AGRICULTURE & FOOD RESEARCH REPORT 2021
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Funding partners

OUR COMMITMENT

RESEARCH MISSION:
We will build upon Grenfell Campus’s vibrant culture of creativity and innovation and continue to foster research excellence and scholarly collaborations to create, share, and apply knowledge with integrity, respect, and purpose.

AGRICULTURAL GOALS:
1. To develop a productive and sustainable food production system in Newfoundland and Labrador
2. To grow the agriculture sector in NL, with a focus on supporting the development of a regional food economy
3. To improve the viability of the agriculture sector through research and innovation, education and training, and by supporting sustainable management practices
4. To reinvigorate the culture of food production and build support for local food systems in NL through adoption of innovative and emerging techniques, and community outreach and engagement
5. To foster productive research collaborations among farmers, researchers, governments, industry and other stakeholders at national and international levels

Grenfell faculty and student researchers had a visit from Dr. Yvonne Timmins, president and vice-chancellor, at the Pym’s Brook Research Station.
A message from the Vice-president

Never before has agricultural sustainability been more important to the province of Newfoundland and Labrador. In The Way Forward, the province’s Agriculture Sector Workplan states that government is aiming to double Newfoundland and Labrador’s food self-sufficiency to at least 20 per cent by 2022.

To help achieve the province’s food self-sufficiency goals, Grenfell Campus, Memorial University, is collaborating with industry, federal and provincial government departments, NGOs, organizations, farming communities and funding agencies to remove the barriers currently facing agriculture sector growth.

Our research expertise is diverse: soil, plant and water relationships, cropping systems, greenhouse gas mitigation and adaptation strategies, functional foods, hydrological modelling, high-value vegetable production in hydroponics, soil fertility, soil health and nutrient cycling, and integrated nutrient management.

WE WILL SUPPORT THE PROVINCE’S GOALS THROUGH

• capacity building
• new graduate programs at the master’s and PhD levels
• entrepreneurship and innovation

Herein you will find many examples of the ways we are committing to the sustainability of Newfoundland and Labrador. And if you wish to learn more about research at Grenfell, take a look in our annual reports, available at pubscre@grnfll.com.

DR. IAN SUTHERLAND

Vice-president (Grenfell Campus) Memorial University pro tempore

A Message from the Associate Vice-president

Research & Graduate Studies

I am very pleased to share this report on agricultural activities at Grenfell Campus, Memorial University. I have the privilege of observing the continuous growth in agriculture and food research projects and increases of Grenfell’s agricultural research profile.

In 2021, I had the honour of serving as interim associate vice-president (Grenfell Campus) research and graduate studies. The Office of Research – including our grants facilitators and administrative supports – is critical to increasing our resources and capacity to continue the tremendous work being done to support efforts in making the province agriculturally self-sufficient and make it a more sustainable and environmentally better place to live.

In addition, our collaborative and multidisciplinary research and development activities continued in 2021 with great momentum, with many accomplishments due to the hard work of our outstanding researchers, collaborators and graduate students.

I wish to acknowledge our staff, researchers, postdoctoral fellows, associates, grad students, industry partners, as well as our national and international collaborators and funding partners for their continued strong support and assistance throughout 2020. My special thanks to Department of Fisheries, Forestry and Agriculture, Government of NL, and Agriculture and Agri-food Canada.

Last year we had the privilege of hosting Dr. Vianne Timmons, vice-chancellor and president of Memorial University, at Fynes’s Brook Research Station. It is heartening to know we have strong support from the university’s administration. I hope you will find the examples of our research to be enlightening.

DR. MUMTAZ CHEEMA

Associate Vice-President Research and Graduate Studies
NAME OF PROJECT:
BIOCHAR AMENDMENT MITIGATES GLOBAL WARMING POTENTIAL, GREENHOUSE GAS INTENSITY AND NITROGEN LOSSES IN DAIRY MANURE BASED CROPPING SYSTEM UNDER BOREAL CLIMATE

PRINCIPAL INVESTIGATOR:
DR. MIAMI CHEMA
Boreal Ecosystem Research Initiative, School of Science and the Environment, Grenfell Campus

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WAFIQ ASHFAQ
M.Sc. Candidate, Boreal Ecosystem Research Initiative, School of Science and the Environment, Grenfell Campus

PROJECT RATIONALE:
The global food system is responsible for ~21.17 percent of annual emissions as commonly reported using the 100-year global warming potential. Greenhouse gases such as CO2, CH4, and N2O can be reduced through C sequestration and GHG mitigation strategies in different cropping systems. Management practices that may enhance soil C sequestration include crop residue incorporation, addition of perennial and cover crops in crop rotation, no-tillage practices, manure and other organic amendments. However, some of these practices may be disadvantageous as they increase GHG emissions into the atmosphere. For example, dairy manure (DM) and inorganic nitrogen (IN) fertilizer application to agricultural soils releases significant GHGs into the atmosphere > CO2, CH4, and N2O. DM application emits 32.7% more GHGs than IN fertilizer alone and these emissions may offset the benefit of improving soil organic carbon (SOC). DM application improves SOC, cation exchange capacity (CEC), water holding capacity (WHC), soil aggregation, nutrient uptake, and overall and agronomic performance of crops. DM and IN fertilizers also enhance the risk of nitrate (NO3) and phosphorus leaching from different cropping systems and consequently pollute water bodies, increase cost of production, and pose a serious threat to human health. These N losses (NO3 leaching and N2O emission) indicate ineffectiveness in the current nutrient management system that result in environmental pollution and economic loss to the farmers. There is a need to introduce and evaluate management practices with multiple benefits, which can improve soil physicochemical properties, mitigate GHG emissions and nitrogen losses. Biochar (BC) amendment is known to sequester carbon, reduce nutrient and gaseous losses, improve soil physicochemical properties, and enhance dry matter yield (DMY). A field experiment was conducted to determine the effects of DM and IN fertilizer application alone and in combination with BC on GHG, global warming potential (GWP), greenhouse gas intensity (GHI), DMY, nitrate (NO3) and ammonium (NH4+) retention in 30 and 60 cm soil depth during 2016 and 2017 growing seasons. Experiment was conducted with the following specific objectives:

OBJECTIVES:
1. To monitor temporal and cumulative GHG emission following dairy manure and inorganic N fertilizer application in silage corn,

2. To investigate the impact of biochar amendment in mitigating GHG emission, global warming potential, greenhouse gas intensity and dry matter yield following manure and inorganic fertilization,

3. To evaluate the effects of dairy manure and inorganic N fertilizer application alone and in combination with biochar on N dynamics in silage corn cropping systems in boreal climate.

FUNDBERS/PARTNERS:
- ACDA, $10,000
- Grenfell Campus, Memorial University of Newfoundland
- Government of Newfoundland and Labrador
NAME OF PROJECT:
STUDY OF CORNER BROOK PULP AND PAPER LIMITED (CBPPUL) By-PRODUCTS AND POTENTIAL USES FOR FOOD PRODUCTION

PRINCIPAL INVESTIGATORS:
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(Boreal Ecosystem Research Initiative, School of Science and the Environment, Grenfell Campus)

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PROJECT RATIONALE:
Corner Brook Pulp and Paper Limited (CBPPL) produce 10,000 Mg of wood ash (WA) annually and 120 Mg/day of paper sludge (PS). WA has been traditionally disposed of at landfill sites, with an associated cost for both tipping fees and transport. The rising costs of disposal, combined with increasingly stringent environmental legislation motivates the investigation of alternate uses for the WA and PS waste. Due to high pH and presence of organic matter and plant nutrients, WA and PS can be used as liming or soil conditioning amendments. Agricultural production in NL is severely limited by the acidity and low fertility of the soil, as well as the high costs of inputs. Consequently, less than 30% of arable land is currently under production, and local produce only supplies 10% of protein food requirements. The diversion of CBPPL WA and PS to agriculture land, particularly newly cleared land, has the potential to provide a potentially cheaper alternative for lime and NL producers. Recycling nutrients from the waste resources while adding organic matter to soil are also important benefits for productivity and environmental stewardship.

OBJECTIVES:
Considering the increasingly high cost of liming materials, fertilizers and a preferred economic disposal method of WA and PS generated by the CBPPL, as well as the multifaceted benefits of biochar (BC), the proposed study was designed with the following specific objectives:

1. To assess the temporal bioavailability of nutrients, pH and heavy metals in WA and PS
2. To investigate the effects of WA and PS alone and in combination with BC on plant growth, yield and heavy metals uptake in annual ryegrass and kale in greenhouse conditions.
3. To assess the effects of WA, PS alone and in combination with BC on seed germination, residual N, C, N ratio and N uptake in annual ryegrass and kale in greenhouse settings.
4. To determine the effects of WA, PS and BC amendments on the nutritional profiles of kale grown under controlled environmental conditions.
5. To evaluate the effects of WA, PS and BC on: a) soil greenhouse gas (GHG) emissions; b) N transformation; c) soil microbial biomass; d) denitrification enzyme activity; and e) abundance of selected N functional genes
6. To determine the optimal mixing ratios of WA, PS, BC, wood shavings and poultry manure to develop compost and its effects to: a) minimize GHG emissions during composting and b) improve compost quality
7. To investigate the effect of composts rates combined with chemical fertilizer on GHG emission and N transformation,
8. Assessing the effects of compost rates as soil amendment on plant growth, yield and elemental uptake in annual ryegrass and kale under controlled environmental conditions.

9. Evaluating the impact of different ratios of SW and P5 in combination with BC on physiochemical properties (bulk density, porosity, water holding capacity SWWC, plant available water (PAW), pH, EC, CEC, OMs and heavy metal leaching) of potting soil based horticultural potting media.

9. Determining the feasibility and effectiveness of composting P5 with woody material to create a soil amendment for remediating hydrocarbon contaminated soil.

FUNDERS/PARTNERS:
$1.3 million
- The Agricultural Clean Technologies Program (ACT)
- Miresco
- Atlantic Canada Opportunities Agency
- Industry, Energy and Technology Government of Newfoundland and Labrador
- Corner Brook Pulp and Paper Limited

NAME OF PROJECT: AGRICULTURE AND FOOD PROJECTS

PRINCIPAL INVESTIGATOR: BRENDA WHYATT

CO-INVESTIGATORS: DR. ROZA TECHNO/KALEVSKA

PROJECT RATIONALE: This project will examine food processes in St. Anthony and surrounding communities. We are interested in learning about self-provisioning, which includes activities like home gardens, community gardens, foraging, hydroponics, and many other fresh fruit and vegetable production and gathering methods. The project is led by Brenda Whyatt, who is a nurse educator at the Western Regional School of Nursing, and will include community partners in the St. Anthony area.

PROJECT DESCRIPTION: Surveys (online and paper based) will be used to complete the initial food scan, and focus groups will be used as a follow-up to the survey.

OBJECTIVES:
The project will aim to understand the wide range of food skills and knowledge in the St. Anthony region, and identify the level of self-provisioning in the community.

FUNDERS/PARTNERS:
- The Harris Centre, $18,000
NAME OF PROJECT: ASSESSING THE POTENTIAL FOR AGROECOLOGICAL TRANSITION IN NEWFOUNDLAND AND LABRADOR AGRICULTURE: A TRANSDISCIPLINARY APPROACH

PRINCIPAL INVESTIGATOR: DR. GABRIELA SABAU


INTERNS: MOHAMMAD SEJUM REZA NAZIN SULTANA

PROJECT RATIONALE: Modern, large-scale industrial agriculture aims to maximize yields and profits and negatively impacts food security and ecosystems’ health through monoculture, producing junk food, reducing soil health or damaging farmlands and harming neighboring economies (Gieseman, 2015; Hidden Costs, n.d.; Reza, 2019).

Within this context, agroecology, with its potential to bring positive impacts on the environment and on farmers’ incomes, has become again very popular. Agroecology practices have existed for a long time and still exist in Indigenous cultures around the world (Guzmán-Torres, 2017). However, as a holistic multidisciplinary science, aiming to reconcile agriculture and local communities with natural processes for the common benefit of nature and livelihoods, agroecology was born at the end of the 1970s when scientists started applying ecological principles to agronomy practices.

PROJECT DESCRIPTION: The theoretical framework of this study is agricultural sustainability defined as “the management and utilization of the agricultural ecosystem in a way that maintains its biodiversity, productivity, regeneration capacity, stability, and ability to function, so that it can fulfill today and in the future: significant ecological, economic and social functions at the local, national and global levels and does not harm other ecosystems” (Swift, 1999; Schaefer, 1999).

A transdisciplinary approach (Poh, 2006; Bergmann et al. 2012; Brandt et al. 2013) will be used in order to answer the research questions and address the challenges of agricultural sustainability in NL province. Assessing agriculture’s sustainability is a complex process. Agricultural activities imply choices that involve numerous trade-offs, such as when we use soil for crops or for animal husbandry, or should we keep soil under wheat? or what type of technologies would be best to use? In attempting to answer these questions, it is important to consider the choices of the individual farmer and to understand how farmers make their production decisions by doing research at the farm level. However, farms are productive units embedded in social, legal, economic and political realities, and research needs to be broadened to include these influences, so as to obtain a holistic picture of the conditions that shape farm decisions.

The study involves three phases. The first phase (May 2022-May 2023) will be a bottom-up assessment of the state of the provincial agricultural system (a diagnosis) following the van den Bosch et al. (2007) Sustainability Assessment of Farming and the Environment (SAFE) framework for assessing the sustainability of agricultural systems. The SAFE analytical framework is a comprehensive content-based hierarchical structure of principles, criteria, indicators and reference values. Data for the framework will be collected from existing relevant literature (academic, grey literature and government reports). The PI will work with both students (PhD1 and PhD2) to conduct a literature and document review of relevant academic and grey literature. Primary data will be obtained from an online survey of a random sample of 200 NL farmers/households and an expert workshop with 12 participants: 3 civil servants (one from the Canadian Ministry of Agriculture and Agri-Foods; one from the Newfoundland Ministry of Finance; a farmer and a professor) and one from the provincial Ministry of Environment, Climate Change and Municipalities, two representatives of the NL Federation of Agriculture, one representative of the NL Environmental Industry Association (NIEA), two academic researchers from Memorial University of Newfoundland (MUN), and two community members. The role of the expert workshop is to produce reliable and valid data about the “domain in question” (Bingewell and Leaman, 2017). To complete the research, students will be assigned specific responsibilities: in phase one, PhD1 will be responsible for conducting the survey and PhD2 will be responsible for conducting the expert workshop. The responsibilities will be divided else over the subsequent phases. PhD2 will be responsible for conducting the survey in phase two, and student PhD1 will be responsible for implementing phase three (thesis group).

The second phase of the research will take place 12 months after the first phase begins (May 2022-May 2023). The objectives of this phase is to assess the level of transition to agroecology of the NL agricultural system by following an adjusted form of the 2019 FAD Tool for Agroecology Performance Evaluation (TAPE/FAD. 2019: TAPE is a step-wise framework for assessing the transition to agroecology at the level of farm, community or province/country based on the 10 Elements of Agroecology developed by FAD experts in 2019. The third phase consists of a focus group meeting (2023) whose objective is the participatory analysis and interpretation of the results of the research carried out in the first and the second phases of the research. To carry out the project, the researcher will work with two graduate students enrolled in the new PhD in Transdisciplinary Sustainability program at Grenfell Campus, Memorial University, and with a co-supervisor who will be a natural scientist deeply specializing in soil science or agriculture and climate change.
OBJECTIVES:
The main objective of this study is to assess the potential for agroecological transition in Newfoundland and Labrador’s agriculture. The research study will answer the following questions: What is the state of the existing agriculture system in NL from a sustainable agriculture perspective? Is agroecology considered an option by the farmers and by agricultural policy makers? Is the system making progress toward agroecology? Successful transition to agroecology practices, such as crop diversification, could be the solution to both the province’s food security issues and the need to preserve its largely healthy but vulnerable boreal ecosystem. Previous research has shown that there are incipient agroecological practices in the NL, province, and that farmers are aware about climate change and the need to adopt more environment friendly farming practices (Abdula, 2019; Rasa, 2019). This study will build upon these previous studies and devise a new line of inquiry to assess the potential for transition to agroecology in the NL province.

FUNDERS/PARTNERS:
- SSHRC Insight Grant - $97,985
- In-kind funding will be provided by the co-investigator in the form of farm space for field tests, and seeds for intercropping experiments.

NAME OF PROJECT: FEASIBILITY OF CAPTIVE REARING OF BOMBUS TERNARIUS

PRINCIPAL INVESTIGATOR: DR. JULIE SIRCOM

PROJECT RATIONALE:
Bees are important pollinators, and one way to increase pollination services using wild bees is to rear wild-caught native species in captivity. In bumblebees, only mated queens overwinter. They emerge in spring, locate a nesting site, and lay an initial brood of eggs. Once these offspring reach adulthood, they too all of the foraging while the queen remains in the nest and lays more eggs. Later in the season, new queens and males are produced, and the original colony dies off. The new queens leave the nest and mate to continue the cycle. There are many factors that can cause a wild colony to fail, from a shortage of nesting sites to colony destruction by predators such as bears. By collecting newly emerged queens in spring and providing them with ideal conditions, the chance of colony success is increased, and once such a colony is established, it can be placed where supplemental pollination is needed. New queens produced by these colonies may be mated with wild-caught, i.e. unaltered, males and overwintered. In 2017, a team at the St. John’s Research and Development Centre of Agriculture and Agri-Foods Canada successfully established a number of bumblebee colonies, which produced new queens that they are currently overwintering. These were mostly Bombus vagans boulteri, in which the males are difficult to distinguish from those of several other species. In western Newfoundland, the most common species is B. ternarius, in which wild males can be easily identified.

PROJECT DESCRIPTION:
I collected bumble bee queens in the spring, and placed them in small cages with access to sugar water and a ball of artificial pollen for egg laying. I kept them in an incubator held at 20°C and regulated humidity to 40-40% using paper towels in a dish of water, which was replaced every other day. I monitored their activity, looking for signs of eggs and brooding behaviour. If they were not brooding eggs after 10-15 days, I released them as close as possible to where I collected them. Had any produced viable eggs, I would have transferred them to larger bees with nesting material; however, any eggs that were laid appeared to have been nonviable, and eventually the queens destroyed them.

OBJECTIVES:
The chief goals of this project were: 1) to determine whether B. ternarius is suited to captive rearing, and if it is, 2) to observe colony development and individual foraging behaviour, and 3) to explore optimal overwintering conditions. Developing these techniques has both agricultural and research applications.

FUNDERS/PARTNERS:
- Grenfell Campus Research Award - $535
NAME OF PROJECT:
THE IMPACTS OF AGRICULTURAL DRAINAGE ON CARBON CYCLING IN BOREAL PEATLANDS

PRINCIPAL INVESTIGATOR:
DR. JIANGHUA WU

PROJECT RATIONALE:
Northern peatlands, storing about 30% of global soil carbon (C), are susceptible to climate and land-use change. They have been, and are still being, converted into agriculture and forestry lands through drainage. Land-use change and other human disturbances, which can be as large as, or larger than, the direct effect of climate change, are key uncertainties in the global C cycle. How do these drained peatlands, with different hydrology and vegetation composition from pristine peatlands, function with respect to C cycling? There is an urgent need to study these changes because the effects of drainage since 2012 have to be accounted for in national greenhouse gas inventories and therefore will become part of land management in the future. However, the peatland C cycling models cannot simulate drainage as they are only parameterized to simulate C cycling under natural conditions. To include drainage in the peatland ecosystem C models requires a greater understanding of the hydrological, ecological and biogeochemical processes of the drained peatlands, and an incorporation of that understanding into the simulation models.

PROJECT DESCRIPTION:
Initially, I will use my new pristine and drained-abandoned pasture peatland sites as my first test cases, but my research will expand to other land-use changes over time. Both field measurements and modeling will be employed in my research program, where field measurements will assist in parameterizing and testing the newly developed Drainage-MWM. This study will be of great value to global change science, especially wetland C cycling science. The measurement will provide us with rigorous and continuous carbon dioxide and methane flux data from both pristine and drained peatlands for model parameterization and evaluation. Moreover, this research will provide climate change and land-use policy makers with a simulation tool for examining how agricultural drainage could potentially affect the ecosystem functions of northern peatlands in terms of carbon cycling. The first definitive results will be pertinent to policy on peatland drainage and use of peatlands as pasture in Canada.

OBJECTIVES:
Agriculture is the most widespread use for peatlands globally, the majority being used as meadows and pasture. Canada has one of the largest areas of agriculturally used peatlands. In this study, we are mainly interested in peatlands converted to pastures.

The long-term objectives of my research program is to understand how the C cycling in northern peatlands is altered by climate and land-use change, and eventually to incorporate that knowledge into peatland ecosystem biogeochemical models for climate and land-use change studies.

The short-term objectives of this five-year research program are to examine the impacts of drainage on ecological and biogeochemical processes and C cycling of northern peatlands, and to parameterize these drainage impacts in the McGill Wetland Model (MWM).

FUNDERS/PARTNERS:
- NSERC (Discovery Grant) – $4,000 per year for six years (one-year extension funding due to pandemic)
NAME OF PROJECT:
ASSESSING THE DAIRY DIGESTATE AS A NUTRIENT AND WATER SOURCE IN SOIL-BASED AND HYDROPONIC GREENHOUSE VEGETABLE PRODUCTION

PRINCIPAL INVESTIGATOR:
DR. ADRIAN UNC

CO-INVESTIGATORS:
DR. MUI ntAZ CHEEMA
DR. LACHMAN KALAGIDARA

INTERNS:
VANESSA MANUEL
MUHAMMAD FARAK
MUHAMMAD NADEEM
EMMANUEL IMONINE

PROJECT RATIONALE:
Newfoundland has relatively extensive livestock farming with a potential to fully satisfy the local requirements for dairy products, chicken, and eggs. Yet, the agriculture of NL is not currently capable to satisfy the entire food requirements for the province’s population. Fresh vegetables, a critical component of a healthy diet, are mainly imported. “The Way Forward” document recently released by the Government of NL targets to increase the agricultural production to 20% from the current 10% by 2032 (The Way Forward, 2016). On the other hand, livestock farms are also one of the largest producers of nutrients rich wastes. A direct integration and efficient utilization of such a resource for satisfying a critical need for the province’s food security is becoming a rather obvious answer. Critically, such an activity would enhance the local economic power with minimal agro-ecosystem matter inputs and cost of production, while enhancing the availability of locally produced fresh vegetables and supporting the province’s food security targets in an environmentally friendly approach.

PROJECT DESCRIPTION:
New World Dairy (NWD) is the largest dairy farm in NL and Atlantic provinces, producing approximately 25% of all milk produced in the province. NWD has established an anaerobic digester at its farm located in St. Davids on NL’s west coast in 2013. The digester generates approximately 55 million liters of nutrient-rich liquid (NRL) by-product annually. The use of dairy digestate (DD) in agriculture could reduce the necessity of inorganic fertilizer application to the forage crops. However, reuse of the DD stream for the growing of high-value vegetables can be seen as more desirable both for the farm and for the consumer, making fresh produce of consistent value and nutrient quality available locally. Climate and poor soil conditions are the main limiting factors for year-round vegetable production in the province. Therefore, production of high-value vegetables under controlled conditions with minimum inputs would be one of the best options available for the province. The overall goal of the project is to comprehensively assess the value of the nutrients in DD and the feasibility of employing DD for the production of greenhouse vegetable under Newfoundland conditions.

OBJECTIVES:
The overall goal of the project is to comprehensively assess the value of the nutrients in DD and the feasibility of employing raw digestates for the production of greenhouse vegetable under Newfoundland conditions. Both soil and artificial substrates (coconut coir/wool-based) based systems were tested. Both fast cycle vegetables (e.g. leafy greens such as lettuce) and vegetables in high demand and with potential for high economic returns in the province such as tomatoes were grown in hydroponic settings using DD.

FUNDERS/PARTNERS/TOTAL FUNDS:
Total funding $288,407.00 (Atlantic Canada Opportunities Agency, $90,000; New World Dairy Inc., $64,995; Memorial University of Newfoundland, student funding, $53,812; TCI, $55,000 (2018-2020))
NAME OF PROJECT:
INTEGRATED EMI-GPR SURVEYS CAN SUPPORT PRECISION AGRICULTURE BY MONITORING AND EVALUATING THE EFFECTS OF LAND USES AND AGRICULTURAL MANAGEMENT

PRINCIPAL INVESTIGATOR:
DR. LAKSHMAN GALAGEDEARA

COLLABORATORS:
DR. MKAMTAZ CHEEMA
DR. ADRIAN UND
DR. RAYMOND THOMAS
DR. CRISTINA SIMEATON
DR. VANESSA KAVANAGH

PROJECT RATIONALE:
Soil physical properties, thus soil hydrology, varies across the landscape and is altered following land use changes and different agricultural practices. Precision agriculture has become the key to increase the productivity and maintaining the sustainability of agriculture. Ground penetrating radar (GPR) and electromagnetic induction (EMI) methods can be used to assess the spatiotemporal variability of soil properties that will directly or indirectly effect on soil hydrology. For achieving this, soil apparent electrical conductivity (ECa) and radar wave velocity (RWW) will be used through integrated EMI/GPR. However, estimating soil properties using traditional methods is expensive, labor intensive, and time consuming and provides point information only, which hinder any rapid response management activities. A potential way to acquire information at field level is by noninvasive mapping of easily recordable and reproducible physical variables such as EC using the EMI and RWW using the GPR that correlates with relevant soil properties. The application of the integrated EMI/GPR methods for estimating the spatiotemporal variability soil properties are unique in broad ecosystems and will aid in the development of new scientific knowldege for sustainable management of land and water resources. In this research, combined multi-coil and multi-frequency (EMI) sensors integrated with GPR using different frequencies will be correlated with fundamental soil properties.

PROJECT DESCRIPTION:
The proposed research will address key research gaps regarding the understanding of the effects of different land uses and agronomic practices for supporting precision agriculture. Development of protocols and guidelines for conducting ECA surveys using combined (EM) sensors integrated with GPR will help to monitor the spatial variability of soil properties across different landscapes rapidly. Thus, current soil, water and nutrient management decisions can be decided in supporting precision agriculture.

OBJECTIVES:
Objectives of the research are to: (a) allocate ECA data to stable soil relatively stable soil properties and generate regression models using measured data, (b) obtain variable soil parameters to reveal hydrological processes such as water holding capacity, water repulsion and infiltration capacity by means of time-lapse EMI; (c) evaluate the accuracy of two different (EM) sensors and their exploration depths for predicting nearsurface soil properties by integrating with GPR measurements and ground truth data; and (d) assess the effects of different land use and agronomic practices on soil properties based on the results from a-c. The integrated EMI-GPR soil sample information will build the baseline for different management scenarios and concepts. The long-term goal is to generate high-resolution maps of key physical and hydraulic properties in order to assess the effects of different land uses and agronomic practices on soil hydrology, and thus on precision agriculture.

FUNDERS/PARTNERS:
• NSF under Discovery Grant - $155,000
NAME OF PROJECT:
DESIGN, FABRICATION AND EVALUATION OF A SMALL SCALE AND LOW COST VERTICAL GARDEN HYDROPONIC SYSTEM

PRINCIPAL INVESTIGATOR:
DR. LAKSHMAN GALAGEDARA

CO-INVESTIGATORS:
DR. MUMTAZ CHEEMA
DR. MAPO KANINULLAY
DR. RAYMOND THOMAS
DR. MUHAMMAD NAJAF

INTERNS:
KAMROZA JIYARASA
ELHAM FATHI/MARINJUEH
ABIDIN A. ADELOWOYIN

PROJECT RATIONALE:
The main goal of this research project is to develop a sustainable fruit and vegetable production system for households and small communities. One of the major agricultural challenges faced by Newfoundland and Labrador (NL) is the lack of locally produced fresh vegetables, primarily due to major barriers such as harsh climatic conditions, and poor soils leading to food insecurity on the island. Hydroponic growing systems could be a reasonable solution to address acidic and nutritionally poor soil as well as climatic limitations in NL. Through this project, we expect to address these main challenges related to hydroponic agriculture and propose a suitable system for large scale adoption in households across the province including small and rural communities.

PROJECT DESCRIPTION:
This two-year research project will design, fabricate, and evaluate a small scale and low cost vertical garden hydroponic system with enhanced capabilities of water and nutrient use efficiency. One of the major agricultural challenges faced by Newfoundland and Labrador (NL) is the lack of locally produced fresh vegetables. On the other hand, the well-being of residents depends on the production, and availability of fresh affordable foods. According to a report from the Harris Centre (2010), the province of NL currently imports 90% of its fresh fruits and vegetables. These fresh fruits and vegetables are more expensive in NL, compared to other provinces in Canada. Therefore, people of the province are more likely to turn to other less healthy but readily available food options due to the modest supply of locally produced or imported foods. These food choices contribute to the prevalence of diet-related chronic diseases, such as cancer, cardiovascular disease, obesity and diabetes and prevalence of these diseases is higher in NL, than the national average (Public Health Agency of Canada, 2008). Climatic conditions (seasonal changes) in the province, poor soil quality, lack of infrastructure, inadequate skilled labor, poor knowledge on advanced production technologies, etc., are the main barriers for expanding small scale agriculture in the province. Greenhouse vegetable production of NL decreased by 17.1% between the period of 2011 to 2014 (Statistics Canada, 2017). These factors might be the reason for the low availability and high demand and price for leafy vegetables in NL. Small scale production of vegetables and fruits at the household or community level using hydroponic systems could be a reasonable solution for acidic and nutritionally poor soil base media as well as climatic limitations in NL. The following research questions will be explored in this project: 1. What is the current vegetable production, importation, and availability of fresh vegetables, and their seasonal price variability in Newfoundland? 2. Do people (or communities) in NL prefer to have an indoor hydroponic system at the household level and grow their own vegetables? 3. What hydroponic systems are available for small-scale agriculture and what are their main drawbacks? 4. What is the possibility of developing and testing a small scale and low cost vertical garden hydroponic system suited to households and small communities in NL? 5 Can this system maximize the production quality with enhanced water and nutrient use efficiency?

OBJECTIVES:
The overall goal of this project is to develop a sustainable fruit and vegetable production system for households and small communities in NL through the design, fabrication and evaluation of a small scale, low cost vertical garden hydroponic system. In achieving this goal, currently available small-scale hydroponic systems will be evaluated with respect to technology, operation and maintenance, initial cost, and suitability to produce fresh vegetables at household and small community levels in NL. Two new systems (flood & drain (S&F) and modified flood & drain (re-circulating deep water culture, R&DWC)) will be designed and fabricated and will be evaluated for producing commonly consumed leafy vegetables and micro-greens. Biomass production as well as the sensory and nutritional quality of the produce will be evaluated and compared against other simple hydroponic systems available in the market.

FUNDERS/PARTNERS:
• Mires – Accelerate – $75,000
NAME OF PROJECT:
IMPROVING SOIL QUALITY FOR ENHANCED CROP PRODUCTION AND WATER USE EFFICIENCY USING INTEGRATED EM-EMI SURVEYS

PRINCIPAL INVESTIGATOR:
DR. LASHMIK BALAGESWARA

CO-INVESTIGATORS:
DR. DANIEL ALTSCHIFF
DR. ADRIAN UNG
DR. MUMTAZ EHERMA
DR. VANESSA SARRANAGH

INTERNS:
KAMAL KUMAR SALMAN
KEERTHANA KEETHIWARAM

PROJECT RATIONALE:
To become less dependent on food imports in Newfoundland and Labrador (NL), the local food production must increase. This project will support the province’s goals of increasing food security by developing ways to increase crop productivity. The dominant soil type in NL is Podzol, a mainly sandy soil, considered unattractive for arable cropping and prone to leaching of additives. Agricultural activities in NL are additionally challenging due to the cold climatic conditions and climate change related alteration of weather patterns, which can in turn limit existing agricultural production. Efforts to successfully increase local food production require a better understanding of the interplay between climate and soil.

PROJECT DESCRIPTION:
One important way to become less dependent on food imports in Newfoundland and Labrador (NL) is the increase of local food production. However, the dominant soil type in NL is Podzol, a mainly sandy soil, considered as unattractive for arable cropping which limits its agronomic outcome. While higher rainfall amounts are likely to increase surface runoff, erosion and nutrient loss, certain months are expected to receive less rainfall, particularly during the early growing stages, resulting in irrigation requirements. Knowledge about hydrological conditions targeting soil and water conservation is therefore essential in sustainable agriculture for improving productivity while minimizing negative environmental effects.

To address these challenges, precision agriculture (PA), tailored treatments in relation to spatial and temporal variability of soil properties and nutrients, become a key strategy. However, mapping and monitoring of soil properties and related hydrological processes using traditional methods is expensive, labour intensive, and time consuming. A potential way to acquire these key properties at field scale is given by non-invasive measuring of easily recordable physical variables, such as apparent electrical conductivity (ECa) using electromagnetic induction (EMI). The proposed project aimed hence to generate a comprehensive set of variables to investigate the ability in integrated GPR-EMI method for discrete allocation of key soil hydraulic properties as needed for enhanced crop production and water use efficiency.

Here, we propose a project to improve local soil and water management towards higher crop and water productivity by combining hydrological modeling and PA. Hydrological modeling and some ground truthing will focus on the soil column (small scale), while the proximal soil sensing, approaches will help to transfer these findings into the field scale. By combining field measurements, hydrological simulations and using already available climate data, the project will investigate the interplay between different management practices, focusing on key hydrological parameters such as infiltration runoff relationships, water holding capacity and deep drainage. The resulting effects on these parameters are basically unknown, although they are essential for water management and crop growth. Regional climate analysis will allow to assess the likelihood of climatic conditions for the next 10-15years while its outcome will be used for simulation and planning of water management practices, for example the requirement of either irrigation or drainage. Once the effects of various land use on hydrological conditions are understood, certain land use recommendations on local farmland can be amended. (e.g. suitable crop selection, irrigation rates and timing and beneficial management practices for best outcomes).

OBJECTIVES:
To reached the desired higher cropping outcome, this project aims to deal with three key issues: (i) predicting local weather as relevant for agricultural planning, (ii) understanding the climate impact on local soil, (iii) adjusting and improving existing and future agricultural management based on findings and (iv) minimizing the ecological impact of food production activities.

FUNDERS/PARTNERS:
• TERRI - $47,350
NAME OF PROJECT: HYDROGEOPHYSICAL CHARACTERIZATION OF AGRICULTURAL FIELDS IN WESTERN NEWFOUNDLAND USING INTEGRATED GPR-EMI

PRINCIPAL INVESTIGATOR: DR. LAXMAN GALAGEDEARA

CO-INVESTIGATORS: DR. ADRIAN UNC DR. MUNTATZ CHEIMA DR. RAYMOND THOMAS DR. VANESSA KAVANAGH

INTERNS: EMMANUEL BADEWA CHAMEERA ILANKATHURE DINUSHKA WANNAPRACHCHI KAMALESWARAN SADTHARAM DANIEL ALTOFF (POSI) MARLI VERMooten (BSc-HONORS)

PROJECT RATIONALE:
Development of an environmentally sustainable agricultural industry through improved farm practices has become a top priority of the province of NL. It is not always possible to increase the extent of arable lands as that can negatively affect biodiversity and threaten the ecosystems’ sustainability. The main goal of this proposed research project is to evaluate the accuracy of integrated GPR-EMI method for non-invasive mapping of the spatiotemporal variability of soil physical and hydraulic properties in boreal soils. The results and knowledge generated through this project will be useful in sustainable management of soil and water resources in increasing agricultural and crop productivity while protecting valuable ecosystems.

PROJECT DESCRIPTION:
The inherent nature of shallow depths and low water holding capacity of provincial soils may restrict the yield potentials in agricultural lands. New protocols for water and land management and efficient use of these resources is therefore essential for improving the agricultural and water productivity. This will directly support the food security, economic development, and generates employment. Moreover, improved agricultural and water productivity is essential when facing the challenges from climate change, population growth and global market integration.

The knowledge of near-surface hydrology is extremely important in fields such as agriculture, forestry, meteorology, environmental soil engineering etc., as it controls plant growth, key hydrological processes and climate and the contamination of surface and subsurface waters. Additionally, changes in soil properties and contamination of both soil and water resources directly affect agricultural sustainability as well as the sustainability of adjacent managed or natural (eco) systems. Due to the natural heterogeneity of the subsurface, its accurate characterization is essential for understanding movement of water in the vadose zone, groundwater recharge and solute transport. Additional subsurface investigations include groundwater table mapping, variability of soil properties, locating buried objects and cavities, mapping stratigraphy etc., most of these are not often possible to carry out accurately. The conventional methods used in such characterizations are invasive, time-consuming, costly, and provide point measurements with large uncertainties across field scales. Recent advances in digital technology, computing and geophysical instrumentation provide opportunities for researchers and managers to efficiently map the heterogeneity of soil properties at both spatial and temporal scales. Among these, near-surface geophysical methods, ground penetrating radar (GPR) and electromagnetic induction (EM) methods have been tested and used extensively. A simple literature survey indicates a lack of research on western Newfoundland soils and the impacts of their properties on near-surface hydrology for both managed and natural lands, water use efficiency and agricultural production, contaminant transport, groundwater recharge potential, and climate. To fill this gap, we propose the development and implementation of an integrated GPR-EMI as a non-invasive geophysical approach for remotely sensing the spatiotemporal variability of soil physical properties to support precision agricultural and environmental management under both managed and natural landscapes in western Newfoundland.

OBJECTIVES:
Objectives of this research project are to: (1) measure spatiotemporal variability of soil physical and hydraulic properties during growing seasons of cereal crops under different management systems using integrated GPR-EMI methods, (2) evaluate the accuracy of estimated soil physical and hydraulic properties using GPR-EMI methods with standard methods and (3) develop soil hydraulic functions and develop a methodology to measure crop water requirement for soils of the research farm using the GPR methods.

FUNDERS/PARTNERS:
• RDC-Ignite R&D & MUNI - $150,000
NAME OF PROJECT: EFFECTS OF CROP ROTATION AND NITROGEN STABILIZERS ON SOIL, QUALITY CROP YIELD, N LOSSES, AND GHG FLUXES UNDER COOL CLIMATIC CONDITIONS

PRINCIPAL INVESTIGATORS: DR. MUNIRZ CHISMAA (Boreal Ecosystem Research Initiative, School of Science and the Environment, Grenfell Campus)

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CO-INVESTIGATORS: DR. LAKEEM MALALAGADAR (Boreal Ecosystem Research Initiative, School of Science and the Environment, Grenfell Campus)

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SALMAN
(M.Sc. Candidate, Boreal Ecosystems and Agricultural Sciences program, Grenfell Campus, Memorial University)

PROJECT RATIONALE: Newfoundland and Labrador (NL) is located in the boreal climate and is dominated by podzolic soils which are acidic, stony, and rocky. The short, cool growing season with erratic late spring or early fall frost often limit the capacity to grow sufficient food and feed in the province. Food production in NL is currently at 10% of local demand, leading to overreliance on imports and low food security. Through the Way Forward on Agriculture, the NL government is committed to doubling food production by 2023. To pursue this initiative, 60,000 ha of land have been earmarked for the expansion of agriculture sector. The low fertility of NL soils hampers crop growth, development and significant reduction in production potential of crops. Furthermore, NL topography and erratic rainfall patterns cause significant nutrient losses through leaching, volatilization or greenhouse gas (GHG) emissions. NL has a robust dairy and livestock industry, but feed forage shortages lead to the importation of most feed ingredients, adding to the overall cost of production. There is significant growth in the area of silage corn in the province, and there is growing interest in the adoption of crop rotations and fertilization strategies that minimize soil degradation and nutrient losses while promoting forage production and quality. Grain crops, oilseeds, and some annual forage legumes are stable crops for NL, and may be suitable for rotation with corn silage; however the implications of such rotations for yield and nutrient use efficiency have not yet been demonstrated.

Nitrogen is essential for achieving optimal crop yield and is commonly applied as urea. It is critical to establish the best timing of application, rate, source and placement of N fertilizers to promote minimal N losses and optimal productivity. One strategy is the application of N fertilizer stabilizers (e.g., urease inhibitor (N)-butyl-N-(2-chloroethyl) phosphine oxide) or nitrification inhibitors (Dicyandiamide and Nitrapyrin) to suppress nitrous N release from urea with plant N uptake. These additives have shown potential to improve nutrient use efficiency and decrease N losses through nitrates (N2O) leaching, ammonia (NH3) volatilization, and denitrification in other regions. Their inclusion in the expansion of boreal agricultural production warrants investigation.

OBJECTIVES: Field plots were established in 2019 at Western Agricultural Research Station in Flynns Brook, NL, to assess five corn-based rotations: (1) corn–corn–clover–alfalfa; (2) corn–spring wheat–corn; (3) corn–faba beans–corn; (4) corn–canola–corn; and (5) corn–oat/pea mix. Five commercially available N sources were evaluated: (a) urea (UC); (b) SuperU™ (SM), urea with DCD and NBPT; (c) Agrotens™ (AG), urea with NBPT; (d) eNrench™ (EN), urea with nitrapyrin; (e) 30/70 split urea (pupH) and (f) No–N fertilizer control (NFC). The specific objectives were to evaluate the short-term effects of corn-based rotation systems and N stabilizers on:

- the growth, yield, N uptake and quality of silage corn, faba bean, spring wheat, canola and oat/pea mix
- grain yield of spring wheat and canola grown in rotation with silage corn
- N leaching, N use efficiency, GHG emissions, and mineral N (NH3- and N2O) dynamics
- diversity and functions of genes involved in nitrification and denitrification
- soil physicochemical and biological parameters (soil health)

FUNDERS/PARTNERS:
- The Agricultural Clean Technologies Program (ACT), Mitacs, ACCA, IET, and CRDFP – $1.3 million
NAME OF PROJECT: USING ADAPTIVE MANAGEMENT TO REDUCE FISHING PRESSURE ON GOLDEN COD NEAR THE GILBERT BAY MARINE PROTECTED AREA (MPA)

PRINCIPAL INVESTIGATOR: DR. PAUL FOLEY

INTERN: CAMERON PYE

PROJECT RATIONALE:
Golden cod are a genetically distinct group of cod within the larger “northern cod stock complex” as assessed by COSEWIC as endangered in 2003. The Marine Protected Area (MPA) monitoring program results show a 95% decline in Gilbert Bay cod biomass since the 8-opening of the 22 stewardship and recreational cod fisheries in 2006 (Morrice and Groves, 2016). The decline in biomass and numbers of commercializable Golden cod corresponds closely to fishing effort of Northern cod near Gilbert Bay (DFID, 2013).

PROJECT DESCRIPTION:
Semi-structured interviews with knowledgeable stakeholders, participatory mapping, and cutting-edge small-scale technology that can be utilized by local fishers.

OBJECTIVES:
We aim to achieve multiple objectives through this work, including: Monitoring the use of gear types and exploring less impactful options, identifying hotspot spots of Abandoned, Lost or Otherwise Discarded Fishing Gear (ALDFG) in order to retrieve, and explore options for improved policy and management as well as alternative practices regarding end-of-life fishing gear. We anticipate a constructive outcome as multiple partners work collaboratively to meet the wide range of priorities, including institutional, social/cultural, ecological, and economic.

FUNDERS/PARTNERS:
- Mitacs Accelerate and Canada World Wildlife Fund - $65,000

NAME OF PROJECT: SUSTAINING PUBLIC SPACE: THE ST JOHN’S FARMERS’ MARKET IN THE TIME OF COVID

PRINCIPAL INVESTIGATOR: DR. ROZA TCHOMKALEWKA

PROJECT RATIONALE:
In an instance where public spaces are seen as key to building urban inclusivity, vibrancy, and opportunities for socialility, changes to the fabric of urban space can impact those variables and change the dynamics of community life. In equal measure, the public spaces alternations enacted by public health regulations via social distancing, closures of public (i.e., parks, playgrounds) and semi-public spaces (markets, shopping malls), and limits on gatherings are essential during these precarious covid times. This unprecedented situation — where the need for solidarity in times of crisis is matched with a need to limit social contact — raises questions about the function of public space and the ability of cities to retain key social and community infrastructure during covid.

PROJECT DESCRIPTION:
Methods: online surveys, qualitative interviews, participant observation/site visits.

OBJECTIVES:
This project aims to understand the impact of public health regulations on urban public and semi-public spaces, with a focus on the St. John’s Farmers’ Market.
NAME OF PROJECT: RESHAPING THE CITY THROUGH AGRARIAN PROTEST: PUBLIC SPACE, RURAL ACTORS, AND THE CULTURAL IMPLICATIONS OF INTERNATIONAL TRADE AGREEMENTS

PRINCIPAL INVESTIGATOR: DR. KOO TCHEN/KALEYKO

PROJECT RATIONALE: The explosive growth of urban areas in the last century means that cities are increasingly sites of political, economic, and social power. Decisions made in capital cities and urban financial centers reverberate for beyond municipal boundaries, and have implications for rural and remote areas. Yet, the process through which rural needs are integrated into urban-based decision making, and in particular the ways through which such decisions are resisted, is not well understood. This project examines rural-urban public space activism in Canada and France, and interrogates the capacity of rural actors to claim a “right to the city.” It builds on the premise that public space is a key site for the enactment of citizenship rights and considers how farmers deliberately disrupt urban/urban divides by occupying city-centric public spaces with tractors, farm animals, and by dumping produce to protest the Canada-EU trade agreement (CETA), the Trans-Pacific Partnership (TPP), and other international free-trade accords.

PROJECT DESCRIPTION: Through semi-structured interviews and sensory ethnography techniques, this project will seek commonalities and differences between Canadian and French case studies. It will draw on three specific instances of urban agrarian protest: dairy farmer protests in Reness (France) in 2015 and in Ottowa (Canada) in 2014, viticultural protests in Montpellier (France) in 2018. Research will take a ‘follow the thing’ approach and trace how agrarian protest links urban public spaces in Ottawa (Canada) to rural regions in Quebec and Ontario, and in Montpellier and Reness (France) to their surrounding countryside.

OBJECTIVES: This work has the following aims to:
1. Consider how farmers use urban public spaces to define rural interests, with attention to the materiality of urban agrarian protests and the sensory and social effect of bringing farm machinery and farm animals into the city.
2. Analyze the role of farmers as transnational political actors, and critically reflect on the complex local-global links formed through organized resistance to international trade accords.
3. Put to question how varied identities are imprinted on public space, and whether urban agrarian protests result in greater civil participation by rural actors.
4. Critically reflect on the interactions between farmers, city residents, state actors, and agrarian unions during urban protests, and examine the economic and political outcomes of these events.

FUNDERS/PARTNERS: + $94,425

NAME OF PROJECT: EFFECT OF BIOCHAR ON SOIL FERTILITY, NITRATE LOSSES, FORAGE CROP PRODUCTION AND GREENHOUSE GAS (GHG) EMISSIONS

PRINCIPAL INVESTIGATOR: DR. JIANHUA WU

PROJECT DESCRIPTION: A significant challenge faced by agricultural industries in NL is boosting sustainable agricultural production. Low soil organic matter and low soil pH are among the most serious limitations to production in NL. Fertilizer, manure or compost needs to be applied to local soils, although it is poorly retained, resulting in financial loss and the leaching of nutrients (e.g., N and P) which eventually results in environmental pollution. In addition, most soils in NL require periodic addition of lime since their natural acidity limits agricultural production. The proposed research will help to identify the suitable biochar for N absorption capacity and mitigation of GHG emissions. Furthermore, the biochar research information will be shared with NL farmers, agricultural industries and governments in order to transfer the knowledge to the farmers.

OBJECTIVES: The specific objectives of this thesis were to determine the effectiveness of biochar on: (i) nitrate removal from aqueous solutions, identify the highest nitrate adsorption capacity among four types of biochar, and determine the associated mechanism of nitrate adsorption onto biochar, (ii) to investigate the capability of biochar application for improving the soil fertility, forage production and quality, and nutrient uptake in the podzolic soil of Newfoundland, (iii) to examine the impact of biochar application on reducing leaching losses of N and C from the eastern Newfoundland podzolic soil; (iv) to investigate the capability of biochar application to improve soil fertility, crop productivity and reduce GHG emissions from podzolic soil.

FUNDERS/PARTNERS: + Canadian Agricultural Partnership (CAP) - $25,000
NAME OF PROJECT:
EVALUATING THE POTENTIAL OF USING A COMBINATION OF BIO-REMEDIATION AND PHYTOREMEDIATION OR A HYDROCARBON AND METAL CONTAMINATED SITE

PRINCIPAL INVESTIGATOR:
DR. MAND KRISHNAPILLAI

CO-INVESTIGATOR:
DR. LAKSHMAN GALAGEDARA

INTERN:
NATALIE PARSONS

PROJECT RATIONALE:
Anthropogenic industrial activities can lead to accumulation of harmful hydrocarbons and heavy metals in soil environment that can have human health impact and may enter food chain affecting ecosystem as well. If these contaminations happen at a public site, then the space cannot be used by public unless the contaminant levels are brought down below the maximum allowable concentrations. While several capital-intensive physical and chemical remediation technologies such as excavating and replacing the contaminated soil or excavating and soil washing or soil burning are available, these technologies can have lasting harmful impact on the soil environment and soil health. Besides, they can be a financial burden to a public property for remediation.

PROJECT DESCRIPTION:
In situ biostimulation by adding nutrients, air, or microbes using natural soil amendments such as compost, and phyto-remediation of hydrocarbon using rhizosphere breakdown by growing plants that have good root density, and uptake of heavy metals by growing suitable native phyto-accumulators can remediate the contaminated soil in the long run while being inexpensive and can also be good for soil health and in the environment at large. Promoting earthworm population onsite can also support in increasing the remediation of hydrocarbon. A demonstration of this combined environment-friendly phyto-technology can have ripple effect in remediating other public and private properties where the owners look for less capital-intensive and less harmful green technologies. This research study will be conducted in a contaminated site in southwestern Newfoundland.

OBJECTIVES:
The main aim of this research project is to develop and test a sustainable green remediation technology to bring down the contaminant levels in a hydrocarbon and heavy metal contaminated site so that it can be used for public use.

FUNDERS/PARTNERS:
- Mitacs: $53,332