30.6	30.9	33.8	32.6	31.5
	MIN TEMP	12.3	12.7	20.0	24.2	28.3	26.4	24.8	23.8	22.6	18.6	16.2	13.5
	RAINFALL	19.5	-	14.5	-	-	67.7	147.3	112.5	177.7	18.0	5.5	-
BHOWALI	MAX TEMP	16.0	13.8	23.9	26.5	27.3	21.9	25.0	25.5	26.8	26.4	21.6	21.2
	MIN TEMP	-0.1	0.6	9.1	9.5	13.8	17.1	18.9	18.1	14.2	11.1	6.1	4.0
	RAINFALL	8.2	20.0	-	65.0	70.0	250.4	374.4	268.4	411	-	7.0	-
CUTTACK	MAX TEMP	27.6	27.8	33.5	34.9	36.3	32.3	31.9	31.1	31.1	31.7	29.6	28.7
	MIN TEMP	14.9	17.5	22.5	24.7	25.7	25.2	25.3	25.4	24.9	23.7	19.3	17.3
	RAINFALL	73.4	7.4	4.2	14.0	72.5	471.3	236.3	473.0	339.0	23.6	-	-
HYDERABAD	MAX TEMP	30.3	30.5	33.4	36.1	39	34.5	32.3	29.3	30.1	31.4	29.6	29.5
	MIN TEMP	13.0	18.2	19.2	21.9	25.8	25.0	24.4	23.1	22.4	20.1	16.6	14.2
	RAINFALL	-	74.4	98.0	62.4	12.0	66.7	2.7	16.3	6.8	1.7	0.4	-
JODHPUR	MAX TEMP	23.4	26.3	36.1	38.1	38.8	37.7	36.3	33.0	35.8	37.4	32.5	28.0
	MIN TEMP	10.7	9.6	19.4	22.9	25.9	28.1	27.5	25.4	25.4	20.6	15.8	14.3
	RAINFALL	-	-	1.6	24.6	91.4	97.5	66.2	138.8	13.8	-	-	3.9
SHILLONG	MAX TEMP	19.7	20.3	26.1	29.7	28.2	27.9	28.0	27.8	28.1	26.5	24.2	22.1
	MIN TEMP	7.3	6.8	11.8	15.7	17.2	19.6	20.4	20.2	18.9	15.9	10.1	9.1
	RAINFALL	34.3	4.7	9.7	58.4	296.2	345.3	285.4	426.1	401.5	228.5	36.4	19.3
SHIMLA	MAX TEMP	17.3	21.8	23.1	22.8	24.8	24.2	24.2	23.9	23.9	22.5	19.5	17.5
	MIN TEMP	-1.7	-0.4	8.2	13.4	15.2	17.0	17.8	17.0	15.0	13.6	11.0	9.5
	RAINFALL	55.9	43.7	3.0	38.4	128.0	507.4	211.1	287.0	233.7	25.7	4.6	5.6
THRISSUR	MAX TEMP	32.3	33.6	33.2	33.2	33.0	29.9	29.3	29.8	30.6	31.7	32.2	31.6
	MIN TEMP	21.7	22.9	23.4	24.9	24.7	23.5	23.2	23.6	23.2	23.4	23.1	22.5
	RAINFALL	-	29.7	205.3	65.6	11.5	636.7	416.3	321.9	301.2	380.8	21.7	2.6

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