



Digital platform for quality seed production data of pulses

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ABSTRACT

Quality seed is a key determinant of productivity and sustainability in pulse cultivation. Farmers frequently encounter challenges in accessing timely and accurate information on improved varieties, seed availability, and centre-wise or crop-wise production, which affects planning and adoption of quality seeds. This study aimed to develop a digital platform that enables systematic retrieval and dissemination of quality seed production data for pulses to support better decision-making across the seed value chain. The platform was conceptualised to consolidate seed production data from different seed hub centres and present it through an intuitive and searchable interface. Its structure includes three main functional modules: database design, data management, and report generation. Seed production data covering foundation, certified, and truthfully labelled classes were compiled and organised to facilitate efficient access. Users can retrieve information using flexible filters such as crop, variety, centre, and production quantity. A dashboard provides real-time summaries of total seed production, participating centres, and seed availability, allowing stakeholders including farmers, researchers, and policymakers—to quickly assess the current status of seed resources. The platform contributes to improved transparency, enhanced accessibility, and more efficient management of quality seed production data for pulses. By centralising information that was previously dispersed, it serves as a valuable decision-support tool for planning and monitoring seed-related activities. A key limitation is that the system relies on timely data updates from participating seed hub centres, which may influence the accuracy of data-driven insights. Future enhancements may include automatic data integration and mobile-based access to increase usability and scalability.

Keywords: Data-driven insights, Digital platform, Data retrieval, Pulses, Quality seed

Pulses have been an integral part of Indian agriculture as they are rich in proteins of high biological values along with essential vitamins, minerals and dietary fibres. In India, over a dozen pulses are grown with the continuous growth in production and productivity especially during 2021–22 with total production of about 27.30 million tonnes. Per capita availability of pulses has showed increasing trend during last two decades although it is still low as compared to the recommended availability of 52 g/capita/day. In most of the pulses, there is a huge gap between the potential yield and the actual yield. One of the most important reasons behind low yield in pulses is that these are generally grown in poor and marginal lands, rainfed with less inputs. Farmers of the country are still growing pulses by their home saved seeds of old varieties. Seed is a most critical input, playing a pivotal role for sustainable pulses production in the country. It is estimated that the direct contribution of quality seed alone to the total production is about 15–20% depending upon the crop and it can be further raised up to 45% with

the efficient management of other inputs (Paroda 2019). In pulses, availability of quality seed always remains a major constraint limiting production and productivity in the country (Chauhan *et al.* 2024). Singh *et al.* (2019) observed that pulses productivity can be increased substantially if the availability of right kind of seed in right time is ensured.

Considering availability of quality seed as a crucial factor in increasing the production of pulses, 150 seed hubs on pulses were created by Department of Agriculture, Cooperation and Farmers Welfare under National Food Security Mission (NFSM) to augment the availability of quality seed of pulses with targeted production of 1000 q of quality seed by each centre every year. The most critical challenges farmers encounter are timely access of quality seeds, unavailability of improved varieties, lack of information about where to get the required amount, type of seeds and weak planning and management (Singh *et al.* 2019, Saiz-Rubio and Rovira-Mas 2020). Understanding these issues led to the development of digital platform for retrieval of quality seed production data for pulses (Chenliang *et al.* 2018, Bacco *et al.* 2019, Bamanikar *et al.* 2022, Wiki *et al.* 2022, Roopashree *et al.* 2023). Digital seed information systems have been increasingly utilised to enhance transparency, traceability and decision-

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making in the seed sector. The Digitally Enabled Seed Information System (DESIS) in Nepal demonstrated the role of national digital platforms in integrating seed balance sheets, demand–supply monitoring and variety catalogues for coordinated planning. In India, the ICAR-IIWBR Seed Portal developed for wheat and barley enables farmers to access seed availability and supports efficient distribution. For hybrid crops, CIMMYT's Maize Seed Tracker provides digital monitoring of seed production, lot quality and traceability across the value chain. Additional initiatives such as SeedTrace and SATHI offer QR-based tracking and MIS reporting to strengthen seed quality assurance. While these systems highlight advancements in digital seed management, a dedicated, multi-centre digital platform for quality seed production in pulses remains limited, underscoring the need for a comprehensive and integrated solution. Digitalisation in the pulses seed system increases accessibility, efficiency and innovation while reducing the transaction cost (Sah *et al.* 2024).

A digital platform is an integrated, web-based information system that enables the collection, organisation, processing, and dissemination of data among multiple stakeholders within an agricultural ecosystem (Shresheva and Belyaev 2024). In the context of seed systems, a digital platform consolidates centre-wise, crop-wise, and variety-wise seed production information, providing a transparent and efficient mechanism for tracking seed availability, production trends, and resource planning across institutions and end-users such as farmers, researchers, and policymakers (Gupta and Subedi 2024). A digital platform for quality seed production data of pulses has been developed with the objectives to create databases about 150 pulses seed hub centres responsible for seed production and sale/distribution; and to provide variety-wise information on production and availability of quality seeds of pulses on real-time basis.

MATERIALS AND METHODS

Quality seed production is one of the vital steps of the seed multiplication process. The production of foundation and certified seeds inherently takes place from the breeder and foundation seeds, respectively. The task of quality seed production is carried out by different agencies including central government, state departments, private sector companies, cooperatives, agricultural universities and FPOs (Farmers Producer Organisations) primarily at their own farm and/or at farms of contractual farmer. The procurement of seeds from the contractual farmers is subjected to prior agreement between the concerned parties. State governments and public sector seed businesses predict seed demand for different crops at least three years ahead of time. Indents from both public and private sector organisations registered with the Department of Agriculture Cooperation (DoAC), Government of India, New Delhi, are the basis for producing breeder seed. The DoAC then compiles the indents and forwards them to the ICAR. Breeder seed is generated by several crop-based nodal institutes of ICAR (such as ICAR-IIPR, Kanpur), State Agricultural

Universities (SAUs), and National Seed Corporation (NSC) for arranging the production of breeder seeds (crop-wise, variety-wise) through various seed producing agencies (150 seed hub centres) by giving the target production of seed to be produced. Breeder seed is provided by the NARS to indenting organisations based on DoAC allocations for additional multiplication to foundation and certified seeds that are distributed to farmers.

Design, development and implementation of digital platform for retrieval of quality seed production data for pulses have been presented. The proposed system was deployed by the ICAR-Indian Institute of Pulses Research, Kanpur (20°27' N, 80°14' E, at an elevation of 152.4 m amsl), Uttar Pradesh under the project “Digitalisation of Quality Seed Production data for Pulses” during 2021–2023 using XAMP (X-operating system, Apache, MySQL and PHP) technology (Vignesh *et al.* 2020). It is an open source technology that is readily available free of cost. It is a cross-platform supported software package and has Secure Socket Layer (SSL) feature. The proposed system having three-tier architecture as described by Dahiya *et al.* (2004), Sharma *et al.* (2006), Dahiya *et al.* (2008) and Devraj *et al.* (2014). The client side interface layer has been developed using HTML, CSS and JavaScript that contains the digital platform to access the desired information for data entry and reports. The server side application layer was implemented through PHP language. The queries were implemented using this layer for data entry, updation and retrieval. The access rights are also given in this layer. Database layer contains quality seed production data of pulses for which the relational and normalised structure was used for implementation using MySQL described by Kumar *et al.* (2006), Kumar *et al.* (2013) and Horler *et al.* (2018). The modules communicate sequentially and bi-directionally:

1. Data Entry Module → Application Layer → Database
 - Validated entries are stored in respective relational tables.
2. Data Management Module ↔ Database
 - Validated entries are stored ↔ in respective relational tables.
 - Supports updating, correcting, and validating existing records.
 - SQL queries run through the application layer ensure accurate data handling.
3. Report Generation Module ↔ Application Layer ↔ Database
 - Extracts filtered information (crop-wise, variety-wise, centre-wise).
 - Generates tabular and graphical reports.
 - Aggregated data are rendered back to the client interface.

Digital platform for retrieval of quality seed production data for pulses is developed using the data entered by 150 seed hub centres for 11 pulse crops, viz. chickpea, pigeonpea, mung bean, urd bean, lentil, field pea, rajmash, lathyrus, cowpea, moth bean and horsegram grown in three seasons (*kharif*, *rabi* and spring/summer) in the country. The system

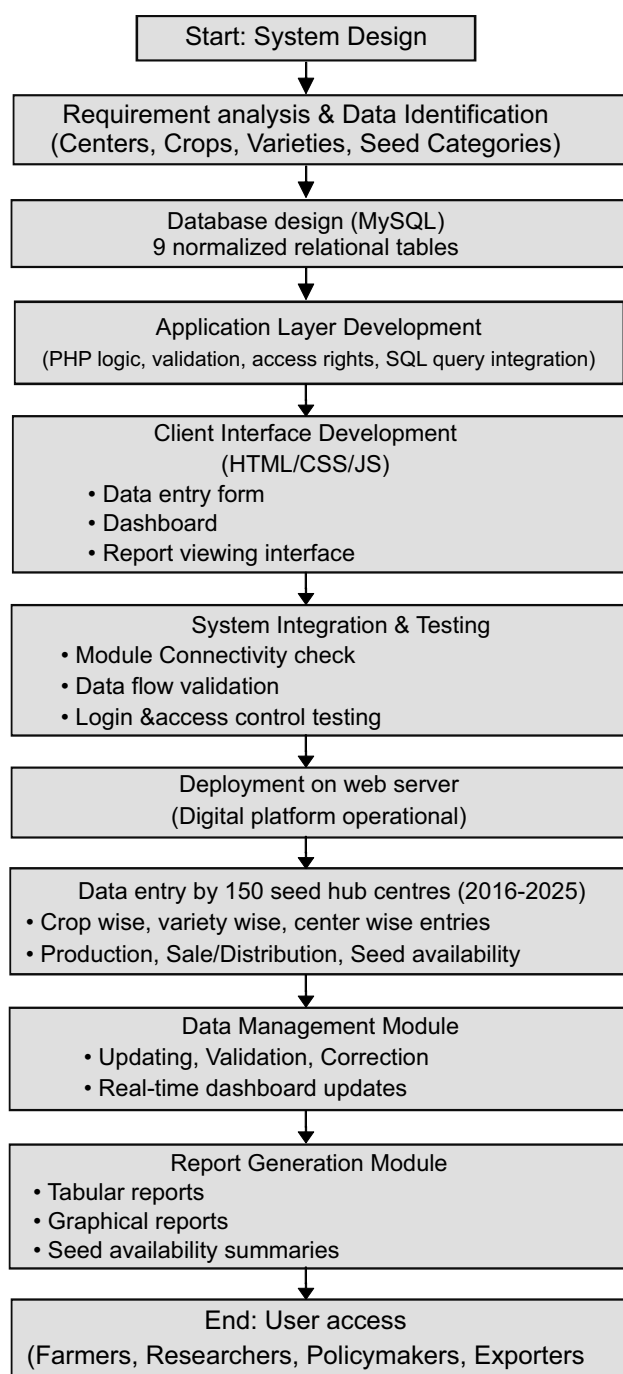


Fig. 1 Methodology flow diagram.

contains the quality seed production data of different pulse crops for three seed categories (Foundation, Certified and Truthfully leveled) grown in past 10 years (2016–2025) (Fig. 1).

Input: Input forms capture: Centre profiles, crop-wise and centre-wise seed production targets, actual production, carryover stocks, and distribution, financial details (revolving fund), and infrastructure development data.

Output reports: The platform generates centre details, target vs actual seed production reports, year-wise graphical trends, seed sale/balance reports, revolving fund and infrastructure reports, and seed availability reports.

RESULTS AND DISCUSSION

Digital platform for retrieval of quality seed production data for pulses is web-based, user-friendly and integrated system (Vignesh *et al.* 2020). Home page of proposed system provides the basic information about seed hub project (seed hub centres, map, budget, project proposal, etc.) (Fig. 2). System allows various responsibilities to different users, viz. System Administrator, Nodal Officer and Centre Incharges through their authentication rights via valid login credentials (Chandra and Collis 2021). System Administrator manages the overall system operations and having responsibilities to add, edit and delete any information in the database. Dashboard, reports and manage reports are managed by the System Administrator. Nodal Officer approves/disapproves the data entered by the Centre Incharges. They have only the exclusive right to add, edit and delete seed target data through seed target form and seed target manage form. Nodal Officer also have the right to view the different reports as per the given query and its combination. Centre Incharges are the persons who can enter information through different forms, viz. Centre detail form, Seed production form, Seed sale/distribution form, Revolving fund form and Infrastructure development form. They are the only users having rights of data entry, updation and submission of quality seed production data (year-wise, crop-wise, variety-wise) for different pulse crops related to their centre. Pratheepa *et al.* (2014) described that the users have all the rights to update and delete their own data at any time.

Creation of tables and designing forms, reports, queries and dashboard are the main features of the system. Table is an object that maintains data in records (rows) and fields (columns) similar to spreadsheets. Every table in our database focuses on one subject. The relationship between different tables is defined using primary key and foreign key implemented by Devraj *et al.* (2014). Primary key is used to identify each record uniquely in a table. The proposed system comprises total nine tables, viz. User master, Crop master, Centre master, Seed category, Seed target, Seed production, Seed distribution, Revolving fund and Infrastructure development. The database design schema of the system is presented in Fig. 3.

Form is the most convenient layout for data entry, updation and display records in the database (Mundankar and Karibasappa 2008, Ravisankar *et al.* 2009). A total of six forms, viz. Centre details form: Centre name, state name, address, seed sales license certificate, bank details, nodal officer name, designation, email, mobile no.; Seed target form: Year, crop season, crop name, state name, centre name, production target; Seed production form: Year, crop season, crop name, state name, centre name, variety name, recommended zone/state, release year, seed category, seed production; Seed sale/distribution form: Year, crop name, state name, centre name, seed category, variety name, agency name, quantity, rate, amount; Revolving fund form: Year, state name, centre name, opening balance, closing balance; Infrastructure development form: Year, state name, centre name, fund for processing plant, fund for seed storage,

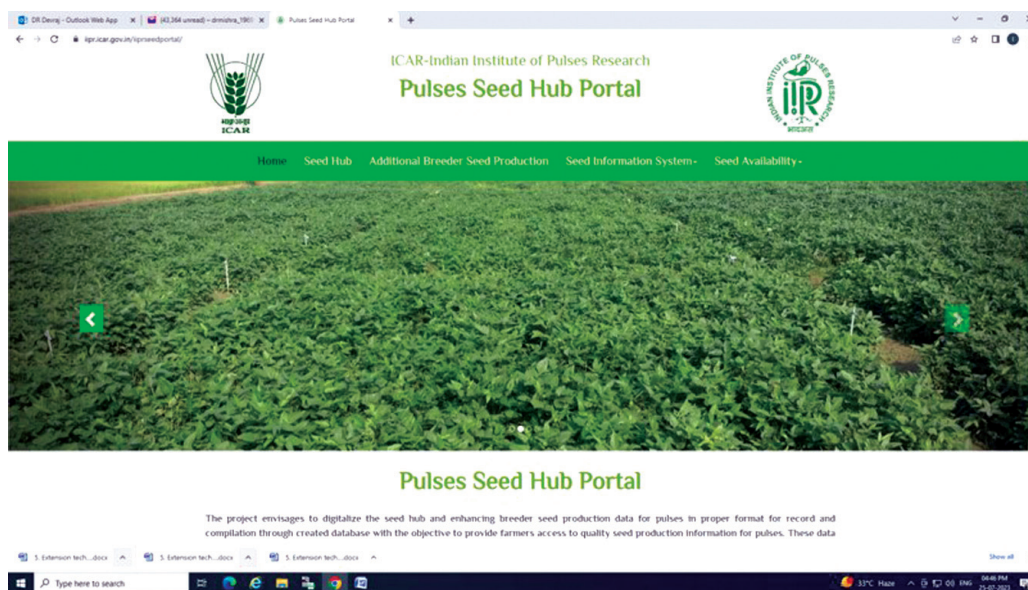


Fig. 2 Home page of seed hub portal.

Table	Action	Rows	Type	Collation	Size	Overhead
add_centre	Browse, Structure, Search, Insert, Empty, Drop	11	InnoDB	utf8mb4_general_ci	16.0 KiB	-
add_crop_name	Browse, Structure, Search, Insert, Empty, Drop	18	InnoDB	latin1_swedish_ci	16.0 KiB	-
add_crop_season	Browse, Structure, Search, Insert, Empty, Drop	3	InnoDB	latin1_swedish_ci	16.0 KiB	-
add_infrastructure_development	Browse, Structure, Search, Insert, Empty, Drop	14	InnoDB	utf8mb4_general_ci	16.0 KiB	-
add_infrastructure_development_report	Browse, Structure, Search, Insert, Edit, Drop	~0	View	---	-	-
add_seed_availability	Browse, Structure, Search, Insert, Edit, Drop	~0	View	---	-	-
add_seed_distribution	Browse, Structure, Search, Insert, Empty, Drop	238	InnoDB	utf8mb4_general_ci	64.0 KiB	-
add_seed_production	Browse, Structure, Search, Insert, Empty, Drop	183	InnoDB	utf8mb4_general_ci	48.0 KiB	-
add_seed_production_target	Browse, Structure, Search, Insert, Empty, Drop	3	InnoDB	utf8mb4_general_ci	16.0 KiB	-
add_seed_sales_balance_report	Browse, Structure, Search, Insert, Edit, Drop	~0	View	---	-	-
add_target_production_report	Browse, Structure, Search, Insert, Edit, Drop	~0	View	---	-	-
add_user	Browse, Structure, Search, Insert, Empty, Drop	14	InnoDB	utf8mb4_general_ci	16.0 KiB	-
add_variety_table	Browse, Structure, Search, Insert, Edit, Drop	~0	View	---	-	-
centre	Browse, Structure, Search, Insert, Empty, Drop	134	InnoDB	utf8mb4_general_ci	64.0 KiB	-
centreview	Browse, Structure, Search, Insert, Edit, Drop	~0	View	---	-	-
city	Browse, Structure, Search, Insert, Empty, Drop	5,924	InnoDB	latin1_swedish_ci	336.0 KiB	-
crop_name	Browse, Structure, Search, Insert, Empty, Drop	18	InnoDB	utf8mb4_general_ci	16.0 KiB	-
crop_season	Browse, Structure, Search, Insert, Empty, Drop	3	InnoDB	utf8mb4_general_ci	16.0 KiB	-
district	Browse, Structure, Search, Insert, Empty, Drop	641	InnoDB	latin1_swedish_ci	64.0 KiB	-
infrastructure_development	Browse, Structure, Search, Insert, Empty, Drop	66	InnoDB	utf8mb4_general_ci	16.0 KiB	-
infrastructure_development_report	Browse, Structure, Search, Insert, Edit, Drop	~0	View	---	-	-
revolving_fund	Browse, Structure, Search, Insert, Empty, Drop	153	InnoDB	utf8mb4_general_ci	16.0 KiB	-
revolving_fund_new_report	Browse, Structure, Search, Insert, Edit, Drop	~0	View	---	-	-
seed_availability	Browse, Structure, Search, Insert, Edit, Drop	~0	View	---	-	-
seed_category	Browse, Structure, Search, Insert, Empty, Drop	4	InnoDB	utf8mb4_general_ci	16.0 KiB	-

Fig. 3 Database design schema.

expenditure for processing plant, expenditure of seed storage, balance amount, return amount and date are designed in the proposed system. Data are entered from the forms to be saved in a designed table (Ashalatha and Rao 2023). This functionality of the system is required at centre level and done by the Centre Incharges and Nodal Officer through valid user id and password.

Report is an effective way to retrieve/search information based on user requirement to generate comprehensive/integrated information on various parameters of quality

name, year of release, actual production, carry over seed, and seed category will be displayed.

Seed sale/balance report displays the information about availability of the seed, seed category, selling agency, selling quantity and rates as per the options selected by the user: Year, crop name, variety name, state and centre name.

Revolving fund report displays the centre-wise information about the amount of opening and closing balance and details of audit utilisation certificate for the selected year.

seed production data in a printable format as described by Morris and Raykowski (1993) and Chen and Huang (2007). Data in report comes from tables or/and queries. Total six reports (Seed target/production report, seed sale/balance report, seed availability report, revolving fund report, infrastructure development report and centre details report) were generated through report generation module. Reports have been customised in tabular form which can be downloaded in text format (.csv file). These reports are used to act as decision making tool for getting the right seed of the variety at the right time. This is done by the System Administrator and Nodal Officer only. The brief descriptions of the designed reports that can be generated from the proposed digital platform are given below.

Seed target/production report generates report by selecting the desired parameters (Year, crop name, state and centre name), target production, variety

Infrastructure development report contains centre-wise details of the funds received and spent for the processing plant and seed storage alongwith their images, balance amount, etc.

Seed availability report shows variety-wise seed availability and other related information (seed quantity, rates, centre details) of current year based on the selected crop name, recommended zone/state, centre name, variety name and seed category. It is a most significant report of the system and useful for all the stakeholders (farmers, policy planners, govt. agencies, NGOs, scientists, etc.). This report is also linked on the Home page in the link buttons (Seed availability and Seed hub). All users are allowed to see this report without any user authentication.

Centre details report displays the name of centre, address, name of centre incharge, contact details, seed sale license certificate, bank account details.

Dashboard is a process of showing different kinds of visual data at one place. It provides at-a-glance visibility and availability of seeds which improve decision making, save time and resources. Dashboard of the proposed system contains real-time information on total users, total centres, total seed target, total seed production and total seed availability.

The option “Manage Reports” is also available for both the users (System Administrator and Nodal Officer). The proposed system allows to edit and delete the desired information through this option.

The results of this study showed that the national digital seed information system successfully meets the objective of creating an integrated platform for managing and retrieving quality seed production data for pulses. The unified database improves accessibility to breeder, foundation, and certified seed information and enhances transparency across stakeholders (Upadhyay 2019, Zhou *et al.* 2023). The incorporation of real-time seed sale and balance sheet modules further demonstrates the system’s capacity to support timely and coordinated decision making among seed-producing centres and farmers.

The multi-criteria search and retrieval functions significantly improve user access to precise seed information, aligning with earlier reports on the value of flexible information systems (Chrisanthi 2008, Matsenjwa *et al.* 2019, Raquel 2023). Seasonal monitoring features reinforce the platform’s relevance for long-term planning and distribution management (Zeamane 2018, Prakash 2022). The provision of real-time seed availability without login underscores the system’s user-centric and transparent design (Kenney *et al.* 2020). Collectively, these functionalities strengthen decision making in breeder seed allocation, foundation and certified seed planning, and seed production forecasting (Borrero and Mariscal 2022).

The web-based deployment (<https://icar-iipr.org.in/iiprseedportal/>) demonstrates that distributed data entry with centralised reporting is both feasible and effective. Role-based security ensures data integrity and prevents unauthorized access, confirming the platform’s reliability

for national-level use. The system’s ability to generate comprehensive reports and support diverse stakeholders including research institutions, seed agencies, government departments, cooperatives, FPOs, and policymakers, highlighting its operational and strategic value.

In conclusion, the digital platform provided a secure, scalable, and user-friendly solution for managing quality seed production data for pulses. By offering dynamic, accurate, and real-time information, the system enhanced national seed management and supports evidence-based planning across seasons. Future work will continue to refine and updation as per the user response/feedback with the addition of other food crops in the existing database. The further enhancements may include automatic data integration using AI tools/techniques and mobile-based access to increase usability and scalability in Hindi and other regional languages.

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