IC-IMPACTS

2023 IMPACT REPORT

PHOTOGRAPHY CREDITS: FRONT COVER PHOTOS BY GABRIEL WHILEIMOUT AND RAGHU NAYYAR, BACK COVER PHOTOS BY RYUNOSUKE KIKUNO AND SHALENDER KUMAR ON UNSPLASH.

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RECENT YEARS IN REVIEW

The past few years have seen steady progress resulting from IC-IMPACTS Canada-India scientific collaborations as we continued to develop community-based solutions in the areas of Public Health, Safe and Sustainable Infrastructure, Integrated Water Management, and more recently, in Food Security and Agritech. We are pleased to report that IC-IMPACTS continued to advance research collaborations and knowledge transfer between Canada and India, and launched a number of new Calls for Proposals.

Throughout the year, IC-IMPACTS continued to explore opportunities for expanding the Board of Directors, with regional diversity and equity, diversity, and inclusion (EDI) principles as priorities. As a result, we welcomed three new Board members in the 2021–2022 fiscal year, all of whom have diverse expertise and an exceptional academic, research, business and professional track record. Our new Board members will certainly strengthen our leadership and will bring additional insight to our work.

IC-IMPACTS unique model is a tangible demonstration of the importance of collaboration in science and technology and we particularly value the support received from the Government of India through the Departments of Biotechnology (DBT) and Science and Technology (DST).

We remain committed to providing students and researchers in both countries, the support they need to develop skills, perspectives, and mindsets to pursue research for social good. The success of our entrepreneurship training can be seen in the employment rate of our graduates. IC-IMPACTS also continues to expand its network by collaborating with universities, NGOs, industry leaders, and communities across Canada and India as we progress towards our long-term vision of building a financially sustainable Centre.

We are grateful to our entire team - Board members, Research Management Committee, CEO and Scientific Director, staff, partners, researchers, and students across Canada and India - for their dedication and commitment to IC-IMPACTS. We also acknowledge the amazing support we continue to receive from the Networks of Centres of Excellence (NCE) and the Natural Sciences and Engineering Research Council of Canada (NSERC).

Mr. Barj S. Dhahan
Chairman of the Board of Directors

We are pleased to share with you IC-IMPACTS' IMPACT report. The past years were ones with opportunities, discovery and development. The report summarizes the impact of our network on research, innovation, and student training and captures some of the main achievements of our work, illustrating how Canada-India partnerships help drive innovation.

IC-IMPACTS' work has always been identified and steered by community need with a focus on helping communities adapt to a changing world. We continue to facilitate collaborations between Canada and India, as it is our commitment to expand the very successful model of applied research, through partnerships with industry and the engagement of local communities in order to contribute to the well-being of communities in both countries. We remain fundamentally committed to the model of science-based research and social innovations that accelerate trade and transform the lives of citizens.

Our collaborations with the Government of India's Department of Science and Technology and the Department of Biotechnology have strengthened over the years. These collaborations have resulted in exciting new research in the areas of health, water, infrastructure and agritech.

Collaborations with a number of First Nation communities across Canada have led to transformative social changes, particularly the target Indigenous communities, and IC-IMPACTS technologies are now being scaled up and installed in other communities across Canada and India.

Creating innovative training and networking opportunities for our Highly Qualified Personnel (HQPs), including graduate students and postdoctoral fellows, remains a key mandate. With 1,331 HQPs trained, IC-IMPACTS continues to create innovative and hands-on training and networking opportunities for our HQPs. Our researchers have produced 1,431 peer-reviewed research publications and launched 8 start-ups. IC-IMPACTS continues to play an important role in developing partnerships between researchers and companies. With more than 383 partnerships created and 33 patents, IC-IMPACTS is accelerating knowledge-based trade between Canada and India.

Dr. Nemy Banthia
Chief Executive Officer and Scientific Director

IC-IMPACTS AT A GLANCE

74
RESEARCH PROJECTS

1,331
HQP TRAINED

383
PARTNERSHIPS CREATED

8
START-UPS LAUNCHED

33
PATENTS FILED

1,431
SCIENTIFIC PUBLICATIONS

RECENT WORKS

Translating Research Into Communities

IC-IMPACTS announced two Calls for Proposals during the past two years. The first Call was for Innovative Technology Demonstrations, for which the project titled 'High-Performance Connections for a Tall Indigenous Timber Sculpture' by Dr. Tony Yang of The University of British Columbia, received funding. As part of this demo project, five 20-foot-long timber segments will be connected to form a 100-foot-tall timber sculpture. The work is part of the Medicine Wheel Puzzle Project, with UBC researchers assisting in the fabrication of structural engineering components.

The second Call for Proposals was for projects in Food Security, and following a rigorous review, the following 3 projects were announced as awardees:

- Variable Rate Application of Nutrients by Developing Nutrient Estimation Sensor andPrecision Spraying Mechanism
  Led by Dr. Ahmad Al-Mallahi, Dalhousie University and Dr. Narasimha Murthy, IIT-Tirupati
- Irrigation Scheduling Using Model-Based Reinforcement Learning for StochasticDifferential Equation Control
  Led by Dr. Chi-Guhn Lee, University of Toronto and Dr. Subimal Ghosh, IIT- Bombay
- Exploration of an Intra- and Inter-National Blockchain-Powered and Physical Internet-Enabled Food Supply Chain Traceability System in Canada and India
  Led by Dr. Eric Li, University of British Columbia (Okanagan) and Dr. Mansi Babbar, University of Delhi

BUILDING WORLD'S TALLEST FREE-STANDING INDIGENOUS SCULPTURE WITH ENGINEERED CONNECTIONS

ADVANCING RESEARCH:

INNOVATION

DEMONSTRATION

COMMERCIALIZATION

DEVELOPMENT OF INNOVATIVE TECHNOLOGY

IC-IMPACTS' bilateral Canada-India model is identified and driven by community need, with outcomes being deployed internationally, from Canada's Indigenous communities to urban and rural communities in India. The following theme-based examples demonstrate the success of IC-IMPACTS' model.

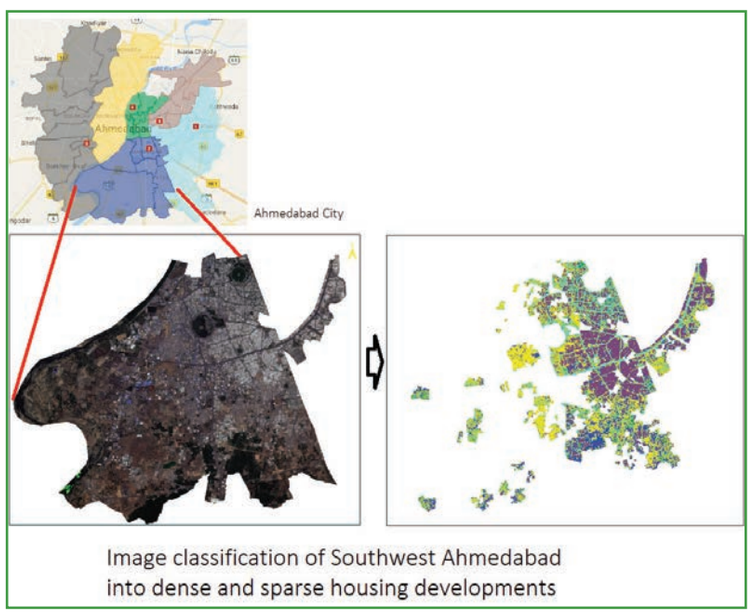
Public Health and COVID-19 Related Projects

Biovalorization of Lignin
Canadian Lead: Dr. Vikramaditya G. Yadav, The University of British Columbia
Indian Lead: Dr. Syed S. Yazdani, International Centre for Genetic Engineering & Biotechnology (ICGEB)

This project seeks to develop a bioprocess for the manufacture of capsaicinoids and capsinoids from lignin. The project is a key piece in the development of innovative biotechnologies to reduce the environmental footprint of current manufacturing operations. Researchers employed bioinformatics and synthetic biology to replace the rate-limiting biocatalyst with a more active heterologous enzyme and observed enhanced production of the fatty acyl-CoAs.

Agent-Based Simulation of COVID-19:
Estimating the Spread and Disease Burden Using Advanced Epidemiological Modelling
Indian Lead: Dr. Deepak Saxena, Indian Institute of Public Health-Gandhinagar (IIPHG)
Canadian Lead: Dr. Raja Sengupta, McGill University

Researchers from three institutions (McGill, BITS Pilani Goa Campus, and the Indian Institute of Public Health Gandhinagar (IIPHG)) worked closely to provide geospatial data support for the location of reported COVID-19 cases and identification of hospital resources, which in turn were used by Ahmadabad Municipal Corporation (AMC). Researchers obtained, via IIPHG, the location of COVID-19 cases for the city of Ahmedabad. This allowed for the calculation of the "rate" of infection spread, or the "R" value by region. Importantly, these rates have been shown to vary by density of housing. Additionally, housing density maps were identified from high resolution Satellite Imagery (Planet Labs).



RATE OF SPREAD OF COV ID-19 IN AHMEDABAD
WITH RESPECT TO HOUSING DENSITY

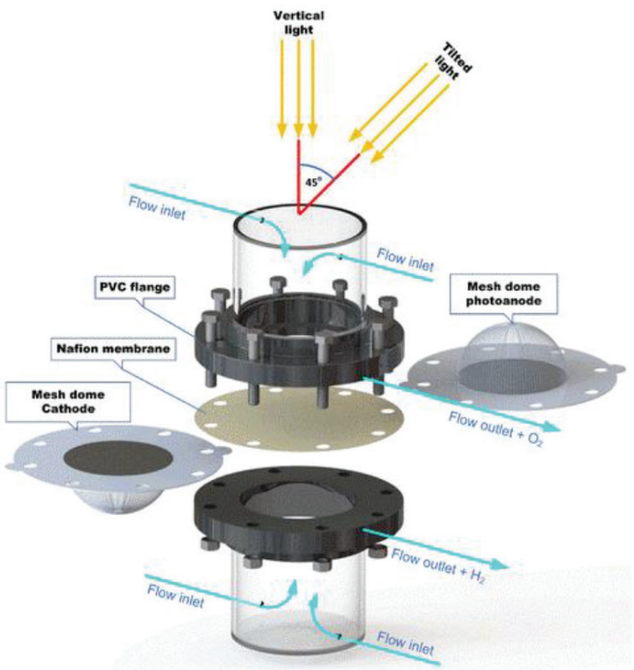
Integrated Water Management

Carbon Neutrality through Combined CO_2 Capture and Novel H_2 Technology with Production of Non-Conventional Fuels for Smart Cities

Canadian Lead: Dr. Ibrahim Dincer, Ontario Tech University
Indian Lead: Dr. Subrata Borgohain Gogoi, Dibrugarh University

CO_2 is recognized as the main pollutant responsible for the super green-house effect, causing global warming and climate change. This project aims to convert CO_2 into valuable synthetic, non-conventional and non-renewable fuels for reducing CO_2 emissions and boosting the deficient energy sector. Two novel photoelectrochemical (PEC) reactors have been designed, developed and tested experimentally in Clean Energy Research Laboratory (CERL), at Ontario Tech University. The two hydrogen reactors bring a new perspective to PEC process via novel photoelectrodes' geometries improving the effectiveness of the process considerably.

Moreover, a significant study has been conducted on developing ammonia-based carbon capturing systems that produce useful chemical outputs (primarily ammonium bicarbonate) to offset the energy penalty typically imposed by implementing a carbon capture retrofitting to a power plant. Researchers working on this project have published 15 peer-reviewed research articles in highly prestigious energy journals and have presented a number of papers at reputable international conferences.



VIEW OF THE DEVELOPED PEC HYDROGEN APPARATUS

Development of Capacitive Deionization Technology for Point-of-Use Water Purification
Indian Lead: Dr. Satish Kumar, Eureka Forbes Ltd.
Canadian Lead: Dr. Madjid Mohseni, The University of British Columbia

This project aims to further understand carbon corrosion under a variety of experimental conditions. Researchers identified the importance of conducting long-term assessment experiments using a three-electrode cell.

Fundamental work was carried out using an electrochemical cell that allowed fine-tuning and exceptional potential control. This helped overcome issues with potential allocation that occur in classic, more practical, two-electrode cells. The new setup enabled the careful control over the thermodynamic state of the electrode being studied.

The research revealed the unsuccessful outcome of electrochemical regeneration approaches and in fact, demonstrated the need for adequate pre-treatment for iron containing brackish waters to avoid increased decay and loss of performance.

Safe and Sustainable Infrastructure

Development of Cost-Effective, Energy Efficient, and Resilient Housing Technologies for First Nations Communities
Lead: Dr. Ashutosh Bagchi, Concordia University

The housing shortage and the lack of long-term durability of housing structures in northern and First Nations Communities are well recognized. In this project, a holistic and integrated approach is adopted to incorporate renewable energy technologies into conventional heating and cooling systems for buildings in order to support development of resilient First Nations Communities. The components of which include: (a) development and fine-tuning of low-cost sensors for measuring vibration and thermal comfort in buildings; (b) integration of solar power, which is intermittent with the traditional power source to provide resilient and sustainable energy supply for indigenous housing; (c) innovation in prefabricated and modular housing to achieve lower cost, faster construction and higher durability, necessary for the studied community.

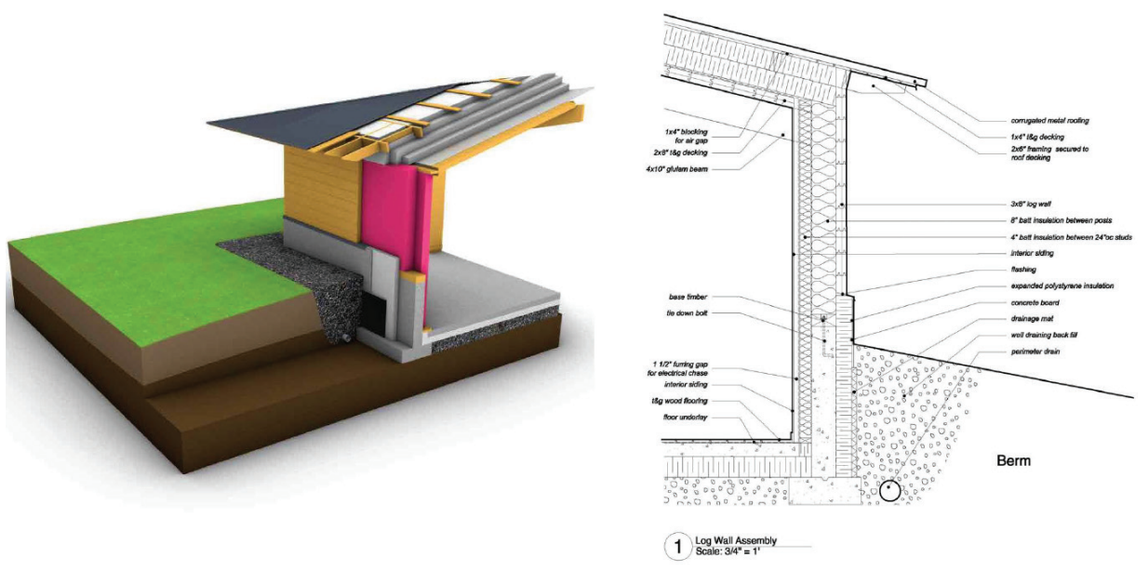
To date, researchers have built and tested low-cost innovative sensors for thermal and vibration monitoring. A simulation study on Photovoltaic-thermal (PV/T) collector systems for on-site energy production and integration with heat pump systems and desiccant cooling in small dwellings has been performed.

Prototype Building Model

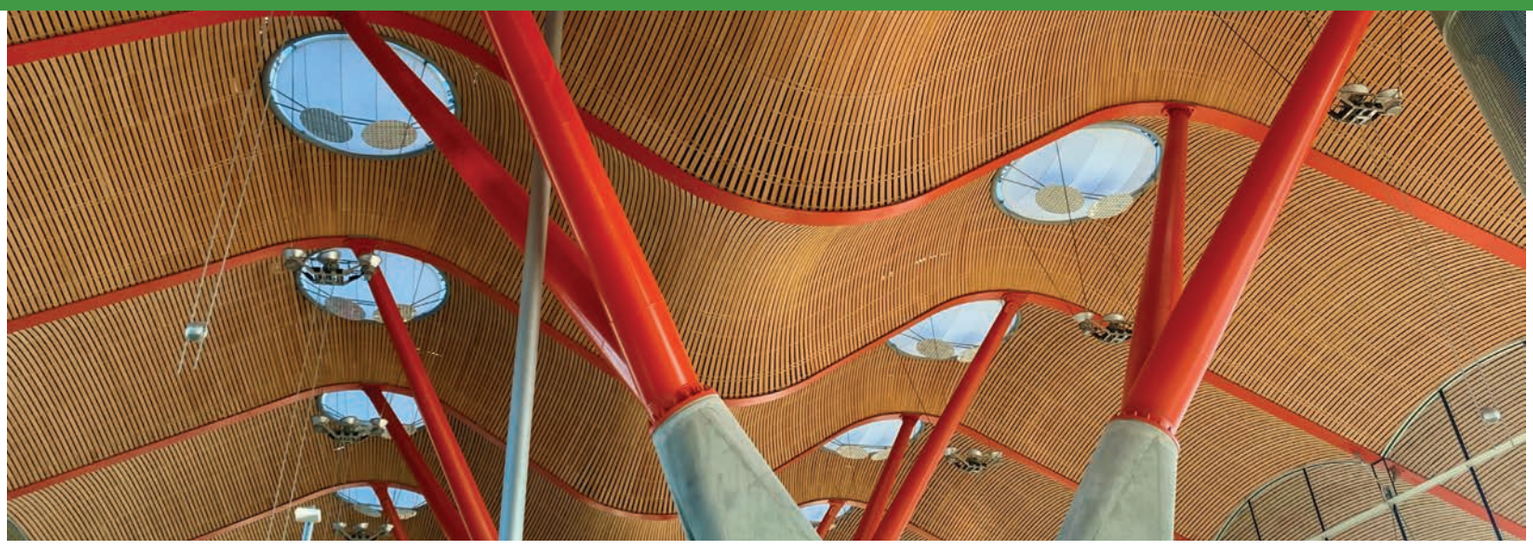
Wildfire House Prototype
Lead: Dr. John Bass, University of British Columbia

The research team has produced a set of technical design and construction documents that lead to the realization of a house prototype in Yunesit'in. This prototype will set a standard of house construction for remote Indigenous communities with chronic indoor air quality (IAQ) problems in their existing housing stock and effectively address the threat of fire, both of which are exacerbated by climate change related processes. Researchers who are continuously working with the Indigenous community are raising the bar of a growing body of knowledge about how that research should be carried out.

Through the Project Charter, the team performs and represents a high standard of ethical research. Researchers have set up clear lines of communication, to articulate roles and responsibilities, and to be flexible to the timelines of those in the partner community who work on the project.



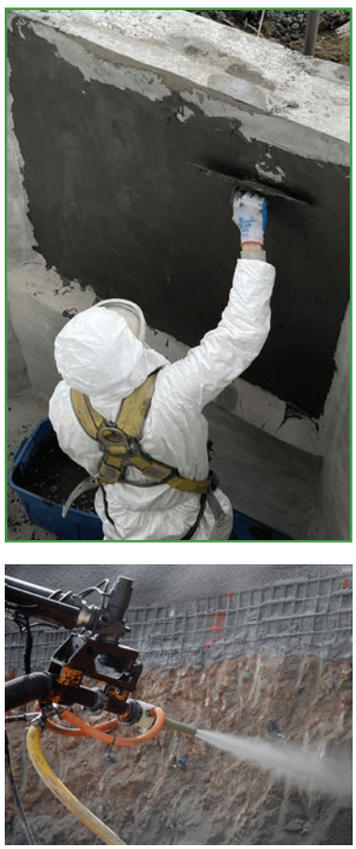
Wall and Roof Assemblies with Locally Sourced and Milled Lumber



Smart Infrastructure with High Fracture Toughness, Durable Concrete Employing Large Amounts of Industrial Wastes
Lead: Dr. Nemkumar Banthia, The University of British Columbia

Repairing aged and deteriorated sewer infrastructure is an ongoing challenge for municipalities and is often complicated by the fact that sewer pipes are located in crowded and developed areas that have changed significantly since the original design and installation. To tackle this issue, the research team at UBC is collaborating with Metro Vancouver to develop a carbon-neutral, geopolymer coating with biocides (called multi-phase composite coating, MCC) that when applied on sewer infrastructure, will resist bacterial attack, prevent further corrosion and extend the infrastructure's existing service life. This coating was recently applied at the Tilbury Junction Chamber near Annacis Island, in Delta, BC. During the initial trials, a better than expected performance of the MCC coating was observed.

An additional field study is currently in progress and the first stages of performance evaluation are being carried out. The rheological study is in full swing and researchers are progressing towards improving the sprayability and preparing for the final mix design. With various HQP (including undergraduate and graduate students) involved, the project is a good example of industry-academia partnership leading to significant long-term benefits for essential public infrastructure.



Testing the Workability and the Sprayabilty of the Material

Food Security and Agritech

Variable Rate Application of Nutrients by Developing Nutrient Estimation Sensor and Precision Spraying Mechanism
Canadian Lead: Dr. Ahmad Al-Mallahi, Dalhousie University
Indian Lead: Dr. Narasimha Murty, IIT-Tirupati

This project aims to enable accurate application of nutrients to reduce the negative impact of over application on the environment, by developing simultaneously sensing and actuation methods. This approach of precision agriculture also has a positive economic impact on the grower by reducing the farm input while maintaining the yield. For sensing, the team will be using near-infrared spectroscopy to find correlation between foliar spectral reflectance and 13 different macro and micro-nutrients in petioles.

While the preliminary results of ongoing projects on potatoes show empirical linear relationships between spectrum and most of the nutrients, it is unlikely to estimate nutrients in soil depending solely on spectral reflectance. Therefore, researchers plan to develop a probe based on spectral reflectance accompanied with X-ray fluorescence to find nutrient levels in soil. Developing a non-invasive nutrient sensing method will replace the slow and low-resolution chemical analysis of plant and soil. This will help increasing the number of spatial locations of measurement and the resolution of the nutrient status maps to improve the precision of spraying.

PARTNERSHIPS, SUSTAINABILITY, AND GROWRTH

Dialogue with First Nation Communities

IC-IMPACTS continues to work with First Nation communities on rapid housing construction as researchers look for target communities to build a demonstration house using 3D Concrete Printing (3DCP).

3DCP will provide design flexibility, faster construction speed, enhanced sustainability, greater product quality, reduction in cost, while significantly reducing waste. In addition, through consultation with the target community at the planning stage, the design of each unit can uniquely incorporate the needs of those who will reside in the house.

3D Concrete Printing Facility at UBC

Dialogue with Academic Institutions

All universities in Canada and India can avail funds from IC-IMPACTS on a competitive basis. However, IC-IMPACTS has several exclusive partnerships with prominent universities that steer IC-IMPACTS research program, lead research themes, adjudicate Calls for Proposals, and serve in prominent governance positions including IC-IMPACTS Board of Directors and Research Management Committee.

Dialogue with Governments

With a strong foundation and growing support from the Government of Canada and the Government of India, IC-IMPACTS is focusing on the Centre's sustainability and growth, to deliver technologies more effectively and ultimately help create a strong economy that is beneficial for all sectors.

IC-IMPACTS and West Moberly First Nation Signing of the MoU Ceremony

TOMORROW'S LEADERS

Educating Canadian and Indian Students

Highly Qualified Personnel (HQP) at IC-IMPACTS are involved in all aspects of our funded projects, from early stages of a project, proposal development, to engagement with stakeholders and commercialization. HQP are exposed to unique training and learning opportunities.

Working with both Canadian and Indian researchers, our HQP get to exchange ideas and are trained to broaden their field of knowledge and develop new international connections. Technology development, service delivery, and entrepreneurship are amongst the few things that HQP get to experience while working on IC-IMPACTS projects.

Since 2013, IC-IMPACTS has trained a total of 1,331 HQPs. This year, we welcomed one individual self-declaring as non-binary to the list of IC-IMPACTS HQP.

Start-ups and non-profit foundations launched:

1. Raah Health & Social Development Foundation, Delhi, India
2. INpact, Ontario, Canada
3. Buyuanxiar Inc., Ontario, Canada
4. Mithra Sustainable Solutions, British Columbia, Canada
5. Boost Environmental Systems Inc., British Columbia, Canada
6. HRG Infrastructure, British Columbia, Canada
7. ChipCare, Ontario, Canada
8. Tricca Technologies Inc., Alberta, Canada

HQP Presenting their Research Findings to a Panel from Industry

Knowledge, Mobility and Technology Exchange

IC-IMPACTS continues to facilitate knowledge exchange between Canadian and Indian networks, focusing on technology deployment and commercialization. Helping provide real-world experiences for graduate students and postdoctoral researchers, providing demonstration and field-testing opportunities on community-driven projects, and allowing Canadian and Indian graduate students to take their research skills to the other country.

HIGH COMMISSIONER AJAY BISARIA'S VISIT TO IC-IMPACTS

From providing clean water and self-healing roads in First Nation communities to engaging pharmacists in India, IC-IMPACTS HQP are gaining global perspectives of community challenges and needs, training to become tomorrow's global leaders.

To increase HQP mobility, IC-IMPACTS continues to work synergistically with other institutions. Our aim is to have young talents work and study abroad where they can bring back new experiences, skills, connections and knowledge, to give their careers a boost, and to ultimately enrich Canada and India's economic prosperity.

To encourage engagement and deepen relationships between Canadian and Indian research networks, in July 2021, IC-IMPACTS signed a three-year agreement with Mitacs to support research collaborations in sectors of mutual interest.

IC-IMPACTS AND MITACS SIGNING OF THE MOU CEREMONY

Launch of New Calls for Proposals

IC-IMPACTS, the Department of Biotechnology (DBT), and the Department of Science and Technology (DST) plan to have new joint Calls for Proposals launched in the areas of:

(i) Agritech and Food Security (IC-IMPACTS and DBT)
(ii) Carbon Reduction in Our Built Environment (IC-IMPACTS and DST)
(iii) Water (IC-IMPACTS and DST)
(iv) Health, Post COVID Health Issues and Long COVID (IC-IMPACTS and DBT)

HQP Presenting Work

Commitment to the Principles of Equity, Diversity and Inclusion

IC-IMPACTS remains committed to fostering and maintaining an inclusive environment, bringing together diverse community members. Our HQP network has surpassed the 30% female ratio this year which we see as a small but notable achievement. Our Board of Directors is currently at 42% female ratio and our Administration Office is currently at 66% female ratio.

IC-IMPACTS Participates in Canada's 50-30 Challenge

BOARD OF DIRECTORS

Barj S. Dhahan (Chair)
CEO, Sandhurst Group

Dr. Nemy Banthia (CEO & Scientific Director)
Professor, The University of British Columbia

Krista Connel
CEO, Fertiloam Inc.

Meeru Dhalwala
Author and Entrepreneur
Owner, Vij's

Dr. Matthew Evenden
Associate Vice President, Research & Innovation,
The University of British Columbia

Dr. Arvind Gupta
Professor, Computer Science,
The University of Toronto

Anita Huberman
CEO, Surrey Board of Trade

David Isaac
Acting Executive Director, Centre for
Native Policy & Research

Dr. V.I. Lakshmanan
Vice Chairman and CEO, Process Research Ortech Inc.

Dr. Sujatha Ramdorai
Professor, Mathematics,
The University of British Columbia

Alexandra Otis
PhD Candidate, Université de Montréal

Dr. Christopher Yip
Dean, Faculty of Applied Science &
Engineering, The University of Toronto

NCE LIAISON AND OBSERVER ON THE IC-IMPACTS BOARD OF DIRECTORS AND RMC

Dr. Chris Kelly
Deputy Director, Networks
of Centres of Excellence (NCE)

NOMINATIONS & GOVERNANCE COMMITTEE

Dr. Arvind Gupta (Chair)
Professor, The University of Toronto

Dr. Sujatha Ramdorai
Professor, The University of British Columbia

Dr. Christopher Yip
Dean, Faculty of Applied Science &
Engineering, The University of Toronto

EXECUTIVE COMMITTEE

Mr. Barj S. Dhahan (Chair)
CEO, Sandhurst Group

Dr. Nemy Banthia
Professor, The University of British Columbia

Dr. Arvind Gupta
Professor, The University of Toronto

SCIENTIFIC TEAM

Dr. Nemy Banthia
Scientific Director and Theme Lead, Safe and Sustainable
Infrastructure, The University of British Columbia

Dr. Stewart Aitchison
Theme Lead, Public Health: Disease Prevention
and Treatment, Professor, Electrical & Computer
Engineering, The University of Toronto

Dr. Damase Khasa
Theme Lead, Integrated Water Management, Professor,
Department of Wood and Forest Sciences, Université Laval

Dr. Pratap Pati
Theme Lead, Food Security and Agritech, Professor,
Department of Biotechnology, Guru Nanak Dev University

RESEARCH MANAGEMENT COMMITTEE (RMC)

Dr. Nemy Banthia (Chair)
Professor, The University of British Columbia

Dr. Stewart Aitchison
Professor, The University of Toronto

Dr. Rishi Gupta
Associate Professor, The University of Victoria

Dr. Kevin Kane
Professor, The University of Alberta

Dr. Damase Khasa
Professor, Université Laval

Dr. Madjid Mohseni
Professor, The University of British Columbia

Dr. Daman Panesar
Professor, The University of Toronto

Dr. Stephanie Yanow
Professor, The University of Alberta

STUDENT ENGAGEMENT COMMITTEE

Alexandra Otis (Chair)
PhD Candidate, Université de Montréal

Anurag Krishna (co-Chair)
PhD Student, The University of British Columbia

Afreen Anwar
Country Representative – India
Women Scientist B, Indian Institute of Technology, Roorkee

Archita Borah
Outreach and Social Media Coordinator
Masters of Applied Science Student, The University of British Columbia

Shashank Chandra
Event Coordinator – India
PhD Student, Indian Institute of Technology, Roorkee

Jaskaran Dhiman
Outreach and Alumni Coordinator
Postdoctoral fellow, McGill University

Fuhar Dixit
Co-Chair & Graduate Seminar Coordinator
PhD Candidate, The University of British Columbia

Abhishek Dutta
Graduate Seminar Coordinator
PhD Student, The University of British Columbia

Karl Zimmermann
Webinar Coordinator
PhD Student, The University of British Columbia

FUNDED RESEARCH PROJECTS

PUBLIC HEALTH

A High-Quality Serotype Discriminating Dengue Virus Diagnostic Test Adapted for Field Investigation
Canadian Lead: Dr. Sachdev Sidhu, The University of Toronto
Indian Lead: Dr. Amitabha Chaudhuri, SciGenom Labs

A Point-of-Care Device for Malaria Diagnosis And Drug Resistance Genotyping
Canadian Lead: Dr. Stephanie Yanow, The University of Alberta
Indian Lead: Dr. Aparup Das, National Institute of Malaria Research

A Portable Fever Kit for Dengue and Chikungunya
Canadian Lead: Dr. Stewart Aitchision, The University of Toronto
Indian Lead: Dr. Manoj Varma, Indian Institute of Science

Agent-Based Simulation of COVID-19: Estimating the Spread and Disease Burden using Advanced Epidemiological Modelling
Canadian Lead: Dr. Raja Sengupta, McGill University
Indian Lead: Dr. Deepak Saxena, Indian Institute of Public Health, Gandhinaga

Citizen-lead Evaluation of the Public Health Response to COVID-19 in India: Harnessing Information and Communications Technology (ICT) to Promote Real-Time learning, Human Rights and Good Governance
Canadian Lead: Dr. Mira Johri, Université de Montréal
Indian Lead: Dr. Aaditeshwar Seth, Indian Institute of Technology, Delhi

COPE: Community Health Outcomes and Personalized Education/Exercises for Spinal Injured Individuals
Canadian Lead: Dr. Andrei Krassioukov, The University of British Columbia
Indian Lead: Dr. Nishu Tyagi, Indian Spinal Injuries Centre

Design2Impact: Uniting Researchers, Makers and Spinal Injury Survivors Through Open-Source Technology
Canadian Leads: Dr. Aaron Yurkewich, The University of Toronto, and Stewart Russell, Makers Making Change at Neil Squire Society

Development of a Hand-Held Molecular Point-Of-Care Test Device for Infectious Diseases
Canadian Lead: Dr. James Mahony, McMaster University
Indian Lead: Dr. Daman Saluja, The University of Delhi

Development of a Portable Device for Early Detection of Eye Infection and Dry Eye Disease
Canadian Lead: Dr. James Feng, The University of British Columbia
Indian Lead: Dr. Ashutosh Richhariya, L.V. Prasad Eye Institute

Development of Portable Spine MEG Scanner for Real-Time Spinal Functional Evaluation and Data Acquisition
Canadian Lead: Dr. Teresa Cheung, Simon Fraser University,
Indian Lead: Dr. Rohit Sharma, Indian Institute of Technology, Ropar

Development of Wearable Artificial Muscle for a Tetraplegic Hand
Indian Leads: Dr. Harvinder Chhabra, Indian Spinal Injuries Centre, India and Dr. Sitikantha Roy, Indian Institute of Technology, Delhi

Dialled In: Tapping Community Voice to Improve Child Immunization Services in India
Canadian Lead: Dr. Mira Johri, Université de Montréal
Indian Lead: Dr. Alok Kumar Mathur, Indian Institute of Health Management Research (IIHMR) University

Engaging Community Pharmacists in India to Enhance Early Detection of Tuberculosis
Canadian Lead: Dr. Madhukar Pai, McGill University
Indian Lead: Dr. Nita Jha, World Health Partners

Identification of High Affinity Ligands Against Dengue Virus NS1 for the Development of an Affordable Point-of-Care Diagnostic Kit
Canadian Lead: Dr. Tom Hobman, The University of Alberta
Indian Lead: Dr. Easwaran Sreekumar, Rajiv Gandhi Centre for Biotechnology

Next Generation Molecular Diagnostics for Emerging Viral Diseases
Canadian Lead: Dr. Francois Jean, The University of British Columbia
Indian Lead: Dr. Santanu Chattopadhyay, Nationwide the Family Doctors

Smart App-Based Rapid Multiplex Screening of HIV Associated Co-Infections of at Risk Populations at the Point-of-Care: A Demonstration Study in India
Canadian Lead: Dr. Nitika Pant Pai, McGill University
Indian Lead: Dr. Suma Nair, Manipal Academy of Higher Education

Surface Modulation of CuS Quantum Dots using Biginelli Compounds for Construction of a Portable Fluorescence Sensor for Bacteria
Canadian Lead: Dr. Jan J. Dubowski, Université de Sherbrooke
Indian Lead: Dr. Narinder Singh, Indian Institute of Technology, Ropar

Wearable Technology to Monitor Sitting Posture and Reduce the Pressure Injury Risk
Canadian Lead: Dr. Hossein Rouhani, The University of Alberta

FOOD SECURITY AND AGRITECH

Exploration of an Intra- and Inter-National Blockchain-Powered and Physical Internet-Enabled Food Supply Chain Traceability System in Canada and India
Canadian Lead: Dr. Eric Li, University of British Columbia (Okanagan)
Indian Lead: Dr. Mansi Babbar, University of Delhi

Irrigation Scheduling Using Model-Based Reinforcement Learning for Stochastic Differential Equation Control
Canadian Lead: Dr. Chi-Guhn Lee, University of Toronto
Indian Lead: Dr. Subimal Ghosh, Indian Institute of Technology, Bombay

Variable Rate Application of Nutrients by Developing Nutrient Estimation Sensor and Precision Spraying Mechanism
Canadian Lead: Dr. Ahmad Al-Mallahi, Dalhousie University
Indian Lead: Dr. Narasimha Murthy, Indian Institute of Technology, Tirupati

Extraction of Protein from Brewer's Spent Grain for Human and Animal Consumption
Canadian Lead: Dr. Chijioke Emenike, Dalhousie University and
Indian Lead: Dr. Kiran Babu Uppuluri, SASTRA Deemed University

Food Security and the Problem of Fit: Examining Local Innovations to Milk Wastage in India
Canadian Lead: Dr. Jeremy Pittman of University, Waterloo
Indian Lead: Dr. Sanchayan Nath, Indian Institute of Technology, Tirupati

FUNDED RESEARCH PROJECTS

INTEGRATED WATER MANAGEMENT

A Floating Treatment Wetland System for Removing Contaminants from Rivers and Streams using a Biomimicry Approach
Canadian Lead: Dr. Shiv Prasher, McGill University
Indian Lead: Dr. Ramesh Kanwar, Lovely Professional University

A High-Performance Advanced Septic (HPAS) System for Villages and Roadside Restaurants
Canadian Lead: Dr. Edward McBean, The University of Guelph
Indian Lead: Dr. Y. R. Satyaji Rao, National Institute of Hydrology

A Nanotechnology Enabled Device for the Detection of Harmful Bacteria in Drinking Water
Canadian Lead: Dr. Michael Serpe, The University of Alberta
Indian Lead: Dr. Soumyo Mukherji, Indian Institute of Technology, Bombay

A Study of Technology and Financial Appropriateness of Water and Wastewater Infrastructure in Selected Cities of India
Canadian Lead: Dr. Govind Gopakumar, Concordia University
Indian Lead: Dr. N.C. Narayanan, Indian Institute of Technology, Bombay

An Innovative Green Technology for Treating Municipal and Industrial Wastewater Entering Rivers and Streams
Canadian Lead: Dr. Shiv Prasher, McGill University
Indian Lead: Dr. Rameshwar Kanwar, Lovely Professional University

An Innovative Sustainable Biotechnology for Resource Recovery from Wastewater Streams using Microwave Enhanced Advanced Oxidation with Algae
Canadian Lead: Dr. Victor Lo, The University of British Columbia
Indian Lead: Dr. Pradeep Kumar, Indian Institute of Technology, Roorkee

Application of Emerging Biotechnology for Non-point Source Pollution Control of River Ganga, India
Canadian Lead: Dr. Onita Basu, Carleton University
Indian Lead: Dr. Anirban Gupta, IIEST Shibpur

Biovalorization of Lignin
Canadian Lead: Dr. Vikramaditya G. Yadav, The University of British Columbia
Indian Lead: Dr. Syed S. Yazdani, International Centre for Genetic Engineering and Biotechnology

Biomonitoring of Water Quality in Relation to Human Health Using Biosensors and Improvements through Nanoparticle-Based Purification Systems
Canadian Lead: Dr. Damase P. Khasa, Université Laval
Indian Lead: Dr. Manzoor Shah, The University of Kashmir

Compact High-Rate Water Treatment Systems for Small Communities
Canadian Lead: Dr. Ramin Farnood, The University of Toronto
Indian Lead: Dr. Vivek Kumar, Indian Institute of Technology, Roorkee

Contaminated Land Reclamation Using Hybrid Absorbable Landscape and Native Plant Species
Canadian Lead: Dr. Rishi Gupta, The University of Victoria
Indian Lead: Dr. Neeta Raj Sharma, Lovely Professional University

Development of A Low-Cost Water Monitoring Kit for Multiplex Heavy Metal Detection Based on Aptamer Sensors
Canadian Lead: Dr. David Juncker, McGill University
Indian Lead: Dr. Rohit Srivastava, Indian Institute of Technology, Bombay

Development of an ICT Platform for Water Quality Monitoring
Canadian Lead: Dr. Clarence de Silva, The University of British Columbia
Indian Lead: Dr. Sandhya Shrivastava, Bhavan's Research Centre, Mumbai University

Development and Scale-Up of Technology for Microbial Extraction of Xylose from Agro-Waste Materials and Subsequent Conversion into Xylitol
Canadian Lead: Dr. Tatjana Stevanovic, Université Laval
Indian Lead: Dr. Baljinder Kuar, Punjabi University

Development of Capacitive Deionization Technology for Point-of-Use Water Purification
Canadian Lead: Dr. Madjid Mohseni, The University of British Columbia
Indian Lead: Dr. Sathish Kumar, Eureka Forbes Ltd.

Direct Cryptosporidium Detection for Developed and Developing Nations
Canadian Lead: Dr. Mina Hoorfar, The University of British Columbia
Indian Lead: Dr. Krishna Khairnar, CSIR – National Environmental Engineering Research Institute

Handheld P-Laps Pathogen Detector
Canadian Lead: Dr. Thomas Thundat, The University of Alberta
Indian Lead: Dr. Bhaskaran Muralidharan, Indian Institute of Technology, Bombay

High Quality Potable Water for Small/Remote Communities in Canada And India
Canadian Lead: Dr. Pierre Bérubé, The University of British Columbia
Indian Lead: Dr. Anand Krishnamurthy, GE India

Microfabricated, Low-Cost, High-Sensitivity Chlorine and PH Sensor Systems for Water Quality Monitoring
Canadian Lead: Dr. Jamal Deen, McMaster University

Passive UF Membrane Demonstration
Canadian Lead: Dr. Pierre Bérubé, The University of British Columbia

Quantum Dot Solar Panels for Water Treatment In Remote Settings
Canadian Lead: Dr. Edward Sargent, The University of Toronto

Sensors 4 People / 3 Drops
Canadian Lead: Dr. Michael Serpe, The University of Alberta

Sewage Contaminated Lake Water Quality Restoration through Aeration and Floating Wetland Plants
Canadian Lead: Dr. Rajesh Seth, The University of Windsor
Indian Lead: Dr. Rakesh Kumar, CSIR-NEERI

Testing and Upscaling Phytoremediation Technology in Real-World Conditions
Canadian Lead: Dr. Damase Khasa, Université Laval
Indian Lead: Dr. Manzoor Shah, The University of Kashmir

Thondebhavi Water Quality Assessment
Canadian Lead: Dr. Pierre Bérubé, The University of British Columbia

Thorsby Water Quality Assessment
Canadian Lead: Dr. Michael J. Serpe, The University of Alberta

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SAFE AND SUSTAINABLE INFRASTRUCTURE

Application of Precast Products Made Using Bottom Ash and Fly Ash for Rural Pavements and other Infrastructure in India
Canadian Lead: Dr. Rishi Gupta, The University of Victoria
Indian Lead: Dr. Urmil Dave, Institute of Technology, Nirma University

Assessment of Fire Performance of Structural Elements and Structural Systems through Conventional Fire Tests and Hybrid Fire Simulation
Canadian Lead: Dr. Oh-Sung Kwon, The University of Toronto
Indian Lead: Dr. Dipti Ranjan Sahoo, Indian Institute of Technology, Delhi

Carbon Neutrality through Combined CO_2 Capture And Novel H_2 Technology With Production Of Non-Conventional Fuels For Smart Cities
Canadian Lead: Dr. Ibrahim Dincer, Ontario Tech University
Indian Lead: Dr. Subrata Borgohain Gogoi, Dibrugarh University Assam

Characterization and Use Of Industrial Fly Ash
Canadian Lead: Dr. Daman Panesar, The University of Toronto
Indian Lead: Dr. Bhupinder Singh, Indian Institute of Technology, Roorkee

Conservation of Heritage Masonry Structures within Cauvery Basin Waterworks
Canadian Lead: Dr. Vivek Bindiganavile, The University of Alberta
Indian Lead: Dr. Narayana Suresh, National Institute of Engineering

Development of Cost-Effective, Energy-Efficient, and Resilient Housing Technologies for First Nations Communities
Canadian Lead: Dr. Ashutosh Bagchi, Concordia University

Energy and Water Disaggregation for Non-Intrusive Load Monitoring in Buildings
Canadian Lead: Dr. Ivan Bajic, Simon Fraser University
Indian Lead: Dr. Angshul Majumdar, Indraprastha Institute of Information Technology - Delhi

Evaluating the Integrity of Railways Infrastructure in India and Canada with an Emphasis on Bridges and Tracks
Canadian Lead: Dr. Mustafa Gul, The University of Alberta
Indian Lead: Dr. Pradipta Banerji, Indian Institute of Technology, Roorkee

Fire Performance of Aged Reinforced Concrete Structures
Canadian Lead: Dr. Mark F. Green, Queen's University
Indian Lead: Dr. Umesh Kumar Sharma, Indian Institute of Technology, Roorkee

Full Field Non-Contact SHM Protocols for Long Span Railway Bridges and Heritage Structures
Canadian Lead: Dr. Rishi Gupta, The University of Victoria
Indian Lead: Dr. Balasubramanian Esakki, Vel Tech University

Harnessing the Potential of Renewable Energy (Solar / Wind) for Sustainable Building Energy Management through Compressed Air Energy Storage
Canadian Lead: Dr. Fariborz Haghighat, Concordia University
Indian Lead: Dr. V Gayathri, Vellore Institute of Technology

High-Performance Connections for a Tall Indigenous Timber Sculpture
Canadian Lead: Dr. Tony Yang, The University of British Columbia

High Fracture Toughness, Durable Concrete with Minimized Carbon Footprint Employing Large Amounts of Industrial Waste
Canadian Lead: Dr. Nemkumar Banthia, The University of British Columbia

Improving Building Energy Demand Predictions in Smart Cities through Sensor Observations and Considerations of Landscape Characteristics
Canadian Lead: Dr.Fitsum Tariku, British Columbia Institute of Technology
Indian Lead: Dr. Prasad Avinash Pathak, FLAME University

Improving Fire Safety of Structures Through the Development of Fire Retardant Laminated Glass Glazing
Canadian Lead: Dr. Maged Youssef, Western University
Indian Lead: Dr. Ajitanshu Vedrtnam, Invertis University

India-Canada Initiative for Resilient Global Urban Shelter
Canadian Lead: Dr. Constantin Christopoulos, The University of Toronto
Indian Lead: Dr. Ravi Sinha, Indian Institute of Technology, Bombay

Innovative Field Demonstration of Sustainable Infrastructure
Canadian Lead: Dr. Shamim Sheikh, The University of Toronto
Indian Lead: Dr. Umesh Kumar Sharma, Indian Institute of Technology, Roorkee

Large Area Microbolometer Uncooled Focal Plane Arrays for Thermal Imaging
Canadian Lead: Dr. Ghassan Jabbour, The University of Ottawa
Indian Lead: Dr. Madhusudan Singh, Indian Institute of Technology, Delhi

Metamaterial Walls for Improved Acoustic Performance in Green Building
Canadian Lead: Dr. Umberto Berardi, Ryerson University
Indian Lead: Dr. Arpan Gupta, Indian Institute of Technology, Mandi

Metawall: Metamaterial Based Lightweight Panel Wall For Enhanced Building Acoustic And Seismic Resistance
Canadian Lead: Dr. Sreekanta Das, The University of Windsor
Indian lead: Dr. Arnab Banerjee, Indian Institute of Technology, Delhi

Mobile App for Improving Survival in Fires Through Efficient Egress: The Role of Impromptu Indoor WiFi Localization and Georeferenced Building Maps
Canadian Lead: Dr. Raja Sengupta, McGill University
Indian Lead: Dr. Ashwin Srinivasan, BITS Pilani KK Birla Goa Campus

Modelling and Assessment of Deficient and Repaired Structures
Canadian Lead: Dr. Frank Vecchio, The University of Toronto
Indian Lead: Dr. Umesh Kumar Sharma, Indian Institute of Technology, Roorkee

Scour Monitoring of an Overwater Bridge in Manitoba Using Dissolved Oxygen (DO) Probes
Canadian Lead: Dr. Faezeh Azhari, The University of Toronto

Smart Sensor Deployment in Buildings: Evacuation Planning and Energy Management
Canadian Lead: Dr. Mark S. Fox, The University of Toronto
Indian Lead: Dr. Krithi Ramamritham, Indian Institute of Technology, Bombay

Solar Energy Powered Net-Zero Energy Smart Buildings
Canadian Lead: Dr. Bruno Lee, Concordia University
Indian Lead: Dr. K. Srinivas Reddy, Indian Institute of Technology, Madras

Structural Health Monitoring of Tall Buildings Using Vibration-Based Techniques
Canadian Lead: Dr. Lucia Tirca, Concordia University
Indian Lead: Dr. S.K. Panigrahi, CSIR-CBRI, Roorkee

Sustainable Infrastructure Using Smart FRPs
Canadian Lead: Dr. Shamim Sheikh, The University of Toronto
Indian Leads: Dr. Umesh Sharma, & Dr. Pradeep Bhargava, Indian Institute of Technology, Roorkee

Urban Heat Island Effect and Building Energy Demand: Linkages Explained Using a Dense, Low Cost Sensor Network
Canadian Lead: Dr. Raja Sengupta, McGill University
Indian Lead: Dr. Prasad A. Pathak, Shiv Nadar University

Wildfire House
Canadian Lead: John Bass, The University of British Columbia

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- Ministries of Transportation (Ontario), Ottawa
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- Canadian Society for Civil Engineering
- Chawathil First Nations Community
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- City of Kelowna
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- District of Lake Country
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Projects in Food Security

IC-IMPACTS has ongoing projects in Food Security, to ensure availability, accessibility, and affordability of sufficient and nutritious food for all people, at all times.

Variable Rate Application of Nutrients by Developing Nutrient Estimation Sensor and Precision Spraying Mechanism

Dr. Ahmad Al-Mallahi of Dalhousie University and Dr. Narasimha Murthy of IIT-Tirupati.

Using artificial intelligence techniques, the team is developing models to estimate the concentrations of elements in the plant and soil without the need for chemical testing in the lab.

Performing field demonstrations of nutrients sensing and precision spraying at **McCain Produce Inc** in Monquart, New Brunswick.

Extraction of Protein from Brewer's Spent Grain for Human and Animal Consumption

Dr. Chijioke Emenike of Dalhousie University and Dr. Kiran Babu Uppuluri of SASTRA Deemed University.

This study is exploring the isolation of a potentially protein-rich fraction of Brewers' Spent Grain (BSG) for human food and nutraceutical use. BSG is the major by-product of the brewing industry worldwide, which is around 85% of the total by-products generated.

Exploration of an Intra- and Inter-National Blockchain-Powered and Physical Internet-Enabled Food Supply Chain Traceability System in Canada and India

Dr. Eric Li of UBC-O and Dr. Mansi Babbar of University of Delhi.

The research team is partnering with **MCG Canada Inc**. to explore the development of a blockchain-enabled traceability platform and physical internet-enabled smart supply-chain system to address food distribution and waste concerns at both national and international levels. The goal is to propose a multi-level framework to guide the development of a traceable and transparent food management system.

"IC-IMPACTS plays a crucial role in facilitating fundamental research in agritech, providing a deep understanding of the challenges we face and developing innovative solutions to overcome them, ultimately creating a more sustainable and secure food system for generations to come."

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"It is never a waste if we can still extract from it!"

Dr. Chijioke Emenike,
Dalhousie Univeristy

Food Security and the Problem of Fit: Examining Local Innovations to Milk Wastage in India

Dr. Jeremy Pittman of University of Waterloo and Dr. Sanchayan Nath of IIT-Tirupati.

India is one of the leading global producers of milk. However, there are growing concerns about milk wastage where a lack of refrigeration and other constraints contribute to considerable losses before milk reaches consumers. With milk being a major source of protein, this represents a significant threat to food security. This project will uncover factors influencing innovation among milk cooperatives and identify a toolbox of strategies for addressing milk wastage.

Irrigation Scheduling Using Model-Based Reinforcement Learning for Stochastic Differential Equation Control

Dr. Chi-Guhn Lee of University of Toronto and
Dr. Subimal Ghosh of IIT- Bombay.

Researchers aim to develop a dynamic control framework using reinforcement learning agents to make optimal irrigation decisions at any soil moisture level. In this framework, rainfall uncertainty is incorporated into the environment in which the reinforcement learning agent operates through transition dynamics. The end result is an elegant solution, sustaining productivity and optimizing irrigation water usage while minimizing losses.

Next Steps...

Providing access to food that is safe, nutritious, and culturally appropriate, meeting the dietary needs and preferences for an active and healthy life.

- **Availability**
- **Accesibility**
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