



Research summary

On-farm technologies and strategies to improve nitrogen-use efficiency

About the study

Nitrogen is an essential nutrient that helps crops and livestock grow. However, about half of the nitrogen used in the global agricultural sector—from fertilizer applied on cropland to manure collection and storage—is lost to the environment, principally as emissions from ammonia and nitrous oxide, a greenhouse gas. These emissions can present risks to the respiratory health of hens, egg farmers and their staff, and can have adverse environmental consequences.

In order to identify ways of increasing nitrogen-use efficiency (NUE) in agriculture, researchers at the University of British Columbia and the University of Waterloo completed a review in 2020. They identified and compared NUE technologies and management strategies for application along crop-livestock supply chains, with a focus on the egg sector. A second study compared the relative efficacy of some of the most promising NUE strategies for egg production supply chains.

Methods

The research team conducted a review of reports published between 2009 and 2019 to evaluate different technologies and strategies that mitigate nitrogen emissions. Studies were classified by supply chain activity: feed crop production, feed formulation and manure management.

The assessment was based on a combination of environmental, technical and economic criteria. To be considered an acceptable mitigation option for egg supply chains, the NUE technology or strategy must have a positive net reduction in emissions, be inexpensive or moderate in cost, and rank as easy or moderate in difficulty for farmers to implement, operate and maintain.

Additionally, the researchers developed a series of life-cycle inventory models, which capture inputs and outputs of resources and emissions on-farm, to help evaluate and compare the top identified mitigation technologies and management strategies with respect to NUE and other environmental impact indicators.

Findings

The researchers identified and compared several mitigation options. Recommended strategies for reducing nitrogen emissions during the feed crop production and feed formulation stages include adding biochar to cropland for soil enrichment (biochar is a charcoal-like substance produced using a specific burning process to reduce contamination and safely store carbon); reducing nitrogen excretion by feeding laying hens lower crude protein diets supplemented with synthetic amino acids or enzymes; and implementing the 4R Nutrient Stewardship principles. Designed by Fertilizer Canada, the “4Rs” stand for the Right Source @ Right Rate, Right Time, Right Place®.

Promising strategies were identified for manure management, including implementing appropriately-sized mechanical ventilation and bedded systems in poultry housing systems while also using manure belts or scrapers and ammonia scrubbers; covering and adding biochar to manure storage; and integrating manure as a fertilizer for crop production as opposed to surface application.

The NUE technologies and strategies were then compared using a life-cycle assessment to identify potential consequences, benefits and trade-offs. For example, while nitrogen excretion can be reduced by adjusting feed formulation, it is essential to consider the impacts of growing and producing that feed to ensure there is a net positive outcome.

Similarly, while acid scrubbers may improve NUE, reduce harmful emissions from manure and reduce the need to produce nitrogen fertilizers, they are energy-intensive. However, integrating renewable energy generation on-farm alongside acid scrubbers could produce a win-win situation with respect to NUE and environmental impact reduction while also providing an additional economic product—nitrogen fertilizer—from the farm.

Conclusions

These assessments can help farmers better understand mitigation options to reduce nitrogen emissions at key stages of the egg production supply chain. By considering opportunities to optimize feed crop

production, feed formulation and manure management, egg farmers may reduce harmful emissions. This research can also inform efforts to increase the environmental sustainability of egg production, enhance hen productivity and improve air quality on the farm.

Additional research and life-cycle assessments will help identify further opportunities and system-level interactions to ensure that recommended strategies do not create trade-offs with respect to other important sustainability goals for Canadian egg farmers.

About the researchers

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Citations

Shiva Zargar Ershadi, Goretty Dias, Mohammad Davoud Heidari, and Nathan Pelletier (2020). *Improving nitrogen use efficiency in crop-livestock systems: A review of mitigation technologies and management strategies, and their potential applicability for egg supply chains*. *Journal of Cleaner Production* (2020), Vol. 265.

Shiva Zargar Ershadi, Mohammad Davoud Heidari, Baishali Dutta, Goretty Dias, and Nathan Pelletier (2021). *Comparative life cycle assessment of technologies and strategies to improve nitrogen use efficiency in egg supply chains*. *Resources, Conservation and Recycling* (2021), Vol. 166.



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