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Automation Needs for the National Bureau of Plant Genetic Resources New Delhi, India

Review, Plans and Recommendations

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in cooperation with the
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Table of Contents

1. Introduction..... 3

2. Materials and Methods..... 4

eds by Divisions/Remote Sites..... 5

3. Rational for Hardware and Software..... 9

4. Hardware and Software Requirements..... 13

Microcomputer Software..... 13

Microcomputer Hardware..... 13

5. Central Computer..... 14

6. Database Management System Software..... 16

7. Tape Drives, Data-entry Devices, Printers..... 17

8. Training..... 19

9. Recommendation for Existing Equipment..... 19

10. Data Standardization..... 19

11. Disk Space Allocation..... 20

12. Summary of Key Points..... 21

National Bureau of Plant Genetic Resources
Automation Review and Recommendations

Introduction

The United States Agency for International Development (USAID), USDA, in cooperation with the Agricultural Research Service, USDA, appointed me as a data processing consultant to review the existing and future activities within the Indian National Bureau for Plant Genetic Resources (NBPGR) and to prepare a plan for automating the existing manual processes. A three week program was developed to analyze and document the requirements.

The attached "Scope of Work", Appendix D, was the guideline I followed in carrying out the assignment. Dr Mark Smith, USAID, and Dr Guy Baird, Winrock International, were the coordinators of the project.

The NBPGR data processing staff consisted of three statisticians having one and a half years of data processing experience. They are currently involved in a training program to gain knowledge in the development and implementation of database management systems. Their experiencemanagement
software in the Documentation Unit.

The NBPGR consists of the headquarters located at New Delhi containing five divisions (Conservation, Evaluation, Exchange, Quarantine, and Seed Exchange) in addition to research stations

located at Shimla, Bhowali, Jodhpur, Shillong, Cuttack, Akola, Hyderabad, Trichur, and the Plant Tissue Culture Repository, New Delhi. There are numerous other related institutes that will provide research data for inclusion in the national database.

Materials and Methods

Analysis

I reviewed the existing automated systems to determine what progress had been made and if the existing hardware/software could be integrated into the proposed national system. The initial review of their installation indicated that considerable progress had been made in only 1 1/2 years of effort by the statisticians assigned the task of introducing automation tools to the NBPGR scientists. A machine room exists that includes air conditioning and an electrical power conditioner to stabilize the electrical power to the microcomputer hardware. However, the air conditioning and power conditioner is not adequate for larger minicomputers that require very stable power and cooler operating temperatures.

The machine room equipment consists of one Olympia/32 microcomputer which is an indigenous product utilizing a Xenix operating system, two IBM-PCs, one Tandy 1000 microcomputer, two Epson FX 105, 132 character printers, one Radio Shack letter quality printer and one Microline printer, and one streamer tape drive.

There are approximately 80 scientists at the NBPGR Headquarters in New Delhi. An additional 5-7 scientists at Shimla and 3-4 scientists in the other six regional stations strategically located throughout India. Additional scientists are located at nine base centers. The names of

the scientists interviewed or who submitted information for this review are listed in Appendix A.

A summary of the information provided by the scientists assigned to a division or regional station are listed below for all headquarter divisions and regional stations. Included in the summary are data processing capabilities the scientists have stated are critical to their research program.

Summary of DP Needs by Divisions/Remote Sites

Conservation Division

Personnel consists of six scientists and two technicians.

Currently 70,000 accessions stored in the genebank; 3 year estimate is 100,000; a total of 200,000 accessions will be stored in the next 5-10 years of which passport data must be stored on every accession.

Twenty descriptors will be stored for each accession that averages approximately 105 characters a record. Appendix B contains the known descriptors required for the genebank data.

Each accession may have a maximum of 10 multiple viability tests.

Request procedures to track shipment of germplasm, generate packet and shipping labels, and produce annual reports.

Want the system to ensure that temporary identifiers are assigned to germplasm that must be replenished or grown out before reaching the genebank. The temporary identifiers will permit the germplasm to be more effectively tracked.

Exchange Division

Personnel consists of six scientists.

Currently exchanges with over 100 countries; Introduces 7,000-16,000 germplasm samples annually.

Processes all introduced material and most of the indigenous material entering the national germplasm system.

Produces a Quarterly Plant Introduction Reporter and Crop Inventories on an ad hoc basis.

Quarantine Division

Nematology, Entomology, and Pathology research equally represented in the division.

Personnel consists of 17 scientists at Delhi. Station at Hyderabad has 5 additional scientists. Two additional stations are planned within next 3-4 years.

Twenty percent of information generated will be stored into the national database; all data will be kept for 10-20 years by the scientists.

Scientists screen 70,000 samples annually with approximately 25-30 descriptors for each sample. Germplasm samples are screened for the following:

1. *Insects, Mites, Nematodes*
2. *Fungi, Bacteria, Virus*
3. *Weed Damage*

Scientists want to acquire or develop a bibliography database containing country name and insects, viruses, nematodes, etc. Scientists have already developed more than 70,000 references.

Exploration Division

Personnel consists of four scientists.

Produces a semi-annual Plant Collection Reporter.

Annual entries of 6,000 samples with 40 descriptors; Anticipate approximately 18,000 entries the next three years.

Need distribution maps to be generated by the automated system;

Graphical display and statistical capabilities are desired.

Evaluation Division

Personnel consists of 16 scientists.

Approximately 54,000 accessions are evaluated annually at the headquarters and regional stations with an average of 10-15 descriptors recorded. Evaluation trials are conducted at most locations over a period of more than one season. Desire biometrical analysis and graphical display of the data, produce various Crop Catalogs and other reports.

Want to use hand-held data entry devices for recording evaluation data.

The following information describes the current status of the remote stations included in this study:

Shimla

Personnel consists of 5 scientists.

Major crops are Pulses, Minor Millets, Pseudo Cereals, Grasses, Fodder Legumes, Oil Seeds, Spices and Medicinal Plants, Beverage Plants, Root and Tuber Crops, Vegetables, Pome Plants, Nut Fruits, Soft Fruits, Ornamental Plants, and Miscellaneous.

There are approximately 12,500 accessions maintained at the site.

Desire biometrical analysis of data, graphical display, hand-held key-entry devices.

Want to produce crop catalogs and ad hoc reports.

Akola and Amravati

Personnel consists of 5 scientists.

Major crops are Soybean, Safflower, Horsegrown, Sesame, Pseudo Cereals, Niger, Linseed, and Minor Millets, Industrial Crops, Sweet Potato, Pulses, Fruits, Legumes, Fruits, Oil Seed, Fibre, and Vegetables.

Both sites collectively maintain 17,000 accessions.

Bhowali (Almora)

Personnel consists of 4 scientists.

Major crops are Cereals, Pulses, Oilseed, Forages, Horticultural, Medicinal and Aromatic Plants.

Maintains 600 accessions with an anticipated annual increase for the next few years.

The station began operating in 1986.

Cuttack (Base Center)

Personnel consists of 1 scientist.

Major crops are Cereals, Grain Legumes, Vegetables, Fruits, and Tuberous Crops.

There are 250 accessions maintained at the site.

Hyderabad (Quarantine Station)

Personnel consists of 5 scientists.

Provide quarantine clearance for paddy and mandate crops of ICRISAT.

Annually process 7,500 accessions.

Site began operation in 1986

A volume of information is captured, however, only about 20% of the data will be stored in the national database.

Jodhpur

Personnel consists of 4 scientists.

Major crops are Legumes, Oilseeds, Forages, Vegetables, Industrial Crops, and Fruits.

There are 8500 accessions maintained at the site.

Evaluation data will be stored in the national database.

Shillong

Personnel consists of 3 scientists.

Major crops are Paddy, Maize, Legumes, Chillies, Cucurbits, and Horticultural Plants.

There are 2500 accessions maintained at the site.

Trichur

Personnel consists of 3 scientists.

Major crops are Rhizomatous and Tuberous Crops, Legumes, Cereals, Vegetables, Fruits, and Spices.

There are 7000 accessions maintained at the site.

Some additional information will be generated by the Kerala Agricultural University which cooperates with the NBPGR.

In addition to the NBPGR, the crop based institutes of ICAR, Crop Coordinated Projects, Agricultural Universities and some State Departments of Agriculture maintain the working collections of different crops. It is estimated that about 1.5-2.0 lakh collections are presently held by the different organizations in India. Data from these projects may become part of the national database. (Plant Genetic Resources - An Indian Perspective, Paroda, R. S., Arora, R. K., 1986)

Rational for Hardware and Software Recommendations

The major issues that must be addressed in developing the national system include proximity of research units to each other, number of scientists at each division/remote station requiring data processing support, volume of information for entry and storage, data processing personnel available to develop and maintain the computer software and hardware, hardware capable of meeting the system requirements,

environmentally stable machine room for the central computer, and stable power for the hardware at the remote sites and divisions. Each one of these issues are critical to the overall development and future performance of the national system.

The research units are strategically located throughout India to direct research efforts on a location specific basis. The national system must provide data processing support for these locations with the capability to link up as a future on-line interactive network when the India communication satellite and fiber optic voice/data system becomes operational.

The microcomputer must have sufficient Random Access Memory (RAM) and disk space to utilize the advanced software available currently and in the near future. The microcomputers supporting the sites should have the same configuration to assure compatibility with the Central Computer Facility (CCF) hardware. An important benefit of compatible hardware is ensuring that software can be processed by all machines regardless of which machine in the network it is developed on. This permits the CCF personnel to develop and disseminate standard software. Additionally, one site can easily share procedures they develop with another site.

Statistical software such as the Statistical Analysis System (SAS) and several microcomputer database management systems are widely used today and require upwards of 2 Mb of RAM to process in an acceptable time frame or process at all. The statisticians are needing more powerful statistical software and data management software (i.e. SAS, DBMS) to meet the needs of their research community. Most scientists interviewed in the NBPGR have listed multiple crops with numerous descriptors requiring large quantities of disk space for massaging and

storing the data. The ratio of scientists to one microcomputer should not be greater than 4 to 1. Sometime in the future each scientist will want a microcomputer once they are trained in the use of computers and the various software, however, that will be a few years. This alleviates the frustration of having to wait in line to use a tool that should be there to save the scientist time. Currently, most microcomputers will have multiple users at a remote site or division requiring larger storage devices and in some instances special equipment (i.e. color monitors for graphics, plotter, special printers). Several of the sites that have small amounts of data and few scientists can probably get adequate support for graphics and special prints from the CCF.

The remote sites must have substantial training in all hardware and software components because of being isolated from the other divisions/sites and the CCF. Headquarter divisions can easily visit the CCF or get assistance from another division requiring less of an in-depth training session. However, all sites should receive thorough training on all hardware/software. Once the scientists have received training and are equipped with microcomputers then an on-site follow-up visit should be mandatory for all sites within a 2-3 month time span. This permits problems to be resolved that will only surface once the sites are fully operational. This is a very important step and should not be overlooked. Each scientist should have training in DOS, DOS Utilities, Lotus, Dbase, and MSTAT as a minimum. The training can be provided by the CCF personnel.

The CCF must have personnel knowledgeable in all hardware and software supporting the national system. Scientists in the NBPGR should contact the CCF for resolution of problems they encounter with

hardware, software, data preparation, and statistical analysis. The CCF should be the resident experts covering all data processing activities in the NBPGR. This will require extensive training in various hardware and software initially and will require continuous training in the future to keep abreast of current and future technology. The NBPGR are virtually creating a very talented staff that will support an automation technology center.

At the time this document was written, Drs Supra, Chowdhary, and Nagpal would be categorized as the data processing staff which should become a very cohesive and talented team. Each one of them should be viewed as a team member and as such should receive identical training and experience. A very important aspect to your user community is having one individual as a point of contact at the CCF for resolving all technical problems. This should be determined very soon so the CCF staff and user community can become familiar with the person and their mode of operation.

The NBPGR has an excellent staff to continue in the development of their national system. Training and experience are now needed along with some patience. Perhaps one of the best approaches to quickly increasing their knowledge would be to work with other senior DBMS specialists already experienced in designing, programming, and installing scientific databases using a DBMS. I would only recommend doing this as a team so that all personnel will learn from experienced personnel.

I believe the NBPGR has all the right ingredients necessary to develop and implement their national system if appropriate measures are adhered to early in the development cycle and continues through the implementation phase.

Hardware and Software Requirements

Microcomputer Software

Statistical analysis

1. MSTAT for headquarter divisions and remote sites
2. BMDP for headquarters (2 copies)
3. Statistical Analysis System (SAS) for headquarters (3 copies)

Lotus (spread sheet) for all divisions and remote sites

DBASE-III/PLUS or DBASE-IV if available (data management) for all divisions and remote sites

WordPerfect Ver 4.2 or Ver 5.0 if available (word processing) for all divisions and remote sites

Graphic capabilities - Slide-Write\Plus is an excellent tool for preparing graphs for publication; for all divisions and remote sites

Program Compilers for Fortran and C programming languages for the CCF

Microcomputer Hardware

Microcomputer for all sites with the following specifications:

Intel 80386, 20 Mhz. processor
2 Mb RAM expandable to 8 mb
86 mb hard disk expandable to 155 mb
1.2 mb floppy disk expandable to two drives
84 key PC/AT style keyboard
Monochrome monitor with optional color monitor
220 Watt Switch Mode Power Supply
Enhanced Graphics Adaptor (EGA)
2 serial ports
2 parallel ports
Supports DOS 3.2 or newer release
Supports cartridge tape
80387 Co-processor (Purchase separately from a different vendor if necessary)

Microcomputer Hardware (continued)

Source- Computer Point or PCL Inc., New Delhi
Est Cost- 137,500 - 160,000 Rs
Mfg- Sterling Co, India

Site specific requirements for microcomputers for all sites are listed below. The quantity of microcomputers and the special options per site is in correlation with staff size and data volume.

Evaluation Div-	3 ea. with 86 mb hard disk
	1 ea. with 155 mb hard disk and color monitor
Conservation Div-	1 ea. with 86 mb hard disk
	1 ea. with 155 mb hard disk
Quarantine Div-	3 ea. with 86 mb hard disk
	1 ea. with 155 mb hard disk and color monitor
Exchange Div-	1 ea. with 86 mb hard disk
	1 ea. with 155 Mb hard disk
Exploration-	1 ea. with 86 mb hard disk
Computer Facility -	2 ea. with 155 mb hard disk and color monitor;

Printer with letter quality and draft mode; draft mode capable of 300 cps.; Optional color kit. All divisions and remote sites require at least one printer; Computer facility should purchase the color kit for graphic display. Model EX-1000 or newer model is recommended.

Source- Computer Point or PCL Inc., New Delhi
Est Cost- 25,000 Rs
Mfg- Epson Corp, Japan

Central Computer Facility only:

Plotter, 6 pin that supports HP Graphics language or equivalent
Source- Computer Point, New Delhi
Est Cost- 25,000 Rs
Mfg- Hewelett Packard, USA

HP Laserjet Model II laser printer or equivalent
Source- Computer Point, New Delhi
Est Cost- 85,000 Rs
Mfg- Hewlett Packard, USA

Central Central Computer

The central computer must provide adequate data processing support for the next 3-5 years. The computer should have the capability to easily interface with the IASRI and ICRISAT computers because there may be data transferred between the various installations. The hardware and software cannot be too complex and difficult to manage or a small data processing staff that currently exists in the NBPGR will have serious problems with just the operational aspects of it. (i.e. operating system upgrading, disk maintenance, hardware maintenance, normal operator intervention).

The national system will probably become fully operational in 3-5 years because of the time required to standardize data, develop policies, train personnel, key-enter the backlog of data, and develop the system software. A smaller computer could easily provide the processing power required now with a scheduled replacement in 5 years. This would give the data processing staff time to mature and yet have a manageable system.

There is a price difference of $250,000 between a smaller computer capable of supporting the NBPGR over the next 3-5 years such as the Digital Equipment Corporation (DEC) Micro VAX II Model 3600 and the next size minicomputer that I think would be worth recommending such as the DEC VAX 8650. The larger machine would probably provide adequate processing power for the next 8-10 years, however, it would demand at least 2-3 more personnel to provide system programming and operator support. These would be full-time positions.

The smaller DEC VAX model or an equivalent computer would provide adequate processing power for a minimum of 3 years and would probably support the NBPGR for at least 5 years since the national system will take a few years before the volume of data records increase dramatically.

Therefore, I am recommending that a smaller computer equivalent to the DEC VAX Model 3600 be purchased. I think the recommendation would be for the much larger computer if the life of the hardware is expected to be 5-10 years. IASRI is now replacing their computer after 10 years of operation. NBPGR and USAID should carefully consider the IASRI experience and decide the overall life expectancy of the hardware since this will be a very critical and costly decision. An upgrade to existing hardware is usually considerably more expensive than if the larger equipment was purchased initially.

I am recommending the following equipment for the central computer:

32 Mb memory
2 ea. 477 Mb disk drives expandable to 2.5 gigabytes
2.5 Million Instruction Per Second or faster processor
Support 80 users
I/O throughput 3.3 Mb sec or faster
Communication must support Local Area Networks, and Ethernet

Source - Digital Equipment Corp. (DEC)
Micro VAX Model 3600
Est Cost- $125,000 - $150,000 US Dollars
Mfg.- Digital Equipment Corp, USA

Database Management System Software

A relational database management system should be selected that is machine independent, globally accepted, easily maintained by a data processing staff, has a good performance record for small and medium size databases, security measures for protecting data during hardware failure or abuse by unauthorized personnel, and has a good vendor maintenance record.

There are probably a dozen DBMS packages currently marketed today. Most of these systems have similar basic capabilities but some have additional features that can make the software more attractive. Most of these features are ease in designing the database structure, machine independence, performance, and simplicity in using the software for non-DP personnel.

I prioritized three DBMS packages that will perform very well for the NBPGR application.

(1) Source- Oracle Inc., USA
Est Cost- $125,000 (depends on the size of computer)
Mfg- USA
Excellent system but very costly!

(2) Digital Equipment Corporation RDB
Est Cost- $30,000
Mfg-Digital Equipment Corp, USA
Good system but must reside on a DEC computer.

(3) Unify DBMS
Est Cost- $30,000
Good system but must operate on a Unix operating system. Restricts the computer make and type of operating system.

Tape Drives, Data-entry Devices, Printers

Line Printer capable of 600 LPM

Source-Printronix
Est Cost-$6,000
Mfg-Printronix Inc., USA

Streamer Tape Drive- 1600 - 6250 BPI

Source-Ministreamer Model 1260
Est Cost-$8,000
Mfg-Qualstar Corp
9621 Irondale Ave
Chatsworth, California 91311 USA
Phone 818-882-5822
or
Chi Ninetrack
26055 Emery Road
Cleveland, Ohio 44128 USA Phone 216-831-2622

Portable Data-entry Devices (hand held)

The data-entry devices must have the durability to withstand dust, heat, moisture, and an impact from a 4 foot drop on a hard surface. There must be a low battery indicator and an automatic logout feature to protect against loss of data when the battery reaches a dangerously low voltage. It is preferable to have a device with a programming language that can be developed on a microcomputer and then download the program to the data-entry device for execution. The device must have the capability to download data from a microcomputer or the device is seriously limited in functionality. The interface should be a standard RS-232 which is a standard for most microcomputers including the model recommended for the NBPGR. The memory storage should have a minimum 256K. This permits collecting data for an entire day and possibly multiple days before having to transfer the data to a microcomputer.

Source-Omnidata Inc
Est Cost- $1800
Mfg-USA

Source-Panasonic
Est Cost- $1500
Mfg- Japan

Source-Epson
Est Cost-$1500
Mfg-Japan

Uninterrupted Power Supply providing minimum of 25 minutes of backup time with central computer operating under a full power load (all peripherals operating). The size must be determined after the central computer and peripherals are selected. Probably in the 15-25 KVA range.

Source-Static Power
Est Cost-$30,000-45,000
Mfg- USA

The existing air conditioning system must be upgraded if a minicomputer is selected to replace the microcomputer currently installed. The power to the air conditioning unit must also be protected by a UPS to prevent temperatures to exceed a maximum degree set by most computer manufacturers. There is no benefit in protecting the power to the machine room if the temperature is not maintained at an acceptable level.

Source- Local company in New Delhi

Training

Training must be provided to the data processing staff in all programming languages, hardware, operating systems, Database Management Systems required for the various hardware and software requisitioned by NBPGR. There should be one week of training for each new programming language or DBMS introduced to the data processing staff.

Source- Vendors getting the contract for for the central computer and DBMS

Training should also include 3-4 months working with experienced DBMS programmers such as the Database Management Unit that supports the United States Germplasm Resources Information Network. This will be on the job training which will produce the database design and some application supporting software for the NBPGR. I would recommend that all three team members be sent as a team.

Recommendation for Existing Equipment

Olympia 32 Microcomputer

Once the central minicomputer is installed, this equipment can easily be converted to a work station for key-entry of the backlog of research data, training scientists, training future data processing personnel, and perform as a backup for site and division microcomputers. Several inexpensive non-intelligent terminals can be purchased for this purpose.

IBM PCs

The IBM PCs would need memory expansion to 2 Mb and processor upgrade to the 80386 technology permitting execution of complex statistical and DBMS software.

Data Standardization

A critical element that must be present in the development of any database is to ensure that the information is recorded in a format that is easily understood by the user community. Standardization is the key to the usability of the data and must be addressed before the system can really be designed.

Crop specific committees currently being recommended by NBPGR management can provide the leadership necessary to standardize descriptors for the taxonomy, passport, genebank, evaluation, and quarantine data. These crop specific committees should serve their crop commodity groups and provide expert advice to individuals and organizations such as the NBPGR, ICAR, and others on technical matters relating to plant germplasm, its breeding, and effective utilization.

Standardization of coding schemes (i.e. 0 = poor, 9 = excellent), determining number of descriptors for each data record, and creating labels identifying the descriptor (i.e. GHABIT = Growth Habit) are data

related topics that must be thoroughly discussed and agreed upon by the scientists before the design of the overall system can proceed. This is an area that the scientists who are the subject matter specialists must provide the input and resolve any differences of opinions. All scientists should have an opportunity to critique the data standards. Once the data standards are adopted, then all scientists who wish to have their information included in the national database must adhere to that standard.

The NBPGR is encouraging scientists to use the International Board for Plant Genetic Resources (IBPGR) descriptors when the descriptors are similar in content. This will aid in establishing descriptors that will be internationally understood.

Disk Space Allocation

The following table contains an estimation of the disk space required by the system.

Anticipate 200,000 records in 5-10 years

Taxonomy- .5 Mb
Passport- 96 Mb
Genebank- 26.9 Mb
Evaluation- 40 Mb
Quarantine- 6 Mb
Other germplasm collections- 7 Mb
Work Space for sorting, report generation, system software - 300 Mb

An industry standard for databases is to not fill the database more than 60% full or efficiency of the database decreases. This requires an additional 60 Mb.

Estimated total disk space- 536.4

I would recommend increasing the total disk space to at least two 400 Mb disk drives to permit adequate disk space during heavy workloads (usually between the hours of 10:00 A.M. -2:00 P.M.) each work day.

Summary of Key Points of the Study

1. *An individual knowledgeable in computer hardware, DBMS, data communication, operating systems, application software development, and programming languages should act as the technical leader for the team. I highly recommend Dr Sapra for this position.*

2. *Standardization of data descriptors.*

3. *Keep the user community informed of automation policies and progress (e.g. Newsletter).*

4. *Make sure the user community has the opportunity to participate in the system design.*

5. *Have one individual as a contact at the CCF for the user community.*

6. *Have an environmentally stable machine room - Uninterruptable Power Supply for the computers and air conditioning, room temperature and humidity should meet manufacturer specifications, limited access to the computer room, machine room locked when personnel are not present, proper electrical grounding schemes for computer equipment.*

7. *Training for the data processing staff.*

8. *Purchase the most current hardware and software technology available.*

9. *Ensure that hardware and software to be purchased will be maintained; Be especially cautious about purchasing products that are not products of India or do not have locally available trained customer engineers (repair).*

10. *There should be a central unified database. This does not exclude site specific databases.*

11. *Microcomputers should be compatible throughout the NBPGR. The computers do not have to be the same name brand but should be able to share diskettes and easily communicate with any other computer in the NBPGR.*

12. *NBPGR should subscribe to data processing journals and magazines from India as well as abroad.*

Appendix A

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Dr Mark Smith, India

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Dr Guy Baird, India

Ms Bhatt, USA

Deputy-General Crop Sciences

Dr. R. S. Paroda

Acting Director, NBPGR

Dr. R. K. Arora

Conservation Division

Dr. P. P. Khanna, Division Head

Dr. R. K. Saxena - Oil Seed, Vegetable

Dr. S. K. Jain - Exotic, Exploration, Sorghum

Mr. Manju Upreti - Rice, Wheat, Millets, Maize

Dr. N. K. Chowdhary - Genebank Documentation

Dr. Neeta Siengh - Pulses, Fibre Crops

Dr. K. Verma - Pseudo Cereals, Amaranths, Misc. Crops

Exchange Division

Dr. B. P. Singh, Division Head - Oil Seed, Horticulture, Floraculture

Dr. Basant Kumar - Cereals, Millets

Mr. Mansur Kazim - Tuber

Dr. R. V. Singh - Pulses, Fibre, Under utilized and under exploited

Mr. Deep Chand - Medicinal and Aromatic, Sugar yielding

Mrs Pratibha Brahmi - Vegetable

Quarantine Division

Dr. V. K. Mathur - Nematology

Dr. Arjun Lal - Nematology

Dr. A. Majumdar - Pathology

Dr. P. C. Agarwal - Pathology

Dr. B. R. Verina - Entomology

Dr. B. Lal - Entomology

Exploration Division

Dr. R. K. Arora, Division Head

Mr. S. Mauria - Millet

Mr. Umesh Srivastva - Vegetable

Evaluation Division

Dr. T. A. Thomas, Division Head

Dr. B. S. Dabas - Bean, Pea, Garlic, Onion

Dr. Bhag Singh - Maize, Chickpea, Lentil

Dr. S. Mandal - Legume, Oil Seed

Dr. S. K. Pareek - Medicinal, Aromatic

Dr. P. N. Mathur - Forage, Pearl Millet, Tree Species

Evaluation Division (continued)

Dr. S. K. Mittal - Wheat, Barley

Dr. Umesh Srivastava - Vegetable, Millets, Poppy, Edible Curcubits (Also provided information on Shimla and Akola)

Dr. Vandna Bhatt - Under utilized, Under exploited crops

Dr. I. P. Singh - Sorghum

Dr. R. L. Sapra, Statistician

Dr. R. Nagpal, Statistician

Dr. M. L. Meheshweri, Chemist

Plant Tissue Culture Repository

Dr. K. P. S. Chandel, Head

Indian Agricultural Statistics Research Institute

Professor Prem Narain, Director

Dr. S. S. Pillai, Joint Director

Appendix B

List of Descriptors Pertaining to Various Records

There was not adequate time to record the descriptors for all crops. The NBPGR data processing staff will begin the process of standardizing descriptors by crop. Once descriptors for all crops have been determined, then a Data Dictionary can be completed describing every data item in the national database.

Conservation Division

Genebank Descriptors

Accession No	10	Characters
Crop Name	20	
Botanical Name	30	
Collectors ID Adl #	12	
Variety	30	
Source	15	
State name	15	
District name	15	
Village name	20	
Senders Name	20	
Group	15	
Germination %	3	
Moisture %	3	
Storage Year	4	
Storage Month	4	
Genebank location	12	
Seed count/seed wgt	3	
Next test date	6	
Year of rejuvenation	4	
Seed viability most recent test	30	

Appendix C

Literature References

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Appendix D

Scope of Work

1. *Review progress of genebank database management (GBDBM) work at NBPGR.*

2. *Assess GBDBM division and computer facilities at NBPGR and visit Indian Agricultural Statistics Research (IASRI) and National Informatics Centre (NIC).*

3. *Assess needs and develop plans for comprehensive GBDBM facility.*

4. *Develop plans to meet future GBDBM needs in evaluation - descriptors, standardization of codes, variable and fixed format, flow and organization of information and data banking storage systems and infrastructure.*

5. *Present lectures on USDA GBDBM system.*

6. *Prior to departure from India, prepare report on activities including conclusions and recommendations.*