P. ISSN: 0971-8184 II E. ISSN: 0976-1926
DOI: 10.61949/0976-1926.2023.v36i02.07

Indian Journal of Plant Genetic Resources

RESEARCH ARTICLE

NBPGR-PDS: A Precision Tool for Plant Germplasm Collecting

Ankur Tomar, Anjula Pandey, KC Bhatt*, NS Panwar and SP Ahlawat

Abstract

An explorer uses a passport datasheet to record information of collected germplasm in the field. The present paper discusses the utility of a Digital Passport Data Sheet (NBPGR-PDS) for collecting information during exploration. NBPGR-PDS is an App developed for Android users that supports Android version (4.1; API 16) to version (10.0; API 30) smartphones with offline inbuilt SQLite DB, Core Java program code in Android Studio Platform. App containing PDS is a digital book to collect large amounts of data with photographs to be stored systematically. Users can easily transfer their data in MS Excel format. The App also has the facility to operate offline and standalone to protect data at the user's end and can be freely downloaded from Google Play Store (https://play.google.com/store/apps/details?id=com.nbpgr.nbpgr_pds) for researchers, students, botanists and entrepreneurs.. It has added features like 'More Info' and 'Feedback', which the users can easily access to additional details and share queries directly to the host Institute. This paper includes details on developing the App for germplasm collectors, growers, and researchers to maintain records of collected germplasm in digital form.

Keywords: Android, SQLite DB, Germplasm, SDK, Modern tool.

ICAR-National Bureau of Plant Genetic Resources, New Delhi, India.

***Author for correspondence:**

kailash.bhatt@icar.gov.in

Received: 15/07/2022 **Revised:** 08/02/2023

Accepted: 10/02/2023

How to cite this article: Tomar, A., Pandey, A., Bhatt, K.C., Panwar, N.S., Ahlawat, S.P. (2023). NBPGR-PDS: A Precision Tool for Plant Exploration and Germplasm Collection. *Indian J. Plant Genetic Resources*. 36(2), 250-255. **DOI:** 10.61949/0976-1926.2023.v36i02.07

Introduction

The main objective of collecting is to capture available genetic diversity for *ex-situ* conservation and document the genetic diversity of the target species in a particular area. Passport data of existing collections are an important source of information since they help to establish the historical occurrence of the species in particular areas and the sampling it has been subjected to in the past. In Plant Genetic Resources science (PGR), documentation fundamentally refers to recording, organizing and analyzing information to understand the germplasm and make management decisions. Usually, while on exploration, the plant collector records information on details of many passport data of the germplasm acquisitions (domestic collections and exotic introductions). The shape of the data in hard format may be a book form containing sheets (called passport datasheets). As per Hawkes (1976), the passport data should be recorded on pre-numbered sheets. A comprehensive review of data recording in the field is also provided by Moss and Guarino (1995). However, the information on both the essential and optional fields needs to be recorded in the passport datasheet at the site of the collection (Zippel *et al.* 2010).

Documentation in most of the early plant germplasm collection missions was in the form of handwritten records before the "computer era" where passport data were

generally limited to a few records in a field notebook. Exact location and the "unique" number (passport number that identifies the collected germplasm) are supposed to be the most important item in passport data because only this unique identifier number/code of a collected population remains associated with the sample at all times. The passport data book contains various fields/parameters for gathering the observations like species name, country/state/district/village of origin, vernacular/cultivar name, date of collection, collector's number; geographical location (latitude, longitude and altitude), etc. are the major fields for recording the information.

The passport datasheet consists of the following four major parameters:

- **Taxonomic:** Genus, species, subspecies, variety name, pedigree and biological status of sample.
- **Geographical:** Latitude, longitude, altitude, country of origin, state/province and location.
- **Ecological:** Site environment, soil characteristics, temperature and vegetation type.
- **Ethnobotanical:** Local use, cultivation methods and processing of plant parts.

Management of field records in paper bounded passport data book is a cumbersome method, time-consuming and has more scope for inaccuracy (appendix I-II). During survey and germplasm collecting, the explorer is involved in activities like interaction with the farmer (to obtain information about local names, origin and use of the material), data recording, collecting and leveling of samples, taking photographs, gathering and pressing herbarium specimens, etc. NBPGR-Passport Datasheet (PDS) as an App would be the most useful tool for users to manage germplasm collecting records systematically and access them anytime in android smartphones or in app or MS Excel format. Android smartphones are popular communication tools in World Wide Web (WWW) which made possible to generate customized digital applications for the target customers/users. The development of mobile apps in PGR Informatics facilitates enhanced access to PGR information, leading to enhanced utilization. NBPGR so far has developed only two mobile apps "Genebank" and "PGR Map" first of their kind for any genebank in the world and have been developed for both android and iOS (Archak and Agrawal, 2012). The NBPGR-PDS App developed in android studio, is the official integrated development environment (IDE) for android app that can create a unified environment for building the apps for android phones, tablets, android wear, android TV, android auto, etc. Apart from this, structured code modules divide project into units of functionality that can independently be built, tested, and debug.

The present paper has been aimed with the following objective:

- To enhance the pace of recording of data during germplasm collecting along with live location data and camera functionality which will enable to increase the size of field records digitally with perfection.
- To strengthen field-based research using quality information, including identification of unique material and its recorded use for PGR management.
- To manage data digitally in an organized manner and to focus on other relevant areas to enhance their knowledge and to lead exploration activity with innovation.
- Ease of handling and minimal user input.

Materials and Methods

The app is devised by following the android studio application framework, an open source software. Android app contains build. Gradle module where dependencies are synchronized and whole android programs which are dependent on xml and Java files, called activity. Multiple activities were created for main screens as well as menu layouts. Default permissions, *"android.permission.INTERNET"* and *"android.permission.SEND_SMS"* had enabled in the Android Manifest.xml file of the application, which users need to allow these permissions for using *Feedback* options. The first author already complied one of the android applications on same platform namely 'Orchids farming' (Tomar *et al.*, 2019) that is user information given application and runs successfully. Application is freely available on Google Play Store (https://play.google.com/store/apps/details?id=com.nbpgr.nbpgr_pds) with the size is 9.4 MB after installation and will work on any device without acquiring much space. Its space-friendly approach, with the insertion of records, data accumulation capacity of app is increased automatically. "Easy to access" theme adopted in the app ensures secure reliability to users.

Inserting, updating, deleting of records are the important features of the android app devised. The architecture which describes the functionality of the app in a stepwise manner is depicted in Figure 1. Currently, the cumulative

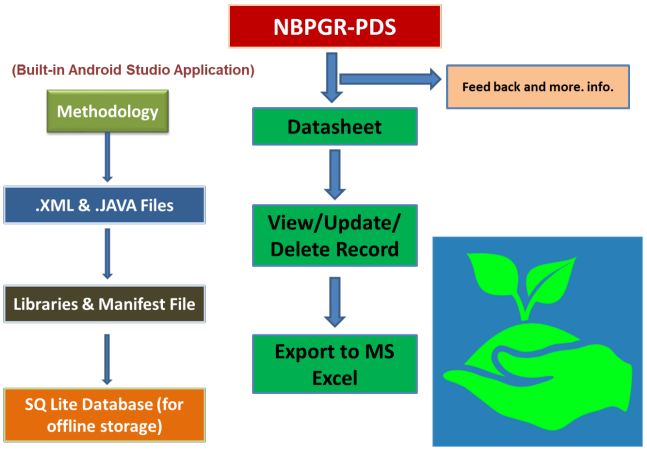

Fig.1: Architecture of app

Table 1: Technical details

Operating system	Android (Linux kernel)
Platform	Google (Android software development kit (SDK))
Programming language	Android Core Java
Software	Integrated development environment(IDE) Android Studio 4.0 version using the Android Development Tools (ADT)
Database	SQLite DB
Package manager	Android Package Kit (APK)
Version	4.1 (Jelly Bean) to 10.0 (Android 10)
Source model	Android is open source
Permission file	Manifest.xml & Build.gradle
File format	.JAVA & Extensible Markup Language (XML)
Availability	https://play.google.com/store/apps/details?id=com.nbpgr.nbpgr_pds

distribution of NBPGR-PDS is 99.8% (Figure 2) as compared to all Android devices belonging to Android version 4.1 (Jelly bean) to version 10.0 (Android 10) smartphones using offline inbuilt SQLite DB, Core Java program code in android studio platform, which generates .apk (android package kit) file for installation as per the requirement of the device. The technical details of app, which work in the integrated environment of android SDK are given in Table 1.

Application contains 20 *AutoCompleteTextView* format fields where users have option to choose or feed the information recorded in selected crop/germplasm (Table 2). There are 16 *EditText* format fields where the user must fill the column as text/number and 4 Searchable Spinner format fields to choose data from the list. The mentioned file format will help the experienced explorers and support new explorers/researchers. Moreover, these format fields will also be helpful in learning the technique of filling passport datasheets efficiently. Major advantages of the app are to get current GPS location of the collecting site with a single click on a button and choose high-definition images of a desired object like whole plant, flower, and field view from a gallery/click live image that would enhance the reliability of the app among the explorers/researchers. The inserted records in SQLite DB can be retrieved by using '*Save in Excel*' Button. This will also convert the .sqlitedb file format record into .xlsx file format and save in mobile internal storage. This is the best way to retrieve inserted information by the explorer from app to the computer system.

Results and Discussion

Devising an app for recording data in digital format has addressed many inherent problems like manual recording leading to mistakes and loss of data using paper field books.

Figure 2: Application Programming Interface (API) level chart

Table 2: Format type and major fields in app

Format type	*Fields*
ScrollView, LinearLayout, RelativeLayout	Layout design
TextView	Heading, Titles,
Button	GetDate, Submit, Get Location, Photograph, Update, Delete
EditText	Date, Collector's No., Accession No., Crop Name, Botanical Name, Crop/ Vernacular Name, Cultivar Name, Village/Block, Region Explored, Longitude, Latitude, Farmer's/ Donor's Name, Ethnic group, Address and Mobile No., Additional Info.
SearchableSpinner	Common Name (searchable-dropdown list), Botanical Name, State, District
AutoCompleteTextView	Collection Site, Biological Status, Frequency, Material, Breeding System, Sample Type, Sample Method, Habitat, Disease Symptoms, Insect infection, Cultural Practices, Season, Associated Crop, Soil Colour, Soil Texture, Topography, Agronomic Scope, Part, Kind, Informant
ImageView	View Image
ListView	List the records in a row
View	Spacing

NBPGR-PDS has almost all source code areas, which hcan be accessed freely and offline manner so that developers can further customize the app to meet specific data collection requirements.

Similarly, first author has designed and developed a similar android-based application called 'Orchidopedia' used for the identification of orchid species with their scientific details and high-quality pictures (Tomar *et al.,* 2022) and working in an offline manner for tribal orchid growers/ farmers. However, NBPGR-PDS is the first of its kind that

Figure 3: Splash screen and demo activity

Figure 4: Splash screen and demo activity

can record crop diversity data and store it systematically. This could be helpful in the planning of future collection missions. It also facilitates easy and rapid data insertion in SQLite Database with low space, can easily viewed/ downloaded using "View Record" option. Data can be exported in "Table format" using the traditional spreadsheet format with a list of entries in rows and corresponding traits in columns. Image file path also stored with individual entry in the database to identify the location. This ability to keep data organized in digital form allows explorers to focus on other tasks simultaneously. In the miscellaneous function, the right side popup menu option can redirect the user on any activity page, showing app flexibility. "How to use" option in the menu popup bar explains the app by showing a small demo to the user. 'Share' option helps users to spread the application in the fastest mode. "More Info"

Figure 5: Recorded activity

option button provides the details on source and contact information, whereas "Feedback" button allows users to interact with the developer of app through inbuilt e-mail address. The data accumulation capacity of app increased automatically with the insertion of records. NBPGR-PDS App allows users to feed information in the inbuilt database as per requirement in simple and straightforward ways hence under mentioned 6 steps for functionality is essential to follow:

1. When app starts working, splash screen will appear (Figure 3), while only demo screen will appear once to show the brief intro of app.
2. After the completion of demo session, screen containing datasheet, and inserted records, more info will be displayed on it, while the feedback option with a menu option will appear on top right corner. While clicking on the datasheet option, user can see 2 scroll view areas. In the first scroll view area, user can insert records using hide and unhide button options, whereas in the second scroll view area, user have the option to check the inserted records as well as to select the updation and deletion options (Figure 4).
3. Users can click the inserted records option to see the number of entries in stack format with the option of export in MS Excel or downloading the data in internal storage derive (Figure 5).
4. Users can easily hide/unhide data as per their need. This functionality gives vital help while accessing particular species detail.
5. 'Feedback' option: e-mail service helps explorers to communicate with in easy manner (Figure 6).
6. 'More Info' option gives details about the organisation and their developer info which will assist the user in performing the desired task smoothly.

Figure 6: Feedback activity and more info. activity

Conclusion

Earlier, the documentation of information pertaining to plant explorations in field began with the handwritten data and later using cyclostyled sheets to be filled by explorers in field. Later, improved versions contained printed passport data sheets with optional records that were developed in early 1990s and now it has taken shape of digital format as "PDS-app". The digital format of NBPGR-PDS was devised to facilitate the task of keeping digital record of passport data of collected germplasm which is fundamental to use in plant breeding and varietal development. The PDS-App was utilized to record the locality information (latitudes, longitude and altitude) without any hindrance in its functionality.

The app has been validated during the execution of national exploration programmes in different states namely Chhattisgarh, Maharashtra, Uttarakhand and Sikkim during the year 2021-22 and 2022-23 for collecting various agricultural/horticultural crops/species like minor fruits-chironji (*Buchanania lanzan*), field crops (rice, maize, wheat, vegetables) and medicinal and aromatic plants from cultivated land to deep forest areas/localities like farmers' field, wastelands, high lands, wild habitats, forest areas, etc. The outcome from the testing phase at mentioned regions are minor technical bugs/errors, altitude fetching errors and repeatedly typing of collector's no. in a predefined format. Including waypoints for generating route map in the revised version will facilitate the opportunity to revisit the already explored area and guide in planning future explorations. We enabled the voice typing technique only in the feedback section for trial because we already cleared that the application supports multi-verse smartphone devices; therefore, voice typing is not supportive to all versions of smartphones. Feedback from readers is welcomed for improvement of this app and suggestions for betterment.

After use of the app by the explorer/researchers during exploration, the following points were noted:

- Totally user-friendly, operative in smartphones, and available round the clock.
- Use in offline mode, does not require internet facility/ connectivity.
- Strong and reliable substitute for paper bounded passport data.
- Efficient in recording data in field and easily accessible from anywhere and anytime.
- Facility to accommodate large data and addition and deletion of fields.
- Operative in English language but has scope for other languages.
- Managing vast inserted records by transferring SQLite DB records to Excel format by easy click.
- Users are expected to provide feedback for its efficiency and improvement of this tool in future.

Acknowledgement

Authors are thankful to the Director, ICAR-NBPGR, New Delhi for support in developing the app and users/explorers for encouraging to devise a digital format of passport data recording. Thanks are also due to various explorers and users for providing feedback on the application.

References

Archak, S. & Agrawal, R.C. (2013). PGR informatics at the National Bureau of Plant Genetic Resources: status, challenges and future chapter 13. In: Halewood, M., Brahmi, P., Mathur, P.N. and Bansal, K.C. Editors. (2013) *A road map for implementing the multilateral system of access and benefit-sharing in India*. Bioversity International, Rome; ICAR and NBPGR, New Delhi, 107-112.

Hawkes, J.G. (1976). Manual for Field Collectors (Seed Crops). *International Board for Plant Genetic Resources*, FAO, Rome, Italy, 36.

Moss, H. & Guarino, L. (1995). Gathering and recording data in the field. In: Collecting plant genetic diversity: technical guidelines (eds. Guarino, L., Ramanatha Rao, V. and Reid, R.). CAB International, Wallingford, 367-417.

Tomar Ankur, Pamarthi, R.K., De, L.C., Rampal, Singh, R.K. & Singh, D.R. (2019). Mobile App - Android Application on "Orchid Farming" based on North Eastern States of India. *Indian J Hortic.* **76(4):** 752-756.

Tomar Ankur, R.K., Pamarthi, R.K., Rampal, De, L.C., Biswas, S.S. & Singh, D.R. (2022). Orchidopedia App -A Tool for Exploration and Collection of Orchid Species. *Indian J. Plant Genet. Resour.*, **35(1):** 73-79.

Zippel E, Wilhalm T. & Thiel-Egenter, C. (2010). Manual on vascular plant recording techniques in the field and protocols for ATBI + M sites – inventory and sampling of specimens, chapter 14. In: Eymann J, Degreef J, HäuserCh, Monje JC, Samyn Y, VandenSpiegel D (eds) Manual on field recording techniques and protocols for all taxa biodiversity inventories and monitoring, **8(2):** 346-376.

Appendix-I

ICAR-National Bureau of Plant Genetic Resources
Pusa Campus, New Delhi-110 012

PASSPORT DATA FORM

Collector's Name and Address:
Collaborating Institute: Name of Scientist (s) and Address:
Area Explored:
Duration of Exploration: From_____ To:_____

Sr. No.	Collector No.	IC No.	Crop's common name	Botanical name	Cultivar/ Landrace name	Biological status	Type of material	Collection date	Collecting site /acquisition source	Frequency
1.										
2.										

Sr. No.	Collector No.	Sample type	Sampling method	Habitat	Site of collection				Latitude (N)	Longitude (E)	Altitude (m)	Ethnobotanical information/ Ethnic group	Remarks (Trait-specific characters)
					Village	Mandal/Taluk/ Tehsil	District	State					
1.													
2.													

For allotting IC number the completed sheets should be sent along with samples (2000/4000 seeds of self/cross pollinated crops) to: The Head, Division of Plant Exploration and Germplasm Collection, ICAR- National Bureau of Plant Genetic Resources (old building), Pusa Campus, New Delhi-110 012.
E mail address: [illegible] (please also send soft copy of passport data in MS Excel through e mail), Phone: 011-2584 8405 (O)
For taking IC number to the vegetatively propagated crops/species, also furnish the certificate of conservation and maintaining in field gene bank/NARS

Useful tips

Collector number: denotes a unique/primary identity assigned by the collector at the time of collection, given in abbreviated form of collectors name followed by accession number (for example: KCR/KP/231 (expanded form is: collector number assigned in an exploration by IC Bhatt as team leader and K Pradheep as collaborator/associate; germplasm sample sequence/ serial number is 231)
Biological status: [*Wild*-All wild species that are related and part of the genepool from which genetic introgression into cultivated species is possible using conventional methods; *Weedy*-Weedy form of cultivated species occurring in companionship (fields) of some other cultivated species; *Landrace/Traditional cultivar/ Primitive cultivars/ Farmers variety*- All cultigens under cultivation in farmer's field with/ without specific names frequently associated with unique traits identified by farmers; *Breeding line*-Semi-finished products or segregating material generated out of hybridization programme to meet specific breeding objectives; *Elite line/Advanced/ Improved cultivar*- Selection from population, from coordinated trial (AVTII line), improved cultigens of common knowledge in commercial cultivation (extent, released by institution/organization/State) but not notified from the Central Sub-Committee on crop standards, Notification and Release of Varieties of Agricultural and Horticultural Crops and Parental lines of hybrids; *Released cultivar/ Hybrid*-Varieties/hybrids notified and released by the Central Sub-Committee on crop standards, Notification and Release of Varieties of Agricultural and Horticultural Crops; *Genetic stock/ Registered germplasm*- Trait and gene specific germplasm experimentally developed/identified through scientific interventions (e.g. sources of resistance, mutant, cytogenetic stock etc.) which is registered for unique trait(s) at ICAR-NBPGR; *Others*-Doubtful or material with unknown biological status]
Type of material: Seed/fruit/inflorescence/root/underground parts/cuttings/live plants
Collecting site/acquisition source: Farmer's field/ threshing yard/ fallow/ farm store/ wild/ orchard/home garden/ market/ aquatic/institute name (if others, give source name)
Frequency: Abundant/frequent/occasional/rare; **Sample type:** Population/pure line/individual; **Sampling method:** Bulk/random/non-random/individual plant
Habitat: Cultivated/disturbed/partially disturbed/rangeland/forest/aquatic habitat. Fill the latitude and longitude in decimal points (ex. 75.23) instead of degree and minutes (75° 23').
Note: Please do not merge, delete, change sequence and content of columns in table. However, append additional rows as per need (number of accessions) in above table. Submit separate datasheet for explorations conducted by different collectors or at varying period. For breeding line/genetic stock developed in institute, location of farm/institute to be filled.

Source: http://www.nbpgr.ernet.in/Downloads/cid/1012.aspx

Appendix-II

Date.....Collector's No.....Accession No.....	
Botanical Name..... Common Name (English)..... Crop/Vern.	
Name..... Cultivar name..... Region Explored.....	
Village/Block.....District.....State..... Latitude.....°N	
Longitude.....°E Altitude.....m	
Temp..... Rainfall	
COLLECTION SITE	1. Natural wild 2.Disturbed wild 3.Farmer's field 4.Threshing yard 5.Fallow 6.Farm store 7.Market 8.Garden 9.Institute 10.....
BIOLOGICAL STATUS	1.Wild 2.Weed 3.Landrace 4.Primitive cultivar 5. Breeder's line
FREQUENCY	1.Abundant 2.Frequent 3.Occassional 4.Rare
MATERIAL	1. Seeds 2.Fruits 3.Inflorescence 4.Roots 5.Tubers 6. Rhizomes 7. Suckers 8.Live plants 9.Herbarium 10.....
BREEDING SYSTEM	1.Self-pollinated 2.Cross-pollinated 3.Vegetatively propagated
SAMPLE TYPE	1.Population 2.Pure line 3.Individual plant
SAMPLE METHOD	1.Bulk 2.Random 3.Selective (non-random)
HABITAT	1. Cultivated 2.Disturbed 3.Partly disturbed 4.Rangeland 5.....
DISEASE SYMPTOMS	1.Susceptible 2.Mildly susceptible 3.Tolerant 4.Resistant 5.Immune
INSECT/ PEST/ NEMATODE INFECTION	1. Mild 2.Moderate 3. High
CULTURAL PRACTICE	1. Irrigated 2.Rainfed 3.Arid 4.Wet 5.....
SEASON	1.Kharif 2.Rabi 3.Spring-summer 4.Perennial type
ASSOCIATED FLORA	1. Sole 2.Mixed with.....
SOIL COLOUR	1. Black 2.Yellow 3.Red 4.Brown 5.....
SOIL TEXTURE	1.Sandy 2.Sandy loam 3.Loam 4.Silt loam 5.Clay 6.Silt
TOPOGRAPHY	1.Swamp 2.Flood plain 3.Level 4.Undulating 5.Hilly dissected 6.Steeply dissected 7.Mountainous 8.Valley
AGRONOMIC SCORE	1.Very poor 2. Poor 3. Average 4. Good 5. Very good
ETHNOBOTANICAL USES	
PART(S)	1. Stem 2. Leaf 3.Root 4. Fruit 5.Flower 6.Whole plant 7.Seed 8.Others
KIND	1.Food 2.Medicine 3.Fibre 4.Timber 5.Fodder 6.Fuel 7.Insecticide/ Pesticide 8.Others
HOW USED	.....
INFORMANT(S)	1.Local Vaidya 2.Housewife 3.Old folk 4.Graziers /Shepherds 5.Others
PHOTOGRAPH	1.Colour/Video
FARMER'S/ DONOR'S NAME.....ETHNIC GROUP.....Mobile No.....	
ADDRESS	
PLANT CHARACTERISTICS/ USES ADDL. NOTES	

Source: http://www.nbpgr.ernet.in/Downloads/cid/1012.aspx