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Plant germplasm registration goes online...

ICAR-NBPGR, New Delhi was enacted to be the nodal agency for registration of germplasm. Till date, a total of 1,313 crop germplasm accessions comprising 209 species have been registered for possessing unique and valuable traits that might be useful for various crop improvement programmes. To cater the needs of various researchers, and farmers, the present user-friendly online system of application for plant germplasm registration has been put in place.

Log on to www.nbpgr.ernet.in/registration/ to register yourself. Fill the application form online and attach documentary evidence. Upload your application and track its progress using your personal dashboard. Obtain registration certificate online too! The review process is also online, making the whole cycle of application-to-registration quick.

For guidelines regarding germplasm registration and further details: <http://www.nbpgr.ernet.in:8080/registration/Guidelines.aspx>



भाकृअप – राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो
ICAR – National Bureau of Plant Genetic Resources
A nodal organization in India for the management of plant genetic resources
(An ISO 9001:2008 Certified Institute)

जननद्रव्य पंजीकरण सूचना प्रणाली
Germplasm Registration Information System (GRIS)

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Indian Council of Agricultural Research, Ministry of Agriculture and Farmers Welfare (Govt. of India), Pusa Campus, New Delhi-110012, INDIA

PGR ACTIVITIES

EXPLORATION AND GERMLASM COLLECTING

Crop wild relatives: Exploration for wild relatives of okra and cucumber/ muskmelon was undertaken by BC, Cuttack from Kalahandi, Nuapada and Nabarangpur districts of Odisha in collaboration with ICAR-IIVR, Varanasi. A total of 93 accessions comprising *Cucumis sativus* var. *hardwickii* (28), *C. melo* subsp. *agrestis* (19), *C. callosus* (8), *Abelmoschus ficulneus* (9), *A. tuberculatus* (6), *A. tetraphyllus* (3), *A. esculentus* (1), *A. crinitus* (1) and others (8) were collected from diversity rich pockets including Karlapat and Sunabeda wildlife sanctuaries. Diversity with respect to fruit shape, size, skin



Collecting *Cucumis sativus* var. *hardwickii* from Nabarangpur district

colour, stripes and spines in *Cucumis* spp.; plant height, flower and capsule characters among wild *Abelmoschus* spp. was collected.

An exploration trip for major spices was undertaken by RS, Shillong in Karbi-Anglong and Dima Hasao districts of Assam and adjoining parts of Meghalaya in collaboration with ICAR-IISR, Kozhikode and collected 71 accessions comprising four species each of *Zingiber* and *Curcuma*. The Jowai region of Meghalaya lying adjacent to above districts is known for *Lakadong* landrace of turmeric. It was observed that the forest cover connecting Jowai and the western side of Karbi-Anglong abode rich species diversity in *Piper*. Large scale cultivation of ginger was found in Zirikindeng region of Karbi-Anglong.



A: *Curcuma longa* (Lakadong); B: *C. amada*; C: *C. caesia* (Chowkihola collection); D: *C. caesia* (Kohora collection); E: *Zingiber officinale* (from Zirikindeng, Karbi-Anglong); F: Variation in rhizome colour in turmeric

Exploration for minor tuber crop “soh-phlang”

A crop-specific exploration was conducted by HQ and RS, Shillong in collaboration with ICAR Research Complex for NEH Region, Shillong in Khasi and Jaintia hills of Meghalaya for collection of *Flemingia procumbens* (syn. *Moghania vestita*) locally called as 'soh-phlang' – a minor tuber crop domesticated in these hills. Although widely distributed in Indian subcontinent and Indo-China, its cultivation is restricted within the centre of origin (i.e. Khasi and Jaintia hills). A total of 27 accessions (in the form of vegetative tuber) were collected. Variability for tuber shape (round, fusiform, napiform, terete), size (3-12 x 2-10 cm), peel colour (cream, creamish-yellow), peel thickness, tuber taste, flavour (nutty, mild sweet, bitter) and moisture content was observed. The crop is grown in the *jhum* fields in raised bed under rainfed organic cultivation, along with other vegetatively propagated crops (taro, ginger, potato and turmeric) and oilseed crop (perilla). Peeled and cleaned tubers along with perilla chutney (prepared from roasted seeds), salt and chilli powder were sold in local markets and roadside shops. Collected tubers have been established at RS, Shillong.



Top row (left to right): Grading of harvested tubers; Close-up of tubers; Inter-cropping with ginger; Bottom row (left to right): Inter-cropping with taro; Peeling for sale; Ready-to-eat tubers

An exploration programme was organized by RS, Akola for fibre crops germplasm in collaboration with ICAR-CRIJAF, Barrackpore, and collected 81 accessions comprising seven *Corchorus* spp. (50), two *Hibiscus* spp. (29) and *Crotalaria juncea* (2) from Buldana, Jalgaon, Dhule, Nandurbar, and adjoining districts of Maharashtra. *Corchorus depressus*, *C. pseudo-olitorius* and *C. tridens* were found to be rare in occurrence. Good variability in *Hibiscus sabdariffa* was collected with reference to plant stature and fruit colour.



Green type roselle from Dhule district

A multi-crop exploration was conducted by RS, Thrissur in Chitradurga and Davangere districts of Karnataka in collaboration with ICAR-IIHR, Bengaluru and UAHS, Shivamogga and 130 accessions were collected. Salient collections include landraces in rice (Kirvan, Inden, Olesal, Hankal, Hamsan, Sannabatha, Gopika, Ambimohari, Sinduram madhusali, Chakavoporiyatan, Kumbalarusali, Adanur sane), brinjal (Rampur Local, Manjarikotta Local) and field bean (Nattavarai, chapravarai, chigatti), and crop wild relatives (CWR) – *Sesamum alatum*, *Cucumis prophetarum*, *Solanum incanum* and *Abelmoschus ficulneus*.



'Rampur Local' brinjal (JBS/17-36)

GERMPLASM EXCHANGE

Import

A total of 6,768 accessions comprising various crop plants were imported from 30 different countries. Promising accessions were:

Rice: high yielding hybrids from China (EC930152-421); **Wheat:** cv. Wirtas with resistance to the most dangerous fungal pathogens combined with high protein content from Poland (EC930686) and core set from Australia (EC933715-915); **French bean:** core set from CIAT, Colombia (EC931101-2597); **Rubber:** (EC929513-33) from Ivory Coast.

Export

Two varieties of rice to IRRI, The Philippines; and 100 wheat lines each to Bangladesh and Bolivia.

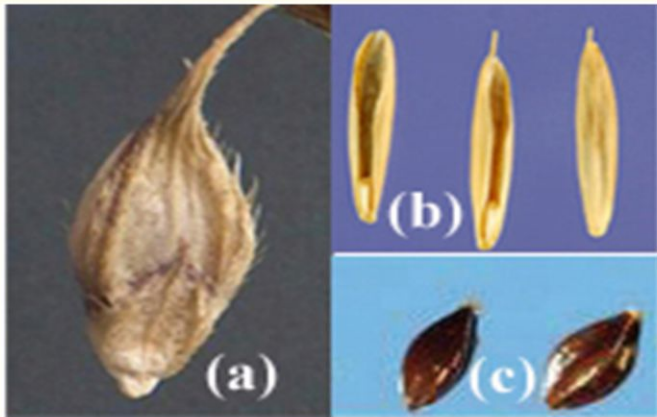
National supply

A total of 428 samples of various crops were supplied to different institutes/ researchers/ users in the country with Material Transfer Agreement.

PLANT QUARANTINE

A total of 76,951 samples of imported germplasm including transgenics were processed (HQ-73,396; Hyderabad-3,555) for quarantine clearance. Out of these, 3,248 samples were found infected/ infested with various kinds of pests (fungi-2,865; insects-286; weeds-51; nematodes-46). Out of the total infected/infested samples, 3,044 were salvaged and released to the indenters, and one detained, while 203 samples were rejected due to heavy infection/contamination/damage. Various types of prophylactic as well as curative treatments were given to the imported germplasm as per the need. In addition to import, 6,988 samples were released for export purpose and 35 phytosanitary certificates were issued.

Among pest interceptions, *Bruchus ervi* was intercepted in lentil, *Rhizopertha dominica* in wheat and barley, *Tilletia caries* in wheat, all imported from Lebanon; *T. barclayana* in rice from China. Besides, *Aphelenchoides besseyi* was intercepted in rice seeds imported from China, Japan, The Philippines, USA and Vietnam. Further, exotic weeds namely *Bromus secalinus* in barley imported from Morocco and USA, *Echinochloa crus-gavonis* in rice from China, Vietnam and *Polygonum cuspidatum* in wheat and barley from Morocco and Poland were intercepted.



Echinochloa crus-galli (a), *Bromus secalinus* (b) and *Polygonum cuspidatum* (c)

Major fungal interceptions include *Colletotrichum dematium* on sorghum from Argentina; *Drechslera setariae*, *Phoma* sp., *Curvularia lunata* on chilli from Taiwan; *Phoma* sp. on brinjal from Taiwan; *Pestalotia macrotricha* on maize from Mexico and *Lasiodiplodia theobromae* on maize from Thailand.



Colletotrichum dematium on sorghum seed A: Close-up view of acervulus; B: Acervulus along with setae-view

A total of 572 exotic germplasm samples of *Glycine max* (246), *Psophocarpus tetragonolobus* (8), *Vigna mungo* (8), *V. radiata* (283), *V. trilobata* (2) and *V. umbellata* (25) were being grown in post-entry quarantine greenhouses.

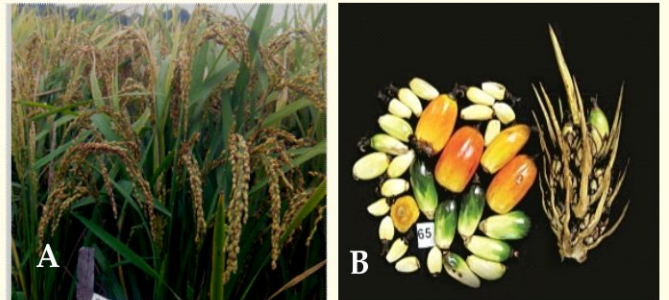
Seed health testing

Seed health status of 3,244 samples of indigenous germplasm was tested for pest free conservation in National Genebank. Out of these, 2,659 samples were healthy while 585 (insect-386; fungi-106; weeds-36; nematodes-57) samples found infected. Out of the infected samples, only 71 samples were rejected and rest of them was salvaged prior to release for gene bank storage.

GERMPLASM CONSERVATION

Germplasm registration

The XXXVII Plant Germplasm Registration Committee (PGRC) meeting was held at ICAR-NBPGR, New Delhi on October 23, 2017 under the Chairmanship of Dr AK Singh, DDG (CS) ICAR, New Delhi. In this meeting, a total of 87 proposals (59 new and 28 revised) were considered for registration. Finally, 64 (38 new and 26 revised) proposals belonging to 24 species were approved for registration. Some notable registered germplasm were: **rice** with tolerance to salinity stresses up to EC 10.0 dS/m; **wheat** with resistance to stem, leaf and stripe rusts, karnal bunt and flag smut; **barley** with extra early heading; extremely dwarf **jute** mutant; sterile *pisifera* **oil palm** with *virescens* gene; **rose-scented geranium** with high oil (0.14-0.18%) and rhodinal content (66-75%).



A. IET 24784 (IC0619227; INGR17067) – saline tolerant zinc-rich rice line. B. DOPRG-54-E65 (IC0597689; INGR17085) – sterile *pisifera* oil palm with *virescens* gene as a morphological marker

Addition of new taxon to genebank

Seeds of an unusual job's tear germplasm (ADS-17/33) collected in wild state from Nagaland was identified as *Coix lacryma jobi* var. *stenocarpa* and conserved at National genebank.

Tissue culture and cryopreservation

A total of 518 accessions (5783 cultures) of various vegetatively propagated crop species were subcultured for maintenance. A total of 50 accessions belonging to tomato (35), *Citrus limonia* (1), *Musa puspajaliae* (1), *Rubus* spp. (3), *Pyracantha crenulata* (1), *Holboellia latifolia* (1) and *Cardiocrinum giganteum* (1), seed and pollinia of two orchid species were received for tissue/ cryopreservation. Forty-two accessions belonging to tomato (35), orchid pollen (6) and *Citrus limonia* (1) were cryostored.

GERMPLASM CHARACTERIZATION/ EVALUATION

At New Delhi, 5,657 accessions of various crops comprising maize (796), millets (1,000), pulses (mungbean-1,231, urdbean-851, cowpea-371), sesame (696), vegetables (594) and medicinal and aromatic plants (118) were grown for characterization and evaluation. In addition, 101 selected maize and 84 rice accessions were grown for evaluation against drought tolerance. At RS/ BCs, 2,809 germplasm accessions were grown for characterisation/ evaluation, viz., Akola (326; barnyard millet-60, finger millet-150, okra-66 and winged bean-50), Cuttack (310; rice-260 and *Ocimum*-50), Shimla (550; peas), Bhowali (330; Rabi crops), Hyderabad (213; chilli-165, field bean-48), Thrissur (262; rice-192, yardlong bean-70) and Ranchi (818; rice-771, finger millet-29, rice bean-18).

Rice evaluation

At New Delhi, trait-specific germplasm were identified for drought tolerance and component traits: long panicle (>24 cm) – NR-6, NR-11, NR-12, RSR/SKY-47; short plant height (<70 cm) - RSR-2/JLM-2, SKSS-16; high relative water content (>0.80) – NR-3, NR-11 and NR-17; stay green ability (>0.60 NDVI) - RSR/SKY-46, NR-1 and NR-8; and high effective tillers (>12) - RSR-2/JLM-3, NR-16, KP/VT/AM-2057. Germplasm with purple leaf colour were identified (NR-5, NR-6 and NR-32).



Left: NR-16, with high effective tiller;
Right: NR-6 with purple leaf and grain

Besides, 700 accessions of rice collected from north-eastern India were characterized at BC, Ranchi in collaboration with ICAR-IIAB, Ranchi.

Evaluation at Akola

Barnyard millet germplasm (60) including five checks were evaluated. Three accessions registered tall growth, viz., IEC566 (162.4 cm),

IC338960 (113.2) and IC326757 (110.2). IEC566 also expressed superior performance for raceme length and width, and 1000 seed weight. Number of racemes was high in IC97034 (30.6) followed by IC597323 (28.9). For seed yield per plant, accessions IC338960 (33.52g) and IC340204 (32.83) recorded superior performance.

A total of 50 genotypes (with 3 checks) of winged bean germplasm were evaluated under ABD. High variability was recorded for different traits; promising accessions including a unique purple-podded line (at immature stage) were identified.



EC027886-A3: purple-podded winged bean

GENOMIC RESOURCES AND BIOINFORMATICS

DNA profiling / fingerprinting

DNA profiling/ fingerprinting activity was carried out with details as follows:

Crop	Accessions	Marker
Sorghum	51 (parents, hybrids, released varieties)	25 SSRs
Little millet	46	25 EST-SSRs
Finger millet	46 (landraces)	30 SSRs (18 genomic, 12 genic)
Sponge gourd	7	16 SSRs
Ridge gourd	6	14 SSRs
Cucumber	8	12 SSRs
Cotton	85 (registered)	SSRs
Lentil	70	SSRs
Pigeonpea	54 (released) 24 (registered)	18 SSRs 12 SSRs
<i>Mucuna</i>	20	20 SCoTs 18 CBDPs

Genomic resources

In wheat, *HKT2;1-7A* gene, implicated in salt tolerance, were analyzed and SNPs were found to be present in both coding as well as UTR regions of this gene. A total of twelve SNPs and one InDel was identified in the diverse set of wheat genotypes and sequence alignment revealed five haplotypes of *HKT2;1-7A*. Interestingly, Kharchia and an Australian highly salt tolerant line Krichauff possessed identical haplotype suggesting presence of common mechanism for salt tolerance in both the genotypes.

Based on transcript analyses of seed developmental stages of *Brassica juncea* cv. Varuna, eight molecularly different *FAD3* were identified and *FAD3-1* & *FAD3-2* appears to be critical for 18:3 (Linolenic acid) biosynthesis as their expression peaks beyond 30 DAF during which there is rapid TAG (Triacylglycerol) accumulation.

In sunflower, the SSR primer panel consisting of 15 primer pairs has been developed for varietal differentiation and was used to develop DNA profile for 48 sunflower cultivars/parental types available in the genebank. Along with the recently developed primer pairs, a total of 33 SSRs were developed for sunflower varietal identification.

Database for rice germplasm identification

A database, based on SNP and SSR markers in rice, has been developed for varietal/germplasm identification. Database incorporates information on fingerprint profile of 729 rice varieties generated with 35 SNP and 36 SSR markers. This database project was a collaborative work of ICAR-NBPGR, New Delhi, ICAR-NRCPB, New Delhi and ICAR-IASRI, New Delhi. Database will be useful in settling disputes on identity of a variety or germplasm in rice.

GSRice
Germplasm Identification System for Rice

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Rice is an important food crop which is adopted in wide range of agro-climatic regions. In India rice is grown almost all the states and it is staple food for more than two third Indian population. Keeping in view the demands breeders are releasing new varieties every year for more yield as well as resistance to different biotic and abiotic traits. In India rice breeding programme started in 1911, but during 1911-1949 only varieties based on selection were released. Only 51 high yielding rice varieties were released till 1965 but after this when semi-dwarf varieties were developed, number of varieties released every year became more. India has more than one thousand high yielding rice varieties which were released during last eighty years. Since plant variety has statutory right as intellectual property in India as well as across globe this keeping record of all the released varieties have now become a challenge. New varieties released every year needs to be DNA fingerprinted before their release. This has become a requirement of Central Varietal Release Committee (CVRC).

Keeping this background in view, a Germplasm Identification System for Rice (GIS-Rice) has been developed which contains varietal DNA Signature. Presently it has DNA fingerprint information of six hundred twenty nine rice varieties of released in last 8 decades in India. It has been developed using both microsatellite, also called SSR (Simple Sequence Repeats) and SNP (Single nucleotide polymorphism) markers. Database contains microsatellite DNA fingerprint of 629 rice varieties developed using 36 SSR markers. These thirty-six markers are well selected over twelve rice chromosome and covering both arm of each chromosome to represent genome variability in totality. A panel of 36plex SNP marker has also been used to develop fingerprint of 375 rice varieties. These two molecular marker system will help in establishing the identity of old varieties already in cultivation as well as in establishing the closeness of new varieties with respect to old varieties to be released from the CVRC. This database will be of immense use for management of rice germplasm and also for resolution of varietal dispute establishing varietal identity of the germplasm.

Collaborative Institutions

ICAR-National Bureau of Plant Genetic Resources, New Delhi-110012, INDIA | ICAR-National Research Centre on Plant Biotechnology, New Delhi-110012 | ICAR-Indian Agricultural Statistics Research Institute, New Delhi-110012

Additionally, towards maintenance of genomic resource repository and bioinformatics facility, 380 genomic resources representing 18 species were collected and subsequently stored at -80°C and -170°C conditions. For wider circulation and accessibility of PGR Portal, two mobile apps have been developed for Android and iOS platforms.

GM detection activities

A web page on 'Network of GMO Testing Laboratories (NGTL) of India' (<http://gmolabs.nbpgr.ernet.in:9090/>) has been developed under the project on Networking of LMO Detection Laboratories of India and Regional Network, sponsored by the UNEP-GEF Phase II Capacity Building Project on Biosafety and supported by the MoEF&CC, Govt. of India. This web page had dynamic information about 18 GMO detection laboratories including four National Referral Laboratories for GMO/LMO testing that would facilitate in harmonizing the GMO/LMO detection activities in the country.

SYBR Green 1 based Real-time PCR assays were validated for MON1445 (Roundup Ready) and MON88913 (Roundup Ready Flex) event detection in cotton. Visual Loop-mediated Isothermal Amplification (LAMP) assays were developed. Triplex real-time PCR, targeting simultaneously *T-nos*, *nptII* and *pat*, by using SYBR Green chemistry was developed as a screening tool for stacked GM cotton events and its efficacy was confirmed by using 10 test samples. Similarly, LAMP assays for p-ract, p-nos and t-nos were developed and its specificity was confirmed employing appropriate test samples. Molecular testing of 27 imported cotton samples and two consignments of GM *Arabidopsis* imported for research purposes were performed. Qualitative and quantitative real-time PCR experiments were conducted for two International Proficiency Testing and the results were within range of Z-score.

GERMPLASM FIELD DAY

The germplasm field day on *Vigna* crops (mungbean-1,400 acc.; urdbean-800, cowpea-371) and sesame (696) was organized at Issapur farm on 05.10.2017. More than fifty participants from various organizations, viz., ICAR, SAU, Bioversity International and AVRDC attended this event. Dr. NP Singh, Director, ICAR-IIPR, Kanpur was the chief guest of this event. Dr. Kuldeep Singh, Director had emphasized on the collaborative evaluation of germplasm for identification of trait-specific germplasm, besides

the need of pre-breeding in these crops. Discussion on collection of trait-specific germplasm and screening against biotic and abiotic stresses was also made.



Awareness on phytosanitary issues

A workshop on “Awareness programme on phytosanitary issues” was organized on 27.10.2017 at RS, Hyderabad in collaboration with ICRISAT as part of the one-week programme organized by ICRISAT during 23-27, October 2017.

Mera Gaon Mera Gaurav

RS, Bhowali had undertaken this programme in 14 villages belonging to seven village panchayats in Tarikhet block in Uttarakhand. The need for indigenous food sovereignty, creation of off-farm job opportunity and food-based approaches for community health and nutrition were addressed.

HRD ACTIVITIES

Vigilance Awareness Week was observed by HQ and all RS/BCs from 30th October to 4th November 2017 with the theme “My vision: corruption free India”. Dr. Kuldeep Singh, Director distributed prizes to the winners of various competitions held.

OUTREACH ACTIVITIES

Exhibitions/Fairs

RS, Hyderabad in collaboration with RARS, Chintapalle, Visakhapatnam district organized biodiversity fair cum grassroot level awareness programme on 06.12.2017 at Chintapalle to bring awareness to the tribal farmers regarding the need of conservation of Agrobiodiversity. Seed storage bins and literature were distributed to farmers.

Biodiversity fair cum PGR awareness workshop was organized by BC, Ranchi at Darisai in East Singhbhum district of Jharkhand on 16.12.2017 in collaboration with the KVK Darisai. Mrs. Uma Mahato, DRDA graced the occasion. The kitchen garden seed kit containing ten seasonal vegetables was distributed to tribal people.



RS, Shimla conducted training-cum-awareness programme for farmers of Berthin and Haribahna areas in collaboration with KVKs, Berthin and Mandi on 01.12.2017 and 02.12.2017 respectively.



Training workshop on strengthening capacities of enforcement agency (customs officials) for transboundary movement of LMOs was organized during 22-23, November 2017 at Integrated Check Post, Raxaul, Bihar under the UNEP-GEF capacity building project on Biosafety Phase II.

PERSONNEL NEWS

Awards and recognitions

ICAR-NBPGR has been identified as one of the National Referral Laboratories to detect the presence/ absence of LMOs and GMOs. This was published under sub-section (1) of Section 4 of the Seeds Act, 1966, in Gazette of India: Extraordinary Notification (DAC&FW, MA&FW, GoI) dated 15.10.2017.

Dr. Monika Singh has received Young Scientist Award at the 3rd International Conference on Bioresources and Stress Management held during 8-11, November 2017 at Jaipur.

Dr. Gowthami, R has received Young Scientist Award in an International Conference on Advances in Agricultural and Biodiversity Conservation for Sustainable Development organized at CCS University, Meerut during 27-28, October 2017.

Appointments/ Transfer / promotions

Dr. Veena Gupta took charge as Head (Acting), Division of Germplasm Conservation since 28.10.2017.

Mr. M Venkataramana Reddy, RS, Hyderabad was promoted to the post of Technical Asst. w.e.f 29.11.2014.

Deputation abroad:

Dr. J Aravind was deputed to IPK, Gatersleben, Germany under bilateral programme on "Indo-German Cooperation on seed sector development" for studying genetic integrity, seed longevity, and duplication of long-term conserved

germplasm from 25th September to 15th December 2017.

Dr. Pratibha Brahmi had participated in the workshop on reporting on the state of plant genetic resources in Rome, Italy from 29th November to 1st December 2017.

Dr. Sunil Archak was deputed to participate in 7th session of the governing body meeting of the ITPGRFA held at Rwanda on "The 2030 agenda for sustainable development and the role of plant genetic resources for food and agriculture" from 30th October to 3rd November 2017.

Drs. Kuldeep Singh, Anjula Pandey and Anuradha Agrawal were deputed to participate in the "Regional expert consultation on underutilized crops for food and nutritional security in Asia and Pacific" at Bangkok during 13-15, November 2017.

Dr. B Sarath Babu was deputed to work as Plant Quarantine Expert in the FAO consultancy project "Integrated programme for prevention and control of red palm weevil insect", developed and implemented in the Kingdom of Saudi Arabia from 26th December 2017 to 25th March 2018.

Retirement

Sh. LT Dabekar, STA (Driver), RS, Akola retired from his duties on 31.10.2017.

Dr. KV Bhat, Principal Scientist, HQ retired from his duties on 30.11.2017.

Sh. Benny Mathew, UDC, RS, Thrissur retired from his duties on 30.11.2017.

Smt. Vijay Laxmi Gulati, AAO retired from her duties on 31.12.2017.

Frank opinion about ICAR-NBPGR



"ICAR-NBPGR has contributed significantly towards collection and conservation of plant genetic resources across the country, which is evident from the number of explorations they have made and the quantum of collection it possesses. Towards germplasm import and export the institute has contributed significantly, which remained the backbone of crop improvement activities of India and outside. It has also played a key role in registration and effective utilization of improved genetic stocks. The gaps in evaluation and characterization of the huge collection are largely being addressed through CRP on Agro-biodiversity. NBPGR has made excellent progress in DNA fingerprinting of released cultivars. However, the crop researchers look forward to NBPGR for developing standard marker set to fingerprint unequivocally released cultivars and their parents. Further expectations of the crop researchers will be that NBPGR will develop genomic resources readily usable by the breeders. ICAR-IIMR looks forward effective collaboration with NBPGR towards maize improvement"

----- **Dr. Sujay Rakshit**, Director, ICAR-Indian Institute of Maize Research, Ludhiana

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