



Understanding AI in Agriculture: *Athena's Approach*



Narrative Review Blog

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Climate change, with its escalating temperatures and unpredictable weather, threatens global food security, particularly for vulnerable smallholder farmers. Artificial Intelligence (AI) is touted as a solution, but a clear understanding of its agricultural application is needed (WUR, n.d.; Touch et al, 2024). This study, commissioned by RCC FCDO and 3ie, and conducted by Athena Infonomics, provides a landscape review of AI in agriculture. The study defines its scope, addresses ethical concerns, and informs future investment.

To truly understand the landscape of AI in agriculture, we knew we needed to dig deep. We started with a rapid review (RR), aiming for a quick but comprehensive overview of the usage of AI in agriculture. However, there were limitations to the available evidence. To address this, we innovated by expanding our scope and conducting a narrative review (NR). This allowed us to capture crucial insights that were beyond the scope of the RR, and helped us provide a more holistic picture of AI's potential and challenges in this vital sector.

Narrative Review as an Extension to the Rapid Review



To ensure we captured the most relevant information, our RR focused specifically on studies related to AI in agriculture within low- and middle-income countries (L&MICs). We used the

SPIDER-D framework¹, a helpful checklist, to critically appraise the literature within our study, and guide our search. We looked for studies on small, subsistence, and medium-sized farms, focusing on how AI solutions impact farmers and other stakeholders (Gonzaga University, n.d.). We also included research on the ethical and governance aspects of AI in agriculture, qualitative studies, case studies, and reports from various sources. Essentially, we wanted to understand not just if AI was being used, but *how* and *what* impact it had on the people on the ground.

To complement the findings from our RR, we expanded our scope to an NR. Using relaxed exclusion criteria, this review identified 26 sources, from academic papers to news articles, which we used to inform our thematic synthesis.

Drawing Inspiration



The inspiration to conduct the thematic synthesis can primarily be credited to Dr. Ruth Garside's Qualitative Evidence Synthesis (QES) courses. Within QES, reviewers can analyse evidence in three ways (Noyes, n.d.):

- A. First order constructs are primarily quotes from participants in primary qualitative studies.
- B. Second order constructs are interpretations of the primary study researchers.
- C. Third order constructs are new synthesized findings and hypotheses developed by review authors that move beyond interpretations reported in the primary studies

As soon as we had the initial evidence base, we realized the information was too sparse for conducting third-order constructs. Based on this, we conducted a 'textual narrative synthesis' using first order and second order constructs. The analysis was solely based on the findings portion, where feasible. In blogs and articles, we added the information provided.

In the end, using relaxed exclusion criteria, we identified 26 sources ranging from peer-reviewed publications to newspaper articles. These 26 sources were clustered into four overarching themes: "equity", "inclusion and accessibility", "role of organisations", and "ethics and governance." These themes were then divided into 11 sub-themes: "demographics of farmers and users", "digital divide", "accessibility", "digital inclusion", "funders", "users", "beneficiaries", "implementors", "developers", "ethics", and "governance".

Based on our searches, we found some rich data on using AI in agriculture. Below, we present some of the key insights from our NR.

¹We used the SPIDER-D (Sample, Phenomenon of Interest, Design, Evaluation and Research Type) framework to inform the eligibility criteria of qualitative studies (opinion pieces, and editorials). SPIDER -D framework was employed as an alternative to PICO, since the former is better suited to analyse qualitative research papers

Funding is a crucial part of integrating AI solutions in agriculture



The landscape of digital agriculture is shaped by a diverse array of organisations. From funders like the IDRC, World Bank, and the Bill & Melinda Gates Foundation, to implementers like Precision Agriculture for Development (PAD) and developers like CIMMYT, each plays a vital role. Smallholder farmers and cooperatives are the primary users and beneficiaries, driving the demand for these technologies. It's crucial to acknowledge the contributions of these various stakeholders and foster collaborative efforts to ensure the sustainable and effective deployment of digital agricultural solutions. Recognizing the various funding institutions, such as USAID and the European Union, is also an important part of understanding the ecosystem (Dixit and Gill, 2024; IDRC, 2023; Zhang et al. 2024).

Equity and inclusion



When we delve into the world of digital agriculture, it is impossible to ignore the critical issue of equity. Our research consistently highlights the importance of considering demographics, particularly the role of women. Women are pivotal users of digital agricultural tools, especially for digital advisory services and market access. However, in many smallholder settings, they are often relegated to informal, post-harvest activities like street vending, leaving them more vulnerable and underrepresented in data. To truly harness the potential of smart agriculture, we must prioritize developing value chains that specifically empower rural women, alongside targeted training programmes and women-centric projects. (Couette 2024; FAO 2024; Hossain 2022; Owino 2022; Sheik 2021; Sparrow et al. 2022; Jelinek et al. 2022; UNDP 2024; Yasabu, 2019)

Digital divide casts a long shadow over the accessibility of digital agriculture. Cultural barriers, like those seen in Kenya, where traditional values hinder the adoption of computer vision software, underscore the complexities of this issue. But it's not just about culture; it is also about infrastructure. Rural areas often lack the necessary facilities, internet connectivity, and support systems. To bridge this gap, we need to focus on providing region-specific advice in local languages and addressing the fundamental limitations of accessibility. Digital literacy is also a major hurdle. Many farmers lack the technical knowledge to utilize AI-enabled solutions effectively. Simpler technologies, like mobile apps and SMS services, coupled with robust training, are crucial for fostering inclusion (Owino, 2022)

Governance is crucial for ensuring equity



As digital agriculture advances, ethical considerations and robust governance frameworks become paramount. While some regions, like Kenya and Botswana, are beginning to establish guidelines and data protection acts, there's a need for more comprehensive approaches (Owino 2022; Jelinek 2022). We must ensure that the collection and use of data are conducted responsibly and ethically. AI systems, with their potential for bias, privacy breaches, and environmental impacts, demand careful oversight. Addressing these ethical concerns—decision-making responsibility, false information, and human safety—is essential for building trust and ensuring the long-term sustainability of digital agriculture. We must move beyond simply encouraging adoption to actively governing these powerful technologies.

Conclusion



Our exploration into the use of AI in agriculture began with an RR but quickly revealed the necessity of a more nuanced approach. By transitioning to an NR, we were able to delve deeper and capture a wider range of perspectives and insights from diverse sources. This allowed us to move beyond a simple summary of findings and construct a thematic synthesis that highlighted the intricate relationships between technology, equity, and governance. The NR, inspired by qualitative evidence synthesis methodologies, proved invaluable in navigating the sparse initial evidence and in crafting a comprehensive understanding of the landscape. It allowed us to synthesize first and second-order constructs, revealing key themes such as the role of organisations, the importance of equity and inclusion, and the ethical considerations surrounding AI in agriculture.

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