BIULETYN INSTYTUTU HODOWLI I AKLIMATYZACJI ROŚLIN Nr 303/304 / 2025 : 71–72
E-ISSN: 2657–8913

Artificial Intelligence in Agricultural and Horticultural Research: Opportunities, Limitations, and Perspectives

Krystyna Rybka✉

Institute of Plant Breeding and Acclimatization – National Research Institute (IHAR-PIB)

✉ k.rybka@ihar.edu.pl

Just a few years ago, artificial intelligence (AI) seemed like a tool reserved for IT specialists, technology companies, or the Industry 4.0 sector. Today, it increasingly finds its way into the work of researchers, including those in agricultural, horticultural, and plant biotechnology institutes. AI-powered tools support data analysis, writing, literature searches, experimental design, and the creation of teaching materials. However, these tools are not oracles—they are a new, flexible, and extremely powerful component of the scientific toolkit.

Having previously shared the latest expert knowledge in the form of review articles in the Bulletin of IHAR (Rybka & Nita, 2014; Rybka, 2018; Rybka, 2023), I now offer insights and reflections on artificial intelligence to illustrate its practical applications in agricultural sciences and to consider the opportunities and risks of its implementation. I present these reflections in the form of a Letter to the Editor, based on my experience over the past one to two years, using open-access online resources. The more accessible AI tools become, the more important it is to reflect on how we use them.

There are dozens of AI-based tools available on the market, but only some prove useful in daily research work. Among the most commonly used are:

— **ChatGPT (OpenAI)** – a versatile language model useful for writing, summarizing, paraphrasing, and planning scientific texts (example prompt: “Write an introduction to an article on… our current research topic”);
— **Gemini (Google)** – integrated with Google Search and Google Docs, it facilitates content generation and information retrieval (e.g., “find the latest publications on…”);
— **QuillBot and Grammarly** – tools for improving style, paraphrasing, and language editing (e.g., “rewrite the following paragraph in a scientific tone, maintaining the meaning”). Grammarly also serves effectively as an intelligent thesaurus, suggesting better word choices in context, not just synonyms;
— **Scite.ai, Elicit, Semantic Scholar** – search engines and assistants for literature review, citation analysis, and abstract generation (e.g., “What are recent findings on …?”, “Is this article cited supportively or critically?”);
— **Clarivate / Web of Science** – a classic bibliometric platform enhanced with AI elements for citation and trend analysis (e.g., “show the most influential journals in plant physiology”);
— **Perplexity AI** – a fast assistant for source-based answers (e.g., “does red light influence plastid gene expression?”);
— **BenchSci, AlphaFold** – specialized tools for designing biological experiments (e.g., “Which antibody is best suited for detecting GLK1 protein in barley?”).

AI also supports data analysis and visualization:

— **ChatGPT / Copilot (Excel)** – generating charts and readable statistical summaries (e.g., “interpret Tukey’s test results for three light variants”);
— **R / Python + AI Notebooks (e.g., SciSpace)** – automatically generated code with explanations for PCA, ANOVA, regression (e.g., “prepare R code to perform PCA on a phenotypic data matrix”);
— **Zotero + ZoteroGPT** – AI-assisted reference management (e.g., “generate an APA-style bibliography from collected sources on…”).

These systems function on different principles. Most, like ChatGPT, rely on natural language modeling. Others, such as DeepSeek, are based on a different cognitive architecture that constructs responses at a conceptual level before verbalizing them. This approach may bring AI closer to human-like reasoning in the future. In scientific research, DeepSeek can be useful for:

— formulating conceptual hypotheses without linguistic bias (e.g., “propose a conceptual framework on how environmental stress affects plant epigenetics”);

— analyzing complex interdisciplinary phenomena (e.g., "what are the connections between climate change and in vitro plant regeneration?");
— generating definitions and conceptual frameworks (e.g., "define 'light-induced morphogenesis' in the context of cell cultures");
— drafting mental models before articulating them in natural language.

While DeepSeek is still under development and less publicly available than other systems, it offers a promising direction for future research support.

Each stage of scientific work can be supported by AI:

1) **Formulating research questions and reviewing literature** AI can help identify research gaps, generate questions, and search the literature (Elicit, Scite.ai).
2) **Designing experiments and analyzing data** AI can suggest experimental structures, highlight potential variables, and propose statistical methods (ChatGPT, BenchSci). It can also assist with result interpretation and visualization (Copilot, Python + AI).
3) **Writing and editing manuscripts** AI accelerates the writing process: it generates drafts, introductions, summaries, and abstracts (ChatGPT, Gemini), helps with paraphrasing (QuillBot), and improves language quality (Grammarly).
4) **Preparing publications and communicating science** AI can format text according to journal requirements, create outreach versions, or prepare multimedia presentations (SciSpace, Copilot, Gemini).Przygotowanie publikacji i komunikacja naukowa AI może przekształcić tekst do formatu wymaganego przez czasopismo, opracować wersję popularnonaukową lub prezentację multimedialną (SciSpace, Copilot, Gemini).

Opportunities and limitations

AI can significantly enhance research efficiency, accelerate information processing, organize text, and support data analysis. Its key strengths are accessibility, flexibility, and response speed. However, its use requires critical thinking:

— AI does not replace expert knowledge and carries no responsibility for content;
— it can generate errors (known as hallucinations);
— it requires verification of sources and facts;
— it does not replace creativity but can inspire and organize it.

Conclusion

Artificial intelligence will not solve research problems for us, but it can be an intelligent and convenient partner in scientific work. Mastering not only technical aspects but also reflective and ethical skills is crucial. Researchers must learn to ask the right questions, assess the quality of generated content, and use AI responsibly. The future of science lies not in replacing humans with machines, but in conscious cooperation—also in agriculture and horticulture.

Post scriptum

To conclude this reflection on AI, I would like to emphasize once more that when using AI we must:

— verify facts and citations ourselves;
— clearly distinguish our own intellectual contribution from AI-generated content;
— remember that AI bears no legal or ethical responsibility—the author does;
— use AI in line with transparency and good scientific practice.

Artificial intelligence should not replace the scientific thinking process. The more powerful our tools become, the greater our responsibility as users.

Radzików, June 19, 2025
The content of this letter was verified with the assistance of ChatGPT, version 4.0.

Krystyna Rybka