

Summary of the 12th eConversation, 2nd series



Nutrient Use Efficiency Across Food Systems

Exploring systems thinking, sustainability, and digitalisation

Collaborating organisations

Hosted on the Digitalisation for Agriculture (D4Ag) dGroup, this eConversation was jointly organised by the International Fertilizer Association (IFA), FarmHack, and the Digital Agri Hub, maintained by Wageningen University & Research (WUR).

The three discussion questions were facilitated respectively by Jack Keey's (IFA), Inder Kumar (WUR) and Josien Kapma (FarmHack).

eConversation framework

Improving Nutrient Use Efficiency (NUE), particularly nitrogen use efficiency, is increasingly recognised as an essential pathway towards more sustainable and resilient agrifood systems. Better nutrient management has the potential to increase productivity while reducing environmental impacts such as greenhouse gas emissions, nutrient losses, water pollution and soil degradation. At the same time, advances in digital agriculture, traceability systems, remote sensing and artificial intelligence are creating new opportunities to measure, monitor and communicate nutrient performance throughout food systems.

This eConversation explored how digitalisation can support nutrient stewardship while ensuring that measurement frameworks remain scientifically credible, practically useful, economically viable and farmer-centred.

Questions

Q1. Where does Nutrient Use Efficiency data create the most value, and how do we avoid fragmentation, duplication or placing additional reporting burdens on farmers while still enabling transparency and rewarding improvements?

Q2. Consumers are increasingly conscious of the environmental and social impacts of their purchases, but how can the benefits of improved Nutrient Use Efficiency be communicated in a way that is simple, meaningful and trustworthy?

Q3. Nutrient Use Efficiency is measured differently across fields, farms, processing facilities and product life cycles. What does a credible, comparable and practical measurement framework require, and how can scientific rigour be balanced with usability across diverse production systems?

Starting date	Closing date	Question	Contributors
2 June 2026	22 June 2026	Question 1	7
		Question 2	6
		Question 3	3
Top contributors:	Eric Smaling (WUR) and Gupta-jee (3)	Total contributors	16

Summary of the exchanges

Nutrient Use Efficiency creates value when it supports better decisions.

Across all three discussions, there was broad agreement that the value of NUE lies not in generating more data, but in enabling better decisions across the food system. Whether supporting farmers, advisers, supply chains, processors, retailers or policymakers, nutrient information should ultimately improve productivity, profitability and environmental performance.

Experiences shared from the Netherlands illustrated both the opportunities and challenges of using farm management data to calculate NUE. Contributors also presented examples from India's Natural Farming programmes, where digital public goods, mobile advisory platforms and emerging AI- and IoT-enabled solutions are helping translate nutrient knowledge into practical recommendations for farmers.

A recurring conclusion was that digital technologies should simplify nutrient management rather than create additional reporting burdens.

Farmer-centred solutions remain essential.

Participants consistently emphasised that farmers evaluate nutrient management through practical outcomes rather than technical indicators. Questions relating to input costs, expected yields, profitability and production risks remain central to decision making, particularly for smallholders.

Several contributors stressed that digital advisory systems must therefore convert scientific information into clear, locally relevant recommendations.

Experiences from Africa, Europe and India demonstrated that while nutrient accounting frameworks may differ considerably across production systems, successful approaches are those that remain simple, actionable and economically meaningful.

The discussion also highlighted the importance of trust, local advisory services and co-design with farmers to ensure that digital innovations respond to real farming challenges.

Communication, transparency and trust are equally important.

The second discussion highlighted that while consumers increasingly seek sustainable food products, Nutrient Use Efficiency itself is unlikely to become an effective consumer-facing concept.

Participants agreed that communication should instead focus on the tangible outcomes of improved nutrient management, including healthier soils, cleaner water, lower greenhouse gas emissions, reduced pollution and improved food quality.

Digital traceability systems, QR codes and sustainability reporting were recognised as promising tools for strengthening transparency and consumer confidence. However, contributors also stressed that these systems must be supported by credible verification mechanisms and sound data governance to avoid greenwashing and maintain trust throughout the value chain.

Credible measurement requires balancing scientific rigour with practical usability.

The final discussion explored how NUE should be measured across different production systems and value chains.

Participants agreed that no single indicator is sufficient. Effective measurement frameworks should operate across multiple scales from field and farm level to processing facilities and full product life cycles while remaining sufficiently flexible to accommodate diverse farming systems.

Contributors highlighted the value of integrating plant tissue analysis alongside soil testing, arguing that nutrient uptake measurements often provide stronger links to crop performance and management decisions. They also emphasised that nutrient efficiency depends not only on measurement methods but also on a wide range of interacting factors, including soil properties, climate, crop genetics, microbial activity and farm management practices.

Emerging digital technologies, including remote sensing, plant sensors, AI-supported advisory systems and digital farm records, offer important opportunities to improve measurement accuracy and decision

support. However, widespread adoption will depend on affordability, scalability, user trust and appropriate business models, particularly for smallholder farming systems.

Digitalisation must strengthen governance as well as technology.

An overarching theme throughout the eConversation was that digital innovation alone is insufficient. Participants repeatedly highlighted issues relating to data quality, interoperability, digital sovereignty, ownership of farm data and equitable sharing of benefits generated through digital platforms.

There was broad agreement that future digital ecosystems for nutrient management should remain transparent, interoperable and farmer-centred. Effective governance arrangements will be just as important as technological innovation in ensuring that digital solutions contribute to more sustainable and resilient food systems.

Recommendations resulting from the exchanges

The discussion generated several recommendations for future work:

- Promote farmer-centred digital advisory systems that translate scientific nutrient indicators into practical management recommendations.
- Develop harmonised yet flexible NUE measurement frameworks capable of balancing scientific rigour with operational usability across different production systems.
- Strengthen transparent traceability and sustainability reporting systems supported by credible verification mechanisms.
- Encourage the integration of AI, remote sensing, plant analysis and farm management information systems into decision-support tools while respecting data sovereignty and farmer ownership.
- Support business models and public-private partnerships that make advanced nutrient advisory services accessible to smallholders.
- Foster continued collaboration among researchers, farmers, industry, policymakers and digital innovators to accelerate the adoption of sustainable nutrient management.

The eConversation demonstrated that improving Nutrient Use Efficiency is not solely a scientific or technological challenge. It is equally a question of governance, communication, farmer engagement and systems thinking. Bringing these dimensions together will be essential if digital innovation is to support more productive, resilient and sustainable agrifood systems.

