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CULTIVATING KNOWLEDGE IN AI ERA: ESSENTIAL DIGITAL RESOURCES AND TOOLS FOR AGRICULTURAL RESEARCHERS

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ABSTRACT

Agricultural research todayoperates within a digital knowledge environment that combines field experiments, remote sensing, genomics, socio-economic inquiry, scholarly literature, research data and collaborative networks. This article identifies the most significant digital resources available to agricultural researchers and presents them in an outline. It differentiates specialized discovery services such as CAB Abstracts, AGRICOLA, FAO AGRIS, and J-Gate Agricultural and Biological Sciences from multidisciplinary citation databases, including Google Scholar, while also elaborating on the complementary role of the One Nation One Subscription initiative. The article examines the pathways to open science through the ICAR Open Access Policy, KrishiKosh, DOAJ, Dryad, Zenodo, AgriRxiv, and bioRxiv.It further describes the effective use of reference managers, researcher identifiers, collaboration profiles, field-data applications, MOOCs, and more. Mastery of this ecosystem may shorten the time required to transform reliable information into resilient agricultural solutions. The article concludes that while artificial intelligence can enhance semantic discovery, screening, extraction, and data mining, researchers must retain control over the search process, logic, source verification, ethics, privacy, and understanding.

Key Words: Agricultural information; digital repositories; open science; research data management; scholarly communication; artificial intelligence

Agricultural research primarily represented by the field notebook, experimental plot, laboratory experiments, and communication or extension of farm activities. Those foundations remain essential, but the objects of research and the approaches used to study them have expanded. A contemporary crop experiment may combine soil and weather sensors, drone or satellite imagery, phenotyping records, molecular data, farm-management observations, market information, and computer models. The resulting science is simultaneously biological, environmental, computational, economic, and social. Reviews of smart farming show that data now influence not only production decisions but also supply chains, service models, and relationships among farmers, researchers, governments, and technology firms (Wolfert *et al.* 2017; Klerkx *et al.* 2019).

The shift has influenced the researcher's information challenges. In addition, there are still barriers to access limited resources such as language barrier, limited accessibility, partial digitisation, and uneven institutional resources, as well as paywalls.At the same time, researchers face an excess of search results, duplicate records, low-quality outlets, unreviewed claims, predatory invitations, and rapidly changing software. Information overload is not merely an inconvenience; it can reduce the quality of attention and decision-making when the volume and complexity of information exceed the user's capacity to evaluate it (Roetzel 2019). Therefore, the answer for this is not a longer list of websites. It is a deliberate information architecture in which each resource has a defined

AI IN ONLINE AGRICULTURAL RESOURCES AND TOOLS

Artificial intelligence enables the use of online agricultural resources by helping researchers to find, organise, evaluate and analyse huge volumes of scholarly literature and research data. The use of AI-based tools can enhance semantic searching, identify pertinent studies, support literature screening, extract key information, detect research trends, and aid in data mining. Databases, repositories, reference managers, field-data apps, and collaboration platforms can be optimised with the use of AI. (PIB Backgrounder, 2025).

However, AI-generated results may contain mistakes, bias, or unreliable information. Therefore, it is necessary for the researchers to obey to ethical

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standards, validate their sources, safeguard sensitive information, and take all responsibility for their research methods, findings, and conclusions.

This article discusses the platform of easy access to the worldwide academic literature for the researchers working in agriculture and allied sectors. It includes literature databases and search engines, national, international and institutional repositories, preprints, reference and identity management, field-data tools, Massive Open Online Courses (MOOCs), funding discovery services, and new artificial intelligence (AI) applications. However, artificial intelligence technologies cannot substitute a thorough professional analysis or a clear search. In addition, no single directory is comprehensive, as there is no single source that provides reliable quality information.

SEARCH ENGINES AND ESSENTIAL LITERATURE DATABASES

Specialised agricultural databases

Subject databases are the best starting point when the research question uses agricultural concepts that general search engines may interpret too broadly.

CABI: CABI is a not-for-profit organisation that improves people's lives worldwide by providing information and applying scientific expertise to solve problems in agriculture and the environment. It has an extensive repository of data encompassing agriculture, forestry, environmental studies, human health, and applied life sciences. CABI is developed as a contemporary research instrument since 1910, enables scholars, learners, and professionals to simultaneously search over 15 million entries across several renowned databases.

CAB Abstracts, produced by CABI, is a major abstracting and indexing database for agriculture and the applied life sciences.

AGRICOLA: Agricultural Online Access is the U.S. National Agricultural Library catalogue and index. It brings together 8 million citation records for books and other library materials with citations from selected peer-reviewed journals, which are particularly useful for U.S. agricultural research, government literature, historical materials, and topics connected to USDA programmes (USDA NAL 2024).

FAO AGRIS: Agricultural Information System is a free, multilingual global discovery platform curated from a network of institutions. It has 16-million bibliographical records in Agriculture and allied subjects includes journal literature as well as books, chapters, proceedings, theses, reports, working papers, and datasets., covers 120 languages.

AGROVOC: is a multilingual controlled vocabulary and linked Open Data Set, maintained by FAO of United Nations. It covers about 40K concepts and 1.3 million terms in 42 languages. Its concepts and strong representationof grey literature of global south make itvaluable for location-specific technologies, extension research, policy documents, and outputs that commercial indexes may fail to capture. (FAO 2024).

J-Gate (ABS): J-Gate Agricultural and Biological Sciences functions as an e-journal discovery gateway within many Indian institutions.J-Gate offers free access to all Open Access literature and seamless, direct links to full-text versions from 26,000+ publishers (subscription-restricted articles require institutional credentials).It is a large electronic gate-way and bibliographic database, launched in the year 2001 by Informatics India Limited. It is a discovery and indexing platform for more than 100 million scholarly journal articles in many academic disciplines. The platform gives structured metadata. It enables quick access of full citations, author profiles, and detailed abstract summaries from more than one million scholarly publications. (J-Gate–the largest e-Journal Gateway, 2025).

One Nation One Subscription (ONOS): ONOS is India's national access infrastructure for government-funded higher education and research institutions, including agricultural universities. Phase I began in 2025 with 13,000 plus journals form 30 world renowned publishers or aggregators. The unified service provides access to a large portfolio of peer-reviewed journals from participating publishers (INFLIBNET, 2025).

MULTIDISCIPLINARY DATABASES AND ADVANCED SEARCH

Web of Science and Scopus are curated multidisciplinary citation databases. They are useful for forward and backward citation searching, identifying influential authors and journals, mapping an evidence network, analysing collaboration, and exporting structured records. Their coverage and citation counts are not identical, so bibliometric statements must name the database, document type, timespan, and date searched. Google Scholar offers broader discovery, often including theses, books, repositories, conference papers, and non-English sources that are absent from curated citation indexes. Comparative research has shown that database choice can materially change publication and citation counts (Harzing and Alakangas 2016; Martín-Martín *et al.* 2018). Consequently, Google Scholar is excellent for discovery and citation chasing, but its counts should not be merged casually with Scopus or Web of Science metrics.

SEARCH STRATEGY IN DATABASES

A successful agricultural research study begins with a search of concept, population or production system; crop, species or commodity; intervention or exposure; outcome; geography; and study design. Boolean Operator search concepts are joined with **AND;** synonyms within a concept are joined with **OR**. Truncation and phrase searching should be tested, not assumed. For an agronomy question, a Web of Science topic search might be written as TS=((rice OR "Oryza sativa L.") AND ("nitrogen use efficiency" OR NUE) AND (rainfed OR irrigat*)). The equivalent Scopus search begins TITLE-ABS-KEY((rice OR "Oryza sativa L.") AND ("nitrogen use efficiency" OR NUE) AND (rainfed OR irrigat*)). In Google Scholar, the shorter query "nitrogen use efficiency" rice rainfed review may be more effective because Google Scholar has limited support for long, nested strings. Its advanced search can restrict words to titles, authors, publications, or date ranges. The use of advanced search helps save lot of time and can yield more reliable results.Finally, create alerts for stable searches, key journals, or authors.

The literature review intended to be systematic which report databases, platforms, coverage dates, complete strings, filters, search dates, deduplication methods, and screening rules. AI-assisted prioritisation may reduce screening effort, but it does not validate partial search results.

ENHANCEMENT OF QUALITY OF RESULTS THROUGH REPETITION SEARCH

Step 1: First, verify two or three retrieved key papers.

Step 2: Examine database descriptors and author keywords from those records.

Step 3: Revise the string and record every version in a search log.

Step 4: Use cited-reference and "cited by" links to move backward and forward through the evidence.

Step 5: Repeat the search process, apply filters until desired results

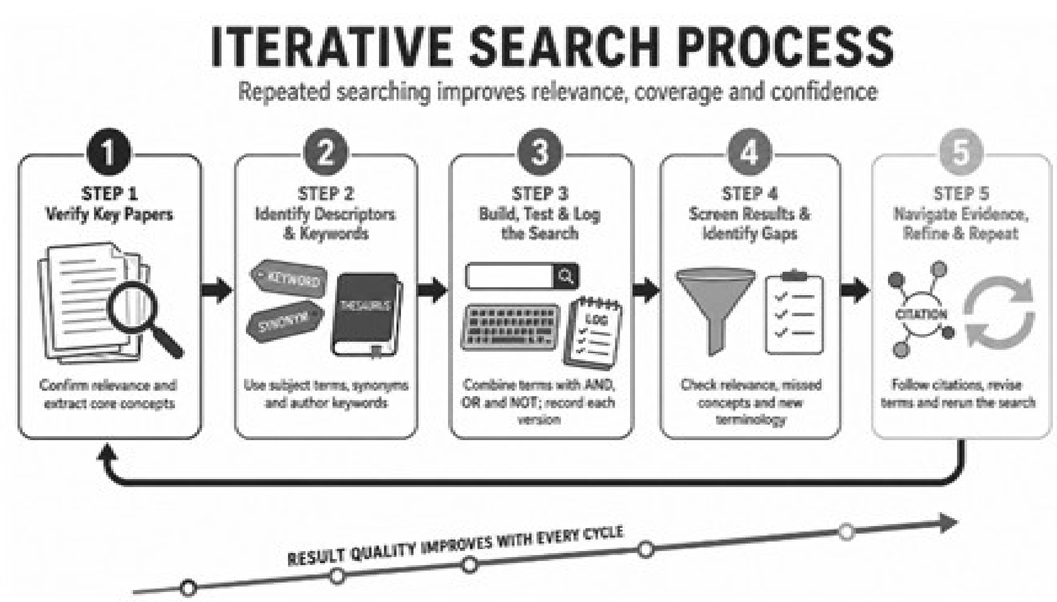

Image 1. Step by step procedure for systematic and repetitive search

OPEN ACCESS DATA REPOSITORIES AND PREPRINTS

ICAR Policy: Open science broadens accessibility beyond the final publication to include the evidence, details, code, methodologies, and preliminary results essential for comprehending and making use of research. The FAIR principles – findable, accessible, interoperable, and reusable – are not synonymous with "free to download" but rather function as a useful framework (Wilkinson *et al.* 2016). A sustainable agricultural dataset requires a permanent identification, explicit ownership and licensing, descriptive file names, machine-readable formats, a data dictionary, units of measurement, treatment and plot identities, geographical and temporal scope, methodologies, quality control annotations, and references to associated publications. Personal, genetic, geographic, agricultural, or commercially valuable data needs permission, anonymity, access limits, and legal control.

The ICAR Open Access Policy entails institutional repositories, central harvesting, and deposit of research articles and a wide range of institutional and grey literature. It also addresses accepted manuscripts, theses and dissertations, embargoes, copyright, and exclusions for patentable, commercially sensitive, or legally restricted content (ICAR 2013). The ICAR Research Data Management Policy strengthens this framework by requiring data-management planning, metadata, FAIR principles, security, backup, documentation, and central research-data stewardship. Researchers should check the current policy, publisher agreement, funder condition, and institutional procedure before deposit because the permissible version and embargo may differ from the final publisher PDF.

KrishiKosh provides a shared repository environment for NARES. It contains about 3 lakh digital items which includes agricultural theses, dissertations, rare books, institutional publications, technical bulletins, project reports, lectures, preprints, and other knowledge products from ICAR institutes and agricultural universities ((*Krishikosh*, 2025).

Its importance is both scholarly and practical. Basically, it preserves locally generated data, reduces unnecessary duplication, supports thesis discovery, and increases the visibility of work that may not enter international databases. Institutional repositories elsewhere serve the same functions for university outputs, and repository records can often be discovered through Google Scholar, BASE, OpenDOAR, or subject aggregators.

SELECTING DATA REPOSITORY

The selection of a repository should be structured and organised. The best type of repository is usually a recognised disciplinary repository that stores information about the field. The following ideal refers to a repository that is required by a funder or a school. In addition, a trusted general repository can be used when there is not a qualified home available. The USDA National Archive and Library Service (NAL),2024 indicates that the Ag Data Commons is a database that preserves information gathered via studies that were either supported by the USDA or financed in part by other agencies. Dryad, as the name implies, is a curated general-purpose data repository, providing a DOI and checking entries for usability (Dryad 2024). Datasets, programs, papers, presentations, and preprints are only some of the many research items that Zenodo, run by CERN and OpenAIRE, accepts and identifies persistently (CERN and OpenAIRE 2023). These services are complimentary, not substitutable.

The researcher should evaluate eligibility, approved file sizes and kinds, license choices, embargo support, versioning, curation, domain information, DOI assignment, cost, and connections between data and the publication before depositing. In comparison with proprietary or image-only files, open formats like CSV, TIFF, plain text, JSON, or defined geographic formats often enable reuse better. It is important to distinguish between raw data, cleaned data, code, and analysis-ready data. A README must elucidate the connection between each file and the experimental design. Data should not only be concealed in supplemental material but also acknowledged in the reference list.

DIRECTORY OF OPEN ACCESS JOURNALS (DOAJ)

DOAJ is a unique and extensive database of various scholarly open access journals from around the world, which an active community propels. DOAJ is a unique and extensive database of various scholarly open access journals from around the world. by an active community. It is committed to ensuring that all individuals have access to high-quality content online. DOAJ is a vital component of the global open access infrastructure (Maraviæ, 2005). The directory currently contains approximately 23,000 journals, with a total of 1,200 journals in the field of agricultural sciences. The global community is made up of team members, ambassadors, and volunteers who are in 45 countries and speak 36 languages. The criteria established by the DOAJ have emerged as the industry standard for open access publishing. It was initially sponsored by Lund University in Sweden. The Directory is currently managed by Infrastructure Services for Open Access (IS4OA), an independent, established Community Interest Company.

PRE-PRINTS IN AGRICULTURE

Preprints can establish a time-stamped public record, permit rapid access, invite feedback, and shorten the delay between analysis and communication. They are particularly useful for fast-moving outbreaks, emerging pests, climate shocks, and methods whose early availability can help other researchers.

AgriRxiv: agriRxiv, initiated in 2017 by Open Access India and later relaunched by CABI, serves as a complimentary, open access preprint repository for agricultural sciences. It enables researchers to disseminate their findings instantly without incurring submission costs, and it is maintained by CABI, utilising its background in agriculture and environmental science. agriRxiv does not get involved in peer review or editing; but it does moderate and index submissions to ensure their accessibility. The preprints are archived in Portico for long-term preservation and are indexed in Europe PMC, Google Scholar, and CAB Abstracts.(CABI, 2017).

bioRxiv is a free online archive for unpublished preprints in the biological sciences, initiated by Cold Spring Harbour Laboratory since 2013. It allows authors to share findings quickly and receive feedback before journal submission. Articles are not peer-reviewed but undergo basic content screening. Posting on bioRxiv does not imply endorsement of scientific quality. Authors can revise submissions before journal acceptance, and articles are citable and cannot be retracted. (Advancing the sharing of research results for the life sciences, 2013).

India Rxiv: A Preprints Repository Service for India, operated from IIHR, Bengaluru. A preprint is a draft of an article that has not yet undergone peer review or been published in a peer reviewed journal. This is a common step in scholarly research. Authors post preprints on a public server. IndiaRxiv (India Archive) preprints server is not a self-publishing platform and the preprints uploaded to the server are screened. Authors retain all rights to works posted on IndiaRxiv and license them under a Creative Commons Attribution 4.0 International Public License.(IndiaRxiv, 2022).

Preprints are essentialin life sciences research aspects.The speed advantage requirespreprint servers accelerate communication. But they do not confer any authorization for publication.

REFERENCE MANAGEMENTTOOLS

The ICT has made certain redundant tasks simple for researchers. They can save their time in using the tools in scholarly communication and writing. Popular reference management tools like Zotero, Mendeley, and EndNote are very handy for maintaining bibliographic entries, organising collections, attaching and annotating PDFs, inserting citations, and generating bibliographies. The selection depends on institutional support, preferred word processor, operating systems, team workflow, storage needs, and journal styles. **Zotero** is a powerful tool for browser capture, flexible collections, tagging, group libraries and merging duplicates. **Mendeley** is a web-based and desktop library that allows users to annotate, sync, and cite their works. The institutional licence for **EndNote** allows for extensive library management and customisation of design. The reference management tools have one official library; import directly from databases in RIS, BibTeX or a native format; keep the DOI and abstract; attach the full text; and use a tiny regulated tag vocabulary for crop, method, location, evidence type and review status.

The reference management tools allow maintaining projects or chapters by collections, whereas tags enable the maintenance of projects or chapters through collections while facilitating spanning between projects. It helps to merge duplicates. These tools help maintain the highest quality of metadata and notes. These tools make systematic notes about the study topic, design, treatments, sample, key result, limitations, and reuse choice. Although sync is convenient, a regular export and local backup help to prevent data loss.

RESEARCH IDENTITY AND COLLABORATION NETWORKS

Open Researcher and Contributor ID (ORCID): A researcher's digital identity should begin with a 16-digit ORCID, a persistent identifier designed to reduce name ambiguity and connect a person with affiliations, grants, publications, datasets, peer review, and other contributions (Haak *et al.* 2012). The ORCID should be used consistently in manuscript submission, grant applications, repositories, and institutional systems.

Indian Research Information Network System (IRINS):

IRINS is a service for managing research information in India, developed by INFLIBNET to collect, curate, and showcase institutional scholarly activity and to integrate external identifiers and citation sources (INFLIBNET 2024). Accurate affiliation names and verified identifiers improve institutional reporting and discovery.

RESEARCHGATE: This academic social networking platform supports networking, questions, project updates, and discovery among researchers, and discipline-specific mailing lists, society forums, GitHub communities, and working groups can create deeper collaboration. It fetches the author-level metrics and helps in research collaborations.

GOOGLE SCHOLAR: Creating a profile in Google Scholar provides broad citation visibility and maintain academic profile.

These networking tools need to be viewed as separate platforms. The institutional research information layer is IRINS, ORCID is the persistent identity anchor, ResearchGate is a commercial academic network, and Google Scholar is a discovery and citation profile. These networking platforms vary in terms of features and benefits, and no single platform serves as a comprehensive repository. The profiles should be updated with authorised links or author manuscripts, merged duplicates, and correct metadata rather than copyrighted full-text PDFs. These metrics support expert research assessment, rather than supplement it.

FROM FIELD DATA TO DIGITAL ITEMS

Research quality is typically enhanced right through collection of data, preceding analysing the data. Open Data Kit (ODK) supports: validation criteria, skip logic, calculations, photos, GPS, different languages, external datasets, and offline collection with synchronisation (ODK, 2024). It is mainly appropriate for farmer surveys, pest surveillance, extension monitoring and multilocation field observations. Field Book is an open-source application for Android developed for phenotypic observations on study plots that can minimise handwriting, transcription and detect errors (Rife and Poland 2014).

MASSIVE ONLINE COURSES FOR CONTINUOUS EDUCATION

Massive Open Online Courses (MOOCs) in agricultural sciences offer free scholarly and adaptable access to superior education including intelligent farming, sustainable practices, agribusiness, and extension management. MOOC courses are provided by global educational institutions, leading technology institutes, and renowned national councils.Numerous institutions, both nonprofit and for- profit, offer these courses globally through MOOC providers. (Ravi Kumar *et al.*, 2022). Some of the popular MOOCs are:

- USA: edX, Udemy and Coursera
- India: SWAYAM, NPTEL, IITs, IISc, offer free online courses.

NAARM, MANAGE offers agriculture specific courses.

AI in DISCOVERY AND DATA MINING

The use of artificial intelligence is improving the mining of agricultural data using tools such as semantic search and recommendation algorithms that can find thematically linked records and propose literature. It helps in several tasks such as picture categorisation, disease detection and yield prediction. But generative AI should be no more than a helper, and cannot be the only arbiter of activities like bibliographic invention or eligibility judgements. Representation and confidentiality are issues with AI, notably biases within literature, and privacy concerns with sensitive data. Applying AI includes leveraging institution-approved technologies, properly managing data, and guaranteeing auditable results. Future advancements are targeted towards a federated knowledge ecosystem in agriculture, integrating literature, datasets and ontologies to provide machine-readable records while maintaining visibility of data attribution.

A Practical Resource-Selection Guide

Table 1. Selection of resources for different research purposes

S.No.	Research task	Starting Points	Essential check
1.	Agricultural literature	CAB Abstracts; AGRICOLA; FAO AGRIS; J-Gate ABS, DOAJ	Coverage, vocabulary, date range, export format
2.	Citation mapping	Web of Science; Scopus	Database and search date named with every metric
3.	Broad discovery	Google Scholar; repository search, DOAJ	Verify version, source, DOI, and peer review status
4.	Full-text access in India	ONOS and institutional subscrip tions, DOAJ	Eligibility, authentication, license, Lawful use
5.	Indian agricultural outputs	KrishiKosh and NARES repositories	Metadata quality, embargo, permissible version
6.	Research data publication	Disciplinary repository; Ag. Data Commons; Dryad; Zenodo	Eligibility, license, DOI, metadata, sensitive data
7.	Identity and collaboration	ORCID; IRINS; Google Scholar; Research Gate	One identity anchor; correct affiliations and rights
8.	Field data collection	ODK; Field Book	Pilot, validation, identifiers, consent, backups
9.	Continuous learning	SWAYAM/NPTEL; FAO eLearning Academy	Match course to a documented competency
10.	Publication of Preprints of Articles, Early manuscripts	AgriRxiv, bioArxiv, India Rxiv	Coverage, archival policy, Clearly label as non-peer-reviewed; link later version

Note: Availability, scope, licence terms, and eligibility can change; verify the official service and institutional guidance before use.

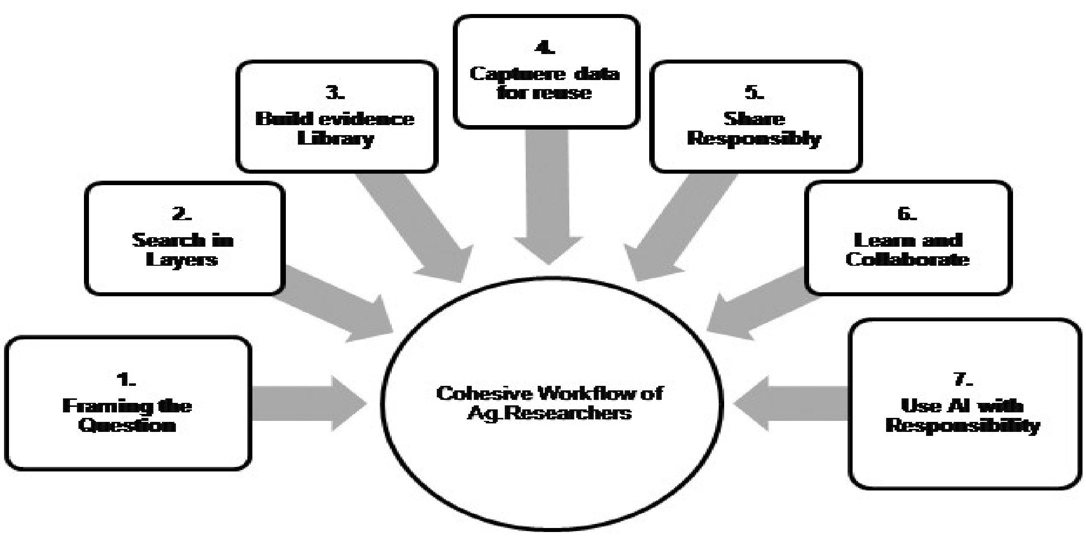

Image 2. A cohesive framework for agricultural researchers in AI era

CONCLUSION

Agricultural research in the AI era highly depends on the ability to find, evaluate, manage, and share reliable digital information. Specialized databases, citation platforms, institutional repositories, open-access resources, data repositories, reference managers, researcher identifiers, field-data applications, and online learning platforms support different stages of the research process. These resources can reduce duplication, improve research quality, encourage collaboration, and accelerate the development of practical solutions for agricultural challenges, when used efficiently. Artificial intelligence further strengthens this digital ecosystem by enabling literature discovery, document screening, information extraction, and data analysis. However, AI-generated results should be verified thoroughly beforeconsideration.

The obligation of developing search strategies, verifying sources, interpreting findings, protecting sensitive data, and adhering to legal and ethical guidelines must be maintained by researchers. Digital and AI literacy therefore, need to be integrated into the training of agricultural research. The strategic integration of responsible AI, human expertise, and trusted digital resources can facilitate the transformation of knowledge intorelevant, resilient, and sustainable innovations.

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