

Beneficial Microbes for One Health

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One Health is an *integrated*,
unifying approach that aims to
sustainably balance and
optimize the health
of people, animals and
ecosystems.

https://www.who.int/health-topics/one-health#tab=tab_1

Beneficial microbes for One Health in Canada: a review of evidence and a policy proposal

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We live on a microbial planet inhabited by **bacteria and archaea** that exceed 10^{30} (Flemming and Wuertz 2019). **10^{31} virus particles** (Mushegian 2020) and potentially **13.2 million fungal species** (Hyde 2022). Most of these are not pathogenic, so how can we use them to restore and maintain a healthy planet?

We have the opportunity in Canada to be the first country in the world to utilize and further develop **biotic applications for One Health**.

Probiotics

Prebiotics

Synbiotics

Co-biotics

Post-biotics

Fermented foods

Fecal microbiota transplants

Due to time constraints, I will only give a few slides on the potential then get to what we propose.

Ran

Innovative 'poop pills' show promising results in clinical trials for multiple types of cancer

Evelyn
Ulrike
Michael

Results
wanted
(prereg

caloric



Above: Saman Maleki, PhD, holding a 'poop pill' developed by Lawson Research Institute (Lawson) of St. Joseph's Health Care London and tested in clinical trials at London Health Sciences Centre Research Institute and Centre de recherche du Centre hospitalier de l'Université de Montréal (CRCHUM)

Two Canadian clinical trials show poop pills could help patients respond to immunotherapy while also reducing toxic side effects of cancer drugs



Fermentation has deep cultural roots in Canada, with long-standing traditions of Indigenous communities, who have used this to preserve foods (such as fish, berries, and roots), practices shaped by geography, seasonality, and community knowledge.

In January this year, a cross-sector workshop was held in Toronto to launch a **Canadian Fermented Foods Initiative**

The broader One Health initiative provides opportunities for biotics applied to:

Livestock - milk quality, growth performance, mastitis and reduced diarrhea in ruminants and decreased diarrhea in piglet neonates

Companion animals - In 2022, there were an estimated 8.5 M pet cats and 7.9 M dogs in Canada. When adding fish, small mammals and pet reptiles, the estimate is **28 M** companion animals living with Canadians

Horses - play an important role in Canadian society from **racing to therapy, working, and leisure**. The major cause of morbidity and mortality in horses is colic



Review

Honeybees and the One Health Approach

Joana C. Prata^{1,2,3,*}  and Paulo Martins da Costa^{1,4} 

Abstract: The One Health approach recognizes the interconnectedness between human, animal, and environmental health. Honeybees (*Apis mellifera*) embody this framework due to their crucial role in ecosystems, food production, and susceptibility to contaminants.

Feature Review

Horizon scanning the application of probiotics for wildlife

Neus Garcias-Bonet,^{1,25} Anna Roik,^{2,3,25} Braden Tierney,⁴ Francisca C. García,¹ Helena D.M. Villela,¹ Ashley M. Dungan,⁵ Kate M. Quigley,^{6,7} Michael Sweet,⁸ Gabriele Berg,^{9,10} Lone Gram,¹¹ David G. Bourne,^{12,13} Blake Ushijima,¹⁴ Maggie Sogin,¹⁵ Lone Hoj,¹³ Gustavo Duarte,^{1,16} Heribert Hirt,¹⁷ Kornelia Smalla,¹⁸ Alexandre S. Rosado,^{1,19} Susana Carvalho,¹ Rebecca Vega Thurber,²⁰ Maren Ziegler,²¹ Christopher E. Mason,^{4,22} Madeleine J.H. van Oppen,^{5,13} Christian R. Voolstra,²³ and Raquel S. Peixoto^{1,19,*}



Dr. Peixoto applying probiotics to corals.

Highlights

Probiotics can enhance the resilience of endangered wildlife.

The use of so-called 'probiotics for wildlife' is a nascent application.

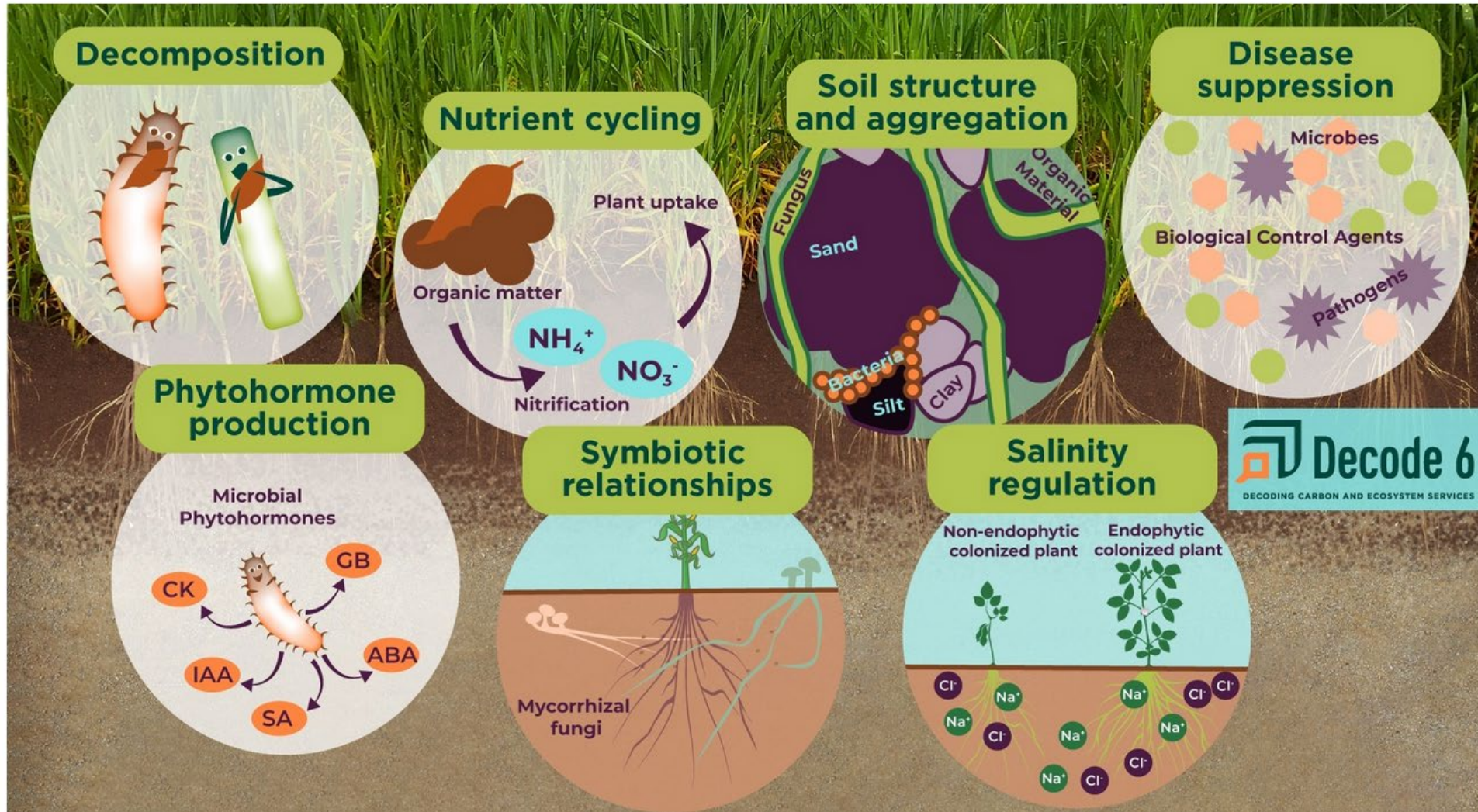
Incorporating reliable negative controls in the experimental design is essential to validate probiotic effects.

Other challenges include culturing and selecting probiotics, risk assessment, optimization and scaling, and understanding the mechanisms of action.

Additional microbial therapies (e.g., postbiotics) should be developed and tested as alternative treatments to protect wildlife.

Delivery of bacteria to the reef via an automated dispenser called Coral AI™

Soil microbes contribute to health in multiple ways:



Bioeconomy - microbes in remediation

Maglione et al. AIMS Microbiology 2024.

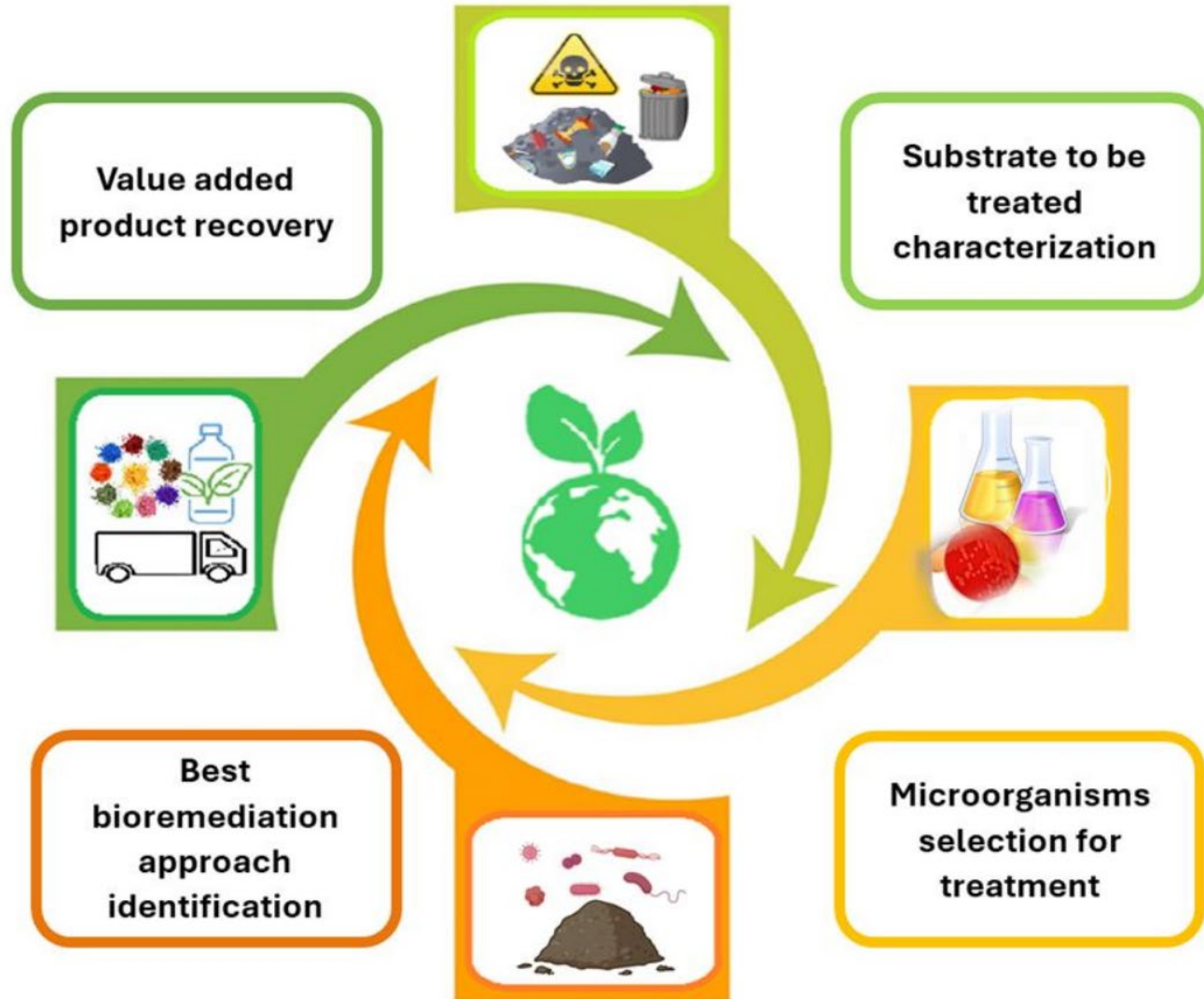
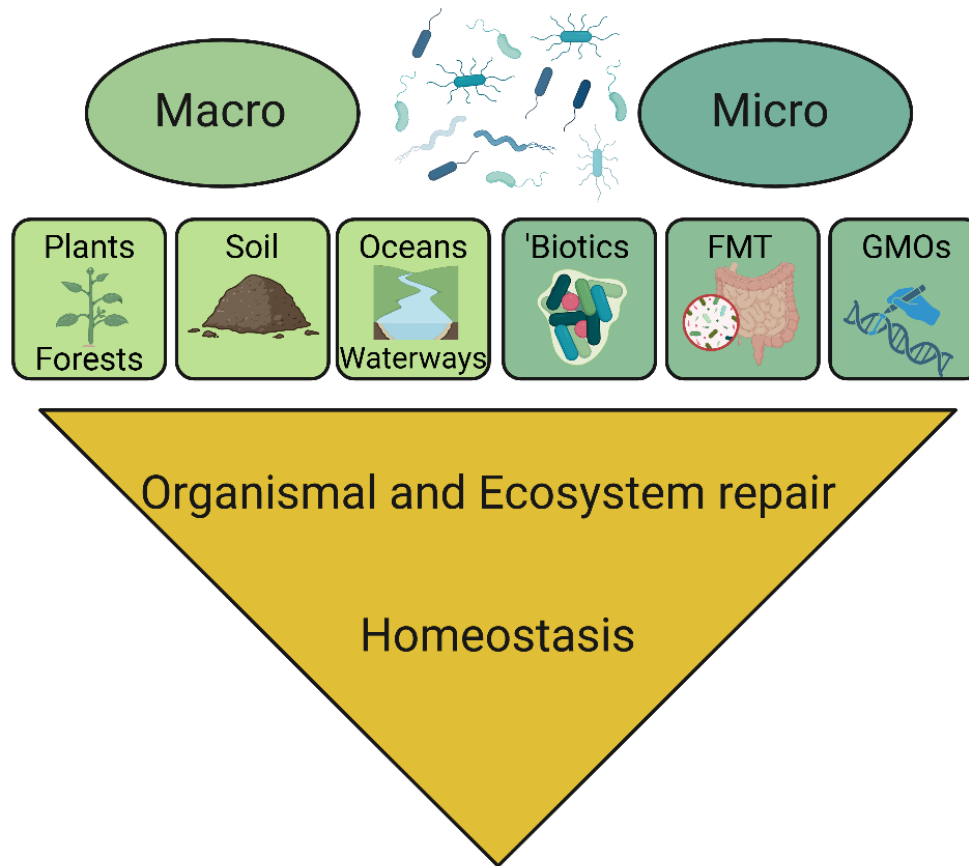


Figure 2. Bioremediation bioeconomy-based outline.

Restoration and rehabilitation approaches



Conceptual framework of a micro-macro-restoration/-rehabilitation approach.

The macro approach at the ecosystem could include **integration of beneficial microbes** into the re-forestation strategy, **countering plant pathogens**, **restoring soil homeostasis**, **reducing pollutants and drugs in waterways**, **oceans and wastewater treatment plants**.

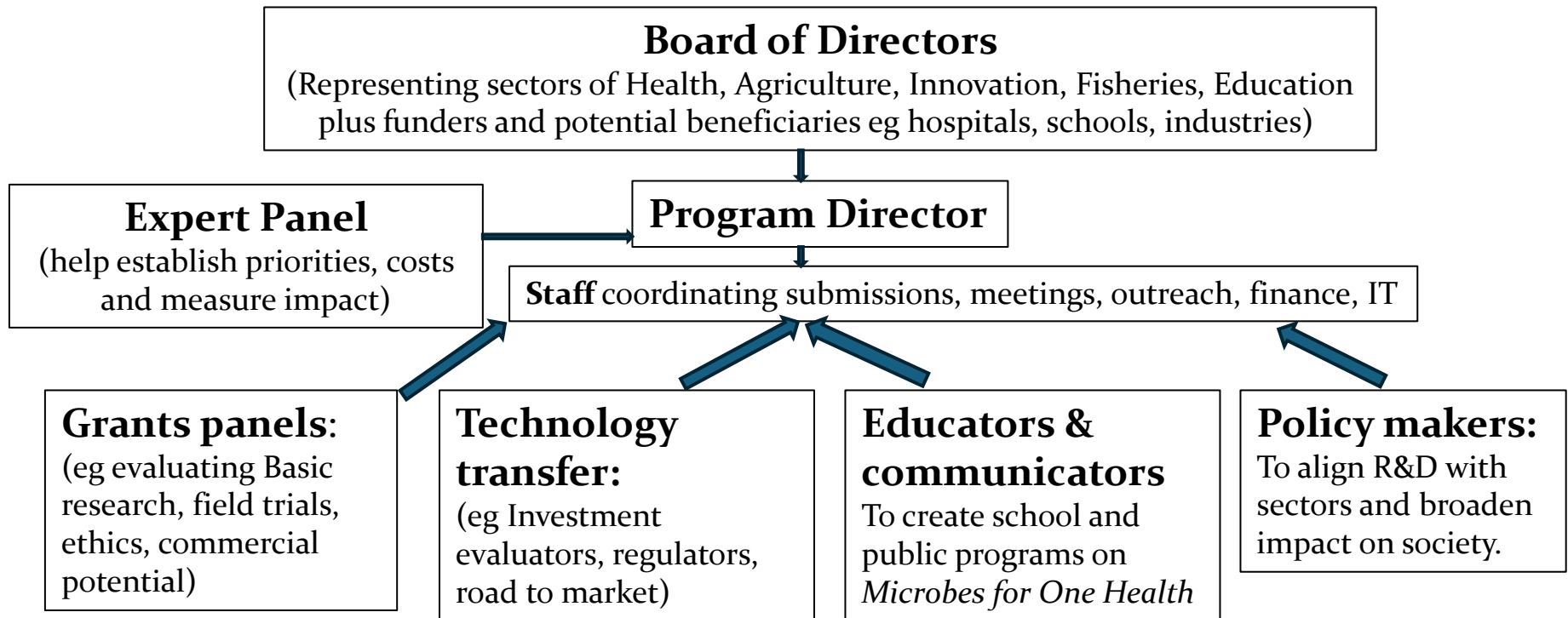
The micro level applies **biotic solutions**, **FMT** and **GMOs** to humans, animals, fish, coral and insect to restore and maintain their health. Restored or rehabilitated microbiomes minimize or **prevent the establishment of pathobiomes**, contributing to human well-being. (*Adapted from Peixoto and Voostra, 2023*).

We propose a radical new program for One Health.

Primary Recommendation:

The establishment of a **new National Program** to study and implement beneficial microbes across the One Health domain with funding mechanism that brings together government, researchers, consumers, industry, NGOs, and philanthropy. This would be integrated with a separate arm at Health Canada focused on safety and regulation of beneficial microbes across all aspects of One Health.

This could begin with funding for a **workshop** involving key stakeholders (governmental and private funding agencies, policy-makers, researchers, regulators, health economists, industry leaders from across sectors, and a representative from the Department of Finance (Canada) to create the program structure as well as identify the most efficient and effective ways to move forward.



Human and aquaculture health:

Implementation of proven biotic and FMT remedies across the country in clinical practice. This includes probiotics for low-birth weight, premature infants so that no site has levels of NEC or sepsis higher than 5%.

Also, using FMT for *C. difficile*, so that chronic rates do not exceed 10% and that specific FMT compositions are selected for each new clinical application (cancer, MS, Parkinson's etc).

All products used in hospitals or on people at high risk of complications from microbial infection, must be **manufactured in such a way as to meet the drug-level requirement for the least pathogen or chemical contamination.** Costs associated with preparation and application of biotics in hospital settings should be covered by the healthcare system.

Reopening at least one aquaculture research station in British Columbia to perform testing on the potential of biotics to reduce fish losses and support Native and commercial fishing.

Use the pre-established framework developed for corals as a guideline to be adapted for other **indigenous threatened marine species.**

Education:

- Programs/courses developed and implemented across all **primary, secondary, and postsecondary institutions** describing the microbiome and application of beneficial microbes to sectors covered by One Health.
- Based on efficacy and mechanistic data with **socio-economic perspectives**, taking into account religious and Native practices and dietary considerations.
- **Educational resources** created for and disseminated **across farming and agricultural sectors and to dietitians, pharmacists, and employees in health stores** to provide consumers with accurate information based on scientific and clinical documentation of each product.

Food production, product labelling, and distribution:

- Integration of the principles of this report into **landscape management and environmental policies** leading to reduction in use of chemical agents that are toxic to One Health constituents, including sentinel pollinators, food and water resources. This is necessary to safeguard soil biodiversity and help restore vital Canadian ecosystems.
- More stringent requirements for **food and dietary supplement labelling**, guaranteeing that foods and NHPs containing probiotics clearly state strain designation, end-of shelf-life viability, and storage conditions to maintain that level, plus specific documentation on websites or other material showing said product efficacy. Strains must be genome sequenced with the results made publicly available. Products without such information should not be permitted to use the designation ‘probiotic’.
- Use of the **term prebiotic** should only be permitted if sufficient material is in the product to confer a proven prebiotic effect.

- **Integration of fermented foods into a Canadian network of school food programs.** Every company selling a 'biotic food, drug or supplement will be encouraged to donate 2%–5% of their earnings in kind or as cash to the network, allowing different health-promoting options based on beneficial microbes, similar to a model in Argentina.
- Industries selling **animal food products** should be mandated to support research that leads to the documentation of the strains, viable counts at end of shelf life, and a link to trials proving benefit.

Exciting outcomes:

The world's first ecosystem-wide application of beneficial microbes addressing many of Canada's resources (water, agriculture/food, oil/gas and waste management; forestry, medical science and education)

A unique One Health program that is broadly engaging, flexible and allows for rapid testing and implementation of products.

Strengthening of important specialties (eg microbiology, public health, manufacturing) needed to prepare for pandemics and biological warfare.

Return on investment through stimulating Canada-wide R&D, IP and trade.

