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OPEN RESEARCH DATA FROM FIELD STUDIES IN THE CONTEXT OF THE TRANSFORMATION OF AGRICULTURAL SCIENCE AND PRACTICE

ABSTRACT. *The modern transformation of agricultural science necessitates a shift toward open, transparent, and reproducible approaches to organizing research activities. Open research data derived from field experiments are of particular importance, serving as a vital source of information for assessing crop productivity, the efficiency of cultivation technologies, and the impact of weather conditions and agro-ecological factors.*

The aim of this study is to substantiate the role of open field research data in ensuring transparency and reproducibility, as well as in enhancing the quality of modern agricultural research.

Methods. *Experimental, field, observation, analysis.*

Results. *The study examines the fundamental principles of generating, systematizing, preserving, and disseminating experimental data obtained from field trials at the «Agronomichne» Research and Demonstration Farm of Vinnytsia National Agrarian University. Emphasis is placed on the necessity of standardized descriptions regarding experimental conditions, research methodologies, soil characteristics, weather data, technological practices, experimental treatments, and observation results. Adopting FAIR principles (Findable, Accessible, Interoperable, Reusable) facilitates the accessibility and reuse of scientific data, enables their integration with other datasets, and supports comprehensive analysis. Data openness fosters independent verification of results, boosts confidence in scientific conclusions, and creates opportunities for meta-analysis and the accumulation of an evidence base.*

Conclusions. *Establishing a culture of open research data in field studies is a crucial component of the digital transformation of agricultural science; it promotes interdisciplinary collaboration, more effective utilization of research findings, and the development of a modern, open scientific environment.*

KEYWORDS: *open research data, field research, agricultural science, reproducibility, FAIR, digitalization, Open Science.*

INTRODUCTION. The digital transformation of the agricultural sector is accompanied by significant changes in approaches to conducting, documenting, and utilizing scientific research (Pantsyreva, 2024). The application of digital technologies in farming, crop production, agroecology, and related fields enables the generation of vast datasets regarding soil conditions, plants, weather patterns, technological operations, and crop productivity (Bakhmat et al., 2023). Under these conditions, scientific data cease to be merely supplementary material for the preparation of publications and acquire independent value as a resource for further analysis, comparison, and reuse (Didur & Pantsyreva, 2025).

This is of particular importance for field research. Unlike laboratory experiments, a field trial is shaped by a multitude of interconnected factors (Didur et al., 2024). Research outcomes can depend on soil characteristics, temperature regimes, the amount and distribution of precipitation, hydrothermal conditions, the preceding crop, the specific properties of the crop variety or hybrid, the timing of agronomic operations, seeding rates, fertilization systems, and other factors (Dubik et al., 2024). Therefore, a reliable interpretation of results requires not only presenting the final metrics but also preserving the context in which those metrics were obtained.

Traditionally, field research results are primarily presented in articles, dissertations, monographs, reports, and other publications (Pantsyreva et al., 2023). While this approach ensures the dissemination of key scientific findings, a significant portion of the raw data remains unpublished (Tkachuk et al., 2024). This includes, for instance, specific measurement results, data from replicates, weather observations, site characteristics, interim measurements, details on experimental treatments, and other information essential for a comprehensive understanding of the experiment.

This issue has become particularly relevant with the rise of open science (Pantsyreva et al., 2024; Petrychenko et al., 2024). Open research data enable not only access to research findings but also the verification of their validity, re-analysis, and integration with other datasets (Petrychenko et al., 2025). For agricultural science, this is significant given the spatial and temporal variability of natural conditions, which complicates the direct transfer of results from one experiment to other locations and years.

Combining open-access field data with Earth remote sensing information, meteorological observations, digital soil maps, geographic information systems, and operational monitoring data offers considerable potential (Tkachuk et al., 2025). Such integration facilitates a shift from isolated experiments to the creation of a cumulative evidence base that can be used for meta-analyses, crop productivity modeling, and the assessment of the effectiveness of technological solutions.

The aim of this work is to substantiate the role of open field research data in ensuring transparency and reproducibility and enhancing the quality of modern agricultural research, as well as to identify key approaches to their systematization, documentation, preservation, and reuse.

METHODS. The theoretical and methodological basis of this work comprises the tenets of open science, principles of responsible research data management, and approaches to the digitalization of scientific activities. Analysis, comparison, systematization, generalization, observation, and the field method were employed to synthesize the specifics of handling data from field experiments.

The study focuses on research data generated during field experiments in the agricultural sciences. The practical context involves field research conducted at the “Agronomichne” educational and research farm of the Vinnytsia National Agrarian University.

The analysis of the field data structure took into account several interconnected groups of information. The first group includes details regarding the experiment site: geographical location, area, characteristics of the experimental plot, and soil cover features. The second group covers information on the experiment's organization: the experimental design, factors, variants, replications, plot sizes, and the layout of variants.

The third group comprises information on crop cultivation technology, specifically the preceding crop, sowing method and timing, seeding rate, fertilization system, crop care measures, and the timing of key technological operations. The fourth group includes results from phenological observations, biometric measurements, yield assessments, and other determinations stipulated by the specific experiment's program.

Meteorological data constitute a distinct component of the dataset. It is advisable to link this information not only to the calendar year of the experiment but also to specific crop development stages. This approach makes it possible to establish a link between growing season conditions and the formation of plant productivity.

The application of FAIR principles is methodologically important; these principles dictate that research data must be findable, accessible, interoperable, and reusable. For field studies, implementing these principles entails not merely making a results table publicly available, but creating a comprehensive informational description of the dataset.

RESULTS AND DISCUSSION. The analysis demonstrates that the quality of open field research data is determined not so much by the volume of data as by the completeness of the accompanying information.

Raw values for crop yield, plant mass, leaf area, or other metrics do not allow for proper reuse without information regarding the conditions and methodology under which they were obtained.

For instance, a crop yield figure can only be used for comparison if the technological and environmental context of the experiment is understood. Key factors include the crop and its specific variety or hybrid, soil conditions, the preceding crop, the fertilization system, plant density, sowing dates, weather conditions, and the data collection methodology. Therefore, an open field dataset should be viewed as a structured complex of interconnected information rather than merely a collection of isolated numerical values.

Standardizing data descriptions is a crucial aspect of improving data management. For every field trial, it is advisable to create a dataset profile specifying the study title, authors, location, research period, object and subject of study, experimental design, measurement methodologies, units of measurement, and data access conditions.

Documenting soil characteristics is of particular importance. Data regarding soil type and texture, humus content, soil solution reaction, nutrient availability, and other parameters allow for an assessment of the experiment's baseline conditions. Including this information in an open dataset enhances the comparability of results across different trials.

Documenting weather conditions is equally important. In agricultural research, simply noting the calendar year is insufficient, as the same year can feature vastly different weather conditions across different regions. Therefore, it is advisable to record temperature data, precipitation levels, and other available meteorological characteristics, while also noting the observation period and data source. In the long term, this enables the analysis of crop responses to various hydrothermal scenarios.

An important outcome of data systematization is the distinction between raw, processed, and derived data. Raw data consists of the direct results of measurements and counts. Processed data is generated following statistical or other mathematical processing. Derived data may be created through the calculation of indices, models, forecasts, or other analytical procedures. Preserving these levels separately makes it possible to trace the path from the initial observation to the scientific conclusion.

The issue of reproducibility requires special attention. In field research, reproducibility does not necessarily imply obtaining an identical numerical result when an experiment is repeated; natural variability in soil and weather conditions can lead to certain differences. Instead, open data must enable the verification of the procedure used to obtain the result, the replication of statistical analysis, the assessment of the logic behind the conclusions, and comparison with other studies.

In this context, the FAIR principles hold practical significance for agricultural science. «Findable» means that a dataset must be identifiable and searchable. «Accessible» implies the ability to obtain data in accordance with established access conditions. «Interoperable» focuses on the use of formats and descriptions that allow information to be integrated with other digital resources. «Reusable» entails the availability of sufficient documentation to ensure the data can be correctly reused.

For field research, this can be achieved by transitioning from unstructured tables to standardized datasets. For instance, specific fields might capture information such as the year, location, crop, variety or hybrid, technology variant, replication, plant growth stage, measured parameter, and unit of measurement. Such a structure facilitates subsequent statistical processing and the integration of various experiments.

At the same time, data openness does not imply the mechanical release of just any information. Before dissemination, it is essential to verify data quality, completeness, the correctness of measurement units, variable naming consistency, the presence of missing values, and methodological coherence. For each dataset, it is advisable to include a description of any limitations that might affect its interpretation.

Using open data for interdisciplinary analysis holds great promise. Field results can be combined with geospatial data, satellite monitoring information, meteorological time series, soil characteristics, and production metrics. This creates new opportunities to identify patterns that could not be established through a single experiment.

For educational and research farms, open data can also serve an educational purpose. Students gain the opportunity to work not only with pre-made charts and tables but with actual experimental datasets. This helps build competencies in statistical analysis, digital data processing, data visualization, and scientific planning.

At the same time, the effective functioning of an open research data system requires a shift in the culture of how experiments are organized. Documentation should not take place merely after the research concludes but throughout its entire lifecycle – from experimental planning to the preparation of publications and the archiving of results. This approach mitigates the risk of losing raw data and enhances the quality of subsequent data processing.

It is also advisable to establish unified internal requirements regarding the structure of field data. For research units, this could entail using standardized templates for field logs, spreadsheets, variable dictionaries, and methodological descriptions. While standardization should not stifle the specific nature of individual experiments, it must ensure basic data compatibility across different studies.

Thus, open research data should be viewed as a fundamental component of modern agricultural science infrastructure. Their significance extends beyond the requirements for open-access publishing; they form the foundation for accumulating long-term datasets, re-analysis, independent verification of results, meta-analysis, and the development of new models to support agricultural decision-making.

The creation of regional databases for field experiments holds particular promise, as it enables the accumulation of research results categorized by year, crop, variety or hybrid, technological factors, and soil-climatic conditions. For the Vinnytsia region, such datasets could serve as a basis for the long-term analysis of crop productivity and the assessment of how stable technological solutions remain under changing conditions.

CONCLUSIONS. Open research data constitute a vital component of the transformation of modern agricultural science, enabling a shift from the one-time use of individual experimental results to their accumulation, verification, and reuse. For field research, it is crucial to preserve not only the final outcomes but also the full context in which they were obtained: soil characteristics, weather conditions, experimental design, cultivation practices, measurement methodologies, and raw observational data.

Applying FAIR principles establishes a methodological framework for enhancing the accessibility, interoperability, and reusability of research data. Standardizing data structure and documentation fosters the reproducibility of scientific procedures, facilitates interdisciplinary integration, and lays the groundwork for meta-analyses.

A promising direction for agricultural science is the development of a system for the long-term preservation of field data, combined with the ability to integrate this information with geospatial, meteorological, and satellite data. Such an approach will help build an evidence base to substantiate technological solutions and increase the practical value of scientific research.

Thus, an open data culture must become an integral part of organizing modern field experiments. Its implementation enhances the transparency of scientific activity, strengthens confidence in research findings, promotes the more effective use of accumulated information, and establishes a foundation for the further development of digital and open agricultural science.

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ORCID: 0000-0002-6612-6592, e-mail: didurihor@gmail.comВІДКРИТІ ДОСЛІДНИЦЬКІ ДАНІ ПОЛЬОВИХ ДОСЛІДЖЕНЬ В УМОВАХ
ТРАНСФОРМАЦІЇ АГРАРНОЇ НАУКИ ТА ПРАКТИКИ

АНОТАЦІЯ. Сучасна трансформація аграрної науки зумовлює необхідність переходу до відкритих, прозорих та відтворюваних підходів до організації дослідницької діяльності. Особливого значення набувають відкриті дослідницькі дані, отримані в результаті польових експериментів, які є важливим джерелом інформації для оцінювання продуктивності сільськогосподарських культур, ефективності технологій вирощування, впливу погодних умов та агроекологічних факторів.

Мета роботи — обґрунтування ролі відкритих даних польових досліджень у забезпеченні прозорості, відтворюваності та підвищенні якості сучасних аграрних досліджень.

Методи. Експериментальний, польовий, спостереження, аналіз.

Результати. Розглянуто основні принципи формування, систематизації, збереження та поширення експериментальних даних, отриманих у польових дослідках в умовах НДГ «Агрономічне» Вінницького національного аграрного університету. Акцентовано увагу на необхідності стандартизованого опису умов проведення експерименту, методики досліджень, характеристик ґрунту, погодних показників, технологічних прийомів, варіантів досліду та результатів спостережень. Використання принципів FAIR (Findable, Accessible, Interoperable, Reusable) створює передумови для забезпечення доступності та повторного використання наукових даних, їх інтеграції з іншими масивами інформації та проведення комплексного аналізу. Відкритість даних сприяє незалежній перевірці отриманих результатів, підвищує довіру до наукових висновків та створює можливості для метааналізу й накопичення доказової бази.

Висновки. Запровадження культури відкритих дослідницьких даних у польових дослідженнях є важливою складовою цифрової трансформації аграрної науки та сприяє розвитку міждисциплінарної співпраці, ефективнішому використанню результатів досліджень і формуванню сучасного відкритого наукового середовища.

КЛЮЧОВІ СЛОВА: відкриті дослідницькі дані, польові дослідження, аграрна наука, відтворюваність, FAIR, цифровізація, Open Science.