



Sustainability in the Egg Industry

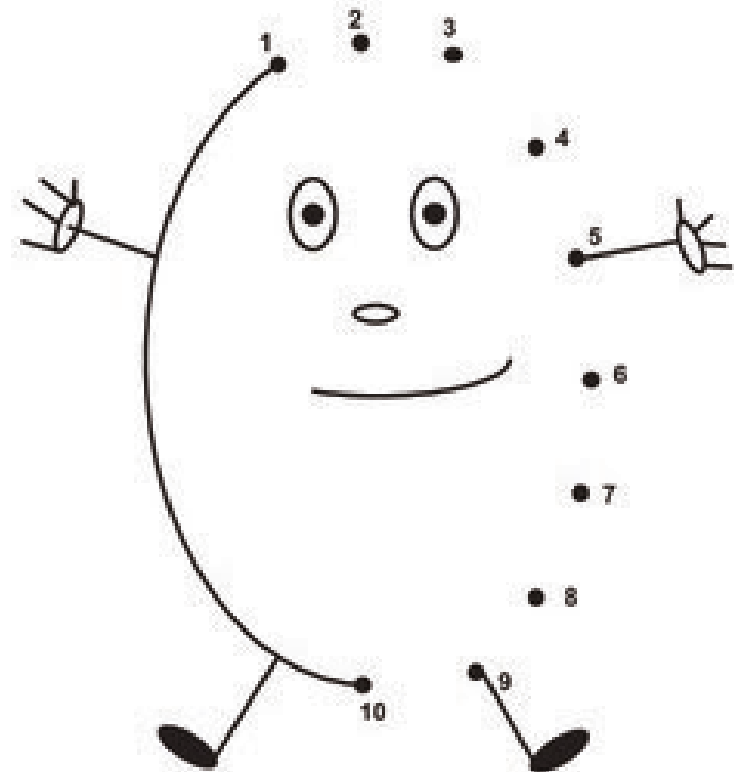
Translating Science into Practice

Egg Farmers of Canada Research Chair in Sustainability
University of British Columbia



Outline

- How to measure and manage for sustainability
 - Life cycle thinking and assessment
- The science
 - Data
 - Models of technologies/strategies
- KTT: The National Environmental Sustainability Tool (NEST)
- Next Steps



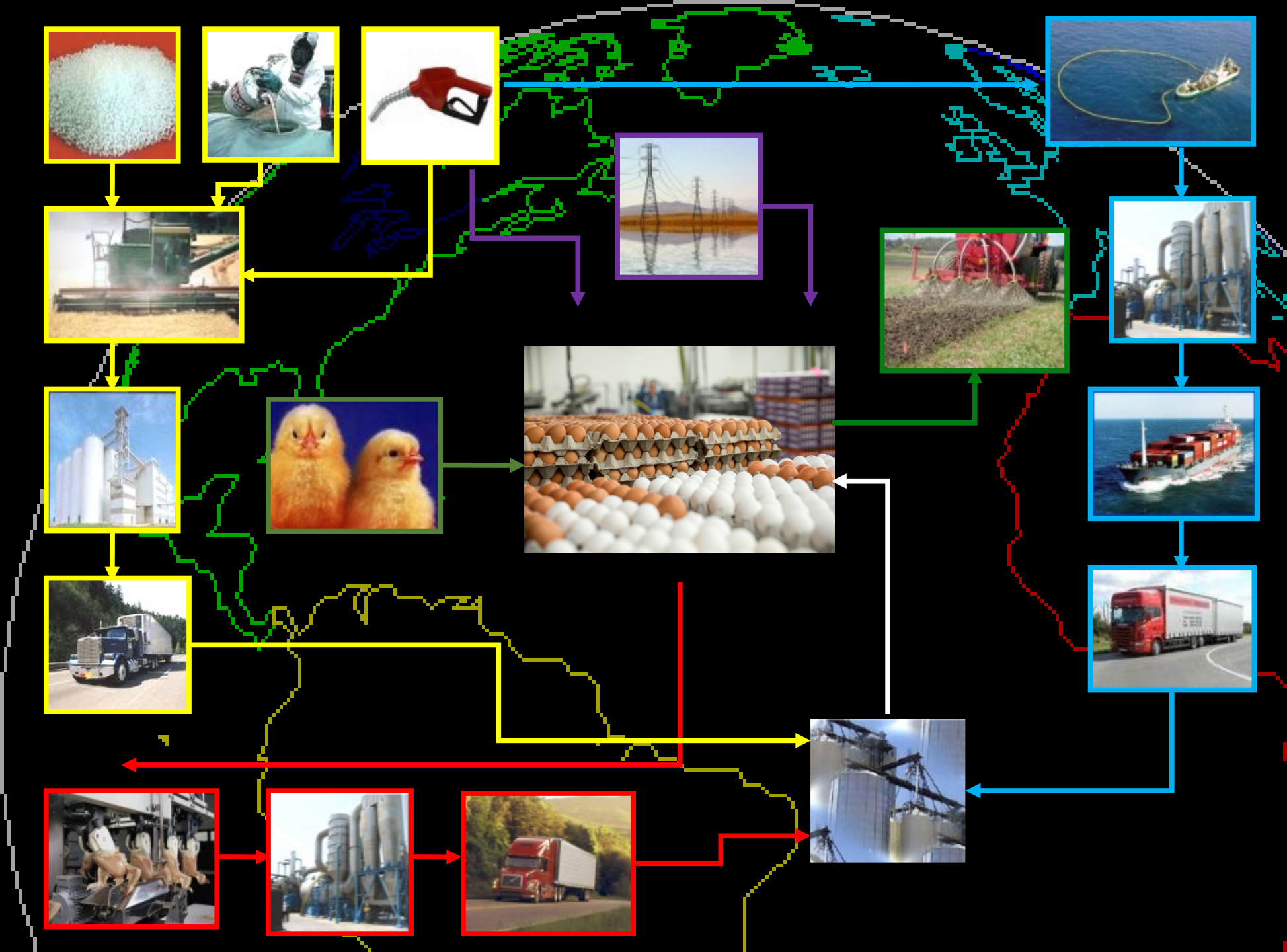
sus.tain'abil'i.ty:

n., the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs.

Measuring and managing at a “systems level”



<http://www.supplychainshaman.com/tag/supply-chain-management/>



SHOOT YOURSELF IN THE FOOT



IDIOMLAND.COM

Environmental Life Cycle Assessment (ISO 14044)

Resources



Energy



Materials



Land Use



Health and Environment



e.g. Climate Change



e.g. Eutrophication

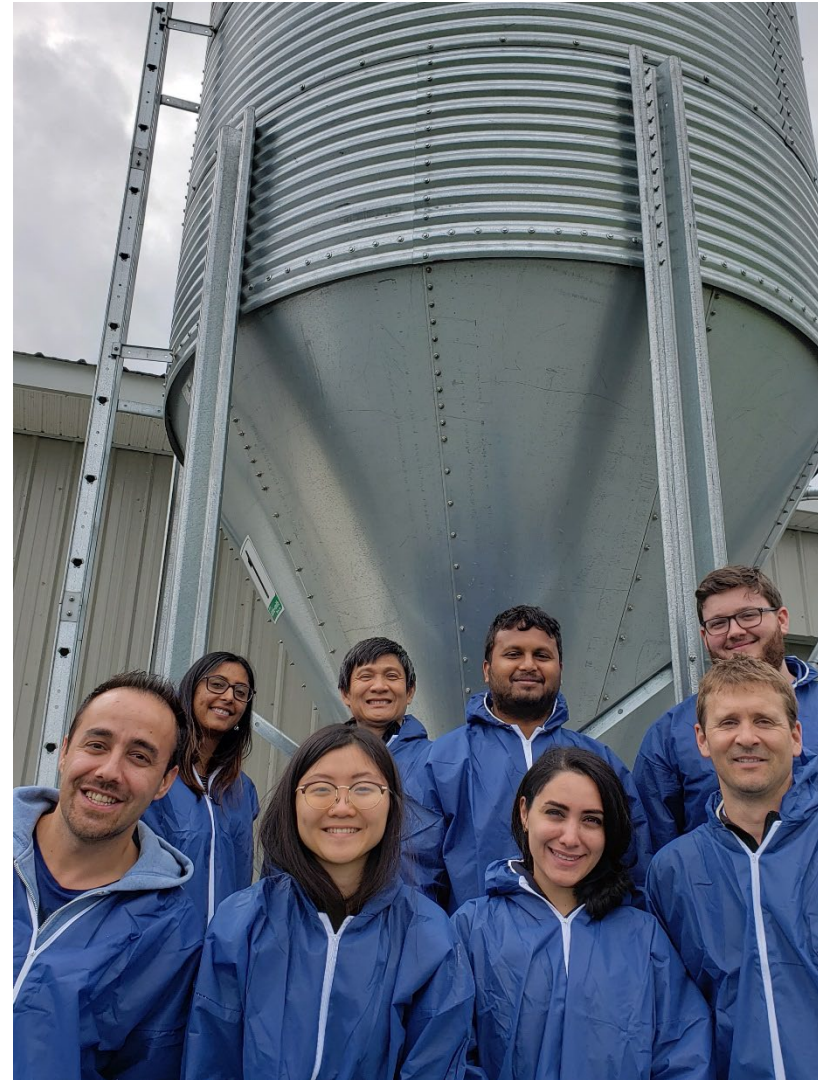


e.g. Toxic Pressure

NSERC/EFC Industrial Research Chair in Sustainability

*“Advancing the science and practice of
sustainability measurement
and management in the Canadian egg industry
based on life cycle thinking and assessment”*

- Egg industry-focused
- 3 undergraduate research assistants, 11 graduate students, 3 post docs
- Funded by NSERC/EFC Industrial Research Chair in Sustainability, and multiple complementary grants

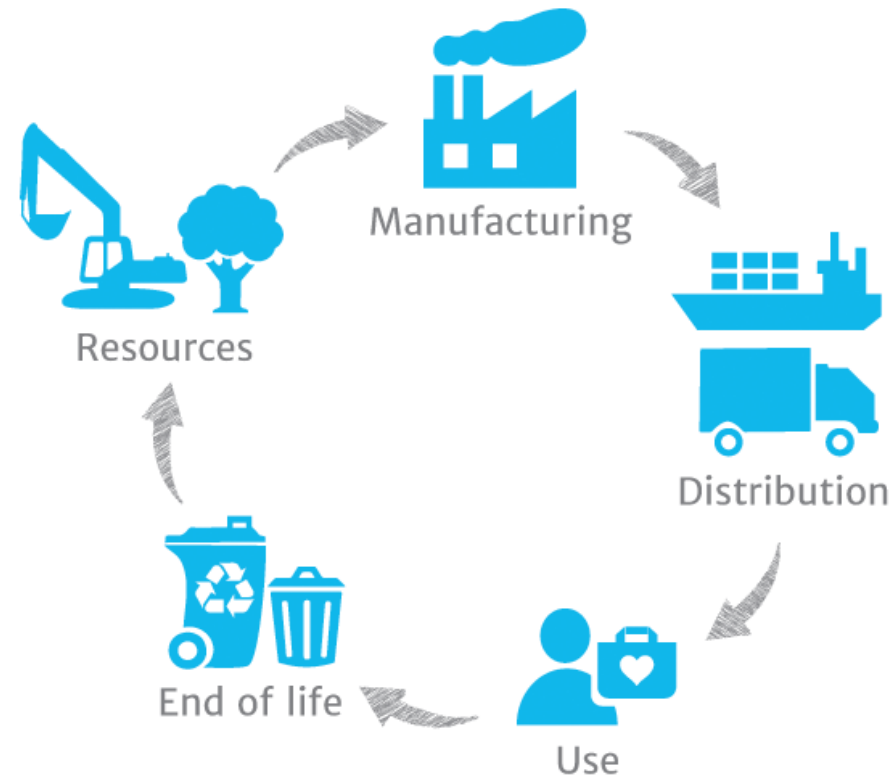


3 Research Themes

- RT1 Canadian Agri-food Life Cycle Data Centre
- RT2 LCA of sustainability technologies and management strategies for the egg industry
- RT3 Sustainability decision support tools for farmers



Life Cycle Inventory Data



- About
- Processes & Activities
- Flows
- Flow Properties
- Sources
- Contacts
- Go To SimplCity



The Canadian Agri-food Lifecycle Database Centre

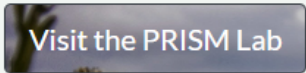
The CALDC is providing public access to 121 LCA datasets for the Canadian Agri-food industry.

The Canadian Agri-food Lifecycle Database Centre is dedicated to providing public access to high quality, geographically and temporally relevant data for agri-food industries within Canada. These datasets are offered free-of-charge and are produced by industry stakeholders, LCA researchers, and LCA practitioners.

Datasets can be created and submitted directly for inclusion to the CALDC using the SimplCity tool. This tool was developed to provide a simple web interface for creating and viewing Life Cycle Inventory datasets. You can click [here](#) to go to the login page to access the SimplCity tool.

The datasets provided through the CALDC are designed to be as interoperable as possible with existing datasets. Datasets are available in the form of ILCD processes as well as EcoSpold2 activities, with reference flows mapped across both for maximum interoperability. Datasets are also available in the form of ILCD flows, flow properties, contacts, and sources.

This project has been developed through the efforts of the University of British Columbia Okanagan Campus Food Systems Priority Research for Integrated Sustainability Management (PRISM) Lab.



Dataset Summary

Type	Count	Newest
contacts	5	2020-03-12
flows	63	2020-05-28
processes	52	2021-04-21
sources	1	2020-05-28

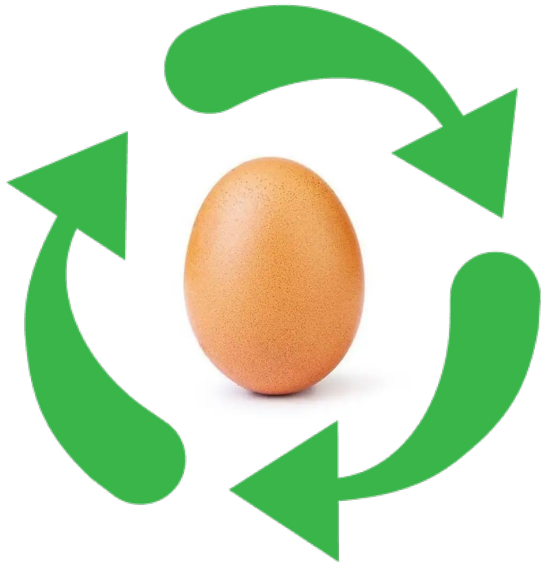
What technologies and practices make sense?



- LCA of net zero energy poultry housing
- Nitrogen efficiency strategies
- Context-specific renewable energy and waste valorization options
- Regionalized sustainable feed formulation decision support tool
- Sustainability best management practices and technologies for Canadian egg farms based on predictive analytics/machine learning



Nitrogen and Sustainability



- *The most resource and emissions-intensive aspect of feed crop production*
- *Manure a major source of eutrophying, acidifying and GHG emissions*
- *An environmental “hotspot” in the life cycle footprint of egg production*

Life cycle assessment of nitrogen efficiency strategies for Canadian egg supply chains

- **Zargar, S. et al. 2021.** Environmental Life Cycle Assessment of Mitigation Technologies and Management Strategies to Improve Nitrogen Use Efficiency Along Industrial Egg Supply Chains. *Resources, Conservation and Recycling*
- **Zargar, S. et al. 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*



Nitrogen Use Efficiency Strategies



Crop Production

“4Rs” and biochar addition to soil



Feed formulation

Reduced crude protein with synth. amino acids



Manure in barn

Acid scrubber



Manure storage

Biochar addition to manure

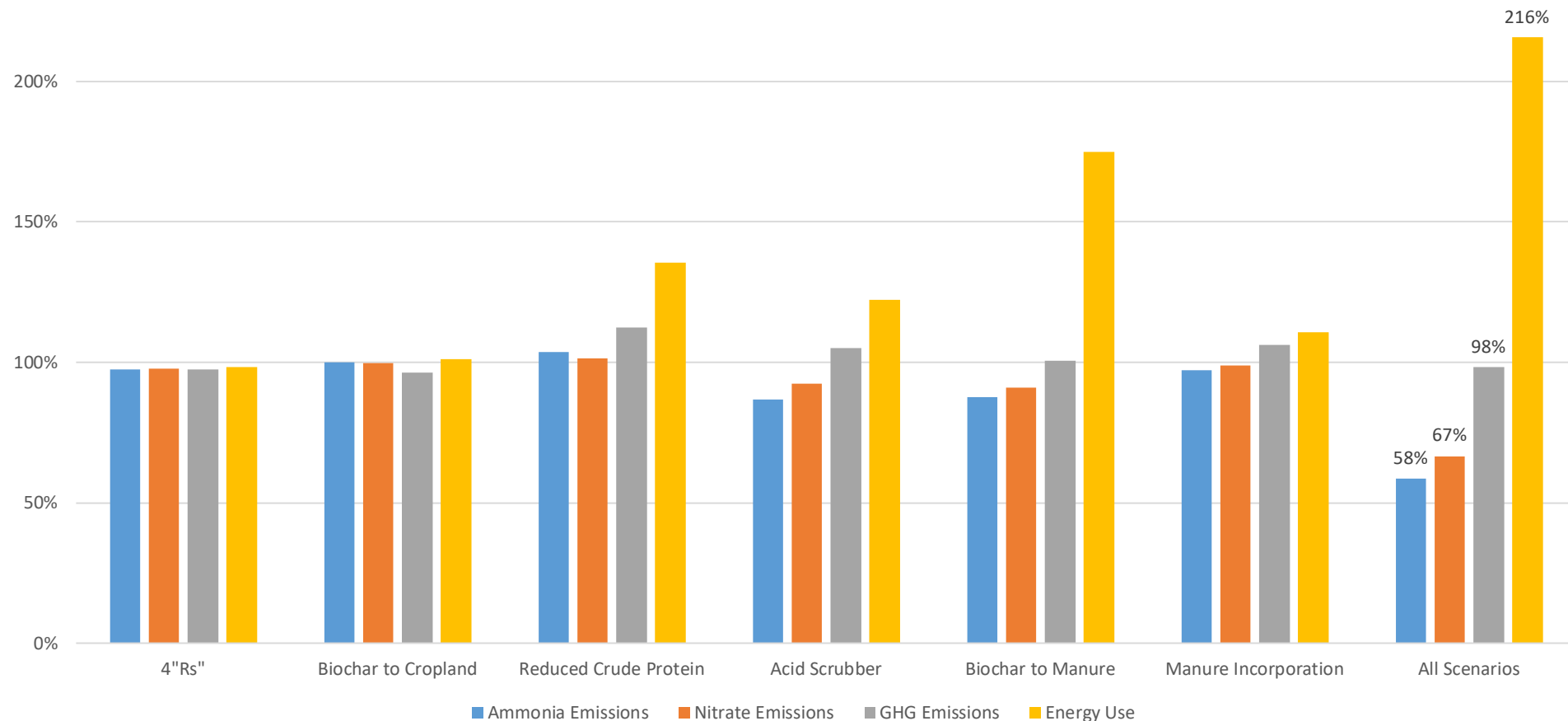


Manure application

Incorporation

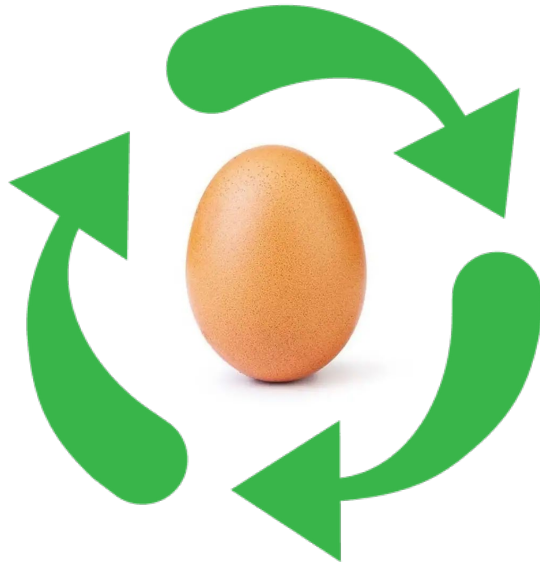
Life Cycle Impact Mitigation Potential of NUE Strategies

(per tonne of eggs, relative to baseline)



What's a "Net Zero Energy Building"?

- "net zero" non-renewable energy consumption via
 - Passive design
 - Energy efficient technology systems (HVAC, lighting, feed delivery, etc.)
 - Renewable energy generation systems



... energy use in barns accounts for ~ 50% of life cycle non-renewable energy use and 15% of GHG emissions

Brant Colony NZE Layer Barn



- Efficient thermal envelope
- Heat recovery ventilator
- Solar panels to offset non-renewable energy use
- LED lighting
- Energy-efficient equipment



LCA of net zero energy poultry housing

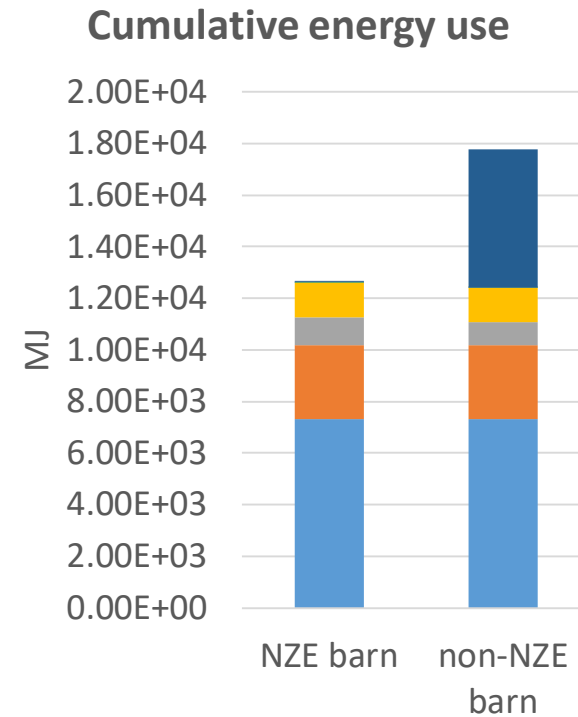
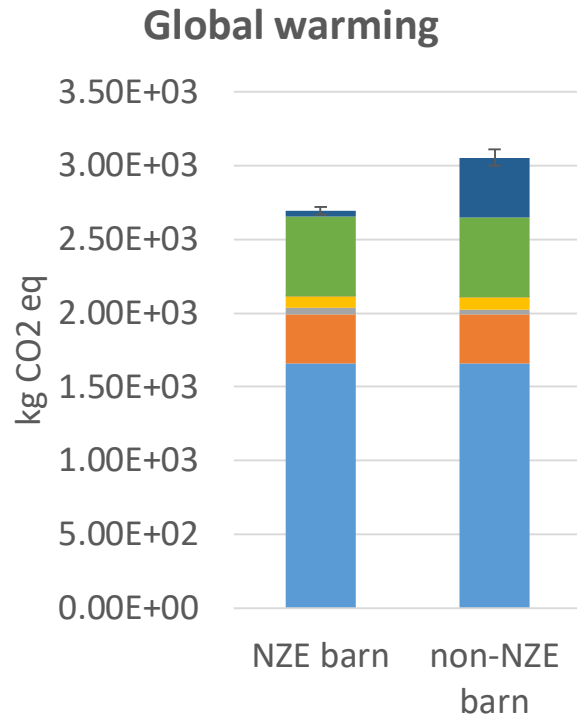
- **Li, Y. et al. 2021.** Net Zero Energy Barns for Industrial Egg Production Facilities: An Effective Sustainable Intensification Strategy? *Journal of Cleaner Production*
- **Li, Y. et al. 2021** Design considerations for net zero energy poultry housing: A review of current insights, knowledge gaps, and future directions. *Sustainable and Renewable Energy Reviews.*



All Inputs to Egg Production

(per tonne of eggs produced)

12%



29%



- Feed
- Pullets
- Housing
- Transportation
- Manure Management
- Direct Energy Use

NEST – National Environmental Sustainability Tool



Developing NEST

- Arulnathan, V. et al. 2020. Farm-level decision support tools: A review of methodological choices and their consistency with principles of sustainability assessment. *Journal of Cleaner Production*
- Close collaboration with *Egg Farmers of Canada* and *Mirego* to develop NEST
- Farmer consultations



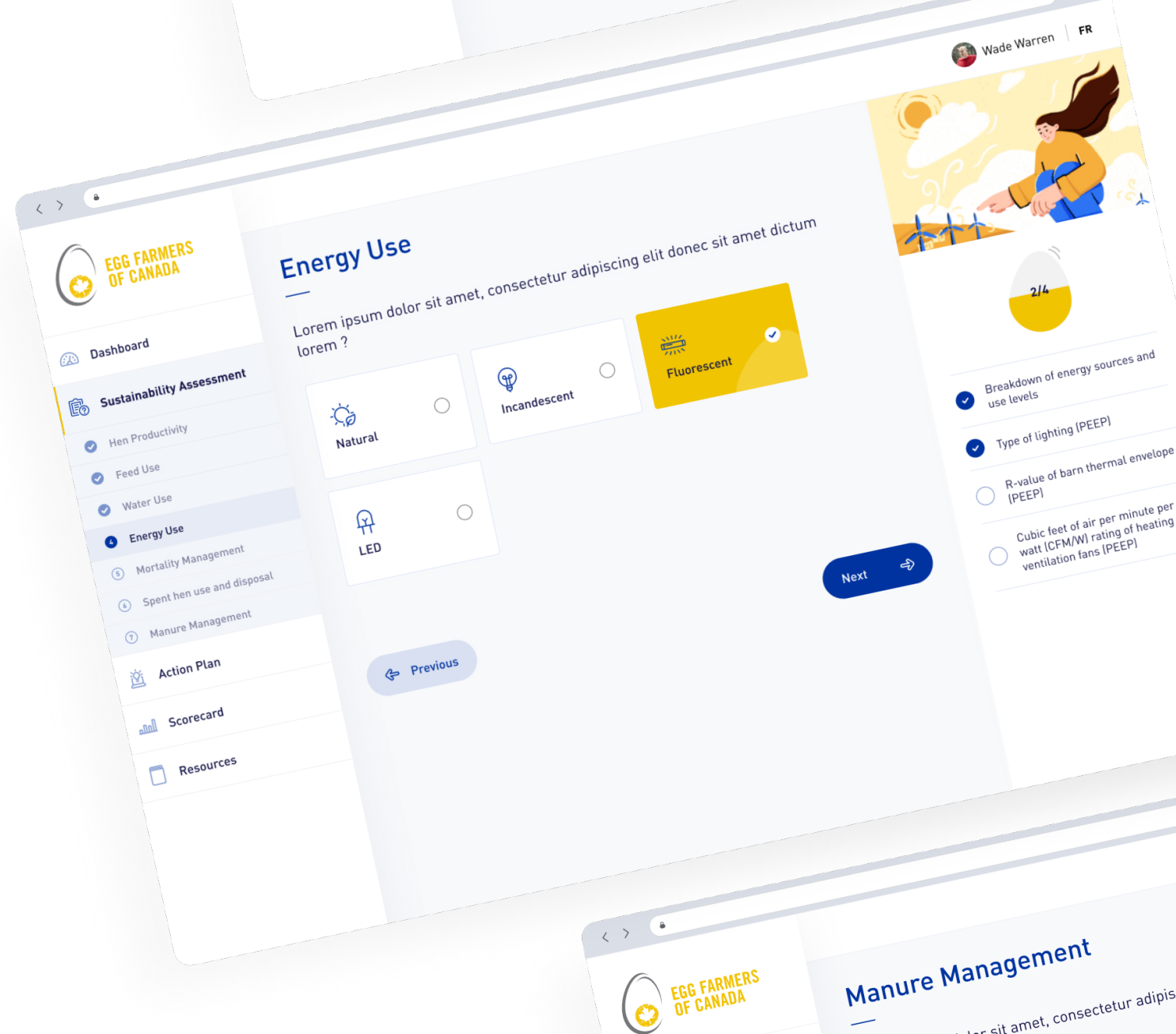
NEST



Farm-level decisions are crucial to sustainable agriculture

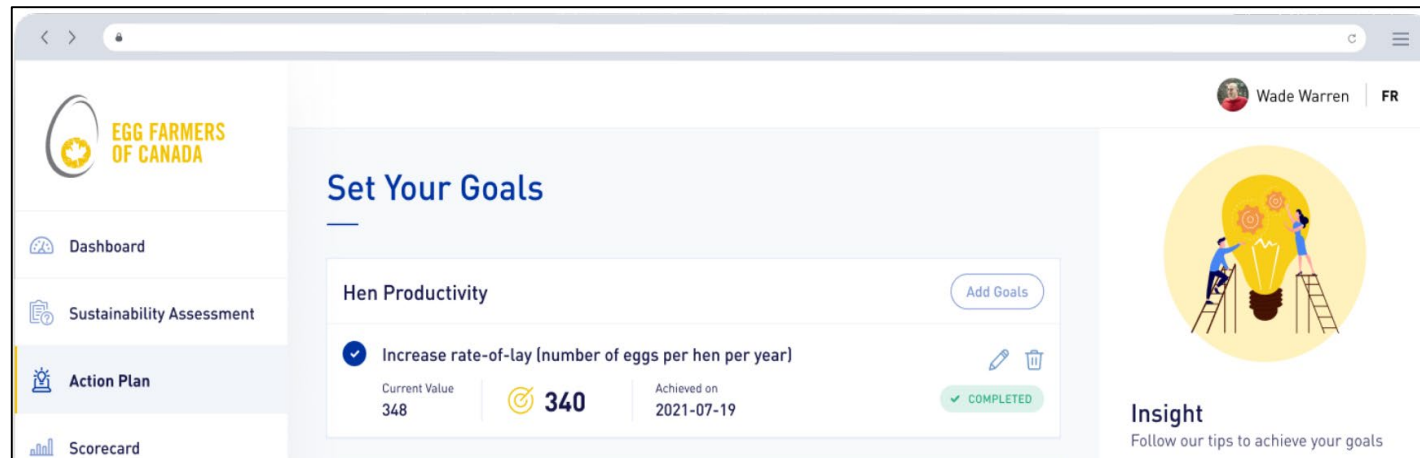


NEST – providing sustainability decision support that is accessible and easy-to-use



NEST – Features

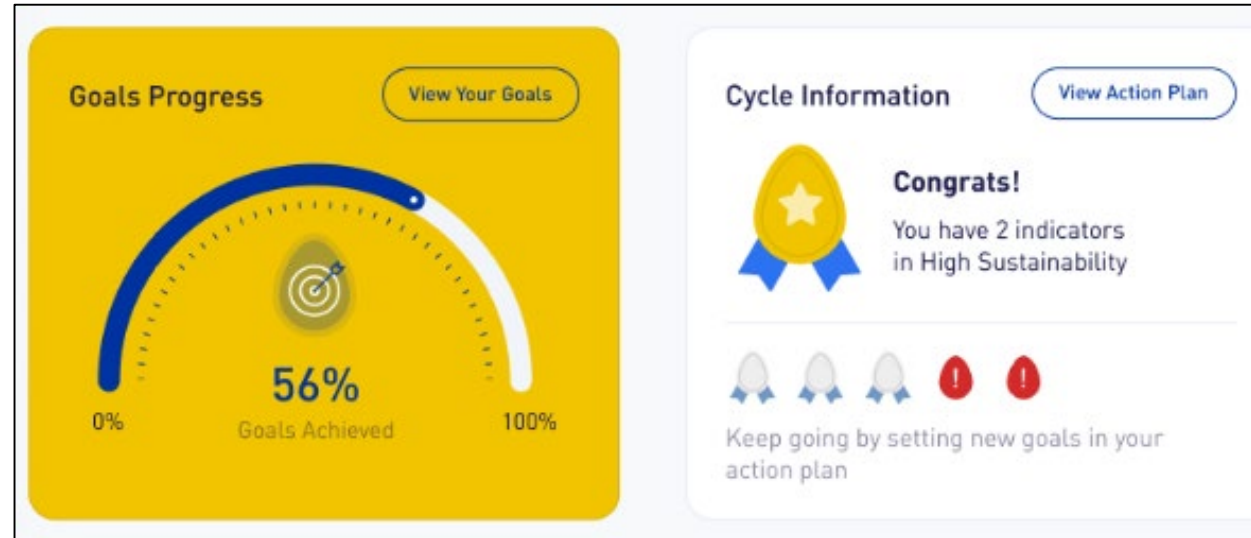
Benchmark your performance



Set sustainability goals

NEST – Features

Track progress



The screenshot shows the EGG FARMERS OF CANADA website. The sidebar menu includes: Dashboard, Sustainability Assessment, Action Plan, and Resources. The main content area features an article titled 'Acid scrubbers in lay facilities to improve nitrogen use efficiency and decrease the environmental impacts of egg production' dated February 1, 2022. The article text reads: 'What are ammonia scrubbers? Ammonia scrubbers use a chemical reaction to remove ammonia from exhaust air from industrial buildings. The air stream containing ammonia is passed through a stacked tower and injected with an acidic solution – mostly diluted sulfuric acid – using special nozzles. The ammonia reacts with the sulfuric acid to produce a salt-like by-product which is collected and removed, while the cleaned air stream exits the building.'

Knowledge transfer

National Environmental Sustainability Tool



NEST – National Environmental Sustainability Tool



Where to from here?





AGRICULTURAL CLIMATE SOLUTIONS

\$185M/10 years
to reduce GHG emissions &
help support climate-smart
agriculture

ON-FARM CLIMATE ACTION FUND

\$200M (2021-2024)
to support on-farm action
on nitrogen management,
cover-cropping & rotational
grazing practices

#COP26



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada



rbi restaurant brands international | *Tim Hortons.* **BURGER KING** **POPEYES**

Our Targets at RBI

Achieve our science-based targets to reduce **GHG emissions 50% by 2030¹** & Reach **net-zero GHG emissions by 2050**

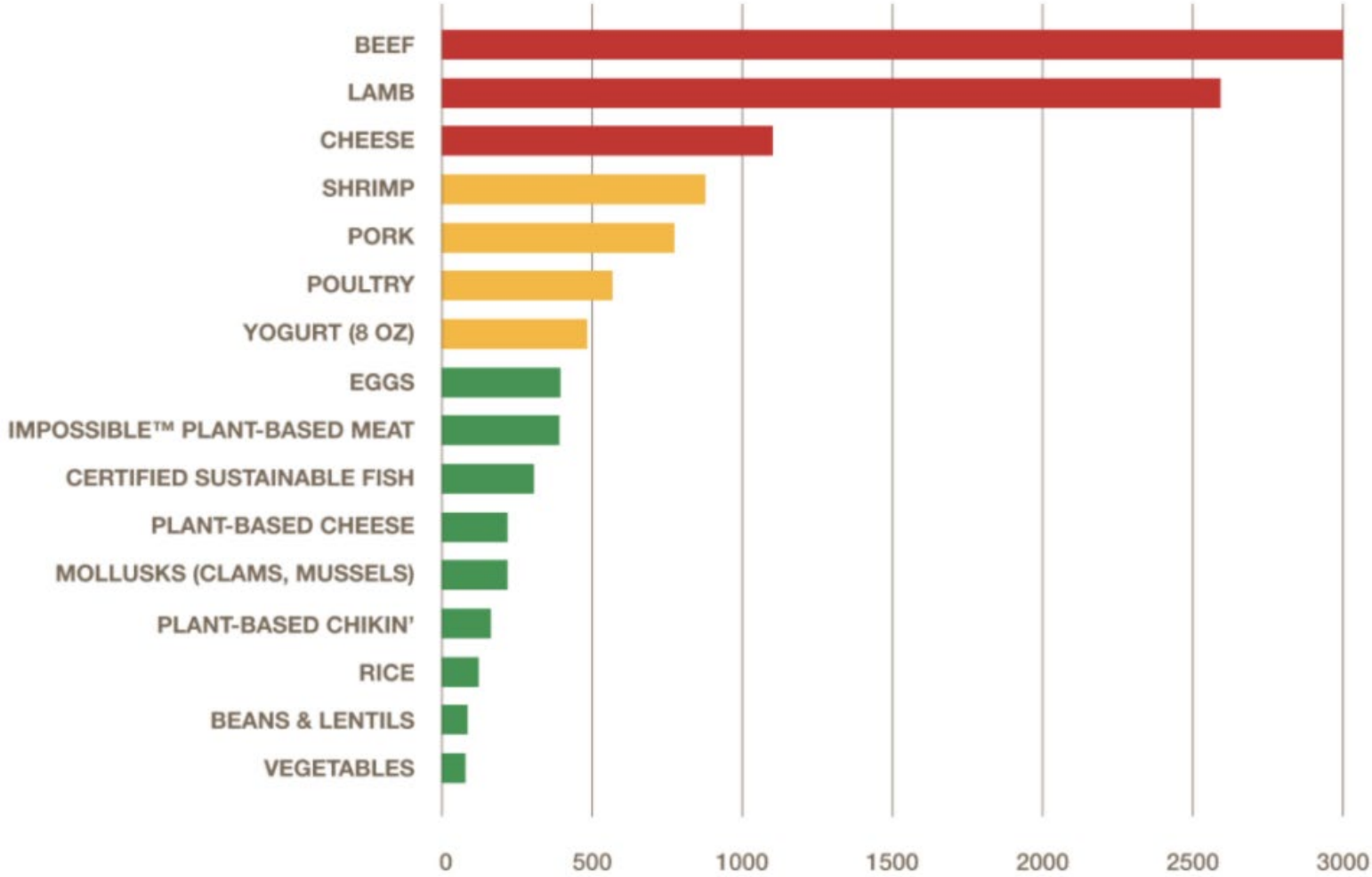
Validated by: SCIENCE BASED TARGETS

RBI's science-based targets by 2030, as compared to a 2019 base year: Reduce Scope 1 and 2 absolute GHG emissions by 50%. Reduce Scope 3 GHG emissions intensity by 50% per metric ton of food. Reduce Scope 3 GHG emissions intensity by 50% per franchise restaurant.



CARBON FOOTPRINT SCORECARD

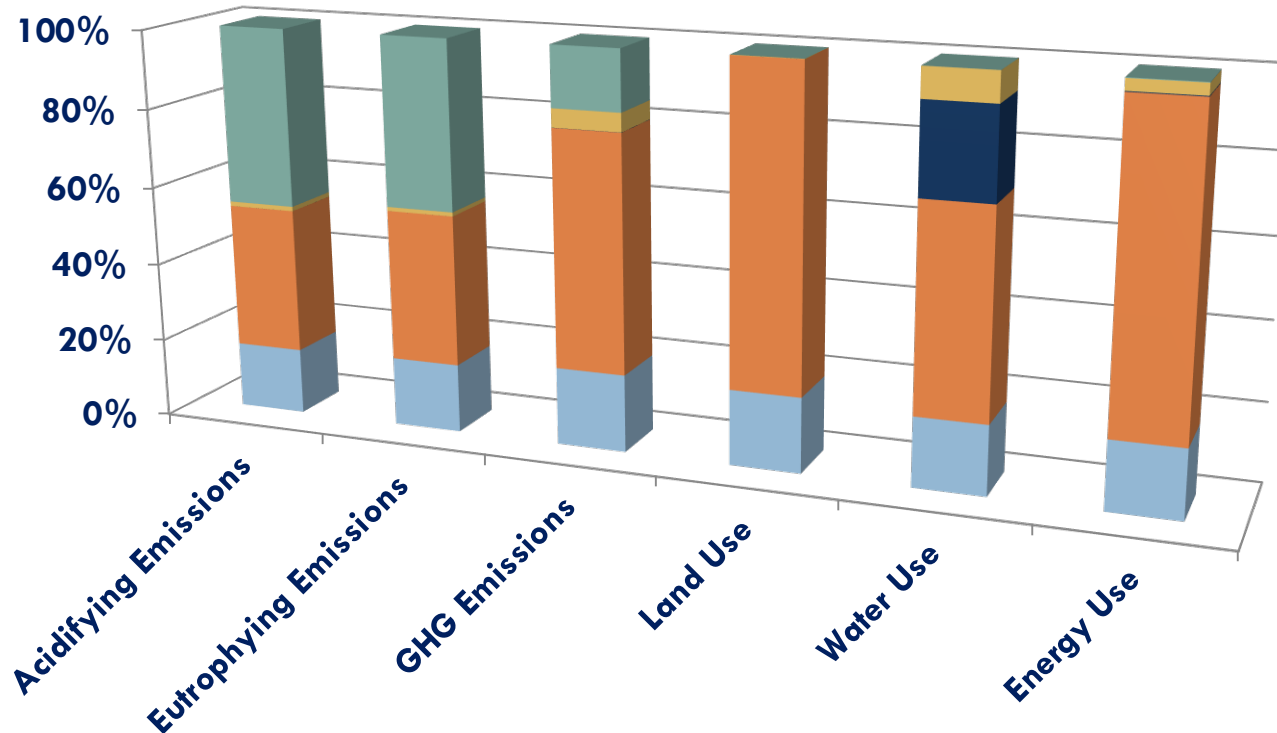
Greenhouse Gas Emissions per 4 oz. Serving



Data Sources: Heller & Keoleian (2014), Clune et al. (2017), Quantis & Impossible Foods (2019)

Canadian Egg Farms

Key Sources of Resource Use and Emissions



■ Pullets ■ Feed ■ Water ■ Energy Inputs ■ Manure Management

Feed

- ~ 2/3 of carbon footprint
- Feed formulation for reduced emissions
- Alternative feed inputs
 - Single cell proteins from forest residues
 - Insect meals
 - Food waste-to-feed valorization
 - Others



Pullets – Long life layers?



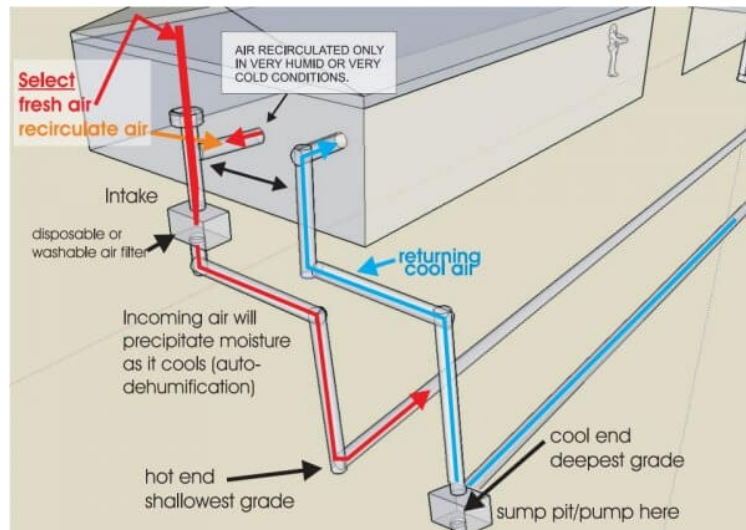
Direct Energy Use

- ~ contributes 5-15% of GHG emissions, depending on province
- What we've learned...
 - NZE barns get “payback” with respect to GHG emissions in 5-20 years
 - Solar and wind can reduce carbon footprint by 0-15%
 - Anaerobic digestion can reduce carbon footprint by ~20%



Further potential measures

- HVAC is major driven of energy use
- Geothermal heating/cooling
 - Passive systems (for example, earth tubes)
 - Active systems (ground-to-air and air-to-air)



Manure Management

- ~ 20% of carbon footprint
- Ammonia scrubbers can be efficacious if driven by renewable energy
- Dry manure is important
- Manure drying/pelleting hold promise



Photo courtesy of Arron Mittlestet

Manure pyrolysis

- ~ 1 tonne of manure/tonne of eggs
 - Most is “short cycling carbon”
 - Pyrolysis produces bio oil (heating) and biochar
 - Biochar reduces emissions when added to manure during storage
 - Long term storage in agricultural soils
 - Storage potential is context specific (soil, climate, SOC)



Data Driven Sustainability Management

- Harness data from barn monitoring systems, IoT sensors, and farm-external data sources
- Machine learning/AI to predict, manage, and reduce emissions



More products than just eggs!

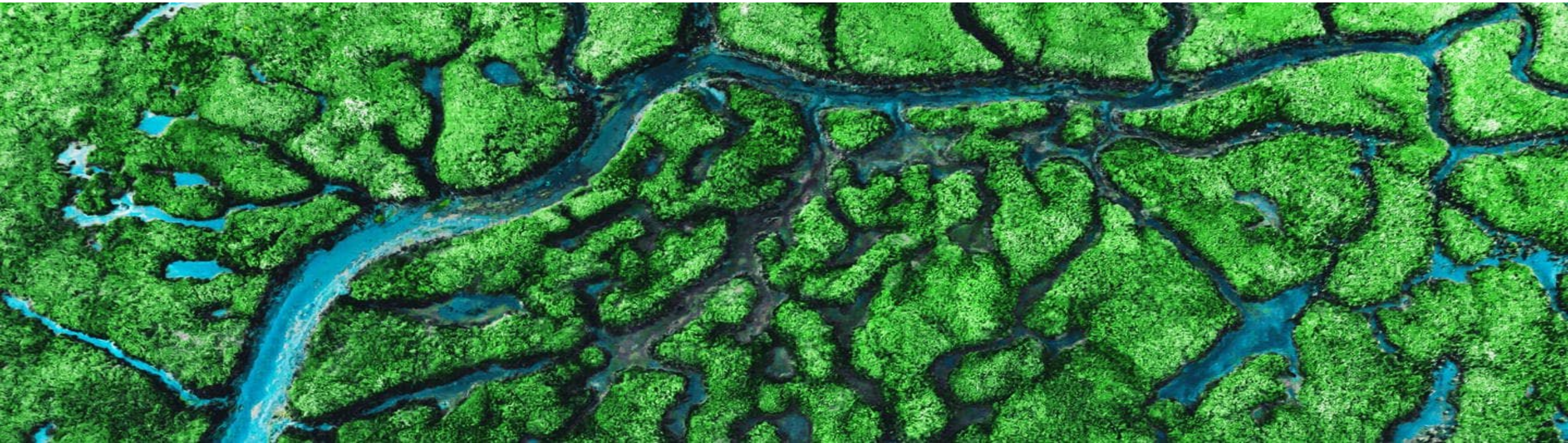
- Spent hen valorization
- Scrubbed ammonia
- Pelleted manure
- Biochar (and carbon credits)
- Green energy



CONTEXT MATTERS!!!

Developing an industry roadmap to net zero

- Identify priority pathways on a regional basis
- Collaborate with EFC to develop a strategic roadmap
- Embed in NEST for farm-specific decision support



Questions

nathan.pelletier@ubc.ca
www.prismlab.weebly.com